O

Human Health and Safety Report

Arafura Resources Limited

Nolans Project Environmental Impact Statement

Appendix O: Human Health and Safety Report

May 2016

Table of contents

Definitions 1

Abbreviations 1

1. Introduction 2
   - 1.1 Project overview 2
   - 1.2 Purpose of report 2
   - 1.3 Study scope 2
   - 1.4 Report structure 3

2. Site overview 4
   - 2.1 Location and surrounding land use 4
   - 2.2 Project description 8

3. Methodology 10
   - 3.1 Hazard analysis 10

4. Results 14
   - 4.1 Human health and safety risk management 14
   - 4.2 Hazard identification and qualitative risk assessment 16
   - 4.3 Risk management discussion 25
   - 4.4 Ongoing risk management 29

5. Summary 30

6. References 31

Table index

Table 2-1 Key project components 8

Table 3-1 Arafura Resources Limited likelihood descriptors 11

Table 3-2 Human health and safety consequence descriptors 12

Table 3-3 Risk criteria 13

Table 4-1 Workshop participants 17

Table 4-2 Hazard identification 18

Table 4-3 Qualitative risk level 24

Figure index

Figure 2-1 Project area and surrounds 6

Figure 2-2 Nolans site 7

Figure 3-1 Arafura Resources Limited risk matrix 13

Appendices

Appendix A - Risk Register

Definitions

Term	Definition
Consequence	The severity associated with an event in this instance the heat radiation from jet fire, flash fire and fireball events or explosion overpressure, i.e. the potential effects of a hazardous scenario.
Consequence Event	The end event associated with a failure and release, considering all detection, isolation and ignition factors, e.g. jet fire, flash fire etc.
Hazard	A physical situation with the potential for human injury, damage to property, damage to the environment or some combination of these.
Hazardous Scenario	The accidental release of a hazardous material from equipment or piping, from identified isolatable section of equipment.
Risk	The combination of frequency and consequences, the chance of an event happening that can cause specific consequences.
So Far As Reasonably Practicable (SFARP)	A level of risk that is below the intolerable level and either the cost of further risk reduction is disproportionate to the benefit gained or where the solution is technically impractical to implement.

Abbreviations

Abbreviation	Explanation
AS	Australian Standard
EPBC	Environmental Protection and Biodiversity Conservation
HAZID	Hazard Identification
HAZOP	Hazard and Operability
JSA	Job Safety Analysis
MW	Mega Watts
NT	Northern Territory
NZS	New Zealand Standard
RE	Rare Earth
REO	Rare Earth Oxide
SMS	Safety Management System
SWI	Safe Work Instruction
TOR	Terms of Reference

1. Introduction

1.1 Project overview

Arafura Resources Limited (Arafura) is planning to develop a rare earths project in the Northern Territory (NT), located north west of Alice Springs (refer Figure 2-1).

The Nolans Rare Earths Project (Nolans project) activities include construction, mining, processing, rehabilitation and decommissioning of an open-cut, rare earth (RE) mine and associated infrastructure. The Nolans project encompasses mining operations using conventional open pit methods (drill, blast, load and haul) to recover up to 900,000 t of ore per annum. Ore would be beneficiated onsite before the RE concentrate slurry would be pumped approximately eight km south to an intermediate processing plant. The RE intermediate plant extracts the RE and includes a sulfuric acid plant, process residue storage facilities and evaporation ponds. RE concentrate would then be transported by road and rail to Darwin's East Arm Port for export. Further processing of the ore would occur at an offshore RE separation plant in an established chemical precinct. The separation plant extracts the RE into individual products through a sequence of solvent extraction (refer Figure 2-2).

1.2 Purpose of report

GHD Pty Ltd (GHD) has been commissioned by Arafura to prepare a Human Health and Safety Report in the Environmental Impact Statement (EIS) for the Nolans project.

In support of the EIS, this report identifies and assesses the potential Human Health and Safety impacts associated with the Nolans project, with the intent of meeting the *Environment Protection and Biodiversity Conservation Act 1999* and the Nolans Project Terms of Reference (TOR) [1] as issued by the Northern Territory Environment Protection Authority (NT EPA).

The purpose of the Human Health and Safety study is to identify and assess the potential impacts to human health and safety as a result of the Nolans project and document the controls that will be implemented by Arafura to mitigate the human health and safety risks so far as is reasonably practicable as per the Northern Territory Work Health and Safety Regulations [2].

1.3 Study scope

The scope of the study includes identification and assessment of the potential hazards to human health and safety associated with all stages and components of the Nolan project. It includes risks to health and safety of the workforce and the general public for the duration of the Nolans project, including post-closure.

Specifically, the scope of this assessment includes the following:

- identification of potential human health and safety hazards
- qualitative risk assessment of the identified human health and safety hazards
- assessment of the risks against the qualitative risk criteria
- discussion of the management, prevention, treatment and monitoring strategies used to minimise the impacts of the Nolans project on human health and safety.

Excluded from the scope of this report are risks associated with radiation exposure. These are covered separately in the radiation chapter.

[1] Terms of Reference, p. 25
[2] NT WHS Regulations

1.4 Report structure

The report structure is as follows:

Section 2: Site overview – This section summarises the proposed location, nearby infrastructure and populations and operational activities proposed for the Nolans project.

Section 3: Methodology – This section briefly discusses the methodology adopted for the preparation of this Report.

Section 4: Results – This section describes the approach to human health and safety risk management for the Nolans project and presents the results of the risk assessment.

Section 5: Summary – This section summarises the findings and conclusions of the risk assessment.

2. Site overview

2.1 Location and surrounding land use

The Nolans site is located 135 kilometres north west of Alice Springs, in the Northern Territory, within Exploration Lease 28473, 28498, 29509. The Nolans project is 10 km west of the Stuart Highway, 65 km west of the Adelaide to Darwin Railway and the Amadeus natural gas pipeline passes directly adjacent to the rare earths intermediate plant and within five kilometres of the mine site (refer Figure 2-1).

The Nolans project site (Figure 2-2) covers approximately 4161 hectares excluding the borefield[3]. The Nolans Bore deposit resource material estimates a total of 47 million tonnes of 2.6% Rare Earth Oxides (REO) using 1% cut-off grade.

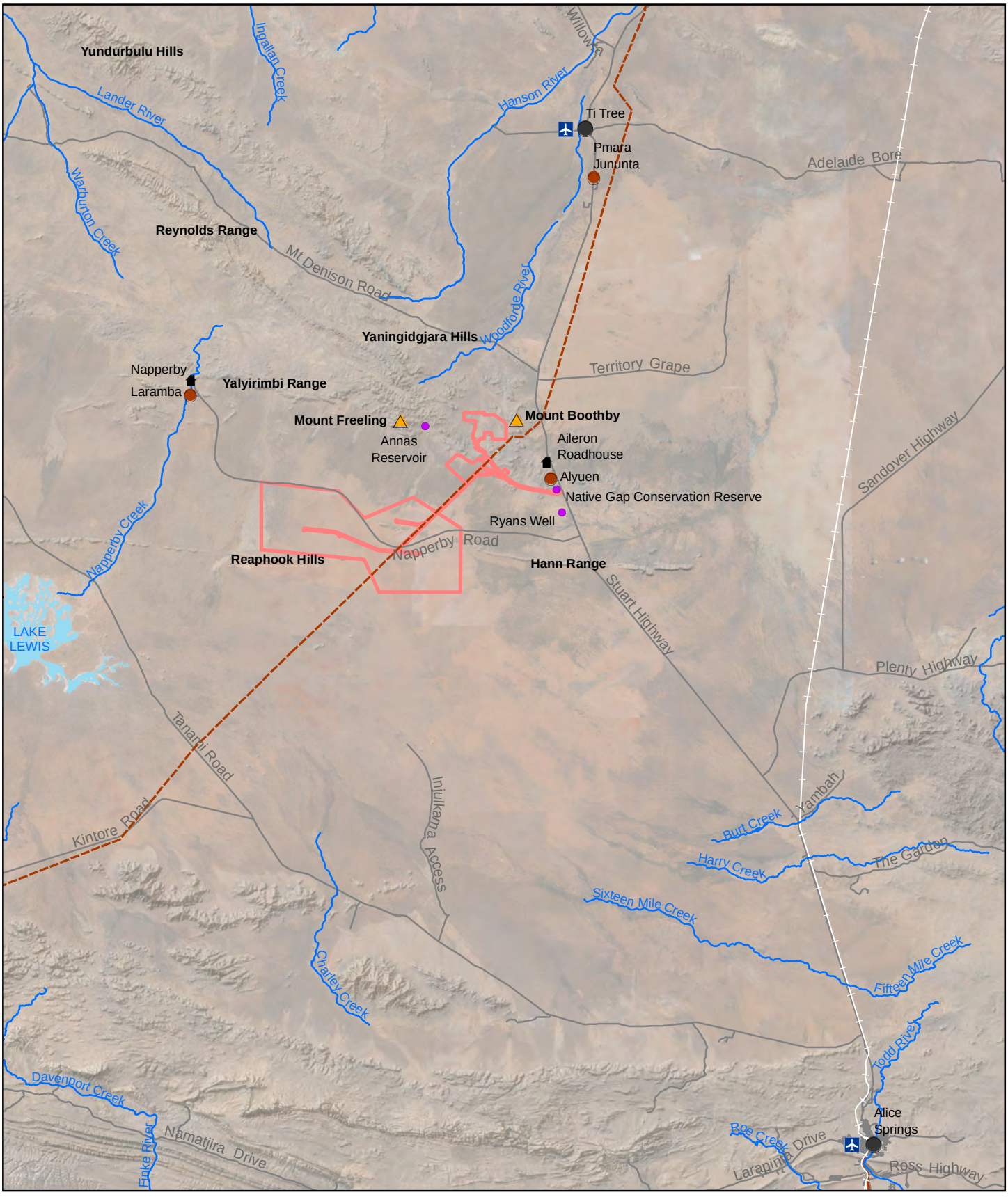
The site is wholly owned by Arafura Rare Earths, a subsidiary of Arafura Resources Ltd. The company is preparing additional applications on EL 28473, EL 28498 and EL 29509 to accommodate for an expanded project footprint [4].

Surrounding the Nolans site is a range of family outstations and small communities. A summary of those closest to the site (within approximately 60 kilometres) include:

- Aileron Roadhouse - important stop-over for travellers on the Stuart Highway providing various amenities, approximately 10 km east of the processing site.
- Alyuen (Aileron) – family outstation 130 km north of Alice Springs and 2 km west of the Stuart Highway (population about 20).
- Alkuptija (Gillans Bore) - family outstation 3 km west of Stuart Highway and 40 km south east of Nolans site (population about 700).
- Burt Creek (Rice's Camp) - family outstation close to Stuart Highway and 50 km south east of Nolans site (population about 700).
- Injulkama (Amburla) – family outstation 40 km south of Nolans site and 100 km to the north west of Alice Springs (population about 10).
- Laramba is a key community due to its relative proximity to the mine site. Access to the community is by the Napperby station road, which runs west from the Stuart Highway. The community is located 83 km from the turnoff. Laramba is a large community of mostly Aboriginal people (population approximately 300) including the traditional owners of the Nolans site and it has a school, community health centre and other facilities.
- Napperby station - 3500 square kilometre cattle station 50 km to the north west which has been owned and operated by the Chisholm family since 1948. This includes a shared borefield area and Laramba community living area.
- Pine Hill (Anyumgyumba) family outstation located 35 km west of the Stuart Highway and approximately 27 km north of the Nolans site (population about 140). Also cattle station recently purchased by the Braitlings, who are planning organic farming.
- Pmara Jutunta (Six Mile) – major community of about 190 people 40 km to the north east of Nolans site and close to the Stuart Highway and Ti Tree community.

[3] Nolans EIS Chapter 3
[4] Nolans Development Report, p. 11.

- Ti Tree community is located approximately 55 km north-northeast of the Nolans site along the Stuart Highway. It is a large community with facilities including a school, health centre, library, police station and airstrip. Population is approximately 280 persons. Ti Tree serves as the operational centre for the Anmatjere Community Government Council (ACGC). Nturiya (Ti Tree Station) is 17 km to the west of Ti Tree and has a population of about 100.



LEGEND

Town	Station	Major Roads	Project Areas
Community	Site of Interest	Gas Pipeline	Waterbodies
Mountain	Airport	Major Waterways	

1:900,000 @ A4

0 10 20 30

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

Arafura Resources Limited
Nolans Project

Job Number	43-22301
Revision	0
Date	18 Mar 2016

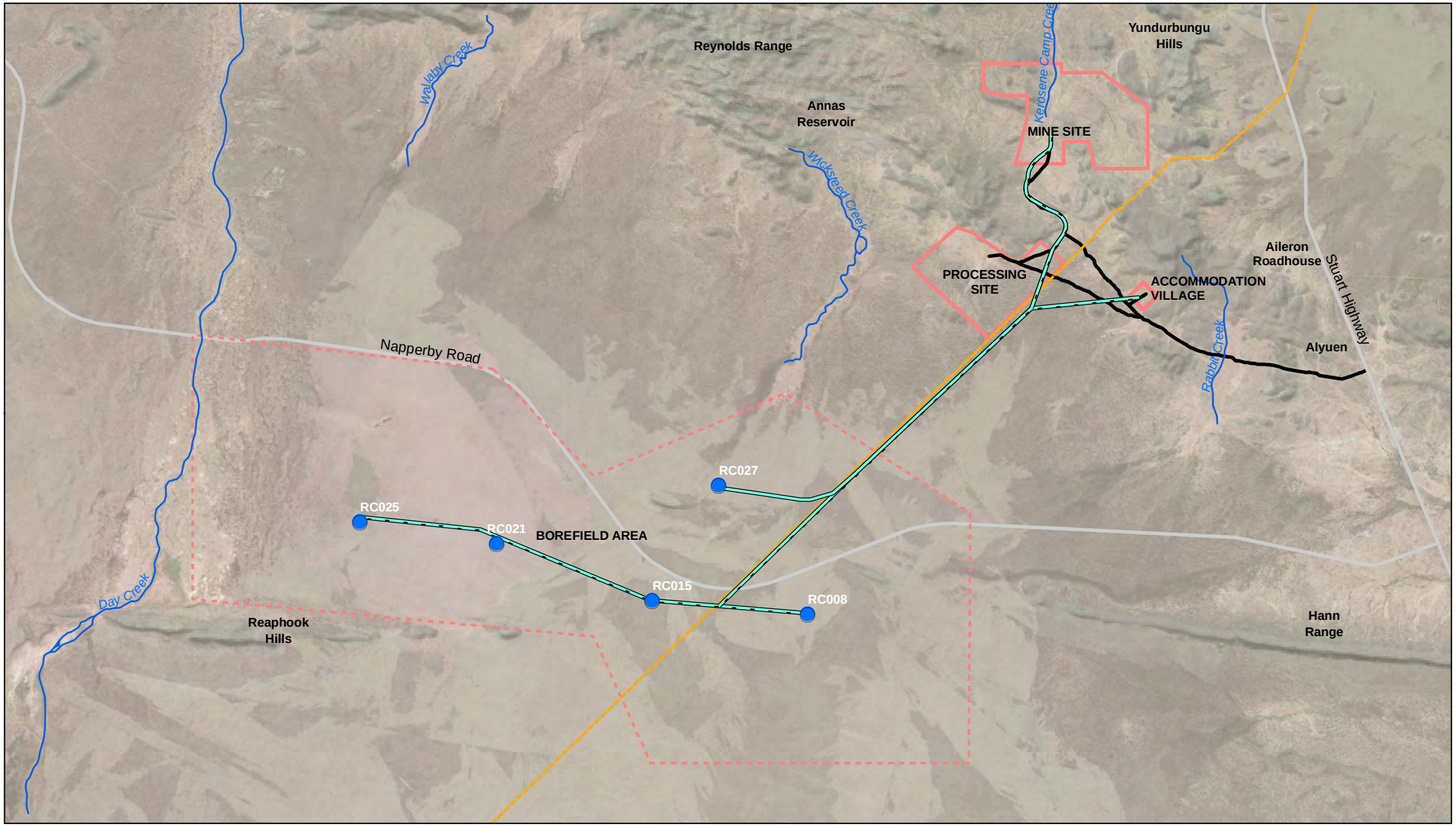
Project area and surrounds

Figure 2-1

G:\43\22301\GIS\Maps\4322301_902_ProjectAreaSurrounds.mxd

Level 5, 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: GA - Roads, Waterways, Placenames, Placenames, Lakes (2015). ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 15/12/2015). ARL - Project Areas (2015). Created by: CM



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Water Bores
- Proposed Powerline
- Proposed Pipelines and Easement
- Existing Gas Pipeline and Easement
- Waterways
- Existing Roads
- Existing Access Track
- Borefield Area
- Site Boundaries

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Nolans site

Figure **2**-2

G:\43\22301\GIS\Maps\4322301_901_NolansSite.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

2.2 Project description

The Nolans project will involve the construction and operation of a range of exploration and production activities and infrastructure. The key components of the Nolans project are presented in Table 2-1 and are shown on Figure 2-1. The Nolans project is expected to be operational for 41 years, depending on production levels. The following project facilities are included within the scope of the human health and safety risk assessment.

Table 2-1 Key project components

Component	Infrastructure or activity
Major facilities	
Mine site	• Mining operation will use conventional drill and blast open-pit mining using trucks and excavators. • A concentrator plant for comminution and beneficiation circuits. These circuits will include staged crushing, grinding circuits, wet magnetic separation and flotation circuits.
Processing site	• RE intermediate extraction. • RE extraction / processing circuits – sulfuric acid pre-leach – sulfation and water leach – double sulfate precipitation and purification – rare earth chloride intermediate and cerium carbonate production. • major components and equipment of each processing operation. • transport of materials to / from the processing circuits.
Borefield area	• Demand for raw water is expected to peak at about 4.8 GL/y. • Water supply from the Reaphook Hills borefield to accommodate for: – processing circuit(s) – process / tailings water – slurry water for product transport – dust suppression – drinking water – water treatments – any other uses.
Ancillary	
Power supply and distribution	• Power demand is estimated to be in the order of 18.5 Mega Watts (MW). • Power supply from an on-site gas turbine-generator (approximately 12.5 MW) and cogeneration from the sulphuric acid plant using excess heat (approximately 6 MW). • Power distributions include overhead lines, High Voltage (HV) switch-gear and transformers from the RE intermediate plant to the Concentrator, accommodation village and borefield.

Component	Infrastructure or activity
Gas supply	• A high pressure gas pipeline from the Amadeus Basin to Darwin passes through the Nolans site. • The close proximity of the Nolans site to the gas pipeline eliminates the need for a significant offtake connection pipeline.
Site access roads	• Site access roads comprising: – Access road from the Stuart Highway (intersection with Stuart Highway approximately 5 km south of the Aileron Roadhouse access road) – Access road and service corridor between the RE intermediate plant and the mine site – Access road and service corridor to the accommodation village – Access track and service corridor to the borefield area.
Site buildings	• Site building, comprising: – Administration building – Concentrator control rooms and operations centre – Concentrator maintenance workshop and warehouse – Concentrator reagents store – Dangerous goods storage – RE intermediate plant control room and operations centre – RE intermediate plant maintenance workshop and warehouse – RE intermediate plant reagents and product warehouse – Sulphuric Acid Plant – Laboratory – Security building – Medical and emergency services centre – Heavy and light vehicle wash station and weighbridge.
Accommodation village	• Accommodation for 300 people in the village will be located approximately 5 km east of the RE intermediate plant.
Water treatment	• 0.25 ML/day capacity potable water treatment facility at the RE intermediate plant to treat raw water from the northern part of the borefield, comprising of: – Filtration and treatment system – Potable water storage tank within the RE intermediate plant sized for 2 days' storage – Potable water pumped from the potable water tank to tanks located within the concentrator / mine services area and accommodation village via HDPE piping

3. Methodology

3.1 Hazard analysis

The main objective of the hazard analysis is to determine the potential risks of the Nolans project to demonstrate that the residual risk levels are acceptable in relation to the health and safety of the workforce and the general public, and to show how the risks will be appropriately managed. The methodology covers the following steps:

- hazard identification, in which site events and external events are identified which may lead to or contribute to human health and safety risks
- qualitative risk assessment to qualitatively ascertain the level of risk associated with the identified hazards.

3.1.1 Hazard identification

The first step in the risk analysis is the systematic identification of all possible hazardous incidents associated with the Nolans project.

This brainstorming activity was conducted as a desktop study based on typical hazards encountered for an open cut mining operation and associated processing facilities.

Subsequent to the desktop analysis, a risk assessment workshop was conducted in Darwin involving representatives from Arafura and GHD to review the draft risk register for completeness and relevance.

The risk assessment workshop included all aspects of the Nolans project as part of the EIS risk assessment, however this report is limited to the human health and safety risks only. Other impacts are covered under the relevant chapters within the EIS.

3.1.2 Qualitative risk assessment

Qualitative analyses use words and descriptive scales to determine the likelihood of each identified hazard and its consequences. This provides an estimate of the likely rate of occurrence of hazardous events and their severity, from which a measure of the risk may be obtained through a simple matrix format of the equation:

Risk = Likelihood x Consequence

The risk associated with the Nolans project is determined by combining the likelihood of the potentially hazardous events and the magnitude of their consequences (refer Table 3-1, and Table 3-2). This is illustrated in Figure 3-1, from a project specific risk matrix developed in consultation with Arafura based on AS/NZS ISO 31000:2009, Risk management - Principles and guidelines.

The process of combining consequences and frequencies gives appropriate weight to the range between small consequence events (which are relatively frequent) and events of major consequence (which are very infrequent).

The risk can then be assessed against relevant criteria as shown in Table 3-3, to determine if additional actions are required to be taken or if the risk is at a tolerable level.

Table 3-1 Arafura Resources Limited likelihood descriptors

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances This event could occur at least once during a project of this nature 91-100% chance of occurring during the Nolans project Substance exposure: Frequent (daily) exposure at very high concentrations e.g. greater than 10 times the OEL.
Likely	The event will probably occur in most circumstances This event could occur up to once during a project of this nature 51-90% chance of occurring during the Nolans project Substance exposure: Frequent (daily) exposure at high concentrations e.g. greater than 100% OEL.
Possible	The event could occur but not expected This event could occur up to once every 10 projects of this nature 11-50% chance of occurring during the Nolans project Substance exposure: Frequent (daily) exposure at moderate concentrations e.g. greater than 50% of OEL, but less than 100% OEL. Infrequent exposure at high concentrations e.g. greater than 100% OEL.
Unlikely	The event could occur but is improbable This event could occur up to once every 10-100 projects of this nature 1-10% chance of occurring during the Nolans project Substance exposure: Frequent (daily) exposure at low concentrations e.g. greater than 10% of OEL. Infrequent exposure at moderate concentrations e.g. greater than 50% of OEL.
Rare	The event may occur only in exceptional circumstances This event is not expected to occur except under exceptional circumstances (up to once every 100 projects of this nature) Less than 1% chance of occurring during the Nolans project Substance exposure: Frequent (daily) exposure at minor concentrations e.g. less than 10% of OEL. Infrequent exposure at low concentrations e.g. greater than 10% of OEL but less than 50% of OEL.

Table 3-2 Human health and safety consequence descriptors

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Safety	Low level short term subjective inconvenience or symptoms. Typically a first aid and no medical treatment.	Reversible / minor injuries requiring medical 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.
Health	Reversible health effects of little concern, requiring first aid treatment at most. Can include minor irritation of eyes, throat, nose or skin, minor unaccustomed muscular or cardiovascular discomfort, nuisance noises, minor headaches.	Reversible health effects of concern that would typically result in medical treatment. Can include temperature effects; travel effects; stress; moderate irritation of eyes, nose, throat or skin, and sunburn. Does not typically require work restriction or reassignment.	Severe, reversible health effects of concern that would typically result in a lost time illness. Can include acute / short-term effects associated with extreme temperature effects (e.g. sunstroke), or musculoskeletal effects, vibration effects, nervous system effects, and some infectious diseases. Typically requires temporary work restriction or reassignment.	Single fatality or irreversible health effects or disabling illness. Can include effects of suspected carcinogens, mutagens, teratogens and reproductive toxicants, progressive chronic conditions and/or acute/short-term high-risk effects. Includes noise induced hearing loss, pulmonary diseases from dusts or fumes, occupational asthma, skin diseases and infectious diseases. Includes acute high risk effects due to exposure to substances such as carbon monoxide, ammonia, hydrogen sulphide. Requires emergency medical assistance and long term work restriction / reassignment.	Multiple fatalities or serious disabling illness to multiple people. Can include effects of known human carcinogens (e.g. chemical substances, radiation), mutagens, teratogens, reproductive toxicants, life-threatening respiratory sensitization and infectious diseases.

Figure 3-1 Arafura Resources Limited risk matrix

Likelihood	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Table 3-3 Risk criteria

Descriptor	Explanation
Extreme	Intolerable - Risk reduction is mandatory wherever practicable. Residual risk can only be accepted if endorsed by senior management
High	Intolerable or tolerable if managed to as low as reasonably practicable - Senior management accountability
Medium	Intolerable or tolerable if managed to as low as reasonably practicable - Management responsibility
Low	Tolerable - Maintain systematic controls and monitor

4. Results

4.1 Human health and safety risk management

4.1.1 Applicable legislation

The Northern Territory (NT) Work Health and Safety Laws are administered by NT WorkSafe and are based on the SafeWork Australia Model Work Health and Safety Act and Regulations.

The applicable NT occupational health and safety legal requirements are defined by the following legislation:

- Work Health and Safety (National Uniform Legislation), Act, 9 September 2014
- Work Health and Safety (National Uniform Legislation), Regulations, 1 July 2015

In addition, the following legal requirements are in effect in the NT and applicable to the Nolans project:

- Dangerous Goods Act 1 January 2012
- Dangerous Goods Regulations, 20 May 2015
- Transport of Dangerous Goods by Road and Rail Act, 14 October 2015
- Transport of Dangerous Goods by Road and Rail Regulations, 31 March 2011

Arafura will comply with the above legislation and applicable codes of practice for all activities associated with the Nolans project.

4.1.2 Management framework

Arafura will implement a health and safety management system that will be used as the basis for the management of all aspects of human health and safety for the Nolans project.

The structure of the management system will be based on guidance provided by WorkSafe Australia and AS/NZS 4801:2001 Occupational Health and Safety Management Systems; and will include the following elements:

- Policies
- Leadership, management, accountability and commitment
- Hazard and risk management
- Information and documentation
- Design and construction
- Incident management
- Management of change
- Contractor management
- Emergency preparedness and response
- Purchasing
- Systems of work / operations and maintenance
- Personnel
- Health and fitness for work
- Monitoring, auditing, review and improvement.

As part of the management system, Arafura's risk management procedures will require the maintenance of a site specific risk register to identify and assess risks to human health and safety throughout the Nolans project lifecycle to ensure those risks are minimised. The risk register will be a live document, formally reviewed on a regular basis to assess the operations and put in place appropriate control measures to prevent and / or mitigate the risks.

The initial revision of the site risk register is that generated for the EIS and discussed in this report. The regular review of the register will enable Arafura to incorporate relevant control measures early into the design of the site and then into the operational plans and procedures.

4.1.3 Hierarchy of control

The hierarchy of controls is a commonly used principle applied across the industry in the management of safety hazards. It involves a prioritised order of control types from the most effective strategies to the least effective strategies.

The aim of applying the hierarchy of control is to have a combination of control strategies to manage a specific risk and to use the hierarchy to reduce the risk so far is reasonably practicable.

The hierarchy of control includes:

- Elimination: Remove or avoid the hazard completely
- Substitution: Replacing with a safer alternative
- Isolation: Separating the hazard from the person, environment or process at risk by isolation, guarding, barricading, alternate duties etc.
- Engineering controls: Constructing new devices to reduce the risk
- Administrative controls: Promote awareness of hazards e.g. signage, procedures, training etc.
- Personal Protective Equipment (PPE): Considered only when other controls are not practical or to increase protection.

By undertaking a risk assessment of human health and safety during the early stages of the Nolans project, Arafura have the ability to implement the hierarchy of control to its fullest extent. During the design stages, control strategies higher in the hierarchy can be applied to eliminate, substitute, isolate or engineer the site, infrastructure and equipment to reduce the risks so far is reasonably practicable.

4.1.4 Incident management

In the event of an unplanned health or safety incident occurring, Arafura will implement an incident management system which aims to identify the hazards and system deficiencies to prevent an incident reoccurring through an investigation and corrective action process.

Arafura will implement an incident management process to enable:

- On-going identification of hazards and reporting of incidents by any site personnel
- Investigation of all reported incidents
- Follow up and close-out of identified corrective actions
- Communication of incidents across the organisation and statutory reporting if required
- Use of findings from incident investigations to improve systems, processes and procedures.

4.1.5 Emergency management

An important element of the management system is emergency response. This incorporates the emergency response systems, procedures and resources. The emergency response process will be managed by the site emergency response team which will consist of dedicated staff. All personnel within the emergency response team will undergo regular training and participate in regular mock and desktop exercises.

As part of the emergency management system, scenario specific emergency response plans will also be developed based on the potential emergency situations that may arise at the operations. Examples include chemical spills, fire and explosions, traffic accident, confined space incident etc.

4.1.6 Reporting and audits

An effective management system includes a monitoring, auditing, review and improvement cycle.

The Arafura monitoring, auditing, review and improvement process will include:

- Routine inspections of assets
- Routine monitoring of control implementation (for example, workplace observation programs)
- Document control system to enable routine review and update of all standards, procedures and work instructions / job safety analysis (JSAs)
- A training management system to identify and track training requirements of all personnel, including refresher training programs
- A permit to work process to monitor and control specific higher risk activities
- A change management system to assess the impacts of changes made
- A communication strategy to notify all relevant personnel of changes made.

Arafura will implement a regular audit program to confirm compliance with the health and safety legislative requirements and company / operations specific processes and procedures. This will also include independent external authorities conducting audits as necessary.

4.2 Hazard identification and qualitative risk assessment

4.2.1 HAZID workshop

A hazard identification and risk assessment workshop was conducted on 11 November 2015 at the GHD Darwin office. The purpose of the workshop was to review the identified human health and safety hazards associated with the proposed Nolans project, identify any additional hazards and assess the risk associated with these hazards.

The workshop was facilitated by GHD and included a cross section of Project personnel. The team members in attendance of the workshop are provided in Table 4-1.

Table 4-1 Workshop participants

Name	Role (Company)
Henry Reynolds	Facilitator (GHD)
Matthew Weir	Co-Facilitator (GHD)
Rebecca Freeman	Principal Risk Consultant (GHD)
Nicole Conroy	Principal Environmental Scientist (GHD)
Brian Fowler	General Manager Northern Territory and Sustainability (Arafura)
Gavin Lockyer	Managing Director (Arafura)
Richard Brescianini	General Manager Exploration and Development (Arafura)

4.2.2 HAZID summary

The full risk register for human health and safety risks is provided in Appendix A.

A total of 25 hazards were identified that could result in a human health or safety risk to the workforce or the general public.

The causes that could lead each hazard to becoming a risk were identified and the associated controls / safeguards to prevent the unwanted outcome occurring were also identified. These safeguards (outlined in Appendix A) are required to ensure the risk scenarios that were identified are contained or at least controlled to an acceptable level.

The only human health and safety hazard identified and assessed to have the potential to impact surrounding land users was associated with off-site transport activities. All other hazards were considered to be able to be contained within the site. Off-site transport is further discussed in Section 4.3.1.

A summary of the hazard identification results are provided in Table 4-2 showing the hazard and maximum reasonable consequence identified.

Table 4-2 Hazard identification

Hazard	Consequences
External bushfire, resulting in structural failures and release of process consumables, products or ignition of gas inventory.	Personnel fatality or injury.
Mobile equipment incident on site including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts.	Consequences will vary depending on severity of impact between minor injury to fatality. Maximum reasonable consequence could be a multiple fatality event when multiple vehicles are involved or multiple personnel in the vehicle(s). The event may occur at any time throughout the life of the Nolans project.
Mobile equipment incident on site including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts.	Consequences will vary depending on severity of impact between minor injury to fatality. Maximum reasonable consequence could be a multiple fatality event when multiple vehicles are involved or multiple personnel in the vehicle(s). The event may occur at any time throughout the life of the Nolans project.
Personnel falling from height or into depth on site including mining, processing, maintenance and administration areas.	Consequences will vary depending on the height and location of the fall between minor injury to fatality. Maximum reasonable consequence would be a single fatality (multiple fatalities may occur e.g. failure of scaffold with multiple personnel on it, however the more reasonable outcome is assumed to be a single fatality). The event may occur at any time throughout the life of the Nolans project.
Personnel exposed to a confined space incident e.g. engulfment, irrespirable or noxious atmosphere.	Consequences will vary depending on the situation and will range from injury to fatality. Maximum reasonable consequence would be a multiple fatality event as it is likely that more than one person will be within a confined space. The event may occur at any time throughout the life of the Nolans project, however is considered most likely during the operational phase.

Hazard	Consequences
Personnel struck by ground failure, rock fall or flyrock event in mining operational areas. Includes material falling from high and low walls, dumps and ramps, falling from loaded trucks.	Consequences will vary depending on the size of material falling and how personnel are impacted (e.g. on foot or in vehicle) and will range between injury to fatality. Maximum reasonable consequence would be a single fatality event as it is unlikely that more than one person will be impacted by a failure. The event may occur at any time throughout the life of the Nolans project.
Personnel in contact with an electrical source (low or high voltage) resulting in electrocution or arc flash burns. This includes all electrical sources on site where exposure may occur during construction or operations.	Consequences will vary depending on the type of contact and energy level associated with the equipment. This would include a range of minor injuries e.g. electric shock, through to electrocution or fatality from arc flash events. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel struck by a dropped or swinging load during lifting by a lifting device or tipping a lifting device.	Consequences will vary depending on the size of the item that falls and the height from which it falls, ranging from an injury to a fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel impacted by fire or explosion. This includes equipment and substance fire and explosions. This may occur during construction or operations. Mining operations fires would typically involve mobile equipment fires. RE intermediate plant fires would typically involve fixed plant fires. This also includes the gas fired power generation plant and Amadeus Basin to Darwin high pressure gas pipeline.	Consequences will vary depending on the size and type of fire and extent of exposure. Personnel may be impacted by smoke, heat radiation from the fire or explosion overpressure. Consequences may range from smoke inhalation, minor burns through to fatality. The maximum reasonable consequence is a multiple fatality event as there is potential for multiple personnel to be impacted in a large fire or explosion event. The event may occur at any time throughout the life of the Nolans project.

Hazard	Consequences
Personnel impacted by an explosives incident during transport, handling, storage or use on site. Potential incidents include misfires, fly rock, person in proximity to a blast and unintended initiation of an explosion.	Consequences will vary depending on the type of exposure and proximity to the event. Personnel may experience projectile / pressure impacts due to tyre pressure release, burns or pressure impacts from tyre fires and crush injuries due to dropped tyres. Consequences may range from minor injury through to fatality. The maximum reasonable consequence is a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel impacted by a tyre or rim incident associated with mobile equipment.	Consequences will vary depending on the type of exposure and proximity to the event. Personnel may experience projectile / pressure impacts due to tyre pressure release, burns or pressure impacts from tyre fires and crush injuries due to dropped tyres. Consequences may range from minor injury through to fatality. The maximum reasonable consequence is a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel exposed to a flood or inrush event into the pit or personnel exposed to flooding within the mine lease e.g. low lying vehicle crossings or dam failures.	Consequences will vary depending on the extent of material released and the material being released. Ground water and flooding events may result in injury e.g. due to slips, trips & falls through to fatality e.g. due to being trapped in a submersed vehicle / drowning. Dam failures may result in injury e.g. due to exposure to tailings products through to fatality from engulfment. The maximum reasonable consequence is a single fatality on the basis of the proximity of personnel to dams and anticipated volumes of material released.
Personnel struck by falling or dropped objects including structural failure.	Consequences will vary depending on the size of the item that falls and the height from which it falls, ranging from an injury to a fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.

Hazard	Consequences
Personnel caught in rotating or moving equipment. This may occur during construction or operations.	Consequences will vary depending on the equipment personnel are drawn into and how they are drawn in, potentially resulting in entanglement and entrapment. This may lead to crush injuries e.g. fingers, amputation of limbs or fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel impacted by a high pressure release (stored energy). This may occur during construction or operations.	Consequences will vary depending on the pressure at time of release, proximity of personnel to the release and the material released. This may lead to fluid injection injuries if personnel are in close proximity or they may be struck by flying debris resulting in either an injury or fatality if the object is large enough or where it strikes the person. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel drowning while working in or around liquid bodies.	Consequences may include minor injuries e.g. due to trips and falls through to fatality (drowning). The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel exposed to hazardous materials via all means e.g. ingestion, inhalation or skin contact.	Consequences will vary depending on the material personnel are exposed to, the means of exposure and the duration of exposure. Consequences range from: - irritation to skin, eyes and respiratory system e.g. due to exposure to sulphur, lime, limestone, sodium sulphate, barium chloride, sodium carbonate - bronchitis and silicosis e.g. due to prolonged inhalation exposure to lime - severe chemical burns and potentially fatality e.g. due to exposure to hydrochloric acid, sulphuric acid, and sodium hydroxide - respiratory & heart failure and potentially fatality due to ingestion of barium chloride. The maximum reasonable consequence would be a multiple fatality, for example due to a catastrophic failure of the concentrated sulphuric acid tank. The event is most likely to occur during the operations phase of the Nolans project.

Hazard	Consequences
Personnel impacted by climatic extremes while working on site in adverse weather conditions.	Consequences will vary depending on the type of exposure, where effects may range from dehydration, sunburn, injuries from being struck by items through to fatality due to heat stroke, struck by lightning or major building / structural failures. The maximum reasonable consequence would be a single fatality as it is considered unlikely for multiple people to be impacted by a single climatic event. The event may occur at any time throughout the life of the Nolans project.
Engulfment of personnel in RE materials while working on site on stockpiles, ROM or around bins, hoppers, chutes etc. Personnel may be engulfed while on foot or in mobile equipment.	Consequences will vary depending on the volume of material in which personnel are engulfed and the ability to self-rescue. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Personnel exposed to hazardous flora or fauna including snakes, spiders, mosquitoes, biting insects, bees, wasps, larger animals such as dingoes / wild dogs, wild pigs etc.	Consequences will vary depending on the flora or fauna to which personnel come into contact and whether or not they have an allergic reaction to bites / stings. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Unauthorised site access / security breach during construction and operation.	Consequences will vary depending on the location of unauthorised access and the reason for access (e.g. if they are deliberately causing harm). Personnel may be exposed to many of the site hazards including mobile equipment movements, residue storage facilities, hazardous chemical etc. The maximum reasonable consequence would be a single fatality. Production losses of 1 week The event may occur at any time throughout the life of the Nolans project.
Personnel exposed to increased noise levels during operation of the mine, RE intermediate plant and associated infrastructure.	Consequences of cumulative noise exposure will be an increased risk of industrial noise induced hearing loss (NIHL). The event may occur at any time throughout the life of the Nolans project.
Personnel exposure to whole body vibration during operation of mobile equipment in mining operations.	Consequences of whole body vibration will ultimately be muscular skeletal disorders. The event is most likely to occur during the operational phase of the Nolans project.

Hazard	Consequences
Personnel exposed to increased risks due to the remote location of the site and / or undertaking lone and isolated work.	Although the initial injury may not be immediately life threatening, there is potential for the situation to escalate due to the distance and time it takes for medical aid. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the Nolans project.
Manual handing injuries during manual work conducted on site across the operations.	Manual handling injuries may include back injuries such as injuries to nerves, bones, joints and soft tissue hernias, ruptured discs and torn back muscles. Other consequences may include sprains of ligaments, strains of muscles or tendons, tendonitis, spondylolisthesis, carpel tunnel syndrome and Repetitive Strain Injury (RSI). The maximum reasonable consequence would be musculoskeletal effects to bones and soft tissue structures. The event may occur at any time throughout the life of the Nolans project.

4.2.3 Risk assessment summary

Of the 25 identified hazards, 2 were assessed as having a current risk rating of 'High', with the remaining 23 rated as 'Medium'. A summary of the risk assessment results are provided in Table 4-3. The full risk assessment is provided in Appendix A.

Table 4-3 Qualitative risk level

Potential Event	Managed Risk Level	Residual Risk Level
External bushfire	Medium	Medium
Vehicle incident off-site	High	High
Vehicle incident on site	High	High
Falling from height or into depth	Medium	Medium
Confined space incident	Medium	Medium
Ground failure, rock fall or flyrock	Medium	Medium
Contact with an electrical source	Medium	Medium
Struck by a dropped or swinging load	Medium	Medium
Fire or explosion	Medium	Medium
Explosives incident	Medium	Medium
Tyre or rim incident	Medium	Medium
Flood or inrush	Medium	Medium
Falling or dropped objects	Medium	Medium
Rotating or moving equipment	Medium	Medium
High pressure release	Medium	Medium
Drowning	Medium	Medium
Exposure to hazardous materials	Medium	Medium
Climatic extremes	Medium	Medium
Engulfment	Medium	Medium
Hazardous flora or fauna	Medium	Medium
Unauthorised site access	Medium	Medium
Noise	Medium	Medium
Vibration	Medium	Medium
Remote location of the site and / or undertaking lone and isolated work	Medium	Medium
Manual handing	Medium	Medium

All human health and safety hazards were assessed to have a medium or above risk level. This is due to the focus of the hazard identification being on the higher consequence events to enable early identification of these events and therefore greater ability to design them out of the operations. The medium risk levels were generally due to the consequence categories of major and catastrophic being selected as the maximum reasonable outcomes.

4.3 Risk management discussion

4.3.1 Transport related risks

The top two highest risks identified for human health and safety were in relation to vehicle movements and the management of traffic on and off-site. The top two risks include:

- Vehicle incidents associated with the transport of materials and personnel off-site on public roads, including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts
- Mobile equipment incidents on site including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts.

In order to manage the vehicle related risks 'so far as reasonably practicable', the proposed control measure that will be implemented for the Nolans project were identified as:

- Design features such as:
  - Segregation between vehicles and vehicles / pedestrians e.g. road access restrictions, dedicated walkways
  - Road design to relevant standards
  - Dedicated laydown / hardstand areas
  - Vehicle design specifications and associated procurement management
  - Vehicle decals and flags, flashing lights.
- Traffic Management Plan
- Authorisation process for vehicles to enter site
- Access restrictions to operational areas e.g. through the use of barricades
- Site speed restrictions
- Vehicle maintenance program including pre-start inspections and routine maintenance
- Road maintenance program, including dust suppression
- Change management
- Equipment and task specific procedures / work instructions
- Equipment and task specific training and competency assessment (including ongoing refresher)
- Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.)
- High visibility PPE.

In addition to the above controls, further systems and processes will be implemented to manage off site vehicle related risks. These include:

- Audit of service provider during selection process to ensure competence and professionalism
- Transport study and associated management systems
- Journey management plans (including minimising travel during dusk / dawn)
- Contractor management system
- National Heavy Vehicle Regulator Scheme accreditation

- Speed limiting on heavy vehicles
- Community consultation and awareness program.

The transport of dangerous goods will be conducted in accordance with the NT Transport of Dangerous Goods Act and Regulations[5] and Australian Dangerous Goods Code[6].

Additional controls have been identified for both vehicle and mobile equipment incidents. This includes in vehicle monitoring systems to track driver behaviour, proximity detection systems and alarms, accident/incident investigation protocols and quarterly road safety briefings.

Although these additional controls have been identified, it is not anticipated to reduce the likelihood from unlikely or the consequence from catastrophic due to the sensitivity of the qualitative risk assessment technique. Therefore, the risk level remains high.

4.3.2 Ground control risks

Inherent within a mining operation is the risk of ground failure or rock fall events. Within the Nolans project human health and safety risk assessment, ground failure or rock fall leading to a person being struck and injured was assessed as a medium risk. Although the consequence is major (potential for fatality), the likelihood is considered to be low (rare) due to the proposed controls that will be implemented.

- Mine design (including review and sign-off processes)
- Mine modelling & mapping (hydrogeological, geological, exploration data etc.)
- Mine geological and geotechnical monitoring e.g. GPS tracking of faults, daily inspections, ground monitoring systems (prism, extensometers, radar, piezometer, survey)
- Geotechnical hazard maps
- Trigger action response plans
- Mine drainage design and systems
- Water management plan
- Blasting design including blasting management and clearance
- Blast vibration monitoring
- Equipment and task specific procedures / work instructions
- Equipment and task specific training and competency assessment (including ongoing refresher)
- Falling object protection systems (FOPS) on mobile equipment
- Access restrictions to pit ramps, slopes & crests
- Hazard reporting.

No further controls were identified for implementation other than those already planned, therefore the risk remains as medium. However, through the ongoing risk management process, if any new technologies or processes are identified that may reduce the risk, these will be considered.

[5] Transport of Dangerous Goods by Road and Rail Act (2015) & Regulations (2011)
[6] Australian Dangerous Goods Code 7.3

4.3.3 Hazardous material exposure

The potential for personnel to be exposed to hazardous materials was identified as a risk associated with the Nolans project, particularly for the processing facilities. Materials identified that may cause harm to personnel include sulphur, lime, limestone, hydrochloric acid, hydrogen fluoride, sodium hydroxide, sodium sulphate, sulphuric acid, barium chloride, sodium carbonate, chlorine, fire suppression chemicals, RE concentrate, tailings, sewage etc.

Personnel may be exposed in a number of ways including during transport and storage or use of the materials. In the event of exposure, consequences will depend on the extent of exposure and the material, therefore it may range from minor consequences such as irritation to skin or the maximum consequence of fatalities, for example due to a catastrophic release of concentrated sulphuric acid.

A number of controls have been identified to reduce the risk, including a number of controls that will be taken into account within the design of the facilities. Some controls include:

- Hazardous substance storage and handling system design specifications
- Plant process control
- Storage, handling and spill management requirements as specified in the Safety Data Sheets, ChemAlert database and legislative requirements for the transport and storage of dangerous goods [7, 8]
- Inspection and maintenance of hazardous substance storage systems
- Spill kits
- Procedure for transport and storage of hazardous substances
- Equipment and task specific procedures / work instructions
- Equipment and task specific training and competency assessment (including ongoing refresher)
- Isolation procedure and associated training
- PPE (eye protection, breathing apparatus, gloves etc.)
- Signage / labelling of equipment containing hazardous substances
- Site induction.

4.3.4 Fire risks

Due to the presence of flammable and combustible materials, there is a potential for fire and explosion events. While the consequences may be catastrophic (fatalities), the likelihood is low (rare) due to the controls that will be implemented; therefore this was assessed as a medium risk.

Scenarios may include equipment (e.g. mobile equipment and fixed plant fires), and substance fire and explosions, for example, diesel storage, gas fired power generation plant and Amadeus Basin to Darwin high pressure gas pipeline. There is also a potential for bushfires to occur which expose personnel to health and safety risks.

A number of controls will be developed during the design stage of the Nolans project, with additional controls developed and implemented throughout operations. Some control strategies include:

[7] Transport of Dangerous Goods by Road and Rail Act (2015) & Regulations (2011)
[8] Australian Dangerous Goods Code 7.3

- Fixed plant & mobile equipment design specifications and associated procurement management
- Hazardous substance storage and handling system design specifications
- Fire detection and suppression systems, fire extinguishers and firefighting training
- Lightning arrestors
- Fixed plant & mobile equipment maintenance program including pre-start inspections and routine maintenance
- Gas pipeline design and SMS (AS 2884)
- Inspection and maintenance of hazardous substance storage systems
- Electrical protection systems
- Thermographic monitoring
- Operational procedures including transport and storage of hazardous substances, isolation, excavation / dig permit; hot work procedure and permit
- Signage and demarcation of gas pipeline
- Fire breaks, cool-season controlled burns, vegetation reduction program
- Fire management plan.

4.3.5 Climate extremes

The location of the Nolans site is in an area with relatively high ambient air temperatures, therefore personnel may be exposed to adverse effects as a result of climatic extremes. This includes high winds, lightning, storms, hail, heat, UV radiation etc.

When working in hot conditions, heat exposure is considered one of the higher risk scenarios which may lead to heat stress or heat stroke. Although it is considered unlikely due to the controls in place, there is a potential for fatality to occur as a result of climate extremes.

There are design features that will assist in reducing the risk of climatic extremes such as equipment design specifications taking into account wind loading, ventilation, lagging of hot surfaces, cooling systems, lightning arrestors etc., however there will also be a number of administrative controls used during operations to reduce the effects of climate extremes such as:

- Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.)
- Adverse weather procedure (including weather monitoring and stop work requirements)
- Trigger action response plans (actions to be taken if the monitored parameter is above the trigger value, with escalation processes for increasing trigger values)
- Lone and isolated workers' procedure
- Heat reducing PPE
- Heat stress / hydration monitoring and provision of camel backs / electrolyte replacement drinks
- Scheduling work to avoid hottest time of day
- Communication protocols.

4.3.6 Remote area risks

Personnel may be exposed to increased risks due to the remote location of the site and / or undertaking lone and isolated work at the Nolans project site due to the increased time for emergency response, potential communication failures and black spots, long travel distances etc. This includes personnel such as exploration crews (drillers, geologists etc.), surveyors, shot firers, pump crew, supervisors, environmental specialists and third party contractors (electrical personnel, fitters etc.).

Although the initial incident may not be immediately life threatening, there is potential for the situation to escalate due to the distance and time it takes for medical aid. Therefore, to reduce the risk associated with the remote location, Arafura will implement the following controls:

- Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.)
- Adverse weather procedure (including weather monitoring and stop work requirements)
- Trigger action response plans (actions to be taken if the monitored parameter is above the trigger value, with escalation processes for increasing trigger values)
- Lone and isolated workers' procedure/protocols
- Journey management plans
- Communication protocols
- Communication equipment suitable for the area and activity
- Vehicles fitted with recovery equipment, first aid kits, water supply etc.
- Emergency response procedures, team and equipment, specifically incorporating the limitations associated with the remote location
- Man down alarms.

4.4 Ongoing risk management

The risk assessment predominantly identifies low likelihood, high consequence scenarios and as the Nolans project progresses, the Safety Management Systems (SMS) will be developed to manage the risks identified. This will incorporate the administrative controls mentioned within the human health and safety risk register to prevent and / or mitigate the identified risks.

The engineering controls identified within the human health and safety risk register will be built into the design of the site and associated infrastructure as the Nolans project progresses. Operational controls will be developed during the design and construction phases and implemented for hand over to operations.

As the Nolans project progresses, there will potentially be further risks identified, and changes may occur to existing risks. These will be identified and recorded in the risk register and the risk assessment will be reviewed and updated regularly.

Each stage of the Nolans project will have specific risk assessment and risk management activities conducted. For example, safety in design assessments, hazard and operability studies and construction risk assessments. When in operations, further task based risk assessments will be developed e.g. safe work instructions (SWI) or job safety analysis (JSA).

5. Summary

A hazard identification and a qualitative risk assessment has been conducted for the Nolans project to identify and assess human health and safety risks to the workforce and general public as a result of the Nolans project.

The qualitative risk assessment identified 25 hazards, two were assessed as having a current risk rating of 'High', with the remaining 23 rated as 'Medium'.

The top two highest risks identified were:

- Vehicle incidents associated with the transport of materials and personnel off-site on public roads, including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts
- Mobile equipment incidents on site including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts.

Although these two transport related risks have been assessed as high, a number of control strategies have been identified to be implemented within the Nolans project, including design features to be incorporated in the facilities to reduce these risks so far as is reasonably practicable.

As the Nolans project progresses, Arafura will implement a health and safety management system that will be used as the basis for the management of all aspects of human health and safety for the Nolans project. The Nolans project will also be developed in compliance with the relevant occupation health and safety legislation and applicable codes of practice.

The health and safety management system will encompass an ongoing hazard identification program to identify any further hazards as the Nolans project progresses and where possible, these will be incorporated into the design of the facilities to eliminate, substitute, isolate or engineer human health and safety risks so far as is reasonably practicable. In the operational phase of the Nolans project, the management system will incorporate operating procedures, systems and processes to manage the identified risks. It will also include incident and emergency management systems, procedures and resources to enable the effective response to an emergency situation and ongoing prevention of incidents through the incident investigation process,

As the Nolans project is in an early stage, further risk assessments will be conducted throughout the project lifecycle to enable ongoing identification and management of human health and safety risks as they arise.

6. References

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Northern Territory of Australia, Work Health and Safety (National Uniform Legislation), Regulations, as in force at 1 July 2015

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Northern Territory of Australia, Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Regulations, as in force at 31 March 2011

Australian Code for the Transport of Dangerous Goods by Road & Rail Edition 7.3, August 2014 (Note: Edition 7.4 is compulsory from 1 January 2017)

AS/NZS 4801:2001 Occupational health and safety management systems - Specification with guidance for use

Appendices

Appendix A - Risk Register

Ref.	Impact pathway			Planned Controls to Manage Risk (as per Project Description, and elements of Standards / Codes of Practice	Initial Risk			Level of Certainty	Additional Controls Recommended to Reduce Risk	Residual Risk			Level of Certainty
	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
36	External bushfire, resulting in structural failures and release of process consumables, products or ignition of gas inventory.	Human health and safety	Personnel fatality or injury	For all receptors: Development and implementation of Fire Management Plan, including: - Maintenance of fire breaks around high-risk areas / activities - Active fire management and vegetation reduction program; - Erosion control in waterways, if fire should occur and results in loss of vegetation that otherwise stabilises soil/sediments. - Fire breaks; - Fire detection and suppression systems, fire extinguishers - and fire fighting training; - Emergency response procedures, team and equipment - Dedicated fire water system around infrastructure - All chemicals and reagents stored in secure compounds on hardstand areas; - Mine water trucks fitted with high pressure monitors and pumps for fire management	Catastrophic	Rare	Medium	Medium Level	No additional controls	Catastrophic	Rare	Medium	Medium Level
37	Vehicle incident associated with the transport of materials and personnel off-site on public roads, including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts. This includes road transport of consumables / products such as sulphur, calcium carbonate, caustic soda (sodium hydroxide), lime, hydrochloric acid, cerium carbonate, barium chloride, RE chloride. It also includes transport of personnel between site and the accommodation village. Causes include: - Human factors (operator non compliance, unfit for work, lack of awareness, third party errors etc.); - Environmental conditions (wet / slippery road, poor visibility, obstructions on road etc.); - Equipment factors (aged or damage, operating outside design limits, modifications to vehicles, poor design etc.)	Human health and safety	Consequences will vary depending on severity of impact between minor injury to fatality. Maximum reasonable consequence could be a multiple fatality event when multiple vehicles are involved or multiple personnel in the vehicle(s). The event may occur at any time throughout the life of the project.	For all receptors: - Audit of service provider during selection process to ensure competence and professionalism; - Transport study and associated management systems; - Journey management plans (including minimising travel during dusk / dawn); - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Contractor management system; - Northern Territory road rules; - National Heavy Vehicle Regulator Scheme accreditation; - Speed limiting on heavy vehicles; - Arafura speed limit operating procedures for buses; - Arafura vehicle design specifications and associated procurement management; - Arafura vehicle maintenance program including pre-start inspections and routine maintenance; - Fit for purpose transport facilities e.g. ISO tank containers; - Community consultation and awareness program; - Police presence; - Bussing of personnel to / from accommodation village and regional centres; - Emergency response procedures, team and equipment; - Trained personnel to assist emergency response services;	Catastrophic	Unlikely	High	Low Level	- In vehicle monitoring systems (Arafura vehicles); - Accident/incident investigation protocols; - Quarterly road safety briefings	Catastrophic	Unlikely	High	Low Level
42	Mobile equipment incident on site including vehicle to vehicle impact, single vehicle incidents (rollover, vehicle over the edge, vehicle impact with structure) and vehicle to pedestrian impacts. This includes all operational areas: in pit, workshops, administration areas, processing plant etc. where vehicle movements are conducted during construction and day to day operations. Mobile equipment includes all vehicle types, including heavy vehicles (haul trucks, cranes, drill rigs, graders, etc.), medium vehicles (water trucks, delivery vehicles, forklifts, service trucks, buses, etc.) and light vehicles (utes, vans and cars). Causes include: - Human factors (operator or pedestrian non compliance, unfit for work, communication failures, lack of awareness etc.); - Environmental conditions (wet / slippery road, poor visibility, obstructions on road, congestion etc.); - Equipment factors (aged or damage, operating outside design limits, modifications to vehicles, poor design etc.)	Human health and safety	Consequences will vary depending on severity of impact between minor injury to fatality. Maximum reasonable consequence could be a multiple fatality event when multiple vehicles are involved or multiple personnel in the vehicle(s). The event may occur at any time throughout the life of the project.	Traffic Management Plan incorporating: -Vehicle design specifications and associated procurement management; - Vehicle maintenance program including pre-start inspections and routine maintenance; - Change management; - Segregation between vehicles and vehicles / pedestrians e.g. road access restrictions, dedicated walkways; - Site speed restrictions; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Dedicated laydown / hardstand areas; - Access restrictions to operational areas e.g. through the use of barricades; - High vis PPE; - Vehicle decals and flags, flashing lights - Road design to relevant standards; - Road maintenance program, including dust suppression; - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Authorisation process for vehicles to enter site; - Operations supervision; - Emergency response procedures, team and equipment.	Catastrophic	Unlikely	High	Low Level	In vehicle monitoring systems; Proximity detection and alarms; Accident/incident investigation protocols.	Catastrophic	Unlikely	High	Low Level

Ref.	Impact pathway			Planned Controls to Manage Risk (as per Project Description, and elements of Standards / Codes of Practice)	Initial Risk			Level of Certainty	Additional Controls Recommended to Reduce Risk	Residual Risk			Level of Certainty
	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
43	Personnel falling from height or into depth on site including mining, processing, maintenance and administration areas. This includes personnel falling while working at height (e.g. greater than 2 m). Examples include falling from scaffolding, personnel lifting devices (e.g. EWP, scissor lift), falling through flooring or an open hatch, falling while accessing & egressing machinery, walkways, ladders and fall from edge e.g. low or high wall. Includes vehicles (HV and LV) driving over bench edges, waste dump tip heads; This may occur during construction or operations where personnel undertake work at heights. Causes include: - Human factors (inappropriate selection or use of fall protection equipment, over reaching, failure to recognise height, unfit for work); - Environmental conditions (wet / slipper surface, poor visibility, trip hazards, uneven or unstable ground, poor visibility, unexpected start up of equipment, external impacts); - Equipment factors (poor design, worn / aged equipment, mechanical failure, missing protection systems, inappropriate equipment for the task)	Human health and safety	Consequences will vary depending on the height and location of the fall between minor injury to fatality. Maximum reasonable consequence would be a single fatality (multiple fatalities may occur e.g. failure of scaffold with multiple personnel on it, however the more reasonable outcome is assumed to be a single fatality). The event may occur at any time throughout the life of the project.	- Equipment design specifications and associated procurement management; - Equipment maintenance program including pre-start inspections and routine maintenance; - Fixed plant design to relevant standards; - Mobile plant design specifications for access/egress (no ladders). - Protective bunds around all pit bench edges, waste dump tip heads. - Fixed plant inspection and maintenance program including structural integrity inspections; - Engineered platforms for specific tasks; - Change management; - Work at heights procedure; - Work at heights training and competency assessment (including ongoing refresher); - Work at heights PPE (fall arrest / fall restraint) including rated anchor points; - Work at heights PPE inspection regime; - Scaffolding training and competency assessment; - Scaffold inspection and management program; - Fitness for work management system including hours of work, drug & alcohol policy etc.); - Operations supervision; - Emergency response procedures, team and equipment; - Designated view points at pit and surveying stations with guarding.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
44	Personnel exposed to a confined space incident e.g. engulfment, irrespirable or noxious atmosphere. Exposure in the confined space may occur as a result of the pre-existing environment or due to changes that occur while personnel are present. Confined space entry may be required during construction and during operations. Gases personnel may be exposed to include methane, carbon monoxide, NOx, SOx, ammonia, solvent fumes, smoke and fire suppression chemicals. Engulfment may occur as a result of unplanned exposure to solids, liquids or gases. Causes include failure to effectively isolate; structural failure within the confined space; failure to identify all hazards within the space; faulty equipment used within the space; chemical reactions; ingress of contaminants from external to the space, monitoring equipment failure, ventilation equipment failure; slips trips & falls.	Human health and safety	Consequences will vary depending on the situation and will range between injury to fatality. Maximum reasonable consequence would be a multiple fatality event as it is likely that more than one person will be within a confined space. The event may occur at any time throughout the life of the project, however is considered most likely during the operational phase.	- Confined space entry procedure and permit; - Confined space entry training and competency assessment including ongoing refresher; - Isolation procedure and associated training; - Restricted access to confined spaces (including signage); - Confined space register; - Pre-entry inspection; - Gas monitor for use during entry; - Adequate ventilation; - Spotter present; - Fitness for work management system including hours of work, drug & alcohol policy etc.); - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
45	Personnel struck by ground failure, rock fall or flyrock event in mining operational areas. Includes material falling from high and low walls, dumps and ramps, falling from loaded trucks. Causes include: - Operational factors (blasting activities causing excessive vibration, poor blast design, poor digging practices, poor low / high wall / bench / dump design, failure to adequately monitor conditions, dropped material from excavator etc.) - Geological / geotechnical factors (underlying geology, variable material properties, excessive water ingress, seismic event, hydraulic conditions etc. Inadequate blast clearance zones.	Human health and safety	Consequences will vary depending on the size of material falling and how personnel are impacted (e.g. on foot or in vehicle) and will range between injury to fatality. Maximum reasonable consequence would be a single fatality event as it is unlikely that more than one person will be impacted by a failure. The event may occur at any time throughout the life of the project.	- Mine design (including review and sign-off processes); - Mine modelling & mapping (hydrogeological, geological, exploration data etc.); - Mine geological and geotechnical monitoring e.g. GPS tracking of faults, daily inspections, ground monitoring systems (prism, extensometers, radar, piezometer, survey); - Geotechnical hazard maps; - Trigger action response plans; - Mine drainage design and systems; - Water management plan; - Blasting design including blasting management and clearance; - Blast vibration monitoring; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - FOPS on mobile equipment; - Access restrictions to pit ramps, slopes & crests; - Hazard reporting; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level

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	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
46	Personnel in contact with an electrical source (low or high voltage) resulting in electrocution or arc flash burns. This includes all electrical sources on site where exposure may occur during construction or operations. Low voltage includes all electrical sources less than 1 kV, for example lighting, pumps, portable tools, welders, gen sets. High voltage includes fixed assets, overhead and underground cables greater than 1 kV AC or 1.5 kV DC. Exposure could occur for a variety of reasons including faulty equipment, equipment damage, excavation or penetration, when isolating power sources, during electrical maintenance, when installing electrical equipment or infrastructure, and during switching activities. Electricians can be exposed to electrical sources at substations, transformers, generators, local panels, cabling etc. Non electrical personnel can be exposed through extension cords, portable tools and distribution centres are considered in this assessment as well as contact with cabling from non-electricians such as digging up electrical cables and contact with overhead cabling.	Human health and safety	Consequences will vary depending on the type of contact and energy level associated with the equipment. This would include a range of minor injuries e.g. electric shock, through to electrocution or fatality from arc flash events. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Electrical asset design specifications and associated procurement management (including extra low voltage used where possible, remote switching, arc flash containment); - Electrical equipment maintenance program including pre-start inspections and routine maintenance; - Electrical protection systems (earth leakage, earth continuity, RCD etc.); - Change management; - Electrical workers training and competency assessment (including ongoing refresher); - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Penetration / dig permit; - Signage and demarcation of electrical cables; - Procedure for working in proximity to power lines; - Isolation procedure and associated training; - Arc flash PPE; - Switching sheets; - Access restrictions to electrical infrastructure (e.g. substations); - Operations supervision; - Emergency response procedures, team and equipment.	Major	Unlikely	Medium	Low Level	No additional controls	Major	Unlikely	Medium	Low Level
47	Personnel struck by a dropped or swinging load during lifting by a lifting device or tipping a lifting device. Lifting devices may include: mobile cranes; overhead cranes; vehicle loading cranes; chain blocks; come-alongs; stands and jacks; equipment with jib attachments (e.g. forklifts, telehandlers). Rigging and restraint equipment that may be used with lifting devices include: ropes, slings chains, restraining devices, shackles, lifting frames and hooks. An incident could occur during a variety of activities including crane lifts, loading/unloading trucks, while transporting a load on a lifting device, while jacking a load into place or during multi-crane lifts. this includes construction and operations / maintenance activities. Causes include: - Human factors (inexperience, unauthorised use of lifting device, communication failures, incorrect equipment selection or use, unsecured loads etc.); - External & environmental factors (load collapse, external impact during lift, confined or restricted work area, uneven or unstable ground, poor environmental conditions / adverse weather etc.); - Equipment factors (poor design, equipment damage / failure etc.)	Human health and safety	Consequences will vary depending on the size of the load and how personnel are impacted and will range from an injury e.g. crushed hand or foot to a fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Lifting device design specifications and associated procurement management; - Lifting device maintenance program including pre-start inspections, routine and statutory maintenance; - Lifting gear (slings / ropes etc.) design specifications; - Lifting gear maintenance program including pre-start and routine inspections; - Change management; - Lifting activity (e.g. dogman, rigger, crane operator) training and competency assessment (including ongoing refresher); - Equipment and task specific procedures / work instructions; - Lift and critical lift plans; - Spotter for lifting activities; - Fit for purpose load restraint devices; - Access restrictions to lifting activities (signs and barricades); - Operations supervision; - Emergency response procedures, team and equipment.	Major	Unlikely	Medium	Low Level	No additional controls	Major	Unlikely	Medium	Low Level

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	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
48	Personnel impacted by fire or explosion. This includes equipment and substance fire and explosions. This may occur during construction or operations. Mining operations fires would typically involve mobile equipment fires. Processing plant fires would typically involve fixed plant fires. This also includes the gas fired power generation plant and Amadeus Basin to Darwin high pressure gas pipeline. Causes include: - Electrical fires (penetration of cables, lightning strike, poor electrical equipment design, faulty wiring, overloading equipment, water / dust ingress, aged / damaged equipment etc.); - Hazardous substance fires or explosions e.g. diesel, LPG, natural gas (hot work in vicinity of flammable materials, static electricity, impact from machinery, leaking valves / pipes, poor transportation or storage, excavation into pipeline etc.); - Friction fires e.g. conveyors, pumps, fans (worn, aged or damaged equipment, loss of lubrication / poor maintenance etc.); - Mobile equipment fires (equipment failure, ingress of dust, poor design, inappropriate use, poor housekeeping etc.); - Operational or maintenance activities (poorly controlled hot work, introduced ignition sources etc.);	Human health and safety	Consequences will vary depending on the size and type of fire and extent of exposure. Personnel may be impacted by smoke, heat radiation from the fire or explosion overpressure. Consequences may range from smoke inhalation, minor burns through to fatality. The maximum reasonable consequence is a multiple fatality event as there is potential for multiple personnel to be impacted in a large fire or explosion event. The event may occur at any time throughout the life of the project.	- Fixed plant & mobile equipment design specifications and associated procurement management; - Fixed plant & mobile equipment maintenance program including pre-start inspections and routine maintenance; - Electrical protection systems; - Thermographic monitoring; - Change management; - Lightning arrestors; - Fire resistant & anti static equipment e.g. conveyor belts; - Dust suppression; - Housekeeping; - Procedure for transport and storage of hazardous substances; - Hazardous substance storage and handling system design specifications; - Isolation procedure; - Inspection and maintenance of hazardous substance storage systems; - Excavation / dig permit; - Gas pipeline design and SMS (AS 2884); - Signage and demarcation of gas pipeline; - Competent maintainers; - Hot work procedure and permit; - Fire breaks; - Fire detection and suppression systems, fire extinguishers and fire fighting training; - Fire management plan; - Cool-season controlled burns, vegetation reduction program; - Emergency response procedures, team and equipment.	Catastrophic	Rare	Medium	Low Level	No additional controls	Catastrophic	Rare	Medium	Low Level
49	Personnel impacted by an explosives incident during transport, handling, storage or use on site. Potential incidents include misfires, fly rock, person in proximity to a blast and unintended initiation of an explosion. Causes include: - Transport incidents (vehicle collision / impact, inappropriate transport e.g. incompatible materials, vehicle fire etc.); - Storage incidents (lightning strike, security failure, poor stock management, external impact, proximity of magazine to other hazards, external fires etc.); - Incidents during charging & firing (external impact to detonators, poor handling practices e.g. external ignition, stray current, poor mixing technique, digging into misfires, equipment / product failure, unintended access to blast zone, failure to establish sufficient exclusion zone, incorrect firing sequence / pattern / layout etc.)	Human health and safety	Consequences will vary depending on the type of exposure and proximity to the event. Personnel may be impacted directly by the explosives (overpressure effects), struck by fly rock or overcome by explosives fumes. Consequences may range from minor injury through to fatality. The maximum reasonable consequence is a single fatality as it is most likely to be a violation leading to a fatality event which would involve a single person. The event may occur at any time throughout the life of the project.	- Procedures for transport, storage and handling of explosives (in accordance with statutory requirements); - Competency and authorisation process for personnel to handle explosives; - Design standards for explosives transport vehicles and magazines; - Inspection and maintenance regime for explosives transport vehicles and magazine; - Explosives transport boxes; - Magazine location selected as far as possible away from personnel and operation areas; - Magazine access restricted to authorised personnel only; - Magazine stock management procedure including segregation, stock rotation etc.: - Explosives & shot firing equipment approved for mine use; Blast design; - Access restrictions for blasting activities; - Procedure for treating misfires including survey pick-up of misfires. - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
50	Personnel impacted by a tyre or rim incident associated with mobile equipment. Incidents may occur during tyre maintenance activities, or while operating equipment with tyres and includes fire, explosion, dropped tyre and rapid air pressure release. Causes include: - Tyre fire or explosion (manufacturing defects, damage, hot work in vicinity of tyres, contact with electrical source, poor inflation management, vehicle overload / excessive travel, lightning strike, external heat source e.g. bushfire, vehicle fire etc.); - Pressure release / rim ejection (damaged rim pieces, tyre overloading, tyre not deflated prior to changing / poor tyre changing practices etc.); - Dropped tyre (tyre handler failure, restricted work area, unplanned movement of load, incorrect storage etc.)	Human health and safety	Consequences will vary depending on the type of exposure and proximity to the event. Personnel may experience projectile / pressure impacts due to tyre pressure release, burns or pressure impacts from tyre fires and crush injuries due to dropped tyres. Consequences may range from minor injury through to fatality. The maximum reasonable consequence is a single fatality. The event may occur at any time throughout the life of the project.	Tyres and Rims Management Plan including: - Tyre and rim design specifications and associated procurement management; - Tyre & rim inspection and maintenance regime including pre-start inspections and routine maintenance / change out; - No hot work on rim when tyre is fitted; - Signage & demarcation of electrical cables; - Procedure for working near overhead powerlines; - Tyre management standard; - Wheel change procedure; - Tyre fire procedure; - Tyre and rim safety procedure; - Fire extinguishers & suppression on mobile equipment; - TKPH monitoring of tyres; - Fit for purpose tyre handling equipment and dedicated tyre handling facility; - Mobile equipment operating procedures and operator competency; - Competency of tyre maintainer; - Tyre cage; - Emergency response procedures, team and equipment; - Operations supervision.	Major	Unlikely	Medium	Low Level	No additional controls	Major	Unlikely	Medium	Low Level

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	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
51	Personnel exposed to a flood or inrush event into the pit or personnel exposed to flooding within the mine lease e.g. low lying vehicle crossings or dam failures. Includes natural occurring events (extreme weather), dam failure, major piping failure, connection to old workings or underground aquifers etc. Dams (tailings and residue storage facilities) include flotation tailings, water leach residue, neutralisation residue, phosphate residue, evaporation ponds. Causes include: - Natural event flooding (failure of drainage system insufficient sump / pump capacity, accessing flooded crossings etc.) - Ground water / aquifer interactions (failure to identify volume of water during planned breakthrough, unplanned breakthrough to aquifer etc.); - Dam / pond failure (wall erosion, inappropriate design, insufficient capacity etc.)	Human health and safety	Consequences will vary depending on the extent of material released and the material being released. Ground water and flooding events may result in injury e.g. due to slips, trips & falls through to fatality e.g. due to being trapped in a submersed vehicle / drowning. Dam failures may result in injury e.g. due to exposure to tailings products through to fatality from engulfment. The maximum reasonable consequence is a single fatality on the basis of the proximity of personnel to dams and anticipated volumes of material released.	- Drainage and pump system design; - Drainage and pump system inspection and maintenance regime; - Water management plan; - Trigger action response plans; - Weather monitoring; - Adverse weather procedure; - Mine design (including review and sign-off processes); - Mine modelling & mapping (hydrogeological, geological, exploration data etc.); - Tailings & residue storage facility level management plan; - Tailings & residue storage facility design including HDPE liner, basin drainage & leakage collection system; - Tailings & residue storage facility inspections including monitoring bores, embankment piezometers, embankment survey pins; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
52	Personnel struck by falling or dropped objects including structural failure. Dropped objects may include tools, RE material, pieces of equipment etc. Structures include buildings, concentrator, conveyors, bins, crushers etc. Objects may fall randomly, therefore person may or may not be in the area, others may fall as a result of operational activities. This includes material falling from conveyors / chutes etc. Causes include: - Falling equipment / components from structures (poor design, poor material selection, high winds, worn / aged / damaged e.g. due to vibration, impact, corrosion etc.); - Falling product / material (poor equipment design, conveyor overload / surge, blocked chutes, product build up over time, hang ups etc.) - Handled items / tools dropped when working above (unintentionally kicked or dropped objects, poor work area set up, poor stacking / restraining practices etc.)	Human health and safety	Consequences will vary depending on the size of the item that falls and the height from which it falls, ranging from an injury to a fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Structural and equipment design specifications; - Structural and equipment inspection and maintenance regime including corrosion control; - Housekeeping including regular wash down: - Process plant design e.g. weightometers, limit switches & interlocks, vibration monitoring, level sensors; - Catch trays / mesh above walkways; - Plant operational process control; - Adverse weather procedure; - Change management; - Restricted access / barriers in locations with risk of falling objects; - Hazard identification; - Tool belts & bags; - Tool restraint devices (lanyards, mats etc.); - Kickboards and mesh between handrails on elevated walkways; - Task specific procedures; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Unlikely	Medium	Low Level	No additional controls	Major	Unlikely	Medium	Low Level
53	Personnel caught in rotating or moving equipment. This may occur during construction or operations. Personnel may be exposed to fixed and mobile equipment on site including conveyors, motors, pumps, crushers, separators, screens, engine bays, drills etc. Causes include: - Guarding failures (failure to replace guards, bypassing guards, interlock failure, modifications to guards, defective / damaged guards etc.); - Isolation failure (non compliance, equipment failure, lack of isolation points, incorrect isolation etc.)	Human health and safety	Consequences will vary depending on the equipment personnel are drawn into and how they are drawn in, potentially resulting in entanglement and entrapment. This may lead to crush injuries e.g. fingers, amputation of limbs or fatality. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Equipment design specifications and associated procurement management includes guarding & interlock requirements; - Equipment maintenance program including pre-start inspections and routine maintenance; - Fixed plant design to relevant standards; - Change management; - Guarding audits; - Isolation procedure and associated training; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Area layout and design to provide sufficient space; - Operations supervision; - Emergency stops / pull wires; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
54	Personnel impacted by a high pressure release (stored energy). This may occur during construction or operations. This includes high pressure release from pipes and storage vessels where personnel may be impacted either by fluid injection or struck by flying debris. Fluids may include grease, air, hydraulics, water, natural gas etc. Causes include: - Equipment factors (poor design e.g. incorrect material rating, poor installation, aged / damaged equipment, overpressure etc.); - Human factors (failure to effectively isolate, operating outside specifications etc.); - External factors (fire impact, external mechanical damage etc.)	Human health and safety	Consequences will vary depending on the pressure at time of release, proximity of personnel to the release and the material released. This may lead to fluid injection injuries if personnel are in close proximity or they may be struck by flying debris resulting in either an injury or fatality if the object is large enough or where it strikes the person. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Equipment design specifications and associated procurement management - includes pressure rating, pressure relief, exclusion zones etc., based on relevant design standards; - Equipment maintenance program including pre-start inspections, routine maintenance and statutory pressure vessel inspections; - Change management; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Isolation procedure and associated training; - Hot work procedure and permit; - Fire detection and suppression systems, fire extinguishers and fire fighting training; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level

Ref.	Impact pathway			Planned Controls to Manage Risk (as per Project Description, and elements of Standards / Codes of Practice	Initial Risk			Level of Certainty	Additional Controls Recommended to Reduce Risk	Residual Risk			Level of Certainty
	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
55	Personnel drowning while working in or around liquid bodies. Liquid bodies include tailings and residue storage facilities (flotation tailings, water leach residue, neutralisation residue, phosphate residue, evaporation ponds), sumps, water ways, tanks, etc. Liquid bodies will be present in the pit, processing plant, tailings and residue storage areas, water and waste treatment plants. Causes include slips, trips and falls (e.g. due to slippery surface, uneven ground), ground failure at edge of storage facility, unintended vehicular entry into liquid bodies (pit sumps, TSF's), failure to identify liquid body (e.g. poor visibility) and handrail / edge protection failure.	Human health and safety	Consequences may include minor injuries e.g. due to trips and falls through to fatality (drowning). The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Adverse weather procedure; - Tailings & residue storage facility level management plan; - Tailings & residue storage facility design including HDPE liner, basin drainage & leakage collection system; - Tailings & residue storage facility inspections including monitoring bores, embankment piezometers, embankment survey pins; - Bunds around pit sump edges, TSF embankments; - Working in and around liquid bodies procedure; - Portable edge protection; - Restricted access to tailings & residue storage facility; - Sump / pit design including demarcation and barricading; - Sump / pit inspection and maintenance program; - Personal flotation device; - Rope ladders installed at intervals around ponds; - Life rings installed around liquid bodies; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
56	Personnel exposed to hazardous materials via all means e.g. ingestion, inhalation or skin contact. Materials include sulphur, lime, limestone, hydrochloric acid, HF, sodium hydroxide, sodium sulphate, sulphuric acid, barium chloride, sodium carbonate, chlorine, fire suppression chemicals, RE concentrate, tailings, sewage etc. Causes include: - Transport & storage releases (leaks from tanks, containers, piping, valves etc., incompatible storage, external impact to storage facility, transport vehicle collision, overfill etc.) - Handling, use & disposal (inappropriate use, isolation failure, inappropriate disposal, poor identification / labelling of materials, overflow or overpressure event etc.)	Human health and safety	Consequences will vary depending on the material personnel are exposed to, the means of exposure and the duration of exposure. Consequences range from: - irritation to skin, eyes and respiratory system e.g. due to exposure to sulphur, lime, limestone, sodium sulphate, barium chloride, sodium carbonate; - bronchitis and silicosis e.g. due to prolonged inhalation exposure to lime; - severe chemical burns and potentially fatality e.g., due to exposure to hydrochloric acid, sulphuric acid, and sodium hydroxide; - respiratory & heart failure and potentially fatality due to ingestion of barium chloride. The maximum reasonable consequence would be a multiple fatality, for example due to a catastrophic failure of the concentrated sulphuric acid tank. The event is most likely to occur during the operations phase of the project.	- Storage, handling and spill management requirements as specified in the Safety Data Sheets, ChemAlert database and legislative requirements for the transport and storage of dangerous goods; - Hazardous substance storage and handling system design specifications; - Inspection and maintenance of hazardous substance storage systems; - Spill kits; - Procedure for transport and storage of hazardous substances; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Isolation procedure and associated training; - Plant process control; - PPE (eye protection, breathing apparatus, gloves etc.); - Signage / labelling of equipment containing hazardous substances; - Site induction coverage;	Catastrophic	Rare	Medium	Low Level	No additional controls	Catastrophic	Rare	Medium	Low Level
57	Personnel impacted by climatic extremes while working on site in adverse weather conditions. This includes high winds, lightning, storms, hail, heat, UV radiation etc. Personnel may be impacted by climate extremes through flying debris or structural collapse in high winds, struck by lightning or experience heat stress when working in hot conditions either due to the local climate or in hot plant areas.	Human health and safety	Consequences will vary depending on the type of exposure, where effects may range from dehydration, sunburn, injuries from being struck by items through to fatality due to heat stroke, struck by lightning or major building / structural failures. The maximum reasonable consequence would be a single fatality as it is considered unlikely for multiple people to be impacted by a single climatic event. The event may occur at any time throughout the life of the project.	- Structural and equipment design specifications including wind loading, ventilation, lagging of hot surfaces etc.; - Structural and equipment inspection and maintenance regime; - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Lightning arrestors; - Lightning tracking and stop work and refuge procedures; - Weather monitoring; - Adverse weather procedure; - Trigger action response plans; - Lone and isolated workers procedure; - PPE - heat reducing clothing; - Heat stress / hydration monitoring; - Use of camel backs, electrolyte replacement drinks; - Scheduling work to avoid hottest time of day; - Communication protocols; - Housekeeping; - Operations supervision; - Emergency response procedures, team and equipment. - Site induction coverage;	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
58	Engulfment of personnel in RE materials while working on site on stockpiles, ROM or around bins, hoppers, chutes etc. Personnel may be engulfed while on foot or in mobile equipment. Causes include: - Engulfment from bins, hoppers & chutes (equipment damage, isolation failure, external impact, process control failure, hang ups etc.) - Stockpile engulfment (unauthorised access, poor stockpile management, poor stockpile stability etc.)	Human health and safety	Consequences will vary depending on the volume of material in which personnel are engulfed and the ability to self rescue. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- RE materials storage systems design specifications; - RE materials storage systems inspection and maintenance regime; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Isolation procedure and associated training; - Plant process control; - Confined space entry procedure; - Stockpile & ROM management procedures and associated competency; - Dust suppression; - Stockpile design including angle of repose, drainage etc.; - Restricted access to stockpiles; - Area lighting; - Operations supervision; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level

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	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
59	Personnel exposed to hazardous flora or fauna including snakes, spiders, mosquitoes, biting insects, bees, wasps, larger animals such as dingoes / wild dogs, wild pigs etc.	Human health and safety	Consequences will vary depending on the flora or fauna to which personnel come into contact and whether or not they have an allergic reaction to bites / stings. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- PPE - Safety boots, long pants etc.; - Induction covering risk; - Snake awareness training; - Vegetation management program; - Snake bites kits and associated first aid training; - Competent snake handlers; - Pest control program (insects, spiders, dingoes, etc.); - Lone and isolated workers procedure; - Communication protocols; - Operations supervision; - Emergency response procedures, team and equipment; - Site induction coverage;	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
60	Unauthorised site access / security breach during construction and operation. This includes all unauthorised access to site and other restricted areas. Access may occur as an intended event or may be unintentional, in both circumstances those entering site will be in danger and may potentially put site personnel in danger. This also includes site personnel accessing site / restricted areas with the intention to cause harm, sabotage and protesters etc.	Human health and safety	Consequences will vary depending on the location of unauthorised access and the reason for access (e.g. if they are deliberately causing harm). Personnel may be exposed to many of the site hazards including mobile equipment movements, residue storage facilities, hazardous chemical etc. The maximum reasonable consequence would be a single fatality. Production losses of 1 week ? The event may occur at any time throughout the life of the project.	- Site security and access restrictions including signage and fencing; - Security management plan; - Additional access restrictions to high risk areas e.g. substations, explosives magazine; - Procedure for escorting visitors; - Contactor management system; - Media communication protocols / plan; - Employee assistance program; - Community engagement program; - Operator observations and reporting; - Emergency response procedures, team and equipment.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
61	Personnel exposed to increased noise levels during operation of the mine, processing plant and associated infrastructure. Noise sources include mobile equipment operations (e.g. engine noise, braking, exhaust, dozer tracks, hydraulics, horns etc.), alarms, dust extraction systems, crushers, screens, ventilation systems, blasting, pneumatic tools etc.	Human health and safety	Consequences of cumulative noise exposure will be an increased risk of industrial noise induced hearing loss (NIHL). The event may occur at any time throughout the life of the project.	- Equipment design specifications include noise limits and associated acoustic attenuation requirements etc.; - Sealed mobile equipment cabs with noise suppression; - Preventative maintenance program for cabins (seals, pressure, noise level test); - Hearing protection; - Hearing protection training; - Signage to indicate areas where hearing protection is required; - Mobile and fixed plant inspection and maintenance program; - Job rotation; - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Noise monitoring program; - Worker audiometry testing; - Site induction coverage;	Major	Unlikely	Medium	Low Level	No additional controls	Major	Unlikely	Medium	Low Level
62	Personnel exposure to whole body vibration during operation of mobile equipment in mining operations. This includes track and rubber tyre equipment activities such as ripping, pushing, tramming and hauling leading to repetitive jolts and jarring.	Human health and safety	Consequences of whole body vibration will ultimately be muscular skeletal disorders. The event is most likely to occur during the operational phase of the project.	- Vehicle design specifications and associated procurement management includes vibration criteria; - Vehicle maintenance program including pre-start inspections and routine maintenance; - Road design to relevant standards; - Road maintenance program, including dust suppression; - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Job rotation; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher);	Moderate	Unlikely	Medium	Low Level	No additional controls	Moderate	Unlikely	Medium	Low Level

Ref.	Impact pathway			Planned Controls to Manage Risk (as per Project Description, and elements of Standards / Codes of Practice	Initial Risk			Level of Certainty	Additional Controls Recommended to Reduce Risk	Residual Risk			Level of Certainty
	Potential event (how the Project interacts with assets, values, uses and location. Include clear description of the cause)	**Environmental Factor (Receptor)**	**Description of consequences** (Clearly understand what is the final impact. Describe whether it is construction, operation or decommissioning)		Consequence	Likelihood	Risk Rating			Consequence	Likelihood	Risk Rating	
63	Personnel exposed to increased risks due to the remote location of the site and / or undertaking lone and isolated work. This includes individuals undertaking unsupervised work or working in an isolated area. Includes any incident where time for response is increased due to insufficient access to communications and monitoring networks as well as emergency, health and vehicle breakdown services. Personnel conducting remote or isolated work may include exploration crews (drillers, geologists etc.), surveyors, shot firers, pump crew, supervisors and environmental specialists, third party contractors (electrical personnel, fitters etc.). The remote location of the site increases the risk to personnel due to the increased time for emergency response, potential communication failures and black spots, long travel distances etc.	Human health and safety	Although the initial injury may not be immediately life threatening, there is potential for the situation to escalate due to the distance and time it takes for medical aid. The maximum reasonable consequence would be a single fatality. The event may occur at any time throughout the life of the project.	- Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Weather monitoring; - Adverse weather procedure; - Trigger action response plans; - Lone and isolated workers procedure/protocols; - Journey management plans; - Communication protocols; - Communication equipment suitable for the area and activity; - Vehicles fitted with recovery equipment, first aid kits, water supply etc; - Emergency response procedures, team and equipment; - Man down alarms.	Major	Rare	Medium	Low Level	No additional controls	Major	Rare	Medium	Low Level
64	Manual handing injuries during manual work conducted on site across the operations. Personnel may sustain injuries due to poor lifting technique, poor workplace and work station layout, incorrect working posture and position, extended duration or frequency of task, over reaching or extending when handling a load, loads moved excessive distances, lifting loads that are too heavy or bulky, tools and equipment unavailable, poor work environment e.g. slippery surfaces, confined or restricted work areas.	Human health and safety	Manual handling injuries may include back injuries such as injuries to nerves, bones, joints and soft tissue hernias, ruptured discs and torn back muscles. Other consequences may include sprains of ligaments, strains of muscles or tendons, tendonitis, spondylolisthesis, carpel tunnel syndrome and Repetitive Strain Injury (RSI). The maximum reasonable consequence would be musculoskeletal effects to bones and soft tissue structures. The event may occur at any time throughout the life of the project.	- Manual handling training; - Plant and equipment design specifications include manual handling / ergonomic requirements; - Fit for purpose lifting aids; - Change management; - Equipment and task specific procedures / work instructions; - Equipment and task specific training and competency assessment (including ongoing refresher); - Fitness for work management system including hours of work, drug & alcohol policy, medicals, fatigue management etc.); - Job rotation; - Area layout and design to provide sufficient space; - Operations supervision; - Site induction coverage;	Moderate	Unlikely	Medium	Low Level	No additional controls	Moderate	Unlikely	Medium	Low Level

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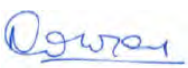
0	B. Jennings	R. Freeman		N. Conroy		29/03/2016

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