Appendix 5
Risk analysis of Ranger 3 Deeps project

ABN 26 895 061 298

Report on Risk Analysis of

Ranger 3 Deeps Project

(for Draft Environmental Impact Statement)

Version No.	Details	Approved by	Date
A	Full report issued	WJD	10.06.2014

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TABLE OF CONTENTS

Page

1 INTRODUCTION 1
2 SCOPE AND OBJECTIVES 1
2.1 Overall Scope 1
2.2 Detailed Objectives 1
3 GLOSSARY 2
3.1 Definitions 2
3.2 Abbreviations 3
4 RISK MANAGEMENT 4
4.1 Risk Management – An Overview 4
4.2 Risk Management Process 4
5 ESTABLISH THE CONTEXT 6
5.1 The Purpose of This Step 6
5.2 Project Scope 6
5.3 EIS Risk Assessment Scope 6
5.4 Assumptions 7
5.5 Exclusions 7
5.6 Stakeholders 8
5.7 Key Success Factors 8
5.8 Participants 9
5.9 Study Methodology 10
5.10 Bow Tie Analysis 12
6 RISK IDENTIFICATION 14
6.1 Overview 14
7 RISK ANALYSIS AND RISK EVALUATION 14
7.1 The Purpose of This Step 14
7.2 Risk Classification Scheme 14
7.3 Risk Register 14
7.4 Role of Risk Register 15
8 RISK TREATMENT 15

8.1 The Purpose of This Step 15
8.2 Generic Risk Treatment Strategies 15
9 SUMMARY OF RISK INFORMATION 16
9.1 Overview 16
9.2 Current Risk Profile 16
9.3 Residual Risk Profile 17
9.4 Summary of Current Risks by RBS Category 17
9.5 Summary of Residual Risks by RBS Category 18
9.6 Summary of Current Class IV and Class III Risks 19
9.7 High Consequence – Low Likelihood Risks 25
9.8 Risk Treatments in Relation to Class IV and Class III Risks 26
9.9 Comment on Risk Certainty 31
10 DISCUSSION OF RISKS IN RELATION TO EIS ELEMENTS 32
10.1 Overview 32
10.2 Summary of Current Risks by Area of Impact 33
10.3 Summary of Residual Risks by Area of Impact 33
10.4 Summary of Current Risks by Life of Mine Phase 34
10.5 Summary of Residual Risks by Life of Mine Phase 35
11 BOW TIE ANALYSIS 36
11.1 Risks Addressed by Bow Tie Analysis 36
11.2 Cultural Heritage Impacts 37
11.3 Solute Transport 38
11.4 Radiation Effects 40
12 CONSULTATION AND COMMUNICATION 42
13 MONITORING AND REVIEW 42
14 REFERENCES 43
APPENDIX ONE: RISK SCHEME 44
APPENDIX TWO: RISK REGISTER 47
APPENDIX THREE: BOW TIE ANALYSIS 65

1 INTRODUCTION

Energy Resources of Australia Ltd (ERA) is seeking to develop the Ranger 3 Deeps Project in the Northern Territory. In order to obtain regulatory approval for the project it is necessary to undertake and submit a draft Environmental Impact Statement (EIS). Part of the requirements of an EIS is to undertake and report a Risk Assessment.

Risk Management Intercontinental Pty Ltd was commissioned to undertake and report a Risk Assessment of the Ranger 3 Deeps Project from the perspective of the Environmental Impact Statement Guideline. The Risk Assessment was undertaken in Darwin on December 9 to 13, 2013 and is reported here-in. Bow Tie analysis was undertaken in Darwin on March 27 and 28, 2014.

2 SCOPE AND OBJECTIVES

2.1 Overall Scope

The overall scope of the Risk Assessment is to ensure that the Project's environment and safety risks are being recognised, and that treatment measures are being developed to adequately reduce risks to acceptable levels when the Project is executed. The overall objective of the EIS Risk Assessment is to ensure that significant risks are identified and evaluated such that appropriate risk treatments can be implemented to mitigate risks. Risk Assessment provides a mechanism to demonstrate to stakeholders that the Project is acceptable for approval. The outputs from this Risk Assessment will assist to define the key risk management activities to be undertaken within the project life cycle.

2.2 Detailed Objectives

The objectives of the risk assessment reported herein are as follows:

- To frame the context, stakeholders and key success factors for Ranger 3 Deeps project
- To systematically examine the Ranger 3 Deeps Project to identify environment and safety risks.
- To identify the possible causes of those risks.
- To identify existing controls in place to manage those risks.
- To identify the consequences of those risks.
- To assess the likelihood of each consequence occurring, taking into account the existing management measures.
- To identify additional risk treatments that could be applied for each risk, its causes or consequence.

- To undertake the risk assessment utilising expert input from Ranger 3 Deeps Project representatives, selected stakeholders and other experts.
- To capture the results in a Risk Register that can be utilised for the on-going management of risks associated with the Project.

3 GLOSSARY

3.1 Definitions

Audit: the process used to confirm implementation of, and compliance with, the controls specified to manage risk. Audit is critical when high risks are controlled by procedures.

Communication: continual and iterative processes that an organisation conducts to provide, share or obtain information and to engage in dialogue with stakeholders regarding the management of risk.

Consequence: the outcome of an event affecting objectives. Consequences may be expressed qualitatively or quantitatively, and may be a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.

Contingency Plan: a detailed, documented plan that seeks to minimise the impact of the occurrence of a specific event.

Critical Risk Controls: those controls associated with risks considered to require Bow Tie analysis.

Cumulative Impact: an impact that occurs and may aggregate over a period of time (in contrast with an impact which occurs once over a short or defined period of time).

Current Risk: level of risk based upon application of existing controls.

Existing risk controls: those controls that are part of existing ERA operational practices (and will automatically be transferred to Ranger 3 Deeps operations), or those controls that have already been confirmed as being part of the Ranger 3 Deeps Project scope.

Impact: the outcome of the occurrence of a risk (for the document herein impact and consequences are used interchangeably).

Likelihood: chance of something happening (it may be expressed as a probability or frequency).

Monitoring: continual checking, supervising, critically observing, or determining the status in order to identify change from the performance level required or expected.

Residual Risk: risk remaining after risk treatment.

Risk: the effect of uncertainty on objectives. It is measured in terms of consequence and likelihood.

Risk Analysis: process to comprehend the nature of risks and the level of risk.

Risk Control: measure that is modifying risk.

Risk Evaluation: the process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable.

Risk Identification: the process of finding, recognising and describing risks.

Risk Management: coordinated activities to direct and control an organisation with regard to risk.

Risk Treatment: process to modify risk.

3.2 Abbreviations

The following abbreviations were used throughout the report:

CR	Current risk level
EIS	Environmental Impact Statement
ERA	Energy resources Australia
GIS	Geographic Information System
HME	Heavy Mining Equipment
HSE	Health, Safety and Environment
LLAA	Long Lived Alpha Activity
LOM	Life of Mine
NEPM	National Environment Protection Measure
NT	Northern Territory
OEL	Occupational Exposure Level
PPE	Personal Protective Equipment
RBS	Risk Breakdown Structure
RDP	Radon Decay Products
RMI	Risk Management Intercontinental Pty Ltd
RPA	Regional Partnership Agreement
RR	Residual risk level
TARP	Trigger Action Response Plan

4 RISK MANAGEMENT

4.1 Risk Management – An Overview

Risk management is an integral part of good management practice. It is an iterative process consisting of steps, which, when taken in sequence, enable continual improvement in decision-making.

Risk management is not a matter of becoming risk averse and unnecessarily avoiding risks. Risk management enables an organisation to understand its risks, and decide how to manage those risks.

Good risk management processes reduce the element of "surprise" in an organisation's activities, and ensures that appropriate resources are allocated to management of risks.

4.2 Risk Management Process

The risk management process is presented in the flowchart (taken from ISO31000-2009) on the next page that shows the key steps in the risk management process. These steps are:-

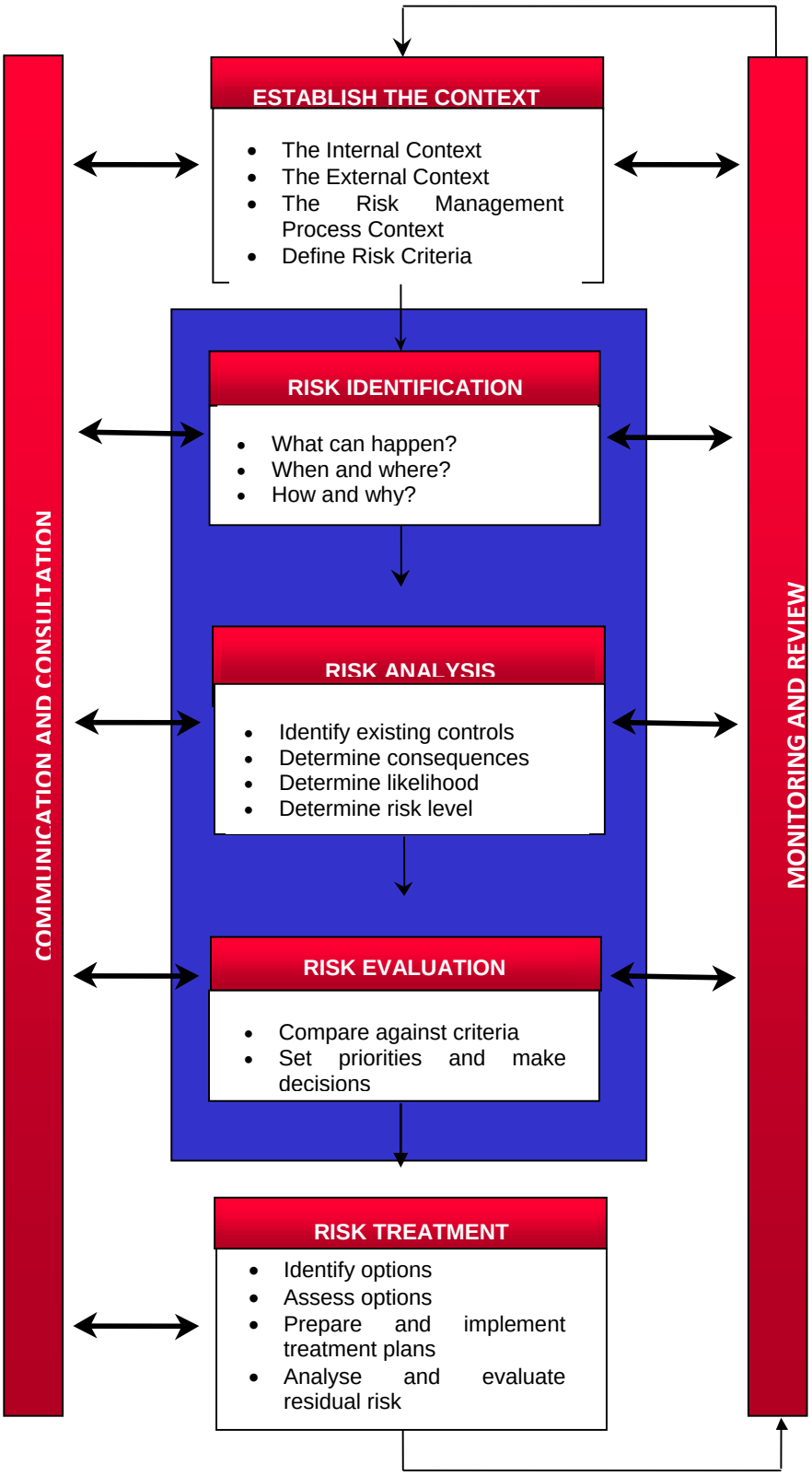
- Establishment of context
- Risk identification
- Risk analysis
- Risk evaluation
- Risk treatment
- Ongoing monitoring and review
- Communication and consultation.

Each step, as applied to the Ranger 3 Deeps EIS Risk Assessment is discussed on the following pages.

It is noted that although terms are often used interchangeably, there is a significant difference between the process of risk assessment and that of risk management.

Risk assessment is fundamentally a "desktop" exercise, which assists an organisation to understand its risks and develop strategies for managing those risks. The full process of risk management additionally involves subsequent implementation of additional risk treatments, and ongoing monitoring and review of risk controls to enable an organisation to confirm that risk treatment strategies have been implemented and remain effective.

Risk Management Process (ISO 31000-2009)



5 ESTABLISH THE CONTEXT

5.1 The Purpose of This Step

It is not possible to identify and assess risks without first establishing a context. In an EIS Risk Assessment such as is reported herein the context is established by the Project objectives and the EIS Guideline.

5.2 Project Scope

The Ranger 3 Deeps Project Scope is described elsewhere in the EIS documentation and is not replicated herein.

5.3 EIS Risk Assessment Scope

The joint Commonwealth and Northern Territory (NT) "Guidelines for the Preparation of an Environmental Impact Statement" issued by the NT Environmental Protection Authority indicate that the EIS should be undertaken with specific emphasis on the identification, analysis and mitigation of risks through a "Whole of Project" Risk Assessment. Through this risk assessment the EIS will:

- Identify and discuss the full range of risks presented by the proposal, including those of special concern to the public.
- Identify relevant impacts.
- Quantify and rank risks so that the reasons for proposed management responses are clear.
- Identify levels of any uncertainty about estimates of risk and the effectiveness of risk controls and mitigating risk.

The requirements also indicate that statements about levels of uncertainty should accompany all aspects of the Risk Assessment. Steps should be taken to reduce uncertainty or precautions taken to compensate for uncertainty should be identified and their affects demonstrated.

The EIS Guidelines specifically addressed the following requirements in relation to key risks.

- The Risk Assessment should consider all aspects associated with the construction, operation, maintenance and decommissioning of the proposal which may potentially result in impacts to human health and safety.

- The Risk Assessment should consider all potential impacts to water resources associated with the construction, operation and closure of the Ranger 3 Deeps underground mine that may cause adverse changes to the quantity and quality of surface and/or ground water or potentially impact regional hydrology and dependent ecosystems.

- The Risk Assessment should consider all environmental aspects associated with the construction, operation and closure of Ranger 3 Deeps underground mine that may result in adverse impacts to listed flora and fauna in the region of the proposal (including listed threatened species and communities and listed migratory species that are protected under Part Three of the Environment

Protection and Biodiversity Conservation Act and the NT Territory Parks and Wildlife Conservation Act).

- The Risk Assessment should consider all potential environmental impacts associated with the closure and rehabilitation of the proposed activity in the context of the closure and rehabilitation of the Ranger Project area.

- The Risk Assessment should consider the risks associated with the construction, operation and closure of the Ranger 3 Deeps underground mine that may result in the potential disturbance or damage to areas of historic and/or cultural heritage.

5.4 Assumptions

The following general assumptions were made:

- Technical advice generated from both internal and external sources (e.g. contractors, consultants, associates, and research partners) was assumed to be appropriate and was not subject to detailed validation during the risk assessment.

- It was assumed that ERA remains in good standing with all applicable Government and approval bodies.

- All existing ERA controls will continue to be applied where applicable.

- All standard Rio Tinto risk controls for an underground mining operation will be applied.

5.5 Exclusions

The following topics were excluded from the risk assessment reported herein:

- There was no consideration of traffic related risks (separate study)

- There was no consideration of socio-economic related risks or any associated benefits (separate study)

- There was no consideration of economic or reputational impacts to ERA

5.6 Stakeholders

The following list provides a summary of the stakeholders with respect to the Project. The stakeholders are:

- Energy Resources of Australia Ltd
- ERA Shareholders
- Rio Tinto Group
- Commonwealth Department of Environment
- Northern Territory Environment Protection Authority
- Commonwealth Department of Industry
- Northern Territory Department of Mines and Energy
- Parks Australia North
- World Heritage Committee of UNESCO
- Australian Safeguards and Non-Proliferation Office (ASNO)
- International Atomic Energy Agency (IAEA)
- Department of Foreign Affairs and Trade (DFAT)
- Supervising Scientist Division (SSD)
- Alligator Rivers Regions Technical Committee (ARRTC)
- Alligator Rivers Regions Advisory Committee (ARRAC)
- Mine Site Technical Committee (MTC)
- Gundjeihmi Aboriginal Corporation
- Northern Land Council
- Djabulukgu Association
- Gagudju Association
- Northern Territory Worksafe
- Northern Territory Department of Health
- West Arnhem Shire Council
- Jabiru Town Development Authority
- Australian Conservation Foundation (ACF)
- Northern Territory Environment Centre
- World Wildlife Fund (WWF)

5.7 Key Success Factors

The key success factors associated with the objectives relevant to the Risk Assessment were:

- Demonstrate alignment with all applicable government regulatory and compliance bodies
- Address EIS risk assessment requirements
- Satisfactorily address community concerns, expectations and impacts as applicable.
- Enhance good corporate standing throughout the community, government organisations and non-government organisations.

5.8 Participants

The formal Risk Assessment was conducted in a facilitated workshop at the ERA Office in Darwin. The Risk Assessment Workshop was facilitated by Dr Bill Danaher, an approved Rio Tinto Risk Facilitator, and was attended by a cross-section of internal stakeholders and consultants.

Attendees are listed in the table below. Workshop sessions were arranged based upon the Risk Breakdown Structure described in Section 5.9.2. All attendees participated in the initial identification session but only relevant specialists attended those in which Risk Rankings were applied and Risk Treatment strategies developed.

Name	Title/Position/Role	Company/ Affiliation
Anderson, Peter	Manager, Major Project Approvals	ERA
Booth, Stephen	Principal Hydrogeologist	ERA
Clark, Jody	Interim Tailings, Water & Closure Study Manager	ERA
Danaher, William	Facilitator	RMI
David, Luci	Principal	ERIAS Group
Foster, Bruce	Principal Advisor - Environment	Rio Tinto
Gordon, Ryan	Operations Readiness Engineer	ERA
Hondros, Jim	Director & Principal Consultant	JRHC Pty Ltd
Iles, Shelly	Principal Advisor Environmental Studies	ERA
Jacobsen, Nicole	Specialist Communities	ERA
Jones, Mike	Principal	ERIAS Group
Kusabs, Simon	Principal Mining Engineer	ERA
McIntyre, Dan	Advisor, Major Project Approvals	ERA
Murphy, John	Principal Mining Engineer - Ranger 3 Deeps	TI
Nott, Mark	Study Manager – Ranger 3 Deeps	ERA
Paulka, Sharon	Senior Closure & Radiation Advisor	ERA
Pevely, Stephen	Senior Resource Geologist	ERA
Pugh, Linda	Specialist, Major Project Approvals	ERA
Smith, Sarah	Ecologist	Eco Logical
Tucker, Claire	Consultant	Banarra
Turyn, Catherine	Advisor, Environmental	Rio Tinto
Von gerdhardt, Larissa	Communications Advisor	ERA
Wilkinson, Lachlan	Project Manager	JBSG
Woodrow, Glenn	Specialist, Major Project Approvals	ERA

5.9 Study Methodology

5.9.1 Basis of Methodology

The Risk Assessment reported herein has used the Rio Tinto Risk Management Approach which is based upon the requirements specified in ISO AS/NZS 31000-2009 Risk Management. This International Standard specifies key elements within the risk management approach and each of these elements has been addressed within the study reported herein. ISO 31000 is not prescriptive in relation to specific risk ranking methodologies. However the methodologies used herein are consistent with the general guidelines provided in ISO 31000-2009.

5.9.2 Risk Breakdown Structure

The process of Risk Identification and the subsequent processes of Risk Analysis, Risk Evaluation and Risk Treatment were based upon a structured Risk Breakdown Structure (RBS). The use of an RBS enabled the Risk Assessment Team to focus on particular areas/elements and ensure that Risk Identification was undertaken at a sufficient level of detail. The RBS (which was tailored to the Ranger 3 Deeps Project) is summarised below.

- Surface infrastructure:
  - Surface preparation
  - Vent raise construction
  - Surface ventilation infrastructure operation
  - Power supply
  - Backfill plant
  - Fuel facilities
  - Potable water supply

- Mining operations:
  - General operations
  - Drill and blast
  - Ground support installation
  - Load, haul and dump
  - Paste backfill
  - Water management
  - Ventilation

- Processing.
  - Beneficiation
  - Material movement
  - Water management
  - Consumables

- Waste management:
  - Waste rock
  - Tailings
  - Radioactive waste

- Non-radioactive waste
- Hazardous waste
- General waste
- Emissions

- Rehabilitation and closure:
  - Grouting of surface drill-holes
  - Infrastructure removal
  - Decline and vent raise backfill
  - Neutralisation of acid waste
  - Soil remediation
  - Re-vegetation
  - Earthworks

- Health and safety:
  - Surface activities
  - Underground activities
  - Radiation exposure

5.9.3 Risk Analysis Methodology

The Risk Analysis Methodology used herein was based upon the general Rio Tinto approach but was tailored to the specific environmental risks likely to be associated with the Ranger 3 Deeps Project or specified within the EIS Guidelines. This is discussed in more detail in Section 7.2 below.

5.9.4 Project Life Cycle

As specified in the EIS Guidelines it is necessary to consider risks at different phases of the project lifecycle. Therefore the risk identification and risk categorisation considered risks associated with the following project phases:

- Construction
- Operations[1]
- Decommissioning
- Post closure

Each risk in the Risk Register is associated with one or more of the above topics.

5.9.5 Workshop Approach

The following methodology was adopted for the Risk Assessment reported herein.

- The scope of workshop sessions was clarified through discussions with ERA personnel.

[1] The term "operations" is inclusive of maintenance activities.

- Risks were identified by a brainstorming process with focus on each of the RBS topics noted above. Brainstorming of risks by experts from the Project Team, consultants and internal specialists under the guidance of an approved Risk Facilitator, provided a forum for information sharing, transparent Risk Analysis and informed Risk Management.

- For each risk, consequences and likelihood were discussed and existing risk controls were noted.

- Current risk rankings were estimated and additional risk treatments recommended as required.

- A residual risk ranking was also conducted. The ERA risk analysis methodology was used.

- All of the identified risks were evaluated in accordance with the agreed risk scheme (see Section 7.2) before potential additional Risk Treatments were proposed (particularly for each of the Class III or Class IV risks).

- No attempt was made to address economic consequences to ERA of identified risks.

5.10 Bow Tie Analysis

A large number of risks were identified in the Risk Register. A selected number of risks were subject to Bow Tie Analysis to gain a better understanding of the extent and quality of barriers and mitigation measures that exist for the management of those risks. The criteria used in identifying those risks to be subject to Bow Tie Analysis were:

- The current risk ranking of the risks was Class IV (most severe level of risk).

- The current risk ranking was such that the risk was a high consequence/low likelihood Class III risk.

There were five main steps in developing the Bow Tie Diagrams reported herein. These are as follows.

5.10.1 Clarify the Event of Interest

Although risk identification may generate a broad range of information it is essential that the event of interest (the risk) is clearly defined. In terms of the perspective of Fault Tree Analysis this would be the "Top Event" of the Fault Tree. From the perspective of Event Tree Analysis this would be the "Initiating Event" for Event Tree development. For a Bow Tie Diagram it is the event that ties both of these structures together.

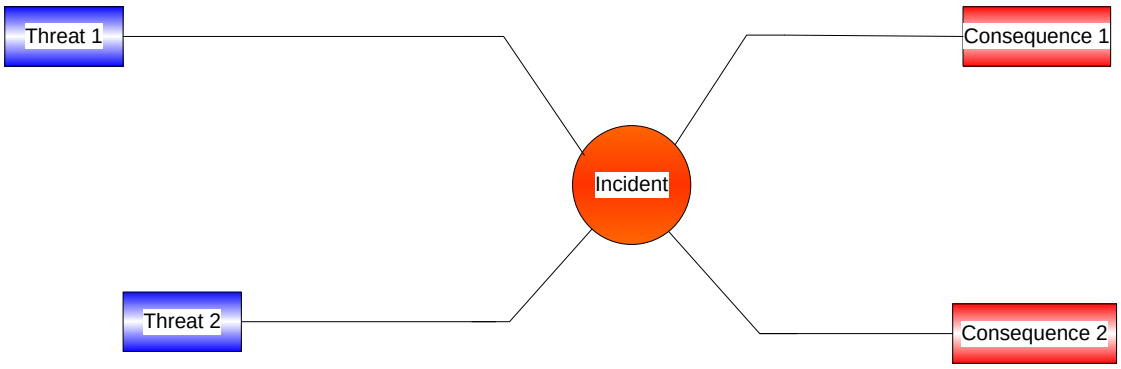
5.10.2 Causal Analysis

The next step involves a causal analysis to identify the possible causes of the event of interest. In Bow Tie Analysis these are typically referred to as threats.

5.10.3 Potential Consequences

The next step involves identification of potential consequences. Within Bow Tie Analysis it is possible to identify different types of consequences within the same broad area of impact, e.g. safety. It is also possible to identify consequences in different areas of impact. For example, if the focus is purely safety then impacts could be fire, explosion, etc. Equally outcomes could be fire, property damage, loss of reputation, etc.

The first three steps provide the basic structure of the Bow Tie Diagram, i.e. the event of interest (risk), possible causes (threats) and possible consequences. An example of the initial development of a Bow Tie Diagram is presented below.

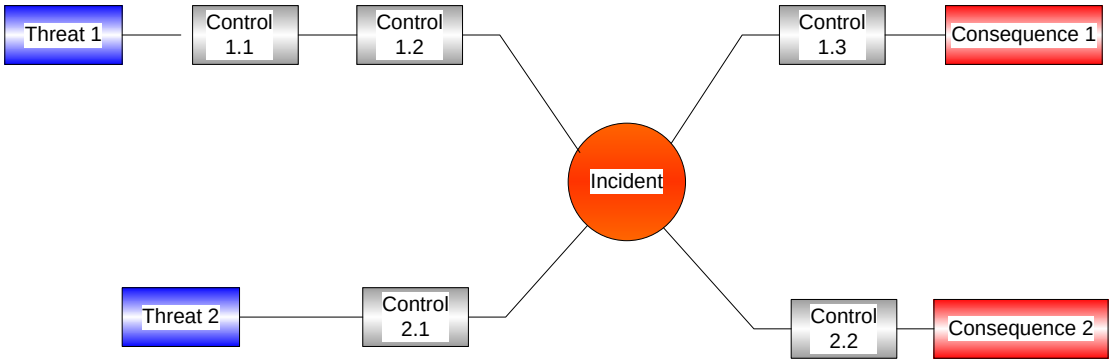


5.10.4 Preventative Controls

The next phase of the development of a Bow Tie Diagram is to identify preventative controls and insert those into the diagram. Preventative controls seek to prevent the event of interest occurring and therefore are located on the left hand side of the Bow Tie Diagram, between the Threats and the Event of Interest. In the example below controls 1.1, 1.2 and 2.1 are preventative controls. (Note that the diagram does not infer that controls 1.1 and 1.2 are sequential).

5.10.5 Recovery/Mitigation Controls

As well as preventative controls there may also be recovery or mitigation controls that seek to prevent the escalation of consequences. These are identified and included on the right hand side of the Bow Tie Diagram. At this point a basic Bow Tie Diagram has been produced which includes threats, preventative controls, consequences and recovery/mitigation controls. In the example below controls 1.3 and 2.2 are preventative controls.



5.10.6 More Detailed Analysis

If desired a second level of Bow Tie analysis can be undertaken to consider threats to the integrity of controls. This level of analysis is not reported herein.

6 RISK IDENTIFICATION

6.1 Overview

The purpose of this step was to identify (for each RBS topic) the environment and safety-related risks associated the Ranger 3 Deeps Project. Risks were identified using a brainstorming activity. The facilitator also referred to previous Ranger 3 Deeps Risk Assessment studies, including those risks identified in the referral process (Hatch 2012). Risks with cumulative consequences were also considered during the risk identification process.

7 RISK ANALYSIS AND RISK EVALUATION

7.1 The Purpose of This Step

The purpose of this step is to assign consequences, and the likelihood of those consequences for a given risk. Consequence and likelihood are combined to give a measure of risk. This analysis is undertaken by considering the existing risk controls.

7.2 Risk Classification Scheme

The Risk Classification Scheme used is presented in Appendix One. This Table is based upon Standard Rio Tinto Consequence Scales but also includes consequence scales that have been designed and tailored to the specifics of the EIS Risk Assessment.

7.3 Risk Register

The Risk Register is provided in Appendix Two. The major sections in the Risk Register are:

- Reference
- Applicability
- Risk Title
- Possible Causes

- Potential Impacts (consequences)
- Existing Controls
- Major Impact Area
- Risk Ranking with Existing Controls
- Recommended Additional Risk Treatment
- Evaluation Rationale
- Risk Evaluation
- Risk Rating
- Risk Management Class
- Risk Certainty Level

Risks have also been categorised in terms of their applicability in the project cycle. The classification used was:

- Construction
- Operations
- Decommissioning
- Post closure
- Applicable to all

It should be noted that three types of risk analysis (qualitative, semi-quantitative and quantitative) are possible. A semi-quantitative analysis was used and is reported in the current study. A quantitative risk analysis was not undertaken, although quantitative analysis associated with the risk topics was undertaken.

7.4 Role of Risk Register

The Risk Register provides a snapshot of the current status of the Project Risk Profile, taking into account the controls which have been implemented throughout to date, or which are incorporated within the Project scope/design. The Risk Register is a live inventory of risk information which will be subject to ongoing review through the remainder of Project activities.

8 RISK TREATMENT

8.1 The Purpose of This Step

The purpose of this step is to develop risk treatments. A summary of generic risk treatment strategies is presented below.

8.2 Generic Risk Treatment Strategies

8.2.1 Risk Avoidance

Risk avoidance requires that a given activity is not undertaken as a means of managing its associated risk. Risk avoidance has limited applicability.

8.2.2 Risk Transfer

Risk transfer involves the transference of risk to another party either by contractual transfer or direct physical transfer of the risk.

8.2.3 Reduction of Consequence and/or Likelihood

Risk controls/treatments may influence consequences and/or likelihood, and so may reduce risk. Typically a hierarchy of risk control options exists:

- Elimination of a risk
- Substitution of a lesser risk
- Reduction of risk by engineering controls
- Reduction of risk by procedural controls
- Use of protective equipment (for safety risks)

8.2.4 Risk Retention

Any risk that cannot be eliminated or avoided must, to some extent, be retained. Risk management enables risk retention to be undertaken with knowledge.

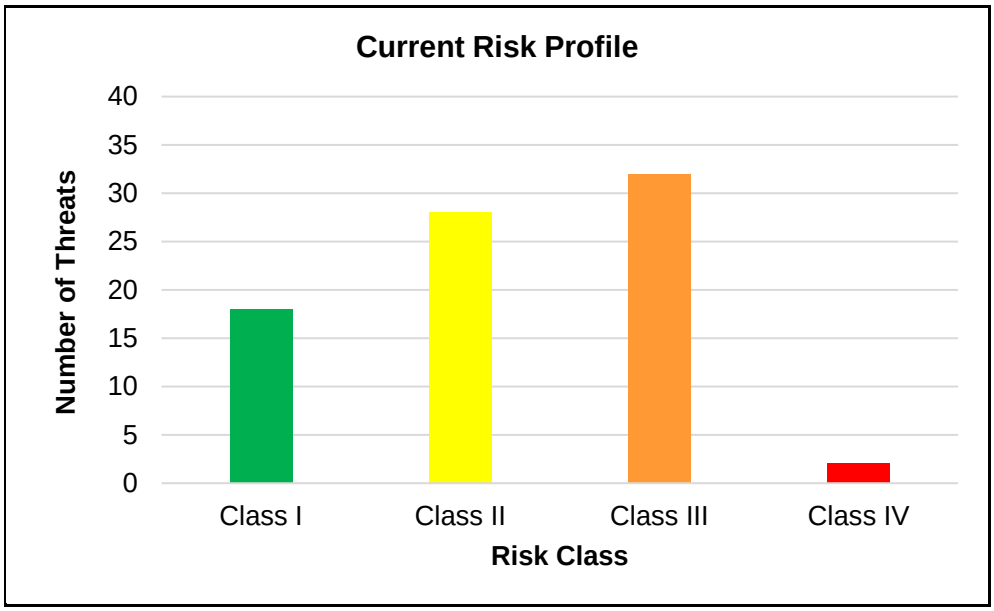
9 SUMMARY OF RISK INFORMATION

9.1 Overview

A summary of major risk analysis outcomes is listed below.

9.2 Current Risk Profile

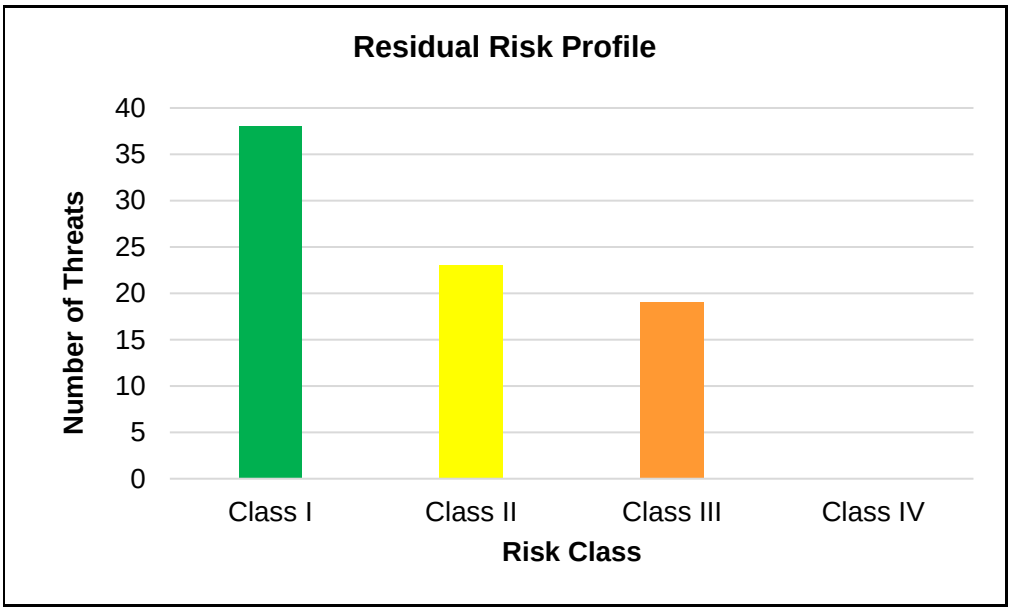
The current risk profile from the EIS risk assessment is presented graphically below. This profile refers to the risk rankings for risks based upon application of existing ERA controls, i.e. those controls that are part of ERA's existing business.



The profile above indicates that there are two Class IV risks and thirty two Class III risks associated with the Ranger 3 Deeps EIS Risk Assessment. A more detailed discussion of the current Class IV and Class III risks is included in Sections 9.6 and 9.7. Additional risk treatments recommended for these risks are discussed in Section 9.8.

9.3 Residual Risk Profile

The overall residual risk profile from the EIS assessment is presented graphically below. This profile refers to the risk rankings taking into account existing controls and new treatments or controls that have been firmly committed as part of the Ranger 3 Deeps Project scope.



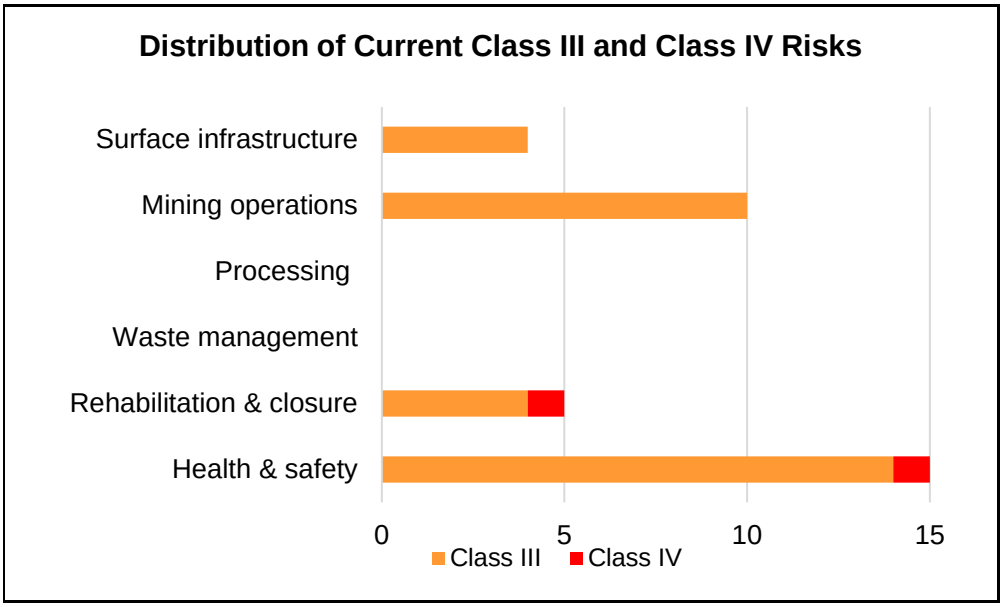
The profile above indicates that there are no residual Class IV risks and 19 residual Class III risks associated with the Ranger 3 Deeps EIS Risk Assessment.

9.4 Summary of Current Risks by RBS Category

The Table below summarises the distribution of current risks across the major Risk Breakdown Structure elements.

Category	Total	Class I	Class II	Class III	Class IV
Surface Infrastructure	18	4	10	4	0
Mining Operations	16	3	3	10	0
Processing	1	1	0	0	0
Waste Management	9	6	3	0	0
Rehabilitation and Closure	10	2	3	4	1
Health and Safety	26	2	9	14	1
Grand Total	**80**	**18**	**28**	**32**	**2**

The distribution of current Class III and Class IV risks on the basis of main risk breakdown structure elements is presented in the Graph below.



The above distribution demonstrates that from an environmental perspective the primary risk areas are associated with surface infrastructure, mining operations and rehabilitation and closure. No Class III risks were identified in relation to processing or in relation to waste management.

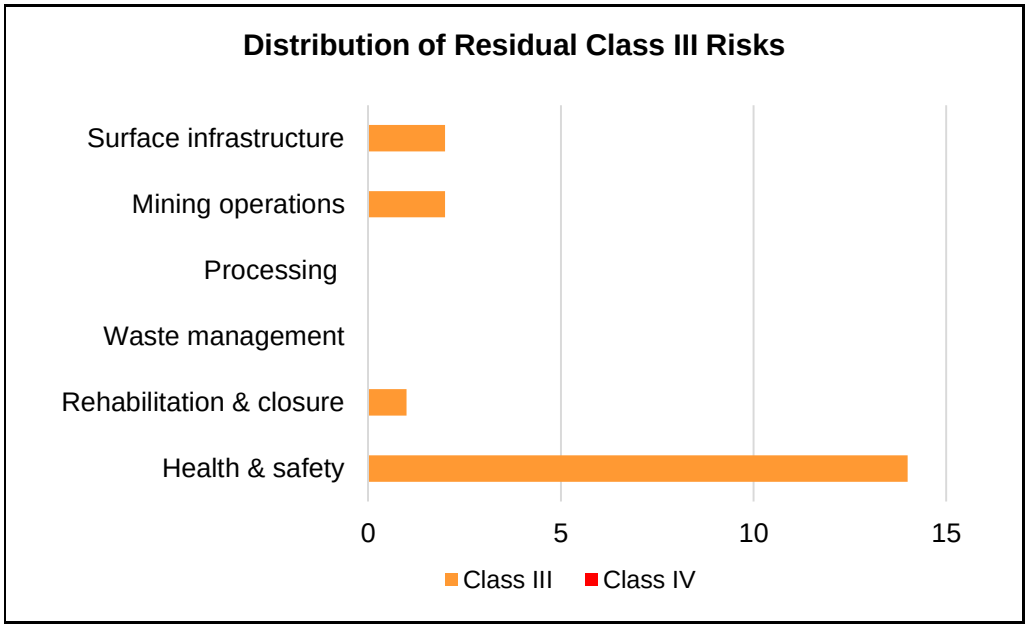
A large number of Class III/Class IV health and safety risks were identified. These are discussed in more detail elsewhere. However the risks which were identified are typical of those of an underground mining operation and it is considered that they can be managed by the application of robust health and safety management controls. It should also be noted that almost "by definition" significant health and safety risks are those with high consequences and low likelihood and therefore are automatically classified as Class III risks.

9.5 Summary of Residual Risks by RBS Category

The Table below summarises the distribution of residual risks across the major Risk Breakdown Structure elements.

Category	Total	Class I	Class II	Class III	Class IV
Surface Infrastructure	18	10	6	2	0
Mining Operations	16	6	8	2	0
Processing	1	1	0	0	0
Waste Management	9	9	0	0	0
Rehabilitation and Closure	10	5	4	1	0
Health and Safety	26	7	5	14	0
Grand Total	**80**	**38**	**23**	**19**	**0**

The distribution of residual Class III and Class IV risks on the basis of main risk breakdown structure elements is presented in the Graph on the next page.



The Graph above demonstrates that through the application of additional risk treatments it is possible to reduce the number of Class III risks in the areas of surface infrastructure, mining operations and rehabilitation and closure.

Application of additional risk treatments has removed both Class IV risks although as noted in the previous section many health and safety risks "by definition" remain as Class III. Therefore the significant number of residual Class III health and safety risks should not be seen as a reflection on the inherent safety level associated with the Ranger 3 Deeps Underground Project.

9.6 Summary of Current Class IV and Class III Risks

9.6.1 Surface Infrastructure

There were no current Class IV risks. The four current Class III risks are summarised below. The current risk level (CR), residual risk level (RR) and associated evaluation rationale are also provided.

Risk ID	Description	CR	Evaluation Rationale	RR
TA2-01	Person/fauna may fall into vent raise.	III	Major contributor to the risk is exposure to fall during decommissioning.	III
TA3-02	Project infrastructure may generate noise levels that are incompatible with traditional lifestyle, public amenity, and/or fauna.	III	The incremental project operational noise level at the defined ecological receptor (Georgetown Billabong) is predicted to be negligible. The cumulative noise emission at this ecological receptor and RP1 is predicted to be below the occasional disturbance effect noise criteria for fauna (<50 – 65 dBA). dBA criteria has been derived from work done by	II

Risk ID	Description	CR	Evaluation Rationale	RR
			Archer (2014). At nearest residential receptors, noise levels are within acceptable intrusive noise criteria.	
TA5-02	Greater than predicted dust generation may occur from paste plant.	III	R-34 site is of high cultural significance but the potential for impact is considered negligible The site is an occupational site and likely to be used again post closure. Dust on the site will be perceived negatively (living culture issue). Modelling has assumed that 90 % dust control is in place because of plant design. Based on this assumption, the modelling has predicted that the paste plant is not a significant dust source. NB: Wheel generated dust is the major contributor to dust generation. This is associated predominantly with haulage activity (surface/underground). Predicted modelling indicates that the R34 site 30 day dust deposition is below the recommended guideline (4 g/m^2/month) (Environment Protection Authority 2005). Cumulative dust emissions will not materially change this outcome. Cumulative emissions for all defined pollutants are below NEPM guidelines.	III
TA7-01	An unsustainable drawdown of potable water aquifer (Magela or Brockman) may occur.	III	Based on previous aquifer performance reviews, the potable water requirement for the Project is approximately 0.2 L/s, compared to the annual average production rate of the borefields 6-9 L/s.	II

9.6.2 Mining Operations

There were no current Class IV risks. The ten current Class III risks are summarised below. The current risk level (CR), residual risk level (RR) and associated evaluation rationale are also provided.

Risk ID	Description	CR	Evaluation Rationale	RR
TB2-01	A sensitive underground anthropological site may be inadvertently discovered or disturbed during mining.	III	Dreaming story known and images of previously disturbed material. Ranking based on the continuation of informal process.	II
TB2-02	Pit 3 walls may become destabilised by Ranger 3 Deeps.	III	ERA expect the prism measurements will identify the failure well in advance and people will not be in the pit or in the area. A Trigger Action Response Plan is in existence. Buttress work has been completed - this risk has been well mitigated. This is an existing risk, the underground has a very minor contribution to likelihood. Current vibration monitoring stopped registering blast vibration from the exploration decline at around 90 m depth. Consequence ranking reflects the fact that a major failure is now not considered to be credible.	III
TB2-03	Vibration from underground mining may impact on cultural sites of significance	III	Current vibration monitoring stopped registering blast vibration from exploration decline at around 90 m depth. Consequence ranking reflects the fact that a major impact is now not considered to be credible.	II
TB5-01	Solutes from tailings paste backfill may transport through host rock and affect groundwater quality and Magela Creek.	III	Modelling indicates that when compared to Pit 3, leaching from Ranger 3 Deeps backfill material contributes negligible additional solute loading to the groundwater or surface water system. Groundwater modelling has shown that the contribution of solute from Ranger 3 Deeps Tailings to Magela Creek post closure is at least 5,000 times less than from the Pit 3 backfill source. Incrementally the consequence is undetectable. Therefore the likelihood of	I

Risk ID	Description	CR	Evaluation Rationale	RR
			a very low consequence which implies a measurable impact is unlikely.	
TB5-02	Brine transported from Pit 3 may react with the paste backfill.	III	Rock that the brine passes through is partially neutralising and the density of brine increases as it cools, therefore making the brine less reactive. Relative quantity of brine compared with the mass of tailings is such that only a small amount of paste backfill could be affected within a limited number of the closest stopes to Pit 3. Intera model indicates a very low probability of brine ingress occurring over the life of the Project, and only a negligible quantity inflow if it were to occur.	III
TB6-01	Quantity of groundwater inflow to underground workings may be greater than water management capacity.	III	In the unlikely event that pond water storage capacity is temporarily exceeded, there are several levels of contingency within the existing water management system to avoid direct discharge to the environment. Unlikely that small blasts will impact rock permeability to any significant spatial extent.	II
TB6-02	Underground water may need to be treated as process water.	III	Consequence and likelihood allocated based upon opinion of risk assessment team. While consequence could be medium it is considered to be unlikely given capacity in the water management system.	II
TB7-01	Ambient air quality in surface and underground work areas may exceed the level acceptable for worker health.	III	Ambient air quality modelling for the Ranger 3 Deeps Project has been completed. This predicts concentrations at the portal to be approximately one third of the OEL at its maximum. Annual averages are significantly lower than the OEL. Other contaminants modelled are well below all limits (OEL and NEPM).	II
TB7-02	Primary ventilation system may not perform to design expectations.	III	Heat stress ranked as highest probability health consequence Radiation risk ranked under separate risk, see TF-3-03.	II

Risk ID	Description	CR	Evaluation Rationale	RR
TB7-03	Secondary ventilation system may not provide acceptable air quality to all work places.	III	Radiation risk ranked under separate risk, see TF-3-03.	II

9.6.3 Processing

There were no current Class IV or Class III risks for Processing.

9.6.4 Waste Management

There were no current Class IV or Class III risks for Waste Management.

9.6.5 Rehabilitation and Closure

There was one current Class IV risk and four current Class III risks which are summarised below. The current risk level (CR), residual risk level (RR) and associated evaluation rationale are also provided.

Risk ID	Description	CR	Evaluation Rationale	RR
TE3-01	Vent shafts may provide pathway for solute transport to Magela Creek post closure.	IV	Depressurisation holes have not been surveyed so rank certainty as a 2. Note: This risk is associated with the potential of the ventilation shafts providing an accelerated pathway for non-Project related solutes encapsulated in Pit 3 to travel. The primary solute pathway is via Pit 3 near horizontal depressurisation holes intersecting ventilation shafts. However the planned backfill strategy for these shafts effectively eliminates the occurrence of such solute transport.	I
TE1-03	Person may be injured from contact with open hole remaining after closure.	III	A few holes may be missed or poorly grouted.	II
TE3-02	Decline may provide a conduit for solute transport from Pit 3 sources to Magela Creek.	III	Preliminary Intera (solute) modelling indicates vent shafts and decline generates a very small proportion of the total solute loading to Magela Creek.	I
TE7-01	There may be an inability to meet the closure schedule due to restrictions imposed by the active underground operations.	III	Undertaking Ranger 3 Deeps will not have a material impact on the in-pit tailings disposal. Volumes of waste material from the	II

Risk ID	Description	CR	Evaluation Rationale	RR
			Project are very small and will not impact material balance (Project generates only 0.56 Mt of waste rock and 0.6 Mt of Category 2 rock, compared with existing waste stockpiles containing approximately 100 Mt). Ranking is consistent with Social Impact Assessment.	
TE7-02	Impacts to archaeological sites may occur during closure earthworks.	III	This is an existing closure risk.	III

9.6.6 Health and Safety

There was one Class IV risk and fourteen Class III risks which are summarised below. The current risk level (CR), residual risk level (RR) and associated evaluation rationale are also provided.

Risk ID	Description	CR	Evaluation Rationale	RR
TF3-04	Workforce may be exposed to gamma radiation that exceeds the annual dose limit.	IV	Risk ranking is based on radiation assessment by external consultants, incorporating the application of the identified treatments.	III
TF1-03	Loss of control of machinery/equipment may occur during surface activities.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF1-04	Surface infrastructure construction and maintenance may impact on other infrastructure.	III	Community trust consequence relates to power disruption.	III
TF1-07	Collision may occur between underground equipment and surface equipment/personnel.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-01	Major fall of ground may occur in drive/decline.	III	Contribution of earthquake considered to be negligible due to location of RPA outside of seismic zone. Standard D1.1 is an existing Rio Tinto standard applied to all underground mining operations. The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-02	Minor fall of ground may occur in drive/decline.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III

Risk ID	Description	CR	Evaluation Rationale	RR
TF2-05	Flooding of underground may occur.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-06	Uncontrolled detonation of explosives may occur.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-07	Loss of control of vehicle may occur.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-08	Fire may occur underground causing heat and smoke in the mine.	III	No plans for underground fuel storage or workshop facilities. The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-09	Cumulative noise exposure may lead to increased risk of industrial noise induced hearing loss in workers.	III	The ranking is typical of an occupational noise exposure risk.	III
TF2-10	Entrapment of workforce underground may occur.	III	Rated on the basis that at the current stage of design a high safety impact is credible but rare. The ranking is typical of a high consequence-low likelihood safety risk.	III
TF2-12	Underground workers may be exposed to Legionella bacteria.	III	Ranked "unlikely" because all causes must occur simultaneously.	III
TF2-13	Person may fall from height while working underground.	III	The ranking is typical of a high consequence-low likelihood safety risk.	III
TF3-03	Underground workforce may be exposed to radon decay products and dust (LLAA) at levels above acceptable standards.	III	Risk ranking is based on radiation assessment by external consultants, incorporating the application of the identified treatments.	II

9.7 High Consequence – Low Likelihood Risks

Significant High Consequence – Low Likelihood risks are summarised below. Further details are in Section 9.6 above. Risk treatments are discussed in Section 9.8. As noted previously non-safety high consequence-low likelihood risks have been subjected to Bow Ties analysis. Safety risks have been excluded from Bow Tie analysis herein because none are considered to be unique to Ranger 3 Deeps, and all will be addressed by standard Rio Tinto and ERA safety risk assessment practices.

Risk ID	Description
TA2-01	Person/fauna may fall into vent raise.
TB2-01	A sensitive underground anthropological site may be inadvertently discovered or disturbed during mining.
TB2-02	Pit 3 walls may become destabilised by Ranger 3 Deeps.
TB2-03	Vibration from underground mining may impact on cultural sites of significance.
TB5-02	Brine transported from Pit 3 may react with the paste backfill.
TE7-01	There may be an inability to meet the closure schedule due to restrictions imposed by the active underground operations.
TE7-02	Impacts to archaeological sites may occur during closure earthworks.
TF1-03	Loss of control of machinery/equipment may occur during surface activities.
TF1-04	Surface infrastructure construction and maintenance may impact on other infrastructure.
TF2-01	Major fall of ground may occur in drive/decline.
TF2-05	Flooding of underground may occur.
TF2-06	Uncontrolled detonation of explosives may occur.
TF2-08	Fire may occur underground causing heat and smoke in the mine.
TF2-10	Entrapment of workforce underground may occur.
TF2-12	Underground workers may be exposed to Legionella bacteria.
TF2-13	Person may fall from height while working underground.

9.8 Risk Treatments in Relation to Class IV and Class III Risks

9.8.1 Surface Infrastructure

There were no Class IV risks. The four Class III risks and recommended additional risk treatments are summarised below.

Risk ID	Description	Recommended Additional Treatments
TA2-01	Person/fauna may fall into vent raise.	Bore holes will be covered during construction to prevent animals falling. C3 Standard - Engineered false floor and barricades during construction. Bore holes will be cordoned off and covered to prevent falls.
TA3-02	Project infrastructure may generate noise levels that are incompatible with traditional lifestyle, public amenity, and/or fauna.	Equipment selection and noise control technology designed to meet sensitive receptor limits.
TA5-02	Greater than predicted dust generation may occur from paste plant.	Initiate dust deposition monitoring at R-34 and other sites. Plant design (e.g. 90% dust control and

Risk ID	Description	Recommended Additional Treatments
		equipment enclosed). Located in current disturbed area.
TA7-01	An unsustainable drawdown of potable water aquifer (Magela or Brockman) may occur.	Existing controls considered to be adequate.

9.8.2 Mining Operations

There were no Class IV risks. The ten Class III risks and recommended additional risk treatments are summarised below.

Risk ID	Description	Recommended Additional Risk Treatments
TB2-01	A sensitive underground anthropological site may be inadvertently discovered or disturbed during mining.	Discuss and negotiate appropriate action with land owners if circumstances arise.
TB2-02	Pit 3 walls may become destabilised by Ranger 3 Deeps.	Underground blasts will be smaller than open pit blasts, due to the nature of the resource and mining method. Approved drill and blast plans. Pit pillar safety margin of 150 m.
TB2-03	Vibration from underground mining may impact on cultural sites of significance.	Blast design and practices to minimise vibration.
TB5-01	Solutes from tailings paste backfill may transport through host rock and affect groundwater quality and Magela Creek.	Paste designed to be low permeability, low moisture content and has binder (cement).
TB5-02	Brine transported from Pit 3 may react with the paste backfill.	Retaining a Pit 3 to Ranger 3 Deeps working minimum distance of 150 m. ERA will visually observe and survey cavity monitor pastefill performance during mining where the pastefill is exposed.
TB6-01	Quantity of groundwater inflow to underground workings may be greater than water management capacity.	Ability to modify mining schedule in the high flow area and mitigate inflow. Stopes are relatively small size with small blast.
TB6-02	Underground water may need to be treated as process water.	Retaining a Pit 3 to Ranger 3 Deeps working minimum distance of 150 m. Cement binding and dewatering of tailings paste. Protocols for the placement of paste backfill to management water. Tailings washing prior to paste generation.

Risk ID	Description	Recommended Additional Risk Treatments
TB7-01	Ambient air quality in surface and underground work areas may exceed the level acceptable for worker health.	A 25 m stack for proposed power station will improve dispersion characteristics and lower the concentration of pollutants at ground level. Ongoing ambient air quality monitoring of work areas (and TARP), supported by a NO_x specific gas monitor (real-time with alarms).
TB7-02	Primary ventilation system may not perform to design expectations.	Design based on full mining fleet and maximum production schedule. Heat modelling input into design and network design. Preventative Maintenance Plan (asset management strategy). Ventilation Management Plan. Refrigeration of air. Low emission diesel equipment.
TB7-03	Secondary ventilation system may not provide acceptable air quality to all work places.	Ventilation Management Plan. Continuous ventilation monitoring stations. Preventative maintenance. Stope Ventilation Plan. Equipment selection. Operator training and competency.

9.8.3 Processing

There were no Class IV or Class III risks for Processing.

9.8.4 Waste Management

There were no Class IV or Class III risks for Waste Management.

9.8.5 Rehabilitation and Closure

There was one Class IV risk and four Class III risks. Recommended additional risk treatments are summarised below.

Risk ID	Description	Recommended Additional Risk Treatments
TE3-01	Vent shafts may provide pathway for solute transport to Magela Creek post closure.	Backfill of vent raises on closure (with cemented plug in weathered zone). Siting of raises to avoid depressurisation bores where possible.
TE1-03	Person may be injured from contact with open hole remaining after closure.	Holes are grouted and/or capped.
TE3-02	Decline may provide a conduit for solute transport from Pit 3 sources to Magela Creek.	A combination of bulkheads and appropriate fill (paste or cemented aggregate) will be applied.

Risk ID	Description	Recommended Additional Risk Treatments
TE7-01	There may be an inability to meet the closure schedule due to restrictions imposed by the active underground operations.	A closure strategy that incorporates Ranger 3 Deeps will be established.
TE7-02	Impacts to archaeological sites may occur during closure earthworks.	Existing controls considered to be adequate.

9.8.6 Health and Safety

There were one Class IV risk and fourteen Class III risks. Recommended additional risk treatments are summarised below.

Risk ID	Description	Recommended Additional Risk Treatments
TF3-04	Workforce may be exposed to gamma radiation that exceeds the annual dose limit.	Real-time personal monitoring. Shotcreting of walls, backs and face. Equipment shielding. Semi automation of selected production equipment. Barren crushed rock or steel plates on floor for shielding. Minimising worker time in ore. Regular mucking out of sumps.
TF1-03	Loss of control of machinery/equipment may occur during surface activities.	Equipment design standards.
TF1-04	Surface infrastructure construction and maintenance may impact on other infrastructure.	Infrastructure design and location has been subject to detailed engineering assessment.
TF1-07	Collision may occur between underground equipment and surface equipment/personnel.	Develop specific underground equipment Traffic Management Plan.
TF2-01	Major fall of ground may occur in drive/decline.	Mine design (e.g. stope dimensions and access drive locations) is based on geotechnical studies.
TF2-02	Minor fall of ground may occur in drive/decline.	Existing controls considered to be adequate.
TF2-05	Flooding of underground may occur.	Collar on vent raises. Flood mitigations for vent raises. Hydrogeological investigations to establish fault locations. Upgrade of mine water management system.

Risk ID	Description	Recommended Additional Risk Treatments
TF2-06	Uncontrolled detonation of explosives may occur.	Majority of explosive stored in above ground magazine; small volume for use taken underground.
TF2-07	Loss of control of vehicle may occur.	Develop Traffic Management Plan for construction and operations, and consider design controls to reduce risk. Develop vehicle specifications and audit/inspection. Develop training and qualification requirements. HME vehicle design - e.g. emergency braking.
TF2-08	Fire may occur underground causing heat and smoke in the mine.	Existing controls considered to be adequate.
TF2-09	Cumulative noise exposure may lead to increased risk of industrial noise induced hearing loss in workers.	Equipment design and selection.
TF2-10	Entrapment of workforce underground may occur.	Mine design incorporates a secondary means of egress.
TF2-12	Underground workers may be exposed to *Legionella* bacteria.	All water that is sent into the mines for services will be treated prior (chlorinated) beforehand.
TF2-13	Person may fall from height while working underground.	Solid barricading of stopes. Signage. Training and competency. Standard operating procedures.
TF3-03	Underground workforce may be exposed to radon decay products and dust (LLAA) at levels above acceptable standards.	Ventilation system design. Single pass ventilation. Exhaust ducting and a range of other secondary ventilation options. Air conditioned cabs on equipment. Real-time personal and area monitoring and associated TARP. Dust suppression. Provision of sufficient staff for ventilation monitoring and management. Stope Ventilation Plan. Ventilation Management Plan.

9.9 Comment on Risk Certainty

9.9.1 Ranking Methodology

Risk certainty was categorized as follows:

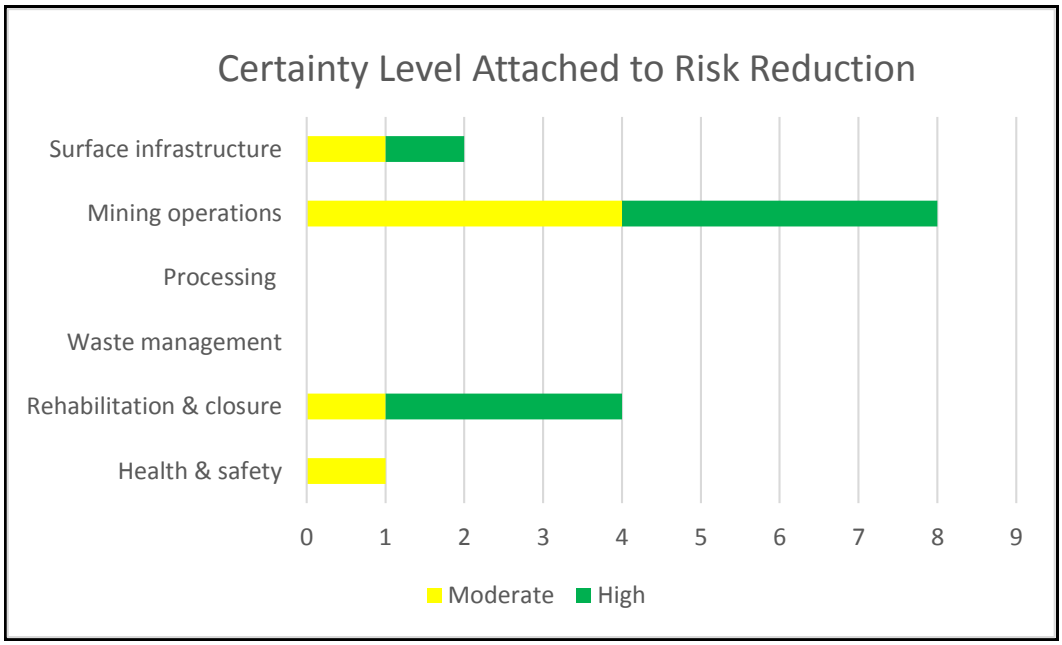
Control Rank	Description	Interpretation
C1	Low	Risk ranking is based on subjective opinion or relevant past experiences.
C2	Moderate	Risk ranking is based on similar conditions being observed previously and/or qualitative analysis. Analysis is based on unverified models and/or data.
C3	High	Risk ranking is based on testing, high fidelity use of verified modelling or simulation, use of prototype or experiments. Analysis is based on verified models and/or data. Assessment is based on an historical basis.-

Certainty is relevant in two key areas :

- Where there has been a significant reduction in risk by the application of risk treatments (e.g. Class III/IV risks reduced to Class I/II risks)
- Residual risk rankings

9.9.2 Risk Reduction Certainty

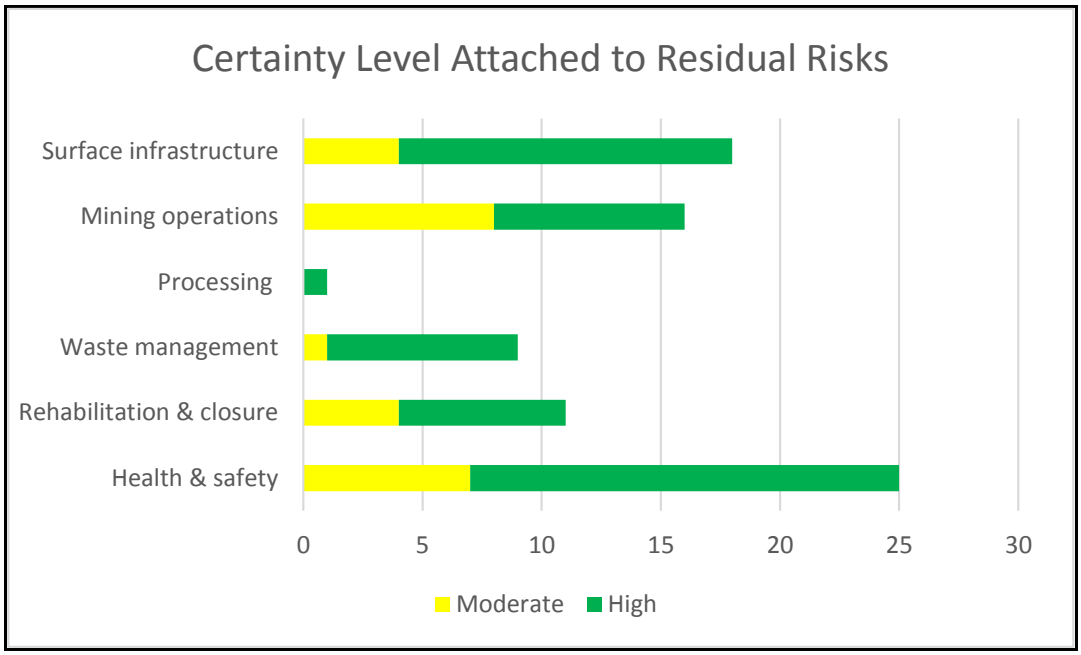
Below is a graph depicting the certainty associated with reduction of risk level.



Fifteen risks are predicted to be reduced from current rankings of Class III/IV to residual rankings of Class I/II by the application of additional risk treatments. All risk reductions had a certainty level of at least C2.

9.9.3 Residual Risk Certainty

The graph below demonstrates the certainty level attached to all residual risks.



The graph above demonstrates that high certainty has been attributed to 70% of the residual risks. No risks were categorized as “low certainty”.

10 DISCUSSION OF RISKS IN RELATION TO EIS ELEMENTS

10.1 Overview

In the EIS Guidelines issued by the Northern Territory Environmental Protection Authority, particular risk assessment topics were noted : Section 4.3 - Human Health and Safety, Section 4.4 - Water, Section 4.5 - Flora and Fauna, Section 4.6 - Rehabilitation and Mine Closure, Section 4.7 - Historic and Cultural Heritage, 4.8. (As noted previously a consideration of socio-economic risks is outside the scope of the risk assessment reported herein).

Risks have been classified in terms of major area of consequence in relation to the other topics noted above. In addition to those specified within the EIS document, consequences associated with air quality and soil has also been considered. However no Class III or Class IV risks were identified with consequences associated with air quality and soil. The Graph below demonstrates the distribution of current Class III and Class IV risks by areas of impact.

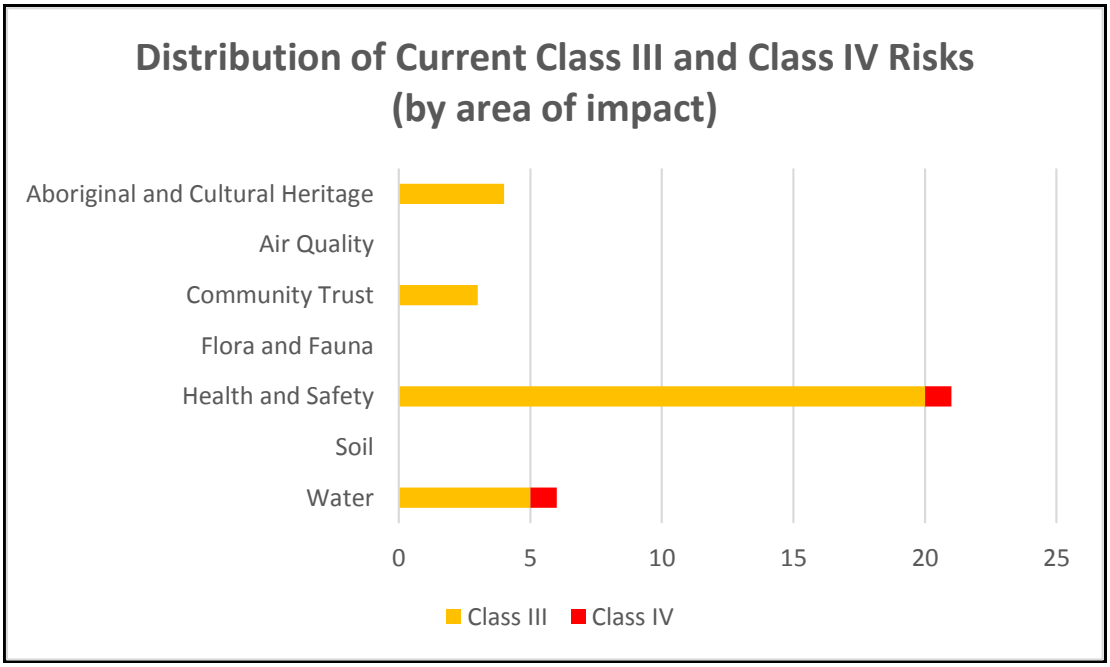
As noted previously a significant number of health and safety risks have been identified. However it has also been noted that these risks are typical of what would be expected for an underground mining operation and therefore the number identified and their associated severity is not in any way unusual.

10.2 Summary of Current Risks by Area of Impact

The Graph below demonstrates that there are no current Class III or Class IV risks in the areas of Air Quality, Flora and Fauna and Soil. Class III risks are present for Aboriginal and Cultural Heritage and Community Trust. One Class IV risk and five Class III risks are present in relation to Water. The Aboriginal and Cultural Heritage risks and the Water risks have been taken forward into a more detailed Bow Tie Analysis (refer Section 12).

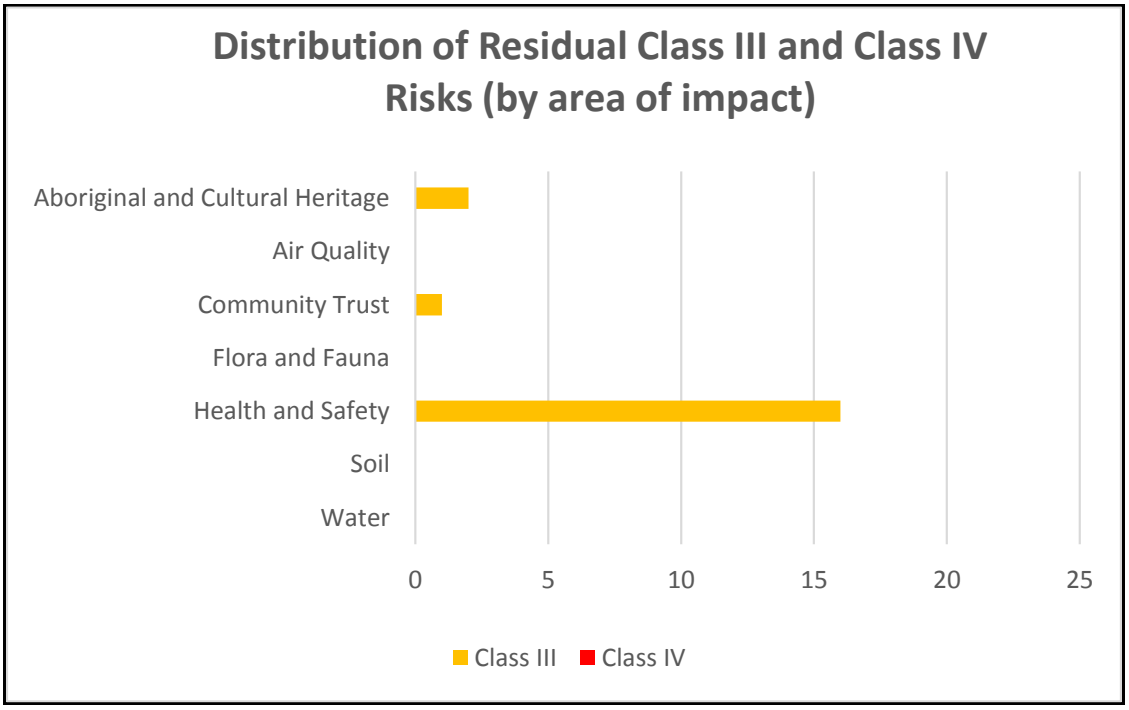
There are 20 Class III and one Class IV health and safety risks. Although these dominate the risk profile these risks are typical of an underground mining operation. Health and safety risks (with the exception of radiation exposure) have been excluded from Bow Tie analysis herein because none are considered to be unique to Ranger 3 Deeps, and all will be addressed by standard Rio Tinto and ERA safety risk assessment practices.

(Note that the number of health and safety listed below is different to that presented in Section 9.4 because some of the risks listed under other RBS elements in Section 9.4 also had health and safety as their primary area of impact).



10.3 Summary of Residual Risks by Area of Impact

The Graph below shows the distribution of residual Class III and Class IV risks by main area of impact. This Graph, in comparison with the one in the previous section, demonstrates that there are no residual Class III risks in Air Quality, Flora and Fauna, Soil and Water. It is important to note that it is believed that risk controls can be applied which reduce the residual risk for water impacts to below Class III. The number of Aboriginal and Cultural Heritage and Community risks ranked Class III has been reduced relative to the current control state.



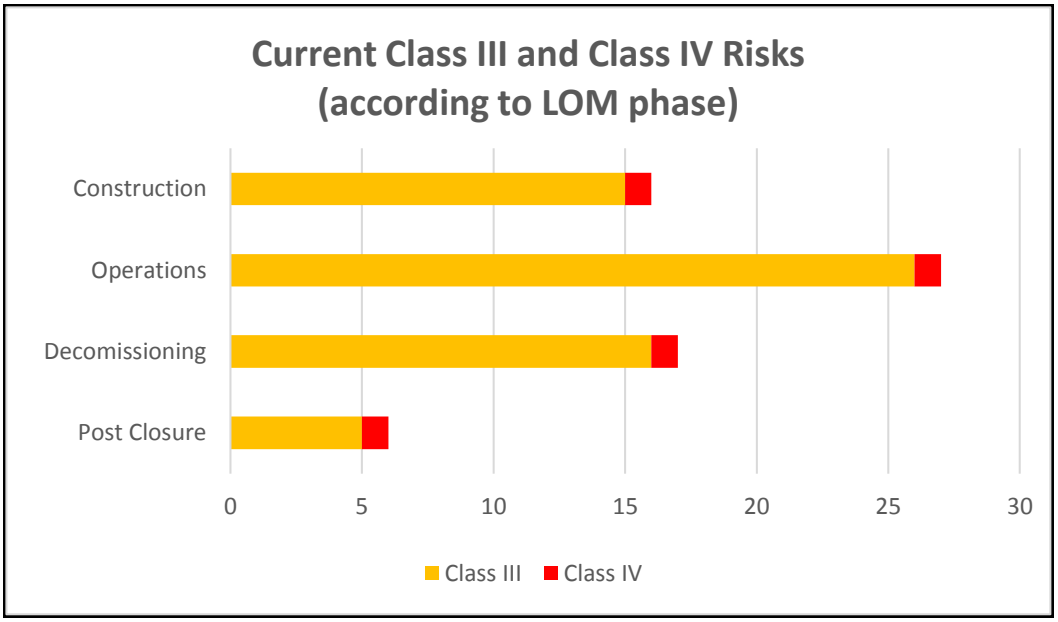
10.4 Summary of Current Risks by Life of Mine Phase

As discussed in Section 5.9.4 risks have been classified in terms of project life cycle:

- Construction
- Operations
- Decommissioning
- Post Closure

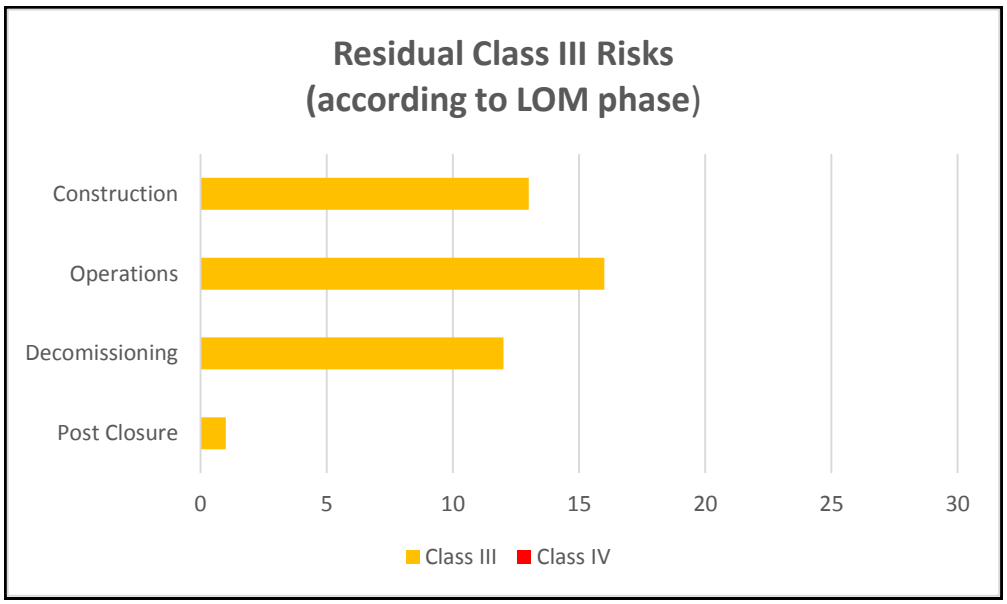
The Graph below demonstrates the distribution of Class III and Class IV risks according to Life of Mine (LOM phase). Based upon current controls the majority of LOM risks fall into the phases of construction, operations and decommissioning.

(Note: It is possible for a risk to be classified in more than one life cycle area, e.g. a risk may manifest itself during operations and decommissioning. Therefore the number of Class III and Class IV risks represented in the Graph above is expected to be larger than that represented in previous graphs and distributions).



10.5 Summary of Residual Risks by Life of Mine Phase

The graph below shows the distribution of residual Class III risks according to Life of Mine phase. As discussed elsewhere this graph demonstrates that application of additional risk treatments is expected to be able to reduce all Class IV risks to Class III risks or lower. This graph also demonstrates that the majority of risks occur during the construction, operations and decommissioning phases with a limited number of Class III risks existing in the post-closure phase. It should also be noted that the many Class III risks applicable to Health and Safety (previously discussed) make a significant contribution to the number of Class III risks during construction, operations and decommissioning.



11 BOW TIE ANALYSIS

11.1 Risks Addressed by Bow Tie Analysis

As discussed in Section 5.10, Bow Tie Analysis was undertaken on those risks which had a current ranking of Class IV or for which the ranking was based upon a high consequence/low likelihood scenario. In undertaking the Bow Tie Analysis three broad topic areas were considered and these involved aggregation of several common risks into the same topic area. This is summarised in the Table below.

Bow Tie Risk Topic	Risk Number	Risk Details
Project interaction with cultural heritage site, place or object.	TB2-03	Vibration from underground mining may impact on cultural sites of significance.
	TA5-02	Greater than predicted dust generation may occur from Paste Plant.
	TB2-02	Pit 3 walls may become destabilised by Ranger 3 Deeps.
	TB6-03	Seepage losses from Magela Creek into the underground workings may impact on flow regimes in the creek.
	TA1-01	Vegetation clearing may generate excessive air borne dust.
Radiation exposure at elevated levels.	TF3-03	Underground workforce may be exposed to radon decay products and dust (LLAA) at levels above acceptable standards.
	TF3-04	Workforce may be exposed to gamma radiation that exceeds the annual dose limit.
Excessive mobilisation of solute.	TB5-01	Solutes from tailings paste backfill may transport through host rock and affect ground water quality and Magela Creek.
	TE1-01	Drill holes in the vicinity of the project may provide fast localised pathways for fluid exchange (solute transport).
	TE3-01	Vent shafts may provide pathway for solute transport to Magela Creek post closure.
	TE3-02	Decline may provide a conduit for solute transport from Pit 3 sources to Magela Creek.

Health and safety risks were not subjected to Bow Tie analysis, because this approach is part of the standard risk analysis approach applied to the management of health and safety risks during the operational phase.

11.2 Cultural Heritage Impacts

The Bow Tie diagram for "Project interaction with cultural heritage site, place or object" is provided in Appendix Three.

The preventative and mitigation controls identified in the Bow Tie analysis may be deemed to be critical risk controls, i.e. they are controls associated with the most significant risks. As such these controls must be embedded in ERA management systems to ensure ongoing application. This is summarised in the table below.

Critical Risk Control	Management System Element
Blast design.	D1 Underground performance safety standard: D1.1 Ground control • Each operation must establish a Ground Control Management Plan that consists of three elements: design, implementation and verification. D1.5 Explosive and hazardous atmospheres D1.9 Explosive agents
Ongoing blast monitoring and assessment.	E2 Air quality control E4 Greenhouse gas emissions
Dust suppression at source (water).	E2 Air quality control
Dust control in infrastructure design.	E2 Air quality control • Demonstrate that, under normal and worst case operating conditions and adverse meteorological conditions, emissions from the operation, current or after a modification, will not cause violation of regional or national air quality regulations, internally derived air quality criteria, and/ or licence conditions.
Ongoing revegetation.	E9 Land use stewardship and biodiversity
Land disturbance permit.	E9 Land use stewardship and biodiversity Cultural Heritage Management Plan
Back filling and buttressing.	D1.1 Ground control: • Each operation must establish a Ground Control Management Plan that consists of three elements: design, implementation and verification.
Pillar distance.	D1.1 Ground control
Prism monitoring and TARP.	D3 Management of pit slopes, stockpiles, spoil and waste dumps

Critical Risk Control	Management System Element
Mine design	D1.1 Ground control:
Rock characterization.	D1.1 Ground control D1.8 Air blasts
Mine design – void size.	D1.1 Ground control: D1.8 Air blasts
Separation and location.	Feature of the physical environment.
Backfilling of stopes/voids.	D1.1 Ground control: • Each operation must establish a Ground Control Management Plan that consists of three elements: design, implementation and verification.
Cultural Heritage training and induction.	Cultural Heritage Management Plan.
Infrastructure design.	E2 Air quality control • Visual amenity assessment indicates that vent raises will not be visible from nearest sensitive receptors.
Equipment pre-fabrication offsite.	EIS commitment to include in construction plan.
Supervision.	HSE Management system standard: Element 5: Organisation resource, accountabilities and responsibilities
Cultural Heritage GIS	Cultural Heritage Management Plan.
Signage.	Cultural Heritage Management Plan.
Steel fencing.	Cultural Heritage Management Plan.
Buffer zone.	Cultural Heritage Management Plan.
Periodic audits.	Cultural Heritage Management Plan.
Boundary markings.	Cultural Heritage Management Plan.

11.3 Solute Transport

The Bow Tie diagram for “Excessive mobilisation of solute” is provided In Appendix Three.

Based on the Bow Tie diagram the critical preventative and mitigation risk controls are summarised in the Tables below.

The preventative and mitigation controls identified in the Bow Tie analysis may be deemed to be critical risk controls, i.e. they are controls associated with the most significant risks. As such these controls must be embedded in ERA management systems to ensure ongoing application. This is summarised in the following table.

Critical Risk Control	Management System Element
Pit backfill strategy.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Low permeability capping of tailings.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Low permeability capping of waste rock.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Tailings dewatering (thickening) and consolidation.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Separation and deep placement of brines.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Final landform design.	• Application to the MTC for Pit 3 tailings deposition • Ranger closure plan
Depth profile of pit sources.	Feature of the physical environment.
Stopes backfilled.	D1.1 Ground control: • Each operation must establish a Ground Control Management Plan that consists of three elements: design, implementation and verification.
Paste design.	D1.7 Inrush of solids: • A system of quality control and assurance to be established for backfill operations and materials
Low volume stopes.	Feature of the rock and geotechnics
Depth profile of mine sources.	Feature of the physical environment.
Paste test work.	D1.7 Inrush of solids: • A system of quality control and assurance to be established for backfill operations and materials
Low permeability paste.	D1.7 Inrush of solids
Low moisture paste.	D1.7 Inrush of solids
Cemented paste.	D1.7 Inrush of solids
Paste QA.	D1.7 Inrush of solids
Vent raises plugged – barren rock/cement.	• EIS commitment for closure • Project closure strategy to be incorporated into Ranger closure plan
Plug design.	• EIS commitment for closure • Project closure strategy to be incorporated into Ranger closure plan
Plug materials QA.	• EIS commitment for closure • Project closure strategy to be incorporated into

Critical Risk Control	Management System Element
	Ranger closure plan
Bulk heads.	D1 Underground safety: • Each operation must establish a Ground Control Management Plan that consists of three elements: design, implementation and verification. D1.7 Inrush of solids
Paste or cemented aggregate fill.	• EIS commitment for closure • Project closure strategy to be incorporated into Ranger closure plan
Fill materials QA.	• EIS commitment for closure • Project closure strategy to be incorporated into Ranger closure plan
Grouting program.	Exploration program –environmental management plan
Drill hole locations documented.	Exploration program –environmental management plan
Rock characterized as low permeability.	Feature of the physical environment.

11.4 Radiation Effects

The Bow Tie diagram for "Radiation exposure at elevated levels" is provided in Appendix Three.

The preventative and mitigation controls identified in the Bow Tie analysis may be deemed to be critical risk controls, i.e. they are controls associated with the most significant risks. As such these controls must be embedded in ERA management systems to ensure ongoing application. This is summarised in the table below.

Critical Risk Control	Management System Element
Static shielding – shotcrete; barren crushed rock on floor.	B5 Radiation Radiation Policy Radiation Management Plan
Extra steel (shielding on mobile equipment).	B5 Radiation Radiation Policy Radiation Management Plan
Semi-automated equipment.	B5 Radiation Radiation Policy Radiation Management Plan
Operational practices, e.g. muck-out of sump.	B5 Radiation Radiation Policy Radiation Management Plan
Real time personal gamma monitoring and TARP.	B5 Radiation

Critical Risk Control	Management System Element
	Radiation Policy Radiation Management Plan
Ventilation infrastructure.	D1.5 Explosive and hazardous atmospheres: • Where there is a risk of hazardous atmospheres, the operation must develop a Ventilation Management Plan • B1 Particulate and gas/vapours exposure • B6 Thermal stress • B10 Occupational exposure limits • B5 Radiation • Radiation Policy • Radiation Management Plan
Dust suppression (water).	B1 Particulate and gas/vapours exposures
Mobile equipment (air con cabs).	• B5 Radiation • Radiation Policy • Radiation Management Plan
Selective Personal Protection Equipment.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Mine water management.	• B5 Radiation • Radiation Policy • Radiation Management Plan • Water Management Plan
Mine design – ventilation districts.	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Stope ventilation plan.	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Real time RDP monitoring and TARP.	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Real time personnel RDP monitoring.	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Qualified ventilation personnel and grab sample monitoring.	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Physical barricades (to shut off areas).	• D1.5 Explosive and hazardous atmospheres • B5 Radiation • Radiation Policy • Radiation Management Plan
Controlled areas.	• B5 Radiation • Radiation Policy

Critical Risk Control	Management System Element
	• Radiation Management Plan
Clean/dirty change rooms.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Hygiene rules.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Surface contamination monitoring.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Personal monitoring and TARP.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Individual dose assessment.	• B5 Radiation • Radiation Policy • Radiation Management Plan
Dose constraints (shift, month, quarter, year).	• B5 Radiation • Radiation Policy • Radiation Management Plan
External auditing and reporting.	• B5 Radiation • Radiation Policy • Radiation Management Plan

12 CONSULTATION AND COMMUNICATION

Consultation and communication are essential parts of the risk management process. The selection of a multidisciplinary group ensured that appropriate consultation occurred. The facilitator notes that adequate input was obtained from all attendees. Consensus was reached regarding risk levels.

Communication of risk is an ongoing process. However, the development of the Risk Register and Critical Risk Controls provides the basis for communication of these aspects of risk to appropriate personnel.

13 MONITORING AND REVIEW

The risk management process is not static and risks may change with time. Therefore, although the study represents an understanding by the workshop group and project team of significant environment and safety-related risks associated with the Ranger 3 Deeps Project it cannot be guaranteed that the level of risk will not change over time and that new risks will not emerge. Therefore, there needs to be an ongoing strategy of monitoring and reviewing of risks. This should become an integral part of the ongoing planning process. In particular, the Risk Management Plans and Critical Risk Controls should be incorporated into the overarching HSE Management System and be subject to regular review.

14 REFERENCES

Archer, N (2014) *Ranger 3 Deeps underground mine noise and vibration impact assessment*, Newcastle, New South Wales. Report # 630.10155-R3.

Environment Protection Authority (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales:* http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf

Hatch (2012) *Energy Resources Australia Ltd Environmental Risk Assessment - Ranger 3 Deeps Underground Mine Project. Report of Environmental Risk Workshop.* Appendix G, Ranger 3 Deeps Underground Mine referral (EPBC 2013/6722): http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=current_referral_detail&proposal_id=6722

Standards Australia (2009) *AS/NZS ISO 31000:2009: Risk management - Principles and Guidelines.*

APPENDIX ONE: RISK SCHEME

Risk Evaluation Scheme

Risk Evaluation Scheme name Ranger 3 Deeps EIS

Consequence Classification

	Consequence Type	Consequences				
		Very Low	Low	Moderate	High	Very High
Non-economic	**Health**	Reversible health effects of little concern, requiring first aid treatment at most. Can include minor irritations of eyes, throat, nose and/or skin, or minor unaccustomed muscular discomfort.	Reversible health effects of concern that would typically result in medical treatment. Can include temperature effects; travel effects; stress; and sunburn.	Severe, reversible health effects of concern that would typically result in a lost time incident. Can include acute/medium-term effects associated with extreme temperature effects or musculo-skeletal effects; vibration effects; nervous system effects; some infectious diseases; and non-falciparum malaria.	Single fatality or irreversible health effects or disabling illness. Can include effects of suspected carcinogens, mutogens, teratogens and reproductive toxicants, progressive chronic conditions and/or acute/medium-term high-risk effects.	Multiple fatalities or serious disabling illness to multiple people. Can include effects of known human carcinogens, mutogens teratogens and reproductive toxicants, and life-threatening respiratory sensitisation and falciparum malaria.
	Safety	Low level short term subjective inconvenience or symptoms. Typically a first aid and no medical treatment.	Reversible injuries requiring treatment, but does not lead to restricted duties. Typically a medical treatment.	Reversible injury or moderate irreversible damage or impairment to one or more persons. Typically a lost time injury.	Single fatality and/or severe irreversible damage or severe impairment to one or more persons.	Multiple fatalities or permanent damage to multiple people.
	General flora and fauna	Insignificant effect	Local short-term decrease in abundance of some species with no lasting effects on local population.	Local long-term decrease in abundance of some species resulting in some change to community structure.	Regional decrease in abundance of some species resulting in some changes to community structure.	Regional loss of numerous species resulting in the dominance of only a few species.
	Species of conservation significance	Minor local habitat modification and/or lifecycle disruption for a listed species. No loss of individuals of listed fauna species.	Moderate local habitat modification and/or lifecycle disruption for a listed species. Minor local decrease in size of population(s) of listed fauna species.	Substantial local habitat modification and/or lifecycle disruption for a listed species. Moderate local decrease in size of population(s) of listed fauna species.	Moderate regional habitat modification and/or lifecycle disruption for a listed species. Substantial local decrease in size of population(s) of listed fauna species.	Substantial regional habitat modification and/or lifecycle disruption for a listed species. Moderate or substantial regional decrease in size of population(s) of listed fauna species.
	Community Trust	Tangible expressions of trust / mistrust amongst a handful of community members with no influence on public opinion and decision-makers.	Tangible expressions of trust / mistrust amongst a few community members with some influence on public opinion and decision-makers.	Tangible expressions of trust / mistrust amongst some community members with moderate influence on public opinion and decision-makers.	Tangible expressions of trust / mistrust amongst most community members with significant influence on decision-makers.	Widespread loss / gain of trust across the community setting the agenda for decision-makers and key stakeholders.
	Compliance	Non-conformance with internal requirement with very low potential for impact. Non-compliance with community commitment goes unnoticed by external party/parties, requiring minimal effort to correct.	Non-compliance with external or internal requirement with low potential for impact. Formal censure. Non-compliance with community commitment, requiring limited effort to correct.	Non-compliance with internal or external requirement with moderate impact. Moderate penalties for breach of legislation, contract, permit or licence. Non-compliance with community commitment reported formally, with significant effort to correct.	Breach of licence(s), legislation, regulation-high potential for prosecution. Contract breach-significant penalty. Systemic internal standards breach-high impact. Community commitment breach-high potential business impact-significant effort to fix.	Suspended or severely reduced operations imposed by regulators. Breach of community commitment results in direct loss of established consents with widespread secondary effects.
	Aboriginal and Cultural Heritage	Insignificant effect Encroachment on non archaeologically surveyed area.	Repairable damage to site or item of low cultural significance. Non conformance with ERA internal land disturbance permit procedures.	Irreparable damage to site or item of low cultural significance. Relocation of archaeological findings in agreement with heritage regulation.	Repairable damage to site or item of cultural significance. Infringement of heritage regulation, as a result of ignoring the current Cultural GIS, likely to tarnish ERA's image.	Irreparable damage to site or item of cultural significance. Damage to AAPA listed site(s) leading to tension with Traditional Owners and NT Government. Negative effect on Rio Tinto's image of an environmentally conscious company supportive of indigenous cultures.
	Amenity	**Visual:** No noticeable change to vista as viewed from sensitive premises. **Noise:** Negligible noise level increase at closest affected receiver <1dBA (not noticeable by all people).	**Visual:** Near-source and short-term change to vista as viewed from sensitive premises. **Noise:** Marginal noise level increase at closest affected receiver 1dBA to 2 dBA (not noticeable by most people).	**Visual:** Near-source and medium-term, or local and short-term change to vista as viewed from sensitive premises. **Noise:** Moderate noise level increase at closest affected receiver 3 dBA to 5 dBA (not noticeable by some people but may be noticeable by others).	**Visual:** Near-source and long-term, or local and medium-term change to vista as viewed from sensitive premises. **Noise:** Appreciable noise level increase at closest affected receiver 5 dBA to 10 dBA (noticeable by most people).	**Visual:** Local and long-term change to vista as viewed from sensitive premises. **Noise:** Significant noise level increase at closest affected receiver >10 dBA (noticeable by nearly everyone).

Risk Evaluation Scheme

Risk Evaluation Scheme name: Ranger 3 Deeps EIS

Consequence Classification

Consequence Type	Consequences				
	Very Low	Low	Moderate	High	Very High
Soils	Near surface soils are confined and short-term impact. Promptly reversible.	Near-surface soils confined and medium-term reversible impact. May take < 1 year to remediation.	Near-surface soils confined and long-term recovery impact. May take > 1 year for full remediation.	Impact most likely affecting deep soil profiles and requiring long-term recovery, leaving residual damage. May take years for full remediation.	Impact most likely affecting deep soil profiles and requiring long-term recovery, leaving major residual damage. May take decades for full remediation.
Surface water	Minimal contamination or change with no significant loss of quality.	Near-source medium-term contamination or change in water quality.	Local short-term contamination or change in water quality.	Local medium-term contamination or change in water quality.	Regional long-term contamination or change in water quality.
Groundwater	**Quality:** Near-source contaminants confined and promptly reversible impact. Promptly reversible. **Drawdown:** Insignificant effect.	**Quality:** Near-source contaminants confined and medium-term reversible impact. May take < 1 year to remediate. **Drawdown:** Near-source minor change in recharge patterns within sub-catchments.	**Quality:** Near-source contaminants confined and medium-term impact. May take >1 year to remediate. **Drawdown:** Near-source major change in recharge patterns within sub-catchments.	**Quality:** Large volumes of, or deep-seated contaminants requiring long-term recovery. May take years for full remediation. **Drawdown:** Local major changes in recharge patterns within sub-catchments.	**Quality:** Large volumes of, or deep-seated contaminants requiring long-term recovery. May take decades for full remediation. **Drawdown:** Regional major changes in recharge patterns.
Air Quality	No measureable air quality impacts.	Local medium-term and minor exceedance(s) of standards.	Local long-term change in air quality.	Regional medium-term change in air quality.	Regional long-term change in air quality.
Radiation	Measurable increase in radiation dose with outcomes remaining below dose constraints.	Increase in radiation dose above the dose constraints but still below international limits	Increase in radiation dose to above international limits	Radiation doses above 100 mSv to an individual and likely to significantly increase the risk of cancer to that individual.	Radiation doses to multiple individuals above 100 mSv or acute radiation syndrome to an individual.

Likelihood Classification

	Likelihood				
	Rare	Unlikely	Possible	Likely	Almost Certain
Frequency Interval (Multiple events)	<1/100 years	1/10 - 1/100 years	1/year – 1/10 years	2/year – 1/year	>2/year
Probability (Single events)	< 0.1%	0.1% - 1%	1% - 10%	10% - 25%	> 25%

Certainty level

Control Rank	Description	Guidance
C1	Low	Risk ranking is based on subjective opinion or relevant past experiences
C2	Moderate	Risk ranking is based on similar conditions being observed previously and/or qualitative analysis. Analysis is based on unverified models and/or data.
C3	High	Risk ranking is based on testing, high fidelity modelling or simulation, use of prototype or experiments. Analysis is based on verified models and/or data. Assessment is based on an historical basis.

Risk Matrix - Threats

	Most serious consequence				
	Very Low	Low	Moderate	High	Very High
Almost Certain	**Class II**	**Class III**	**Class IV**	**Class IV**	**Class IV**
Likely	**Class II**	**Class III**	**Class III**	**Class IV**	**Class IV**
Possible	Class I	**Class II**	**Class III**	**Class IV**	**Class IV**
Unlikely	Class I	Class I	**Class II**	**Class III**	**Class IV**
Rare	Class I	Class I	**Class II**	**Class III**	**Class III**

APPENDIX TWO: RISK REGISTER

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls						Risk Evaluation															Risk Rating															
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Risk Management Class	Certainty level
T	A			**Surface Infrastructure**																																											
T	A	1		**Surface preparation**																																											
T	A	1	01	1		3	4		Vegetation clearing may generate excessive airborne dust.	Flora and fauna	L	L	II	Where practicable, active rehabilitation will be undertaken of areas surrounding new infrastructure to mitigate dust.	Construction is predominately drilling a hole so likelihood of dust compared to other operational activities is low. Short construction phase. Most infrastucture will be constructed on disturbed sites and/or on the inside of the mine access road.		P			VL	VL			VL	VL								I	I				I	I						I	C3
T	A	1	02	1		3			Vegetation clearing may cause the introduction of new weeds or further spread of existing weeds.	Flora and fauna	L	P	II	Majority of new infrastructure will be located on the inside of the mine access road (Pit 3 side).	Land Disturbance Permits, standard operating procedures and management plans have recently undergone revision to minimise impacts of key threatening processes - e.g. clearing, fire, weeds.		U			L	VL												I	I											I	C3
T	A	1	03	1	2	3			Spillage of hydrocarbons may occur during surface activities.	Water	VL	P	I	Existing controls considered to be adequate.	Proposed surface infrastructure footprint is small and situated away from Magela Creek.		P									VL	VL													I	I				I	C3
T	A	1	04	1		3			Damage to long term monitoring bores may occur during vegetation clearing.	Community Trust	VL	U	I	Existing controls considered to be adequate.	Consequence and likelihood allocated based upon opinion of risk assessment team. Consequence and likelihood are considered to be very low/unlikely.		U					VL	VL												I	I									I	C3
T	A	1	05	1	2	3			Surface water runoff from new infrastructure and stockpile may lead to offsite contamination.	Water	VL	U	I	New infrastructure built inside the main access road (Pit 3 side) will be designed to capture and manage rain water within current water management system. Only non-mineralised material will be used for construction of pads/footings, etc.	There is only 400 m of additional haul road. Current management systems ensure no water goes to Magela Creek. This will not be changed. New infrastructure east of the main access road does not require treatment.		R									VL	VL													I	I				I	C3
T	A	2		**Vent raise construction**																																											
T	A	2	01	1		3			Person/fauna may fall into vent raise.	Health and safety	H	U	III	Bore holes will be covered during construction to prevent animals falling. C4 Standard - Working at heights. Engineered false floor and barricades during construction. Bore holes will be cordoned off and covered to prevent falls.	Major contributor to the risk is exposure to fall during decommissioning.		R		H	VL	VL											III	I	I											III	C3

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					Risk Evaluation																		Risk Rating																		Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
T	A	2	02	1	2	3			Birds and/or bats may be injured during the operation of fresh air raises.	Flora and fauna	VL	P	I	Bulk air coolers will incorporate engineering controls to prevent debris that could otherwise effect fan efficiency. These controls, and the low air velocity and pressure also protect against fauna injury.	Fresh air raises are envisaged to operate during build-up/wet season. Risk is ranked on impact to population not individual.		P			VL	VL													I	I									I	C3
T	**A**	**3**		**Surface ventilation infrastructure operation**																																								
T	A	3	01	1	2				Visual design of vents and fans may be incompatible with traditional lifestyle and access.	Community Trust	L	P	II	Design will incorporate short structure compared with other site infrastructure and vegetation in the vicinity. Visual amenity assessment indicates that vent raises will not be visible from nearest sensitive receptors along the northern side of the Magela Creek.	There is limited desire from Traditional Owners to access the area during mine life.		U				VL		VL	VL												I			I	I					I	C3
T	A	3	02		2				Project infrastructure may generate noise levels that are incompatible with traditional lifestyle, public amenity, and/or fauna.	Community Trust	M	P	III	Equipment selection and noise control technology designed to meet sensitive receptor limits.	The incremental project operational noise level at the defined ecological receptor (Georgetown Billabong) is predicted to be negligible. The cumulative noise emission at this ecological receptor and RP1 is predicted to be below the occasional disturbance effect noise criteria for fauna (<50 – 65 dBA). dBA criteria has been derived from work done by Archer (2014). At nearest residential receptors, noise levels are predicted to be within acceptable intrusive noise criteria.		P			VL	VL	VL		L	L									I	I	I			**II**	**II**					**II**	C2
T	A	3	03		2				Visibility of plume from vent fans may cause community concerns.	Community Trust	L	P	II	Fact sheets will be developed to inform public of low risk.	Visible plume will only be water vapour; no health risk. Visible vapour dependent on meteorology conditions - will not be year-round.		P					L			L											II				**II**						**II**	C2
T	A	3	04		2				Vent emissions may adversely affect surrounding environment.	Aboriginal and cultural heritage	M	U	II	Control of generation of pollutants at source (e.g. selection of low emission underground equipment, dust suppression). Ventilation system design. EMP will discuss need for any ongoing dust deposition monitoring at the R34 site to validate modelling predictions.	Air quality considered at sensitive receptors. Predicted modelling indicates that the R34 site 30 day dust deposition will be well below the recommended guideline (4 g/m^2/month – Environmental Protection Authority 2005).		U				M		M				L	VL					II			**II**					I	I	**II**	C3

Ref.				Applicable To					Risk Description	Current Risk Ranking with Existing Controls					Risk Evaluation																		Risk Rating																		Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	Construction 1	Operations 2	Decommissionin 3	Post closure 4	Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation									
T	A	4		**Power supply**																																														
T	A	4	01		2				Generator exhaust plume may have a greater than expected offsite impact.	Air quality	L	P	II	Equipment designed to minimise emissions (e.g. catalytic converters, stack height). Where possible, power generation will be tied into existing power infrastructure. Pollutant monitoring will occur at the nearest residential receptor (e.g. contractor camp) to confirm suitability of the design.	Air quality modelling predicts that emissions for all defined pollutants will be below NEPM and NSW EPA guidelines at "residential receptors".		P	VL							VL				L		I						I				**II**		**II**	**C2**
T	A	5		**Backfill plant**																																													
T	A	5	01		2				Release of tailings may occur during transfer to paste plant.	Soil	VL	L	II	Hazop will be undertaken as part of the Hazard Level 3 study. This will be undertaken during the Feasiblity Study as per Rio Tinto requirements.	New tailings pipelines will be managed in accordance with existing containment practices. The paste plant and pipework will be located in disturbed areas.		L								VL																				**II**					**II**	**C3**
T	A	5	02		2				Greater than predicted dust generation may occur from paste plant.	Community Trust	M	L	III	Initiate dust deposition monitoring at R-34 and other sites. Plant design (e.g. 90 % dust control and equipment enclosed). Plant located in current disturbed area.	R-34 site is of high cultural significance but the potential for impact is considered negligible The site is an occupational site and likely to be used again post closure. Dust on the site will be perceived negatively (living culture issue). Modelling has assumed that 90 % dust control is in place because of plant design. Based on this assumption, the modelling has predicted that the paste plant is not a significant dust source. NB: Wheel generated dust is the major contributor to dust generation. This is associated predominantly with haulage activity (surface/underground). Predicted modelling indicates that the R34 site 30 day dust deposition will be below the recommended guideline (4 g/m^2/month) (Environment Protection Authority 2005). Cumulative dust emissions will not materially change this outcome. Cumulative emissions for all defined pollutants are predicted to be below NEPM guidelines.		P	L		VL	VL	M		L				L		**II**		I	I	**III**		**II**				**II**		**III**	**C2**
T	A	5	03	1	2	3			Illumination from the plant may adversely impact on communities and fauna.	Flora and fauna	VL	AC	II	Directional lighting will be installed.	Lighting will be located in current disturbed area away from sensitive receptors.		P			VL	VL			VL								I	I				I						I	**C3**

Ref.				Applicable To					Risk Description	Current Risk Ranking with Existing Controls					Risk Evaluation																		Risk Rating																		Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
T	A	5	04		2				Paste spill may occur during transfer from backfill plant to underground.	Soil	L	P	II	Bunding around the bore used for paste transfer to underground. Delivery pipes are flushed after use, with waste water collected in sumps and managed according to class and existing water management treatment. All boreholes and pipework will be located on the inside of the main access road (Pit 3 side).	Paste has high viscosity so will not spray or flow.		P								VL													I					I	C3
T	**A**	**6**		**Fuel facilities**																																												
T	A	6	01		2	3			Spillage of hydrocarbons from new day tank and distribution system may occur.	Soil	L	P	II	Secondary containment of pipes. Fast fill connections. Quick connect nozzles with backflow prevention will be used where practicable. HAZOP study to be undertaken during Feasibility Study.	Consequence and likelihood allocated based upon opinion of risk assessment team. Consequence and likelihood are considered to be very low/possible.		P								VL	VL													I	I				I	C3
T	**A**	**7**		**Potable water supply**																																											
T	A	7	01	1	2	3			An unsustainable drawdown of potable water aquifer (Magela or Brockman) may occur.	Water	M	P	III	Existing controls considered to be adequate.	Based on previous aquifer performance reviews, the potable water requirement for the Project is approximately 0.2 L/s, compared to the annual average production rate of the borefields 6-9 L/s.		U	L		L		M					M			I		I		**II**							**II**				**II**	**C3**
T	**B**			**Mining Operations**																																												
T	**B**	**1**		**General operations**																																												
T	B	1	01	1	2	3			Hydrocarbon spillage may occur from underground mining equipment (used underground and on surface).	Soil	VL	AC	II	Equipment fitted with fast fill systems. Quick connect nozzles with backflow prevention will be used where practicable. Minimise storage of hydrocarbons underground. Traffic management rules and radio communications. Passing bays underground to avoid vehicle collisions. Oil water separator on water management system.	Likelihood ranked based on consequence not on spillage frequency.		L				VL				VL	VL	VL							**II**					**II**	**II**	**II**				**II**	**C3**

Ref.				Applicable To					Risk Description	Current Risk Ranking with Existing Controls				Risk Evaluation																		Risk Rating												Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	Construction	Operations	Decommissionin	Post closure	Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
				1	2	3	4	All																																			
T	B	2		**Drill and blast**																																							
T	B	2	01		2				A sensitive underground anthropological site may be inadvertently discovered or disturbed during mining.	Aboriginal and cultural heritage	H	U	III	Discuss and negotiate appropriate action with land owners if circumstances arise.	Dreaming story known and images of previously disturbed material. Ranking based on the continuation of informal process.		U					M	H												II		III								III	C2
T	B	2	02		2				Pit 3 walls may become destabilised by Ranger 3 Deeps.	Aboriginal and cultural heritage	H	R	III	Underground blasts will be smaller than open pit blasts, due to the nature of the resource and mining method. Approved drill and blast plans. Pit pillar safety margin of 150 m.	ERA expect the prism measurements will identify the failure well in advance and people will not be in the pit or in the area. A Trigger Action Response Plan is in existence. Buttress work has been completed - this risk has been well mitigated. This is an existing risk, the underground has a very minor contribution to likelihood. Current vibration monitoring stopped registering blast vibration from the exploration decline at around 90 m depth. Consequence ranking reflects the fact that a major failure is now not considered to be credible.		R		VL	L		M	M	M		L	M					I	I		II	II		II		I	II				II	C3
T	B	2	03		2				Vibration from underground mining may impact on cultural sites of significance.	Aboriginal and cultural heritage	H	R	III	Blast design and practices to minimise vibration.	Current vibration monitoring stopped registering blast vibration from exploration decline at around 90 m depth. Consequence ranking reflects the fact that a major impact is now not considered to be credible.		R					M	M	M										II	II		II						II	C3
T	B	3		**Ground support installation**																																								
T	B	3	01		2				Concrete spillage may occur during transport to underground.	Soil	VL	L	II	Engineered agi-transfer point.	Transfer between agi-trucks occurs within the disturbed mine area.		P									VL	VL													I	I				I	C3
T	B	3	02		2	3			Shotcrete may affect quality of underground mine drainage water (pumped to surface).	Water	VL	U	I	New water management ponds will be acid dosed as per existing controls.	Discharge undergoes dilution in Retention Pond 2 (RP2) before getting to treatment plant.		U	VL									VL					I										I	I				I	C3

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Risk Type (T=Threat)	Category	Subcategory	Item	Construction 1	Operations 2	Decommissionin 3	Post closure 4	Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation						
T	B	4		**Load, haul and dump**																																												
T	B	4	01		2				Dust generated from truck haulage and dumping at the surface may adversely impact the environment.	Health and safety	VL	P	I	Existing controls considered to be adequate.	Ranger 3 Deeps ore will have higher moisture content. Surface haul distances for Ranger 3 Deeps will be significantly shorter than for previous open pit operations. Predicted modelling indicates that dust levels will be below the recommended NEPM and Environment Protection Authority Guidelines.		P	VL		VL					VL				VL	VL	I		I					I				I	I	I	**C3**
T	B	5		**Paste backfill**																																											
T	B	5	01		2	3	4		Solutes from tailings paste backfill may transport through host rock and affect groundwater quality and Magela Creek.	Water	M	P	III	Paste designed to be low permeability, low moisture content and has binder (cement).	Modelling indicates that when compared to Pit 3, leaching from Ranger 3 Deeps backfill material contributes negligible additional solute loading to the groundwater or surface water system. Groundwater modelling has shown that the contribution of solute from Ranger 3 Deeps Tailings to Magela Creek post closure is at least 5,000 times less than from the Pit 3 backfill source. Incrementally the consequence is predicted to be undetectable. Therefore the likelihood of a low consequence which implies a measurable impact is unlikely.		U				L					L	L						I					I	I			I	**C3**
T	B	5	02		2	3	4		Brine transported from Pit 3 may react with the paste backfill.	Health and safety	H	R	III	Retaining a Pit 3 to Ranger 3 Deeps working minimum distance of 150 m. ERA will visually observe and survey cavity monitor pastefill performance during mining where the pastefill is exposed.	Rock that the brine passes through is partially neutralising and the density of brine increases as it cools, therefore making the brine less reactive. Relative quantity of brine compared with the mass of tailings is such that only a small amount of paste backfill could be affected within a limited number of the closest stopes to Pit 3. Intera model indicates a very low probability of brine ingress occuring over the life of the Project, and only a negligible quantity inflow if it were to occur.		R		H											**III**												**III**	**C2**

Ref. Risk Type (T=Threat)	Category	Subcategory	Item	Applicable To: 1 Construction	2 Operations	3 Decommissioning	4 Post closure	All Applies to all	Risk Description (Evaluated 80 of 80 risks (0 Remaining)) Risk Title	Major Consequence Area	Current Risk Ranking with Existing Controls: Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale
T	B	6							**Water management**						
T	B	6	01		2				Quantity of groundwater inflow to underground workings may be greater than water management capacity.	Water	M	P	III	Ability to modify mining schedule in the high flow area and mitigate inflow. Stopes are relatively small size with small blast.	In the unlikely event that pond water storage capacity is temporarily exceeded, there are several levels of contingency within the existing water management system to avoid direct discharge to the environment. Unlikely that small blasts will impact rock permeability to any significant spatial extent.
T	B	6	02		2				Underground water may need to be treated as process water.	Water	M	P	III	Retaining a Pit 3 to Ranger 3 Deeps working minimum distance of 150 m. Cement binding and dewatering of tailings paste. Protocols for the placement of paste backfill regarding management water. Tailings washing prior to paste generation.	Consequence and likelihood allocated based upon opinion of risk assessment team. While consequence could be medium it is considered to be unlikely given given capacity in the water management system.
T	B	6	03		2	3	4		Seepage losses from Magela Creek into the underground workings may impact on flow regimes in the creek.	Water	M	U	II	Backfilling of all stope voids. Mining method with small stopes well below base of weathering will not generate surface subsidence.	There is no evidence to indicate existence of any structure that would cause significant flow out of Magela Creek into underground workings. A small amount of seepage will occur through existing faults to underground workings. This will not have a measurable impact on flow regime. The total open void space available underground for water is very small relative to the quantity of water passing through Magela Creek above.
T	B	6	04		2	3	4		Acid generation from waste rock stockpiles may be greater than expected.	Water	VL	U	I	Existing controls considered to be adequate.	Project generates only 0.56 Mt of waste rock and 0.6 Mt of Category 2 rock, compared with existing waste stockpiles containing approximately 100 Mt.

Item	Risk Evaluation: Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Risk Rating: Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Risk Management Class	Certainty level
01		U						M				M									II					II				II	C2
02		U	VL					M				M									II					II				II	C2
03		R			VL	VL	VL					VL						I	I	I						I				I	C2
04		U										VL														I				I	C2

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					Risk Evaluation																Risk Rating																Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	Construction	Operations	Decommissionin	Post closure	Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
				1	2	3	4	All																																					
T	B	7		**Ventilation**																																									
T	B	7	01		2				Ambient air quality in surface and underground work areas may exceed the level acceptable for worker health.	Health and safety	M	L	III	A 25 m stack for proposed power station will improve dispersion characteristics and lower the concentration of pollutants at ground level. Ongoing ambient air quality monitoring of work areas (and Trigger Action Response Plan), supported by a NO_x specific gas monitor (real-time with alarms).	Ambient air quality modelling for the Ranger 3 Deeps Project has been completed. This predicts concentrations at the portal to be approximately one third of the OEL at its maximum. Annual averages are significantly lower than the OEL. Other contaminants modelled are well below all limits (OEL and NEPM).		U	M				M		L				L		II				II			I				I		II	C2
T	B	7	02		2				Primary ventilation system may not perform to design expectations.	Health and safety	M	P	III	Design based on full mining fleet and maximum production schedule. Heat modelling input into ventilation design and network design. Preventative Maintenance Plan (asset management strategy). Ventilation Management Plan. Refrigeration of air. Low emission diesel equipment.	Heat stress ranked as highest probably health consequence Radiation risk ranked under separate risk, see TF-3-03.		P	L												II													II	C3
T	B	7	03		2				Secondary ventilation system may not provide acceptable air quality to all work places.	Health and safety	M	P	III	Ventilation Management Plan. Continuous ventilation monitoring stations. Preventative maintenance. Stope Ventilation Plan. Equipment selection. Operator training and competency.	Heat stress ranked as highest probably health consequence Radiation risk ranked under separate risk, see TF-3-03.		P	L												II													II	C2
T	C			**Processing**																																								
T	C	1		**Beneficiation**																																									
T	C	1	01		2				Leach tank foaming may occur.	Soil	VL	P	I	Test work and re-commissioning of sorter to optimise for Ranger 3 Deeps carbonate material.	CO_2 emissions will be very small compared to other activities (e.g. power generation). Evaluation is based on increased consumable impacts. Metallurgical testwork and modelling show carbonate digested during the life of project is anticipated to be similar in quantity to 2012.		U							VL		VL	VL									I		I	I		I	C3

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T	D								**Waste Management**																																				
T	D	1							**Waste rock**																																					
T	D	1	01		2	3	4		The amount of mineral waste may be greater than expected.	Water	VL	U	I	Existing controls considered to be adequate.	There is only a small possible increase in Category 2 waste, max 10 %. On closure Category 2 waste will go above the tailings and in the reducing zone (below water table).		U									VL														I				I	C3
T	D	1	02		2	3	4		There may be more geochemically adverse waste than expected.	Water	VL	U	I	Existing controls considered to be adequate.	ERA has an extensive database - any different rock types will be of a small quantity.		U									VL														I				I	C3
T	D	2							**Tailings**																																				
T	D	2	01		2	3	4		Tailings geochemistry may be different to expectation.	Water	L	U	I	Existing controls considered to be adequate.	Currently no observed difference from Pit 3 material. Volume of Ranger 3 Deep tailings material in Pit 3 relative to historic tailings is significantly less and unlikely to alter the magnitude of the solute generation from Pit 3.		U					L	L			L	L							I	I				I	I				I	C3
T	D	3							**Radioactive waste**																																						
T	D	3	01				4		Misclassification of material may occur, i.e. radioactive as non-radioactive.	Water	L	P	II	Primary mechanism for material classification will be incorporation of mine planning and grade control into the mine design. Secondary control is a surface discriminator similar to existing infrastructure that can be used to discriminate material going to waste stockpile(s).	Consequence and likelihood allocated based upon opinion of risk assessment team. Consequence and likelihood are considered to be low/unlikely.		U					L				L	VL							I					I	I			I	C3
T	D	4							**Non-radioactive waste**																																						
T	D	4	01		2	3	4		Existing landfill capacity may not be sufficient to accept waste generated from the Project.	Soil	VL	P	I	Existing controls considered to be adequate.	ERA has ability to create additional landfill containment on site under current management plans.		P	VL				VL		VL	VL	VL	VL			I				I				I	I	I	I			I	C2
T	D	5							**Hazardous waste**																																						
T	D	5	01		2	3			There may be uncontrolled release of gas from refrigerant plant.	Health and safety	L	P	II	Purpose-built refrigeration system. The refrigerant that is to be used is R134A and does not contain ammonia.	This is the same gas that is in general commercial usage in a many applications including car air-conditioning units.		R	VL									VL		I												I		I	C3
T	D	5	02		2	3	4		There may be additional hydrocarbon contaminated waste (above handling capacity).	Soil	VL	U	I	Existing controls considered to be adequate.	This is a routine management requirement.		U							VL	VL	VL													I	I	I			I	C3

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				1	2	3	4	All																																							
T	**D**	**6**	**General waste**																																													
T	D	6	01		2	3			There may not be sufficient sewerage treatment capacity.	Community Trust	L	P	II	The existing Ranger 3 Deeps mine office is to be relocated and the appropriately sized ablutions and associated sewerage treatment are included in the relocated and possibly expanded facilities.	Consequence and likelihood allocated based upon opinion of risk assessment team. Consequence and likelihood are considered to be low/unlikely.		U	VL				L	L										I				I	I										I	C3
T	**D**	**7**	**Emissions**																																												
T	D	7	01	1	2	3			Greenhouse gas emissions may impact air quality	Air quality	V	L	I	Integrating Project power generation with existing power generation. Beneficiation to minimise the processing of carbonate material.	Greenhouse emissions have been established on nationally recognised emission factors (National Greenhouse and Energy Reporting Technical Guidelines).		P												VL											I								I	C3
T	**E**		**Rehabilitation and Closure**																																												
T	**E**	**1**	**Grouting of surface drillholes**																																												
T	E	1	01		2	3	4		Drill holes in the vicinity of the project may provide fast localised pathways for fluid exchange (solute transport).	Water	L	P	II	Existing controls considered to be adequate.	A few holes may be missed or poorly grouted (hence the P ranking for likelihood) but the impact is expected to be low.		P									VL	L										I	**II**							**II**	C2
T	E	1	02			3	4		Fauna may fall down open holes remaining after closure.	Flora and fauna	VL	L	II	Holes are grouted and/or capped.	A few holes may be missed or poorly grouted.		P			VL	VL																I	I								I	C2
T	E	1	03			3	4		Person may be injured from contact with open hole remaining after closure.	Health and safety	M	P	III	Holes are grouted and/or capped.	A few holes may be missed or poorly grouted.		U		M																**II**										**II**	C2
T	**E**	**2**	**Infrastructure removal**																																												
T	E	2	01			3			Habitat disturbance outside of the approved land disturbance area, may occur during infrastructure removal.	Flora and fauna	VL	P	I	Existing controls considered to be adequate.	Consequence and likelihood allocated based upon opinion of risk assessment team. Consequence and likelihood are considered to be very low/possible.		P			VL	VL																I	I								I	C3
T	E	2	02			3	4		Ranger 3 Deeps infrastructure may not be removed post closure.	Community Trust	M	U	II	New infrastructure to be incorporated into the overall Ranger Closure Plan.	Consequence and likelihood allocated based upon opinion of risk assessment team. While consequence could be medium likelihood is considered to be rare.		R				L	L	M															I	I	**II**							**II**	C3

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T	**E**	**3**							**Decline and vent raise backfill**																																					
T	E	3	01				4		Vent shafts may provide pathway for solute transport to Magela Creek post closure.	Water	H	L	IV	Backfill of vent raises on closure (with cemented plug in weathered zone). Siting of raises to avoid depressurisation bores where possible.	The spatial location of the depressurisation holes through the host rock is not precisely known and therefore rank certainty as a 2. Note: This risk is associated with the potential of the ventilation shafts providing an accelerated pathway for non-Project related solutes encapsulated in Pit 3 to travel. The primary solute pathway is via Pit 3 near horizontal depressurisation holes intersecting ventilation shafts. However the planned backfill strategy for these shafts effectively eliminates the occurrence of such solute transport.		P			VL	VL						VL							I	I						I				I		C3
T	E	3	02				4		Decline may provide a conduit for solute transport from Pit 3 sources to Magela Creek.	Water	M	L	III	A combination of bulkheads and appropriate fill (paste or cemented aggregate) will be applied.	Preliminary Intera (solute) modelling indicates vent shafts and decline generates a very small proportion of the total solute loading to Magela Creek.		P			VL	VL						VL							I	I						I				I		C3
T	**E**	**4**							**Neutralisation of acid waste**																																					
T	**E**	**5**							**Soil remediation**																																					
T	E	5	01				4		Ranger 3 Deeps may affect the ability to achieve soil remediation and may induce a greater volume of contaminated soil than planned in the MLAA.	Soil	L	P	II	Various dust suppression applications for underground activities.	Air quality modelling predicts that the uranium concentrations in soils in the MLAA are not expected to significantly increase from current levels. Estimated life of project increase is less than 5 ppm compared to background range in the region of 0-200 ppm.		P			VL	VL					VL				VL			I	I					I				I	I	C3
T	**E**	**6**							**Revegetation**																																					
T	E	6	01		2	3	4		Ranger 3 Deeps may affect ERA's ability to meet its progressive revegetation schedule in the MLAA.	Community Trust	L	U	I	Existing controls considered to be adequate.	Rescheduling of progressive rehabilitation activities will not impact overall closure schedule.		U				L											I									I		C2
T	**E**	**7**							**Earthworks**																																					
T	E	7	01			3	4		There may be an inability to meet the closure schedule due to restrictions imposed by the active underground operations.	Community Trust	M	P	III	A closure strategy that incorporates Ranger 3 Deeps will be established.	Undertaking Ranger 3 Deeps will not have a material impact on the in-pit tailings disposal. Volumes of waste material from the Project are very small and will not impact material balance (Project generates only 0.56 Mt of waste rock and 0.6 Mt of Category 2 rock, compared with existing waste stockpiles containing approximately 100 Mt). Ranking is consistent with Social Impact Assessment.		U				M	M										II	II								II		C3

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					Risk Evaluation															Risk Rating															Risk Management Class	Certainty level
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				1	2	3	4	All																																			
T	E	7	02			3			Impacts to archaeological sites may occur during closure earthworks.	Aboriginal and cultural heritage	H	U	III	Existing controls considered to be adequate.	This is an existing closure risk.		U				H	H	H									III	III		III									III	C3
T	F	1		Health and Safety Surface activities																																							
T	F	1	01		2				Above ground fire may occur (Project generated).	Health and safety	L	P	II	Engineering design controls - e.g. fire suppression. Facility design - e.g. fuel storage.	Fire risk associated with new plant and equipment will be managed within existing systems.		U	L	L	L	L	VL						L		I	I	I	I	I							I		I	C3
T	F	1	02		2	3			Bushfire may occur.	Health and safety	L	P	II	Engineering design controls - e.g. fire suppression. Facility design and location - e.g. fuel storage.	Ranking is based on current propensity for bush fire. The contribution from Ranger 3 Deeps activities is considered to be very low.		P	L	L	L	L									II	II	II	II									II	C3
T	F	1	03	1	2	3			Loss of control of machinery / equipment may occur during surface activities.	Health and safety	H	R	III	Equipment design standards.	The ranking is typical of a high consequence-low likelihood safety risk.		R		H												III												III	C3

Ref.				Applicable To					Risk Description	Major Consequence Area	Current Risk Ranking with Existing Controls			Recommended Additional Treatments	Evaluation Rationale	Risk Evaluation														Risk Rating														Risk Management Class	Certainty level
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T	F	1	04	1					Surface infrastructure construction and maintenance may impact on other infrastructure.	Health and safety	H	U	III	Infrastructure design and location has been subject to detailed engineering assessment.	Community trust consequence relates to power disruption.		U		H			L										III			I										III	C3
T	F	1	05	1	2	3			Public may be injured through contact/interaction with surface infrastructure and operations.	Health and safety	L	P	II	Equipment design and physical barriers.	All the vent raises (excepting the existing Ranger 3 Deeps exploration decline vent raise) will be inside the existing Pit 3 barrier fence. Some of the Ranger 3 Deeps infrastructure will be outside the current supervised mine area. This infrastructure will be fenced. Where the project has to remove this fence for construction or future maintenance purposes it shall be replaced or rebuilt with a fence of equal dimensions. If a maintenance access gate is added it shall also conform to the existing fence dimensions and be lockable.		P		L											II											II	C2
T	F	1	06		2				Personnel may be exposed to oxygen depleted areas during processing of high carbonate ore.	Health and safety	M	U	II	Ore sorting to reduce carbonates.	Processing controls (e.g. acid delivery systems) are such that the situation is unlikely to arise.		R		M											II											II	C3
T	F	1	07		2	3			Collision may occur between underground equipment and surface equipment/personnel.	Health and safety	M	L	III	Develop specific underground equipment Traffic Management Plan.	The ranking is typical of a high consequence-low likelihood safety risk.		P		M											III											III	C2
T	F	1	08		2	3			Cyclone event may impact on the Project.	Health and safety	L	U	I	Infrastructure built to cyclone standards.	Impacts of Ranger 3 Deeps during a cyclone event considered to be negligible.		U		L						VL					I									I				I	C3

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					Risk Evaluation															Risk Rating															Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
T	F	2		**Underground activities**																																								
T	F	2	01	1	2				Major fall of ground may occur in drive/decline.	Health and safety	H	U	III	Mine design (e.g. stope dimensions and access drive locations) is based on geotechnical studies.	Contribution of earthquake considered to be negligible due to location of RPA outside of seismic zone. Standard D1.1 is an existing Rio Tinto standard applied to all underground mining operations. The ranking is typical of a high consequence-low likelihood safety risk.		U		H														III											III	C3
T	F	2	02	1	2				Minor fall of ground may occur in drive/decline.	Health and safety	M	P	III	Existing controls considered to be adequate.	The ranking is typical of a high consequence-low likelihood safety risk.		P		M														III											III	C3
T	F	2	03	1	2				Uncontrolled stope collapse may occur.	Health and safety	M	U	II	Geotechnical modelling informs mine design. Ground support. Tele-remote bogging. Operator training and competency. Paste backfill material in adjacent stopes has undergone design and testwork to ensure sufficient strength.	Workers will not enter into stopes.		R		L														I											I	C3
T	F	2	04		2				Mud rush may occur from backfilled stope.	Health and safety	L	P	II	Engineered bulkheads to retain fill before it cures. QA procedure on the paste before it is injected. Operational procedures - e.g. preliminary plug at base of stope.	Stoping is a standard mining method and Ranger 3 Deeps risks are not unique.		U		L														I											I	C3

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls			Recommended Additional Treatments	Evaluation Rationale	Risk Evaluation														Risk Rating													Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level			Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna	Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
T	F	2	05		2				Flooding of underground may occur.	Health and safety	H	U	III	Collar on vent raises. Flood mitigations for vent raises. Hydrogeological investigations to establish fault locations. Upgrade of mine water management system.	The ranking is typical of a high consequence-low likelihood safety risk.		R		H													III													III	C3
T	F	2	06	1	2				Uncontrolled detonation of explosives may occur.	Health and safety	H	R	III	Majority of explosive stored in above ground magazine; small volume for use taken underground.	The ranking is typical of a high consequence-low likelihood safety risk.		R		H													III													III	C3
T	F	2	07	1	2	3			Loss of control of vehicle may occur.	Health and safety	M	L	III	Develop Traffic Management Plan for construction and operations, and consider design controls to reduce risk. Develop vehicle specifications and audit / inspection. Develop training and qualification requirements. HME vehicle design - e.g. emergency braking.	The ranking is typical of a high consequence-low likelihood safety risk.		P		M													III													III	C3
T	F	2	08	1	2	3			Fire may occur underground causing heat and smoke in the mine.	Health and safety	H	U	III	Existing controls considered to be adequate.	No plans for underground fuel storage or workshop facilities. The ranking is typical of a high consequence-low likelihood safety risk.		U	M	H													II	III													III	C3
T	F	2	09	1	2	3			Cumulative noise exposure may lead to increased risk of industrial noise induced hearing loss in workers.	Health and safety	M	P	III	Equipment design and selection.	The ranking is typical of an occupational noise exposure risk.		P	M													III													III	C3

Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					Risk Evaluation																	Risk Rating															Risk Management Class	Certainty level
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissionin	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Health	Safety	General flora and fauna Species or conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation		
T	F	2	10	1	2	3			Entrapment of workforce underground may occur.	Health and safety	H	U	III	Mine design incorporates a secondary means of egress.	Rated on the basis that at the current stage of design a high safety impact is credible but rare. The ranking is typical of a high consequence-low likelihood safety risk.		R		H			H											III			III											III	C3
T	F	2	11	1	2				Underground blasting may cause discharge from borehole at surface or underground.	Health and safety	M	R	II	Existing controls considered to be adequate.	Consequence and likelihood allocated based upon opinion of risk assessment team. While consequence could be medium likelihood is considered to be rare.		R		M													II													II	C3
T	F	2	12	1	2	3			Underground workers may be exposed to *Legionella* bacteria.	Health and safety	H	U	III	All water that is sent into the mines for services will be treated prior (chlorinated) beforehand.	Ranked "unlikely" because all causes must occur simultaneously for the consequence to occur.		U	H													III													III	C2
T	F	2	13	1	2	3			Person may fall from height while working underground.	Health and safety	H	U	III	Solid barricading of stopes. Signage. Training and competency. Standard operating procedures.	The ranking is typical of a high consequence-low likelihood safety risk.		U		H													III													III	C3
T	**F**	**3**		**Radiation exposure**																																								
T	F	3	01		2				Radiation exposures to the public may be above predictions.	Community Trust	L	U	I	Underground mining method minimises open area (radon emissions reduced).	Air quality modelling predicts that emissions are expected to be very low and much less than current operations. Member of public doses will remain very low and well below the limit of 1 mSv per year.		U					L										VL				I									I	I	C2
T	F	3	02		2				Radiation contamination of the surrounding environment may be greater than predicted.	Community Trust	L	P	II	Majority of vent shafts are located within disturbed mine footprint.	Air quality modelling predicts that the uranium concentrations in soils in the MLAA are not expected to significantly increase from current levels. Estimated life of project increase of less than 15 Bq/kg for each uranium series radionuclide. The ERICA tool ranks this as a very low risk.		U			VL	VL	L										VL			I	I	I							I	I	C2

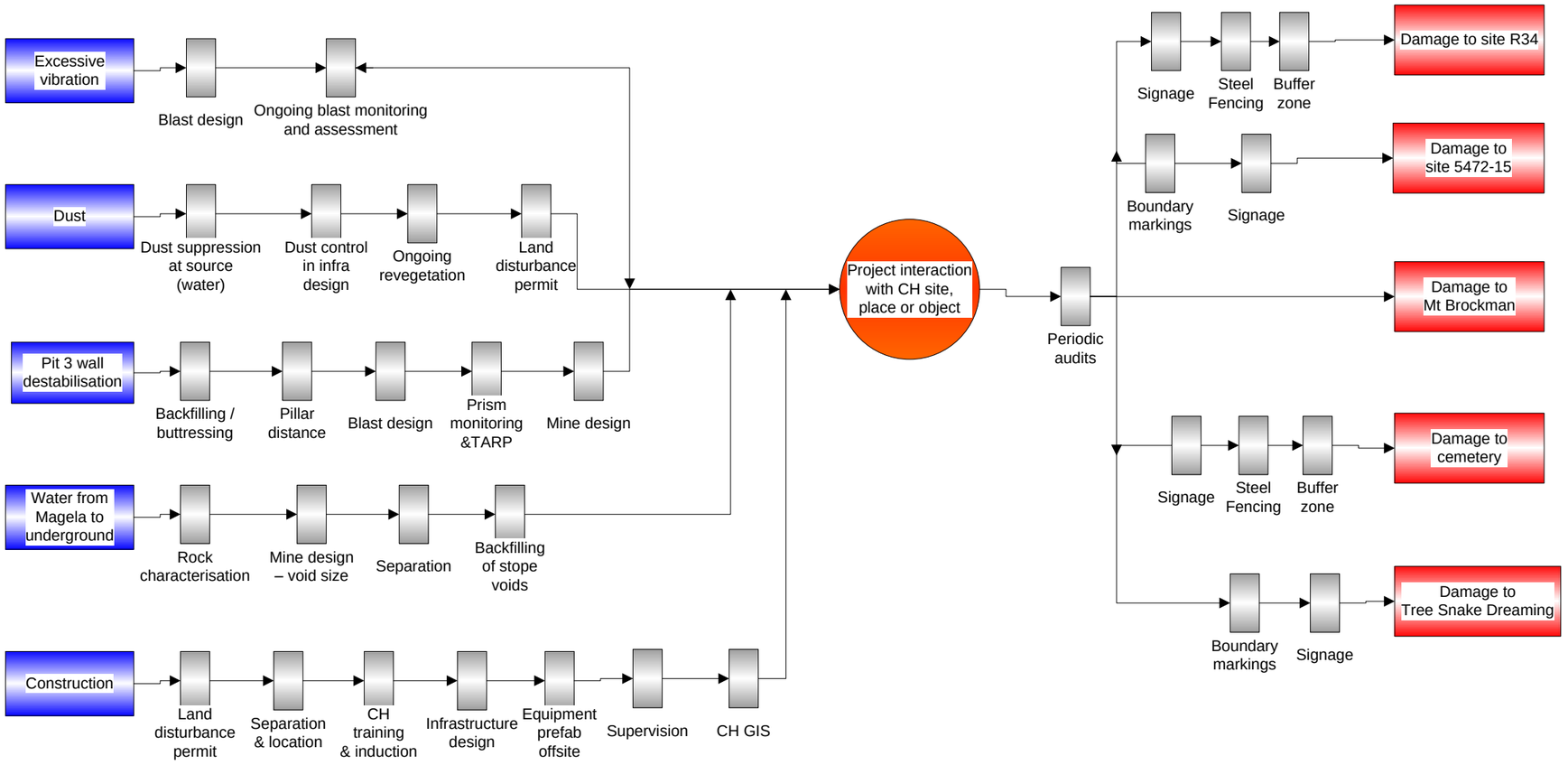
Ref.				Applicable To					Risk Description Evaluated 80 of 80 risks (0 Remaining)	Current Risk Ranking with Existing Controls					
Risk Type (T=Threat)	Category	Subcategory	Item	1 Construction	2 Operations	3 Decommissioning	4 Post closure	All Applies to all	Risk Title	Major Consequence Area	Consequence	Likelihood	Risk Level	Recommended Additional Treatments	Evaluation Rationale
T	F	3	03	1	2	3			Underground workforce may be exposed to radon decay products and dust (LLAA) at levels above acceptable standards.	Health and safety	M	L	III	Ventilation system design. Single pass ventilation. Exhaust ducting and a range of other secondary ventilation options. Air conditioned cabs on equipment. Real-time personal and area monitoring and associated Trigger Action Response Plan. Dust suppression. Provision of sufficient staff for ventilation monitoring and management. Stope Ventilation Plan. Ventilation Management Plan.	Risk ranking is based on radiation assessment by external consultants, incorporating the application of the identified treatments.
T	F	3	04	1	2	3			Workforce may be exposed to gamma radiation that exceeds the annual dose limit.	Health and safety	H	L	IV	Real-time personal monitoring. Shotcreting of walls, backs and face. Equipment shielding. Semi automation of selected production equipment. Barren crushed rock or steel plates on floor for shielding. Minimising worker time in ore. Regular mucking out of sumps.	Risk ranking is based on radiation assessment by external consultants, incorporating the application of the identified treatments.

Ref.	Risk Evaluation														
	Likelihood - Frequency	Likelihood - Probability	Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Aboriginal & Cultural	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation
T F 3 03		U					M	M							M
T F 3 04		P					M	M							M

Ref.	Risk Rating															
	Health	Safety	General flora and fauna	Species of conservation significance	Community Trust	Compliance	Reputation	Aboriginal & Cultural Heritage	Amenity	Soils	Surface Water	Groundwater	Air Quality	Radiation	Risk Management Class	Certainty level
T F 3 03					II	II								II	II	C2
T F 3 04					III	III								III	III	C2

APPENDIX THREE: BOW TIE ANALYSIS

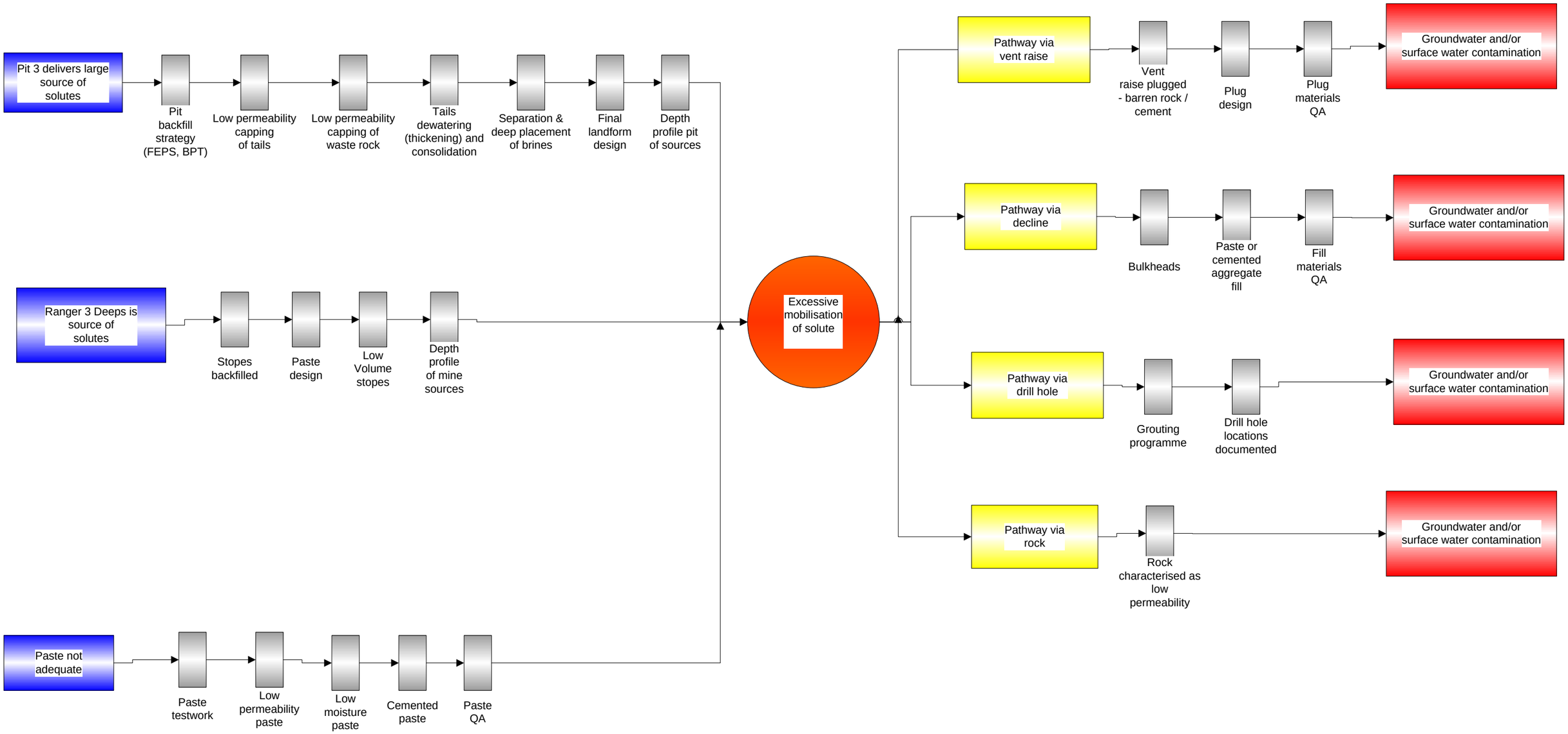
Bow Tie Analysis : Project Interaction with Cultural Heritage Site, Place, Object



Abbreviations:

CH: Cultural heritage
TARP: Trigger Action Response Plan
GIS: Geographic information systems

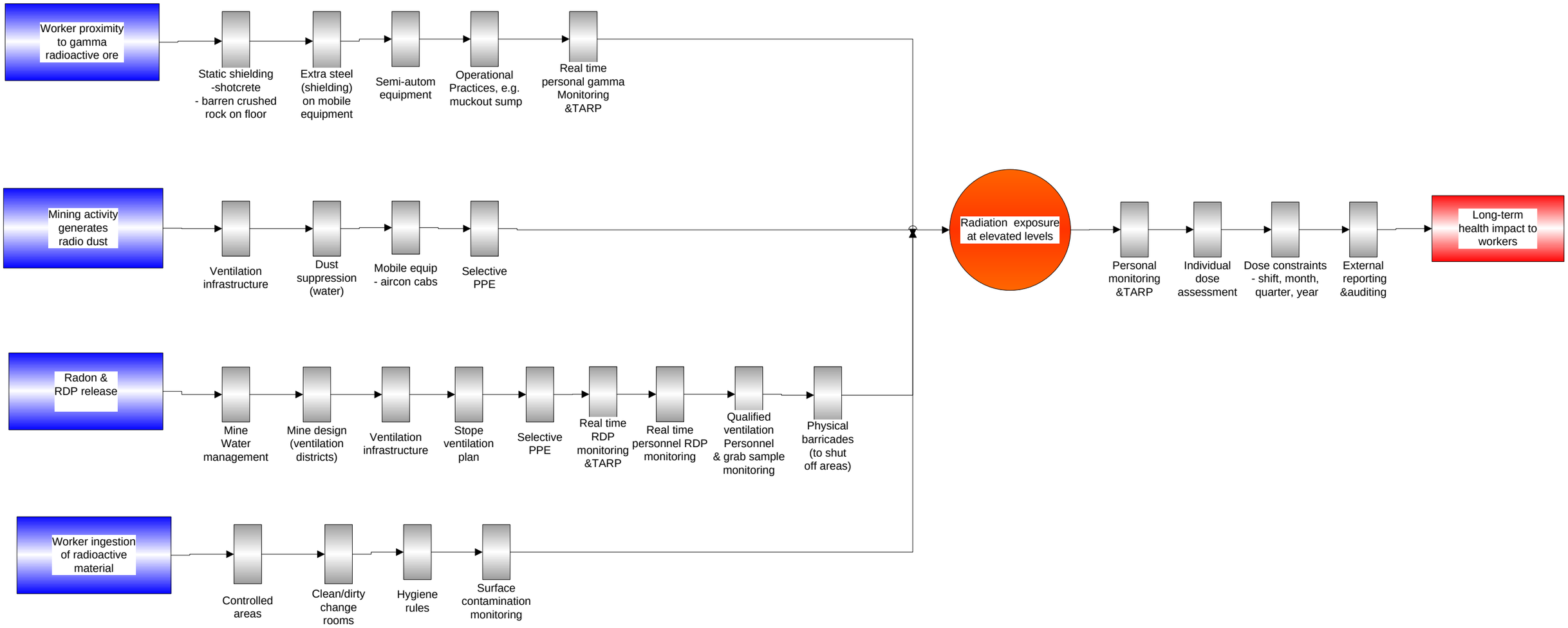
Bow Tie Analysis : Excessive Mobilisation of Solute



Abbreviations:

BPT: Best Practicable Technology
FEPS: Features, Events and Processes analysis
PP: Backfill plant
QA: Quality assurance

Bow Tie Analysis : Radiation Exposure at Elevated Levels



Abbreviations:

PPE: Personal Protective Equipment
RDP: Radon decay products
TARP: Trigger Action Response Plan