

19.0 Hazards and safety

19.1 Introduction

This chapter presents information on the hazards and safety assessment with regards to the Ensham Life of Mine Extension Project (the proposed project, hereafter referred to as 'the Project'). The chapter describes the local conditions and environmental values within the study area and how hazards associated with the study area interact with them. This chapter also provides a preliminary risk assessment to describe potential impacts and mitigation measures to minimise the risk of the hazards during operation of the Project.

Environmental objectives and outcomes

The Project seeks to ensure the risk of, and the adverse impacts from, natural and man-made hazards are avoided, minimised or mitigated to protect people and property. The Project is located in an area known to experience natural hazards including droughts, severe storms and flooding. Project activities are inherently hazardous given the nature of underground bord and pillar mining. However, as the Project is an extension of existing underground operations at Ensham Mine, the risk profile of the identified natural and man-made hazards is not anticipated to change as a result of the Project.

Ensham Mine's existing Integrated Management System (IMS) sets out the framework to enable Ensham to implement a documented and systematic approach to managing risks associated with safety, health and the environment. Specifically, Ensham undertake preparedness activities, including emergency response planning and coordination with local authorities, and in accordance with Environmental Authority (EA) EPML00732813, ensure all hazardous substances are stored and handled in accordance with Australian Standards (G5). These measures are proposed to be extended for the Project to ensure risks are reduced as far as reasonably practicable.

19.1.1 Scope of assessment

The study area for the purposes of the hazards and safety assessment is generally defined as areas of Ensham Mine affected by the Project. Specifically, this includes the Project Site and coal-handling infrastructure which transports product coal from the Project Site to the despatch rail infrastructure. Mining in other areas of the existing Ensham Mine is not included in this assessment. This approach has been selected to ensure that the significant safety risks directly associated with the Project Site are identified and assessed and to verify that the key safety risks already present, identified and adequately managed in the infrastructure supporting extraction and despatch of that coal is unaffected.

The following terms are used throughout the chapter and are defined as:

- Hazards: a source of potential harm or a situation with a potential to cause loss, harm to people or damage to property and environment
- Risks: the chance of something happening that will have an impact on objectives; A risk is often specified in terms of an event or circumstance and the consequences that may flow from it. Risk is measured in terms of a combination of the consequence of an event and their likelihood.

19.2 Legislation and policy

A number of pieces of legislation, regulatory policy, Approved Codes of Practice and Professional Standards govern the activities for the Project, including the requirement for risk assessment; these are identified in the following sections.

19.2.1 Legislation

19.2.1.1 Coal Mining Safety and Health Act

The *Coal Mining Safety and Health Act 1999* (Qld) and *Coal Mining Health and Safety Regulation 2017* (Qld) aim to protect the safety and health of personnel at coal mines as well as people that may be affected by coal mining operations. The Act sets an obligation for the operator, all coal mine workers, designers, constructors, contractors and others on a coal mine, adjacent to a coal mine or contiguous with a coal mine to ensure that the risk of injury or illness to any person resulting from coal mining operations be at an acceptable level. It specifies requirements for Emergency Response, including the requirement for the establishment of a Mine Rescue Capability.

19.2.1.2 Electrical Safety Act

The *Electrical Safety Act 2002* (Qld) and *Electrical Safety Regulation 2013* (Qld) establish the legislative framework to prevent persons from being injured or killed by electricity.

19.2.1.3 Queensland State Planning Policy

The Queensland State Planning Policy provides guidelines to ensure that natural hazards, such as flood, bushfire and landslide are adequately considered when planning developments.

19.2.1.4 Disaster Management Act

The *Disaster Management Act 2003* (Qld) and *Disaster Management Regulation 2014* (Qld) provide for disaster management for Queensland and assist communities in mitigating, prepare, response and recover from a disaster or an emergency. In the context of the Project this relates to the integration of Ensham's Emergency Response Plan with the elements of external Local Disaster Plans.

19.2.1.5 Fire and Rescue Services Act

The *Fire and Rescue Services Act 1990* (Qld) and *Fire and Rescue Service Regulation 2011* (Qld) establish the framework for the management of Queensland Fire and Emergency Services (QFES) and State Emergency Services (SES), while providing the prevention, rescue and responses to fire and other emergency incidents, which may occur at Ensham Mine.

19.2.2 Guidelines and standards

A number of national and international standards apply to the assessment and management of hazards and safety on the Project. These include:

- *AS/NZ 4801:2001 Occupational Safety and Health Management Systems (AS/NZ)* - sets out the requirements you'll need to meet for an effective health and safety management system
- *ISO 45001:2018 Occupational Health and Safety Management System (Int.)* – specifies requirements for an occupational health and safety (OH&S) management system, and gives guidance for its use, to enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving its OH&S performance
- *ISO 31000:2009 - Risk Management - Principles and Guidelines (Int.)* – aims to create standardisation in risk management for all forms of risk to achieve consistency and reliability in risk management.

- *Australian Code for the Transport of Dangerous Goods by Road & Rail Edition 7.6 (Aus.)* - details the technical specifications, requirements and recommendation applicable to transport of dangerous goods in Australia by road and rail
- *AS1940:2017. The Storage and Handling of Flammable and Combustible Liquids (Aus.)* - includes the requirements and recommendations for the safe storage handling of flammable liquids and dangerous goods Class 3 (as classified in the United Nations UN Recommendations for the Transport of Dangerous Goods)
- *AS3780:2008 The Storage and Handling of Corrosive Substance (Aus.)* - sets requirements to ensure the safety of persons, property and the environment where corrosive substances are stored and handled.

19.3 Methodology

19.3.1 Overview

A preliminary risk assessment for the Project has been undertaken in accordance with AS/NZS ISO 31000:2009 and the Queensland Emergency Risk Management Framework (QFES, 2018). The ISO Risk Process Flow Chart is shown below in **Figure 19-1**. This assessment considers the risk to people and property in and around the study area as a result of hazards arising from the Project. The assessment also considers the potential impact on Ensham Mine personnel in relation to hazards with the potential for severe impacts.

As the Project is an extension of the existing operations, this assessment draws on the operational risk management experience and knowledge of the existing operations at Ensham Mine. Furthermore, as there is no construction phase for the Project, the assessment does not consider construction risk. The risks from hazards associated with the decommissioning of the current approved Ensham Mine operations were previously assessed for the current approved activities and will not be considered in this assessment.

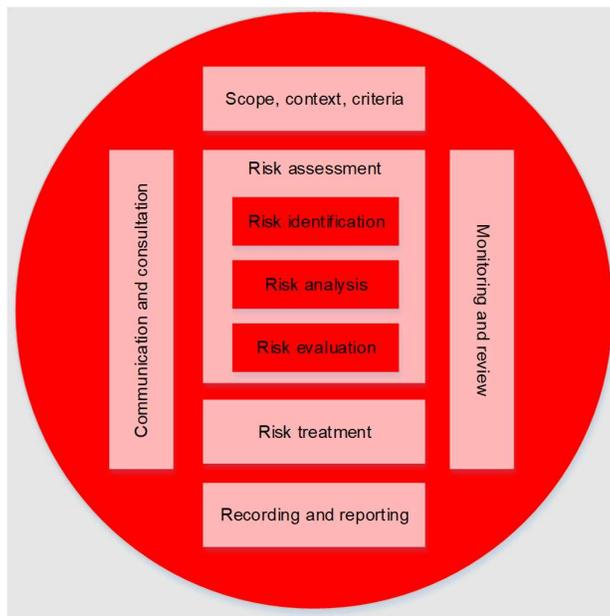


Figure 19-1 AS/NZS ISO 31000:2009 risk process flow chart

The terms used in **Figure 19-1** are explained below:

- Risk identification – the risk identification phase identifies hazards and their potential receptors for the planned extension of the operating life of the Project. Receptors were not restricted to individuals or communities, and included sensitive environmental factors such as land, habitat, flora, and fauna.
- Risk analysis – identified hazards were analysed in terms of the existing operational controls, the range of impacts in the context of those controls, and the likelihood of those impacts arising. Impacts and likelihood were combined to produce an estimated level of risk in accordance with the Ensham Risk Criteria.
- Risk evaluation – risks identified and assessed as part of the risk analysis were ranked in accordance with the Ensham Risk Criteria. Both unmitigated and mitigated risk was evaluated.
- Risk treatment – no mitigated risks were ranked as Critical. Some mitigated risks were ranked as High so the number and type of control measures were reviewed to verify that the mitigated risk was As Low As Reasonably Achievable. Risks associated with the project will continue to be managed through the existing management plans or programs.
- Recording and reporting – all risks associated with the Project are documented in the existing operations risk registers and are monitored.

The assessment of risks to people and property as a result of the Project involved:

- verification of identified hazards with the potential for acute impact on people and property in the surrounding environment, documented in a hazard identification word diagram
- verification of the identified receptors, which are sensitive to exposure to hazards with the potential to emanate from the Project Site
- review of relevant statistics and information to verify the existing probability for hazardous events
- verification of the risks associated with each hazard
- discussion of the existing mitigation measures
- discussion of the existing risk management plan.

Common potential health and safety hazards that could affect site workers in normal on-site day-to day activities during project operation are already considered as part of Ensham Mine's existing operations. These hazards are briefly discussed in **Section 19.5.1**.

The assessment for the Project applies to acute, abnormal, hazardous events and conditions, rather than conditions considered to be routine, which are covered by compliance with regulatory requirements such as licensed release of pollutants e.g. air emissions and waste disposal. The impact of emissions to air are addressed in **Chapter 15** (Air quality) and waste generation is addressed in **Chapter 18** (Waste management).

19.3.2 Risk analysis criteria

AS/NZS ISO 31000: 2009 states that risk analysis consists of determining the causes and sources of risk, their consequences and likelihood taking into account the effectiveness and efficiency of controls. Criteria for likelihood and consequence are detailed in **Table 19-1** and **Table 19-2**.

Table 19-1 Likelihood scale (source: Idemitsu Risk Matrix and Risk Acceptance Threshold Model (2016))

Likelihood	Descriptor	Description	Indicative frequency
1	Rare	The unwanted event has never been known to occur in the business; or is highly unlikely to occur.	Unlikely to occur within 20 years
2	Unlikely	The unwanted event has happened in the business at some time; or could happen.	Could happen within 20 years
3	Possible	The unwanted event has happened in the business at some time; or could happen.	Could happen within 10 years
4	Likely	The unwanted event has occurred infrequently; occurs in order of less than once per year & is likely to reoccur.	Likely to occur within 5 years
5	Almost Certain	The unwanted event has occurred frequently; occurs in order of one or more times per year & is likely to reoccur.	Likely to occur within 1 year

Table 19-2 Consequence scale (source: Idemitsu Risk Matrix and Risk Acceptance Threshold Model, 2016)

Consequence	Descriptor	Safety	Reputation (social/communities)	Environment	Cost
1	Insignificant	First Aid injury. No medical treatment.	Minor disturbance of culture/social structures with no public concern regarding the issue. Potential for localised coverage with no real impact on community.	No impact, or potential impact, on the environment, heritage or animal.	Less than 1% impact on the overall budget
2	Minor	Medical Treatment Injury/illness Reversible disability/impairment	Some impacts on local population, mostly repairable. Single stakeholder complaint in reporting period with some public concern within the immediate community. Localised impact; increased concern from certain groups/organisations with minor impacts over a short period. (e.g. non-government organisations)	Transient impact, or potential impact, on the environment, heritage, or animal. The impact on the environment or heritage is on or potentially on a localised scale, or is of a low intensity.	May result in overall project budget overrun equal to or more than 1% and less than 3%
3	Moderate	Lost Time Injury/illness/moderate irreversible disability (<30%) to one or more workers	Ongoing social issues. Isolated complaints from community members/stakeholders with public concern escalating to a regional level. Regional concern/ adverse publicity over a sustained period within host and neighbouring community's Non-violent protestor action.	Temporary to medium-term impact, or potential impact, on the environment, heritage or animal. The impact on the environment or heritage is on or potentially on a localised to medium scale, or is of a low to medium intensity.	May result in overall project budget overrun of equal to or more than 3% and less than 10%
4	Major	Single fatality and/or severe irreversible disability (>30%) to one or more workers	Significant social impacts. Organised community protests threatening continuity of operations with public concern at a State/National level. Potential for sustained reputational damage through escalated public concern and reaction on a state/national forum with the real potential for negative repercussions affecting shareholders, investors and/or suppliers.	Medium to long-term impact, or potential impact, on the environment, heritage or animal. The impact on the environment or heritage is on or potentially on a medium to wide-scale, or of medium to great intensity.	May result in overall project budget overrun of equal to or more than 10% and less than 30%
5	Catastrophic	Multiple fatalities/irreversible health impacts >50 workers	Major widespread social impacts. Community reaction affecting business continuity. "License to operate" under jeopardy with widespread or high level of public concern about the incident with a National/International impact. Noticeable reputation damage including national/international negative public attention with sustained measurable repercussions affecting shareholders.	Permanent or potential for permanent, long-term impact on the environment, heritage or animal. The impact on the environment or heritage is on or potentially on a wide-scale, or of great intensity.	May result in overall project budget overrun of 30% or more

19.3.3 Risk level

The likelihood and consequence scales are combined to evaluate the overall level of risk, as outlined in Table 19-3.

Table 19-3 Risk levels

Likelihood level	Consequence level				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost certain (5)	Medium	High	Critical	Critical	Critical
Likely (4)	Medium	Medium	High	Critical	Critical
Possible (3)	Low	Medium	High	Critical	Critical
Unlikely (2)	Low	Low	Medium	Critical	Critical
Rare (1)	Low	Low	Medium	High	High

19.4 Existing environment

19.4.1 Existing operations

In the context of hazards and safety, the existing operations at Ensham Mine consist of open-cut and underground operations.

The underground mining method used at the Ensham Mine is bord and pillar, involving the use of a continuous miner to remove the coal while leaving a series of pillars to support the roof. The underground equipment will continue to use continuous miners which will provide sufficient capability to mine within the Project Site. Shuttle cars, mobile bolters and feeder breakers will also continue to be used. Blasting will not be required for the Project. Mined coal from the Project Site will be removed by the existing underground conveyor system to the run of mine (ROM) stockpile just beyond the access portal for handling within the surface infrastructure i.e. truck transfer from ROM stockpile to the Coal Handling Plant, product stockpiling and rail loadout.

Dangerous goods and hazardous substances used in the operations are transported to Ensham Mine by road. Product coal is dispatched from Ensham Mine to Gladstone by rail along a spur line.

19.4.2 Project Site characterisation

The predominant land uses within the wider region include cropping, grazing and resource activities. The land use in the Project Site includes cropping and grazing land and waterways with fringing riparian vegetation.

The area surrounding the Project Site is sparsely populated. Two homesteads are located within the Project Site (Braylands Homestead and Chelbrook Homestead) on freehold land. An additional 10 homesteads are located within 5 kilometres (km) of the Project Site. A significant proportion of the site workforce is accommodated in a camp on the eastern side of Ensham Mine. The nearest town is Emerald, which is 35 km to the west of Ensham Mine.

The region is subject to the residual effects of tropical cyclones.

19.5 Hazard identification

19.5.1 Site workers health and safety hazard identification

The identification of hazard and risks associated with the Project and effective risk control measures draws on existing Ensham Mine operational experience. **Table 19-4** details the common workplace health and safety hazards that are likely will be present in day-to-day activities during Project operation. These hazards and the means to treat the risks they give rise to are well addressed in workplace health and safety legislation, codes of practice and relevant professional standards already adopted by Ensham operations. The extension of the underground mining operations does not introduce any new hazards or alter the existing operational hazards. Therefore, the Project is not expected to alter the site workers health and safety risk profile. These hazards are not carried forward into the more detailed risk assessment.

Table 19-4 Hazard identification - site workers health and safety

Hazard	Description	Consequence	Risk treatment measures
Manual handling	Incorrect handling	Injury likely to recover from	Use approved safe work method, training and competency assessment, provide equipment fit for purpose and suitable allocation of resources.
Slips and trips	Water/oil on ground	Injury likely to recover from	Use approved safe work method, training and competency assessment.
Interaction with mobile equipment	Worker hit by mobile equipment	Injury/fatality	Training, competency assessment, systems of authorisations, inspections, signage, traffic management plan, "no go" zones, dedicated pedestrian walkways.
Working at heights	Fall	Injury/fatality	Training, competency, appropriate scaffolding and/or personal protection equipment (PPE), inspections, safe work methods.
Working with electrical equipment	Electric shock/electrocution	Injury/fatality	Qualified electricians, training, competency, approved safe work methods, equipment maintenance, testing and tagging procedures, inspections, separate/barricade work areas, isolation permit system.
Equipment with moving parts	Failure to isolate correctly	Injury/fatality	Isolation procedures, tag protection system, maintenance of guarding, inspections, training, competency.

Hazard	Description	Consequence	Risk treatment measures
Falling objects	Object falls from height	Injury	PPE, barricading, approved safe work methods.
Fatigue	Operating plant and equipment whilst tired	Injury/fatality	Fit for work program, fatigue management plan, traffic plan.
Confined space	Suffocation	Fatality	Confined space permits, training, competency, approved safe work method statement, equipment serviced regularly.
Pinch points	Crush	Fatality	Safe work methods, training, competency, guarding, barricading, signage.
Lightning	Struck by lightning	Fatality	Storm procedures, approved safe work methods, lightning masts.
Wildlife hazards	Snake bites	Fatality	PPE e.g. long trousers, high sided safety boots, first aid training, emergency management plan.
Disease vectors	Mosquito bites	Illness	PPE e.g. long trousers, long shirts, insect repellent where required. Water bodies, including dams, managed to avoid stagnation hence minimizing potential for mosquito breeding sites.
Dust	Clearing, excavation, unsealed roads, blasting	Respiratory issues	Watering roads, dust suppression, PPE.
Noise	Excessive noise from plant and equipment	Hearing loss	PPE, noise barriers, equipment location.
Sun burn	Working in sun without protection	Skin damage, no treatment	PPE, provision of sunscreen.
Dehydration/heat stress	Working in hot conditions without sufficient water	Hospitalisation	PPE, safe work method statement, provide water, training.
Welding and cutting	Fumes, hot metal, sparks	Poisoning, skin burn, foreign object in eye	PPE, safe work method statement, qualifications.
Exposure to hazardous substances	Oils, diesel, chemicals	Skin, eye irritation	PPE, training, MSDS, standards and procedures for transporting, handling, using and disposing of hazardous substances.
Fire	Buildings, vehicles, conveyors, Coal handling plant (CHP)	Smoke inhalation	Emergency exits, training, Emergency Management Plan, fire extinguishers, fire alarms.

19.5.2 Dangerous goods and hazardous substances identification

The Project involves the transport, use and storage of dangerous goods and hazardous substances. The list of dangerous goods and hazardous substances expected to be used during Project operation, along with their purpose and dangerous goods details are presented in **Table 19-5**. These hazards are carried forward into the more detailed risk analysis in the following sections. The extended underground mining activity does not introduce any new hazards to the existing operations or alter the existing operational hazards therefore is not expected to alter the site workers health and safety risk profile.

Table 19-5 Indicative list of dangerous goods and hazardous substances

Chemical name	Storage location	DG class	UN no.	PG	Purpose/use	Highest likely total storage quantity (litres (L))	Rate of usage	Comments
Diesel	MIA	3	1202	III	Fuel for mobile equipment	353,600 L	33,351 L/day	Diesel is reticulated to heavy vehicle and light vehicle bowzers. Access to the fuel facility is via internal access roads. The fuel facility is located at a safe operating distance from other and surrounding facilities in accordance with AS1940. Diesel fuel is stored in self-bunded tanks. Spill kits are located near the diesel filling stations.
Unleaded petrol	Warehouse	3	1203	II	Emergency use only.	40 L	5 L/day	Stored in self-bunded flammable liquid storage containers in accordance with AS1940.
Oils <ul style="list-style-type: none"> • transmission oil • hydraulic oil • final drive oil • waste oil • lubricants and coolants • engine coolant • gear oil. 	Various locations around mine	3	1170, 1223, 1307, 1268, 3295, 1993	II and III	Lubricate equipment	30,000 L	624 L/day	Stored in self-bunded flammable liquid storage containers in accordance with AS1940.
Solvents (e.g. acetone)	Various locations around mine	3	1268, 1170, 1223, 3295	II and III	Degreasing agent	5000 L	238 L/day	Self-bunded flammable liquid storage containers in accordance with AS1940.

19.5.3 Other significant operational hazards

In addition to the dangerous goods and hazardous substances identified in **Table 19-5**, Other operational hazards present with the potential for major safety consequences if not adequately managed are listed in **Table 19-6**. These hazards are carried forward into the more detailed risk assessment.

Table 19-6 List of other significant operational hazards

Activity	Hazard
Coal mining operations	
Strata failure	Roof, pillar, rib or floor strata failure
Transporting ROM coal (conveyor system and trucks)	Conveyor system fire
	Heavy Vehicle accident
	Dust
CHP facilities including crushing, screening, blending, train loadout	Coal dust
	Fire, explosion
Coal stockpiling	Dust
	Fire
Product coal transport — rail loop and rail spur	Fire
	Vehicle interactions
	Coal dust
Mine-affect water management	
Management of mine-affected water	Unauthorised release: overtopping of storage facility

19.5.4 Natural hazards identification

19.5.4.1 Flood

The Project Site is located to the north and south of the Nogoia River. The Nogoia River consists of a 20,000 km² catchment and has been subject to multiple major flooding events. In January 2008 flood waters washed through Ensham Mine causing a temporary halting of operations in two of the six coal pits. The river was impacted by another major flood in Nogoia's upper catchment and at Emerald between December 2010 and January 2011.

Impacts on surface water flow across the Project Site associated with subsidence are not predicted. The Project will not alter the existing surface topography by more than current natural variation due to wetting and drying of soils. The Subsidence Assessment (**Appendix B-2** (Subsidence)) predicts subsidence as a result of the Project would be less than 40 mm. In addition, no potential changes to flooding including instability and erosion of waterways are predicted based on flood modelling undertaken for the Project. Impacts on surface water resources are discussed further in **Chapter 10** (Surface water resources).

During extreme wet weather events, flood waters within the Nogoia River channel above the mine add additional load to the pillars that support the roof. The Project is proposed to be undertaken using a minimum FoS of 1.6 for pillars supporting the roof within panels, including below the Nogoia River.

Analysis of the proposed mine structure below the Nogoia River has concluded that risk associated with the lower FoS is remains tolerable through application of an increase in pillar dimensions and/or a reduction in mining height within panels, as detailed in Chapter 11 (Flooding and Geomorphology). Between panels, where barrier pillars are located, the FoS increases to 2.75 for 35 m wide barrier pillars and 3.15 for 40 m wide barrier pillars providing additional support for flood loads. Impacts on the mine structure from flood water loading and proposed FoS are discussed in detail in Chapter 11 (Flooding and geomorphology) and Chapter 8 (Land

resources) further detail can also be found in “Increase in Pillar Load During a Flood Event” memo (Gordon Geotechniques, 2021)).

19.5.4.2 Bushfire

The Project is located in an area with heightened bushfire risk (Queensland Fire and Emergency Services, 2020). The bushfire season in the region extends from mid-late winter through to early summer. The threat of bushfires increases with periods of reduced rainfall and increased temperatures, which can increase the amount of dry grass available to burn.

The climate statistics from the Australian Bureau of Meteorology (BoM) show the mean maximum temperature of 34.6°C at the Emerald Airport station in summer (BoM, 2020a). Mean rainfall values also highlight the distinct wet (summer) and dry (winter) seasons experienced by the region, as well as the large variation in rainfall amounts received across the wider area. Climate modelling from the CSIRO projects a temperature rise of up to +2°C by 2030 (CSIRO, 2001). The primary determinant of bushfire in the Monsoonal North is fuel (vegetation) availability which varies mainly with rainfall.

The hot and seasonal dry conditions experienced in the Project Site, both now and in the future, can be conducive for a bushfire event. The Project will not alter the current profile of this risk.

19.5.4.3 Cyclones and storms

In Queensland, tropical cyclones mostly form from lows within the monsoon trough and affect the northern areas of the state (BoM, 2020a). While relatively uncommon, these systems are generally formed during summer months and affect coastal areas. Since 2000, there have been several tropical cyclones of significance in Queensland, of which three impacted the vicinity of the Project Site. Climate modelling from the CSIRO projects tropical cyclones to become less frequent, but with increases in the proportion of more intense storms.

The extended underground mining activity will not alter the current profile of this risk.

19.5.4.4 Earthquakes

Geophysical hazards, such as earthquakes and their associated tremors and aftershocks, are relatively rare in Australia and are usually caused by movements along faults as a result of compression in the earth's crust (QFES, 2019).

The Project Site is located in an area mapped by Geoscience Australia (2020) as being low risk for earthquake activity, with a negligible peak ground acceleration on rock for a 500 year return period. One earthquake has been recorded in the last 10 years, approximately 40 km south-east of the Project near Blackwater (Geoscience Australia, 2020).

The extended underground mining activity will not alter the current profile of this risk.

19.5.4.5 Wildlife

Terrestrial wildlife

Minor direct and indirect impacts to flora, fauna, ecological communities or fauna habitat are expected to occur as a result of the Project owing to temporary surface disturbance across zones 1, 2 and 3 and surface construction that may be required in Zone 2 outside of strategic cropping area and subsidence has been assessed to be minimal (**Appendix B-2**). The Project itself is not expected to increase traffic numbers, lighting or noise beyond current conditions, and therefore the impacts to matters of national environmental significance and matters of state environmental significance during the operational phase of the Project are expected to be negligible.

Impacts on terrestrial ecology values are discussed further in **Chapter 13** (Terrestrial ecology).

Aquatic wildlife

The bodies of water in the Project vicinity including Nogoia River, Winton Creek, Boggy Creek, Corkscrew Creek and Mosquito Creek were all assessed as having a low risk of impact to aquatic ecological values.

Impacts on aquatic ecology values are discussed further in Chapter 14 (Aquatic ecology).

19.5.4.6 Vector-borne disease

Increasing potential freshwater breeding sites such as receding flood waters and pooling water can result in larger numbers of mosquitoes, which in turn increases the potential for outbreaks of mosquito-borne diseases (Queensland Health, 2011). Notifiable diseases reported in Queensland include Barmah Forest Virus, Ross River Virus, Dengue Fever and Malaria. The flood study has indicated that no significant change to flooding behaviours is expected as a result of the extended underground mining activity therefore no change in vector-borne disease risk profile is expected.

19.5.4.7 Climate change

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and BoM report 'Climate Change in Australia Technical Report' (2020a) gives projections on the potential changes to climate over the life of the Project. These climate projections show that the potential impacts of climate change in the region relate to temperature increases and either declining or increasing rainfall depending on the climate model. It is expected that the frequency and intensity of storms and cyclones will not change significantly in the area of the Project for the life of the Project.

19.6 Common risk control measures

19.6.1 Health, safety and environment management system

Ensham Mine's existing Integrated Management System (IMS) sets out the framework to enable Ensham to implement a documented and systematic approach to managing risks associated with safety, health and the environment.

Ensham is committed to achieving continual improvement in safety, health and environmental performance through the setting of objectives. The General Manager – Operations is responsible for establishing objectives which are consistent with the Idemitsu Australia Resources Health and Safety Policy and the Idemitsu Australia Resources Environmental Management Policy.

Ensham's strategic objectives are:

- comply with relevant legislative and regulatory obligations
- address the most significant safety, health and environmental risks
- prevent pollution to the environment
- implement relevant findings of audits and inspections
- take account of the views of interested parties
- achieve continual improvements in safety, health and environmental performance
- to be consistent with the 'Plan, Do, Check, Act' model
- adopt a 'life of mine' approach to all developments
- ensure the management approach is underpinned by strict controls and regular monitoring.

The IMS integrates Ensham's safety, health, training and environmental management system and is made up of standards, impact management plans, procedures, guidelines and supporting tools. However, some components within the IMS are specific to managing either safety, health, training or the environment.

Ensham has also established a Critical Control Management System standard to define the minimum requirements for identification and management of Critical Controls at Ensham Mine. The Critical Control Management Standard applies to hazards with potential for fatal consequences in its Operations and involves an increased level of management oversight and review of these controls.

19.6.2 Maintenance management system

Ensham has established processes to operate plant and equipment in a safe and controlled manner to avoid any loss of asset integrity with resultant safety or environment incidents. The maintenance management system contributes to the suite of operations control measures in reducing risk as low as reasonably achievable associated with any release of hazardous energy or loss of containment of hazardous material with the potential for human or environmental harm.

Key elements of the maintenance management system include the following:

- preventative maintenance activities which are carried out after a predetermined interval of time, number of operations, mileage, etc
- condition monitoring to determine asset performance and condition
- condition-based maintenance, being preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring
- compliance monitoring to determine if asset condition complies with specified integrity criteria
- corrective maintenance to restore integrity after failure in a timely manner.

19.6.3 Emergency response plan

Ensham's Emergency Management Plan documents controls which prevent or mitigate the extent of an Emergency at Ensham, and provide structure for response to emergencies should they arise. The plan identifies the specific accountability for executing the plan for each role specified.

The plan is designed to:

- minimise casualties and effect their rescue and treatment
- obtain maximum benefits from the combined resources of the on-site emergency organisation and outside services
- minimise confusion. The first and most important issue is to delegate responsibilities to ensure necessary tasks are prioritised and completed
- minimise damage to property and environment
- minimise interruption of operations and preserve business assets.

The Emergency Management Plan was developed as a Principle Hazard Management Plan for the purpose of the Coal Mining Health and Safety Regulation 2017 (Qld) and applies to all open cut and underground activities at Ensham Mine.

The Ensham Emergency Plan aims to minimise the extent of emergencies based on the following principles:

- risk management process shall be utilised in managing emergencies at the mine
- the safety of personnel is foremost
- emergency management plans shall be formulated and reviewed in consultation with personnel including the Open Cut Examiner for surface emergencies and Explosive Risk Zone Controller for underground emergencies
- response plans shall be simple but effective

- emergency control personnel shall be trained in their appointed duties and tested via the application of evacuation exercises and desk-top reviews.

The management plan details both preventative and response control procedures to deal with emergencies. This includes making first aid-trained persons available on site at all times, stocking casualty rooms with sufficient supplies to provide first aid treatment and making first aid kits, trauma packs and the surface Emergency Services Ambulance available at various locations around the site which are all inspected and maintained regularly.

The Emergency Management Plan covers how to activate different types of emergencies including what to do when discovering a fire, evacuating the surface, evacuating the underground mine, and re-entering the underground mine. Further, it covers what to do in response to and recovery from an emergency, outlining the following:

- incident command and control structure
- primary, secondary, and tertiary responses
- incident management
- communications with families and next of kin of personnel adversely affected by an emergency
- media communications
- worker rotation schedules for dealing with extended response duration
- how to transition to recovery.

References to resources required in the case of the emergency and emergency training required including staged events, self-escape training, and emergency exercises carried out on a regular basis are also defined.

19.6.4 Local emergency management authorities and local disaster management group consultation

Being an existing operation, Ensham has established protocols and pre-incident planning with local emergency management authorities including the Police Service, Fire and Rescue Service, Ambulance Service and the Local Emergency Management and Disaster Management Group. Ensham is also a member of the Queensland Mines Rescue Service which provides mines rescue services when required.

19.7 Risk analysis

Hazards with the potential for major consequences if not managed are analysed in this section to identify the potential range of impacts and the available control measures. The hazard word diagram, **Table 19-7**, lists these hazards taking into account the processes, type of machinery and equipment used, natural hazards and estimated hazardous substances being stored and used on site. Transport risks and interaction with external projects have also been identified.

Mine hazards not within the study area are excluded from this analysis. Specifically, the following activities are excluded:

- topsoil stripping and storage
- storage and transport of explosives to and from site and within site
- blasting associated with open cut mining activities
- waste rock associated with open cut mining activities
- rejects handling
- earthworks and re-contouring of excavated surfaces and spoil dumps
- waste management associated with existing camp activities, workshops, etc

- external factors already addressed during the initial mine establishment and unaffected by the extension of the underground mining area i.e. interference with site operations by persons external to and unrelated to the site, livestock, wildlife, etc.

Table 19-7 Operations hazard word diagram

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
Hazardous materials transportation				
Transport and transfer of diesel to and within site	Fire, spill, leak	<ul style="list-style-type: none"> • driver error • vehicle collision • failure of equipment • failure to comply with procedures 	<ul style="list-style-type: none"> • property damage (fire) • injury/fatality site worker • injury/fatality public • health impacts from contamination (soil, water, groundwater) 	<ul style="list-style-type: none"> • Speed limits, traffic management plan • Transport in accordance with relevant standards, training • AS compliant hosing • Preventive maintenance protocols • Spill Response Procedure and Spill Kits • Emergency Response Plan and facilities • Provision of firefighting infrastructure strategically across the site.
Transport and transfer of other miscellaneous hazardous materials (small quantities) to and from the site and within site	Spill, leak of liquid or escape of hazardous liquid fumes	<ul style="list-style-type: none"> • incorrect loading • tank failure • collision 	<ul style="list-style-type: none"> • property damage • fire • health impacts from contamination (soil, water, groundwater) 	<ul style="list-style-type: none"> • Speed limits, traffic management plan • Transport in accordance with relevant standards, training • Secure loading of materials, procedures, training • AS compliant hosing • Preventive maintenance protocols • Spill Response Procedure and spill kits • Emergency Response Plan and facilities.

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
Hazardous materials bulk storage				
Storage of fuel	Spill, leak	<ul style="list-style-type: none"> failure of equipment failure to comply with procedures 	<ul style="list-style-type: none"> property damage health impacts from contamination (soil, water, groundwater) 	<ul style="list-style-type: none"> fuel storage designed and operated in accordance with AS1940 fuel spills captured within an enclosed circuit to the recirculation dam bunds, signage, spill procedures, emergency response planning, training, inspection and maintenance program.
	Fire	<ul style="list-style-type: none"> ignition source failure of equipment failure to comply with procedures 	<ul style="list-style-type: none"> injury to site worker fatality to site worker health impacts (site/public) from contaminated soil, air (smoke and other combustion products), water and groundwater (diesel and fire suppression agent) environmental impacts 	<ul style="list-style-type: none"> fuel storage designed and operated in accordance with AS1940 scheduled inspection of firefighting equipment signage, emergency response planning, training.
Coal mining operations				
Board and pillar mining	Roof, pillar, rib or floor strata failure	<ul style="list-style-type: none"> flooding inadequate design faulty materials roof traffic 	<ul style="list-style-type: none"> property damage injury to site worker fatality to site worker 	<ul style="list-style-type: none"> 3D geological modelling Installation of strata load controls via increase in pillar dimensions and/or reduction in mining height.

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
Transporting ROM coal (conveyor, truck)	Conveyor system fire	<ul style="list-style-type: none"> spontaneous combustion ignition sources overheated equipment (friction, etc) 	<ul style="list-style-type: none"> injury to site worker fatality to site worker environmental nuisance (particulate fall-out) 	<ul style="list-style-type: none"> Design/installation & maintenance of explosion protected electrical equipment Hot work permit Application of stone dust in accordance to statutory requirements Thermal overload shutdown system on mobile plant Gas alarm detection systems Spontaneous combustion prevention protocols Adequate ventilation Inertisation and Sealing Control of ignition sources via procedures and training Emergency Management Plan, training.
	Vehicle accident	<ul style="list-style-type: none"> driver error vehicle collision vehicle roll over 	<ul style="list-style-type: none"> injury to site worker fatality to site worker 	<ul style="list-style-type: none"> Falling object protection fitted to Heavy Plant working near Highwall Mobile plant operator techniques (seatbelts, exclusion zones, pos comms) Emergency Response facilities Mechanical design, maintenance and inspection of lifting devices Mine road design and execution Road design, signage, speed limits, vehicle maintenance, roll over bars, fitness for work, training, traffic management.

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
	Dust	<ul style="list-style-type: none"> high wind unsealed roads 	<ul style="list-style-type: none"> respiratory impact to public/site worker environmental nuisance (particulate fall-out) 	<ul style="list-style-type: none"> dust control measures and monitoring.
CHP facilities including crushing, screening, blending, train loadout	Coal dust	<ul style="list-style-type: none"> high wind material handling equipment operation 	<ul style="list-style-type: none"> respiratory impact to public/site worker environmental nuisance (particulate fall-out) 	<ul style="list-style-type: none"> dust control measures and monitoring.
	Fire	<ul style="list-style-type: none"> ignition source spontaneous combustion 	<ul style="list-style-type: none"> injury to site worker property damage air emissions and odour from fire plume 	<ul style="list-style-type: none"> Fire breaks maintained, control of ignition sources via procedures and training, watering, equipment available to rapidly manage stockpiles, Emergency Management Plan, training Capping of stockpiles to prevent air ingress Inspections of the piles to identify signs of heating Standard Operating Procedures (SOP) for the Management of Spontaneous Combustion Segregated gas storage Firefighting equipment available.
	Leak, spill	<ul style="list-style-type: none"> equipment failure failure to comply with procedures 	<ul style="list-style-type: none"> health impacts from contamination (soil, water, groundwater) property damage 	<ul style="list-style-type: none"> Bunding equipment and material, location of CHP away from potential to enter watercourses, spills procedure, Emergency Management Plan, training, inspection and maintenance programs.

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
	Water release rate and water quality	<ul style="list-style-type: none"> used water release flowrate too high 	<ul style="list-style-type: none"> health impacts from water contamination thermal pollution 	<ul style="list-style-type: none"> two nominated release points with relevant infrastructure provided flowmeters installed at the active discharge points.
Coal stockpiling (ROM stockpile and product stockpile)	Dust	<ul style="list-style-type: none"> high winds material handling 	<ul style="list-style-type: none"> respiratory impact to public/site worker environmental nuisance 	<ul style="list-style-type: none"> dust control measures, monitoring.
	Fire	<ul style="list-style-type: none"> spontaneous combustion 	<ul style="list-style-type: none"> injury to site worker site property damage air emissions causing plume and odour 	<ul style="list-style-type: none"> Capping of stockpiles to prevent air ingress Inspections of the piles to identify signs of heating SOP for the Management of Spontaneous Combustion
Product coal transport — rail loop and rail spur	Fire	<ul style="list-style-type: none"> ignition source spontaneous combustion 	<ul style="list-style-type: none"> injury to public/site worker public property damage 	<ul style="list-style-type: none"> Fire breaks maintained around the activity area Control of ignition sources via procedures and training, Emergency Management Plan, training,
	Coal dust	<ul style="list-style-type: none"> high winds 	<ul style="list-style-type: none"> respiratory impact to public/site worker public amenity environmental nuisance 	<ul style="list-style-type: none"> dust control measures for rail wagons
	Vehicle accident - collision	<ul style="list-style-type: none"> vehicle railway crossings 	<ul style="list-style-type: none"> injury to public/site worker fatality to public/site worker public property damage 	<ul style="list-style-type: none"> exclusion of public from rail operations areas dedicated crossing points for landholders and cattle grids.

Activity	Hazard	Cause/initiating event	Potential consequences	Risk treatment measures
Mine-affected water management				
Management of mine-affected waters — collection, storage and disposal	Unauthorised release: overtopping of storage facility	<ul style="list-style-type: none"> equipment failure failure to comply with procedures overflowing or heavy rainfall resulting in exceeding design capacity 	<ul style="list-style-type: none"> environmental harm 	<ul style="list-style-type: none"> appropriate design procedures, training inspection and maintenance. emergency procedures for unplanned releases.
External factors				
Containment of river system	River water reaching mining area	<ul style="list-style-type: none"> levee failure 	<ul style="list-style-type: none"> property damage injury to public/worker fatality to public/site worker 	<ul style="list-style-type: none"> engineered and certified levee to 1:1000 scheduled maintenance performed on the levee monthly visual inspections annual certified inspection.

19.8 Risk evaluation

The risks identified in the hazard word diagram, **Table 19-7**, are evaluated by qualitative consideration of the potential consequence and likelihood taking into account any available quantitative data relating to probability of initiating events and consideration of the frequency factors, project design and available operational details, as well as the local environment.

The risk evaluation takes into account:

- the specific risk treatment measures noted in the hazard identification word diagram
- common risk control measures described in Section **19.6**
- risk treatment measures not explicitly described herein but implied through compliance with all legal requirements, relevant standards, guidelines and codes of practice implemented in the operation of the Project.

The objective of the risk evaluation is to determine whether the residual risks are tolerable and if they are not then to propose new risk treatment measures.

Tables are prepared for the following:

- transportation of hazardous materials
- bulk storage of hazardous materials
- coal mining operations
- mine-affected water management
- interaction with external factors – containment of river system.

19.8.1 Risk evaluation – transportation of hazardous materials

The risk levels associated with the transportation of hazardous materials are summarised in **Table 19-8**. The extended underground mining activity does not introduce new or alter existing hazardous materials transport operations therefore there will be no change in the site safety risk profile. The current risk control measures are considered adequate; no new risk control measures are recommended. A High mitigated risk is associated with transporting diesel to and within the site from the potential for an accident occasioning a fire. It is noted that the risk rating is determined as High when there is a possibility of the consequence resulting in a fatality or severe irreversible disability to one or more persons, even though the likelihood of the event is “rare” (likelihood level rating of 1). No mitigated Critical risks were identified.

Table 19-8 Risk analysis for hazardous materials transportation

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
Transport of diesel to and within site	Fire, spill, leak	Injury to public/site worker	Low	2	2	Low
		Fatality public/site worker	Critical	4	1	High
		Health impacts from contamination (soil, water, groundwater)	Low	2	1	Low

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
		Property damage – contamination requiring remediation	Low	2	1	Low
		Property damage – fire	Medium	3	1	Medium
Transport of other (small quantity) hazardous materials to and from the site and within site	Spill, leak of liquid or escape of hazardous liquid fumes	Injury to public/site worker	Low	2	1	Low
		Health impacts from contamination (soil, water, groundwater)	Low	2	1	Low
		Property damage	Low	1	1	Low
	Fire	Injury to public/site worker	Low	1	1	Low
		Property damage	Medium	3	2	Medium

19.8.2 Risk evaluation - bulk storage

The risk levels associated with the bulk storage activities are summarised in **Table 19-9**. The extended underground mining activity does not introduce new or alter existing hazardous materials storage operations therefore there will be no change in the site safety risk profile. The current risk control measures are considered adequate; no new risk control measures are recommended. A mitigated High risk is associated with storage of diesel on the site from the potential for a major spill or leak occasioning a fire. It is noted that the risk rating is determined as High when there is a possibility of the consequence resulting in a fatality or severe irreversible disability to one or more persons, even though the likelihood of the event is "rare" (likelihood level rating of 1). No mitigated Critical risks were identified.

Table 19-9 Risk analysis for bulk storage

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
Storage of diesel	Spill, leak	Environmental Impact of Contamination of surface water	Medium	2	2	Low
		Health impacts from contaminated soil and groundwater	Low	2	1	Low
		Property damage – contamination requiring remediation	Medium	2	2	Low
	Fire	Injury to site worker	Medium	3	1	Medium
		Fatality site worker	High	4	1	High
		Health impacts (site/public) from contaminated soil, air (smoke and other combustion products), water and groundwater (diesel and fire suppression agent)	Low	2	1	Low
		Environmental impacts	Medium	3	1	Medium

19.8.3 Risk evaluation - coal mining operation

The risk levels associated with coal mining operations are summarised in **Table 19-10**. The extended underground mining activity does not introduce new coal mining operation hazards, however it will alter the locations of existing underground mining hazards. The nature of the surface above the extended underground mining is consistent with that above the existing underground mine areas therefore it is considered that there will be no change in the site safety risk profile. The current risk control measures are considered adequate; no new risk control measures are recommended. High mitigated risks were associated with the potential for:

- strata failure
- conveyor system fire
- vehicle accident associated with truck transfer of ROM coal to the CHP
- stockpile fire
- fires and vehicle accidents related to product coal rail transport.

The above risks were rated as High as there was the possibility of the consequence resulting in irreversible injury/health impacts or fatality. It should be noted that in all cases, the likelihood level was assessed as 'rare' or 'unlikely' (likelihood level of 1 or 2). No mitigated Critical risks were identified.

Table 19-10 Risk analysis for coal mining operations

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
Board and pillar mining	Strata failure	External property damage	Critical	5	1	High
Transporting ROM coal (conveyor, truck)	Conveyor system fire	Injury to site worker	Medium	3	1	Medium
		Fatality to site worker	Critical	5	1	High
		Environmental nuisance (particulate fall-out)	Low	1	1	Low
	Heavy Vehicle Collision, Rollover accident	Injury to site worker	High	3	2	Medium
		Fatality to site worker	Critical	4	1	High
	Dust	Respiratory impact to public/site worker	High	3	2	Medium
		Environmental nuisance (particulate fall-out)	Medium	1	1	Low
	CHP facilities including: crushing, screening, blending, train loadout	Coal dust	Respiratory impact to public/site worker	High	3	2
Environmental nuisance (particulate fall-out)			Low	2	1	Low
Fire		Injury to site worker	Low	2	1	Low
		Site property damage	High	3	1	Medium
Coal stockpiling (ROM stockpile and product stockpile)		Dust	Respiratory impact to	High	3	2

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
		public/site worker				
		Environmental nuisance	Medium	2	2	Low
	Fire	Injury to site worker	Medium	2	1	Low
		Site property damage	Critical	4	1	High
		Air emissions causing plume and odour	Medium	2	1	Low
Product coal transport: rail loop and rail spur	Fire	Injury to public/site worker	Low	2	1	Low
		Public property damage	Critical	4	1	High
	Coal dust	Respiratory impact to public/site worker	Medium	2	2	Low
		Public amenity	High	2	2	Low
		Environmental nuisance	Medium	2	1	Low
	Vehicle accident - collision	Injury to public/site worker	High	3	2	Medium
		Fatality to public/site worker	Critical	5	1	High
		Public property damage	Medium	1	4	Medium

19.8.4 Risk evaluation – mine-affected water management

Risk level associated with mine-affected water management is summarised in **Table 19-11**. The extended underground mining activity does not introduce new or alter existing mine-affected water hazards therefore there will be no change in the site safety risk profile. No mitigated High or Critical risks were identified.

Table 19-11 Risk analysis for mine-affected water management

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
Management of mine-affected waters — collection, storage and disposal	Unauthorised release: overtopping of storage facility	Environmental harm	High	3	2	Medium

19.8.5 Risk evaluation - interaction with key external factor – containment of river system

Risk levels associated with containment of the river system is summarised in **Table 19-12**. Mitigated High risks are associated with river water reaching the mine area during flood. It is noted that the risk rating is determined as High when there is a possibility of the consequence resulting in a fatality or catastrophic property damage, even though the likelihood of the event is “rare” (likelihood level rating of 1). No mitigated Critical risks were identified.

Table 19-12 Risk analysis associated with key external factor – containment of river system

Activity	Hazard	Potential consequences	Pre-mitigated risk level	Mitigated risk		
				Consequence	Likelihood	Risk level
Containment of river system	River water reaching mining area	Fatality to site worker	Critical	4	1	High
		Property damage	Critical	5	1	High

19.9 Summary and conclusion

The risk of hazards to people and property associated with activities required for the Project were identified and evaluated. The risk associated with each identified hazard were determined based on the likelihood of the potential consequence occurring and the consequence severity of the hazard and risk, taking into account standard risk treatment measures as well as specific risk treatment measures.

The risk assessment resulted in the following:

- the majority of hazards associated with the activities have a “*low to medium*” risk level assuming risk treatment measures are implemented and working effectively
- those risks that remain as “*high*” when risk treatment measures are implemented were due to the potential for a severe injury or fatality, even though the likelihood of an event was assessed as rare or unlikely
- no mitigated “*critical*” risks were identified.

The preliminary risk assessment indicates that the greatest risks associated with operation of the Project scope in the study area relate to:

- major leak or spill during diesel transportation to and within site occasioning a fire
- major leak or spill from diesel storage occasioning a fire
- strata failure occasioning external property damage
- overheating of underground coal conveyor system occasioning a fire
- heavy vehicle accidents during ROM coal transport to CHP
- spontaneous combustion of coal stockpiles
- spontaneous combustion of product coal in train
- collision between product coal train and road vehicles
- river system overflow into mine.

This assessment is a preliminary hazard and risk assessment for the Project scope in the study area. The extended underground mining activity does not introduce any new hazards to the existing operations or alter the existing operational hazards (other than their locations) therefore is not expected to alter the Ensham Mine health and safety risk profile.

Though this hazard and risk assessment is characterised as a preliminary assessment it is largely based on actual risk assessment already in place at the Ensham Mine. The Ensham Mine operations risk assessment will be updated in accordance with its existing Integrated (Safety, Health and Environment) Management System and Risk Management System Standard prior to operation in the Project Site. Ensham will continue to maintain the operations risk assessment as operations and conditions change as it has been doing in accordance with the process defined in its Integrated (Safety, Health and Environment) Management System and Risk Management System Standard.