CONTENTS

TABLES

26. HAZARD AND RISK

This section addresses section 6 of the ToR. It details the specific risks that have a potential to affect the environment and community, including the construction workforce. It addresses the dam and pipeline construction, operation, decommissioning and emergency management aspects of the Project from an EIS context. The risks to existing environmental and community values, surrounding land uses and climate change are addressed in detail throughout Chapters 3 to 23. The cumulative risks are dealt with in Chapter 27.

The analysis of the level of risk was undertaken using a semi-quantitative risk technique using a 5 by 5 risk matrix. Each relevant chapter has a consequence scale that is applicable to the context for that chapter. This chapter deals with construction and operations safety and general environmental aspects not covered in other chapters.

Assessment of the mitigated risks with acceptable risk criteria for land uses adjacent to the Project area(s) is not considered necessary for this project as no chemical dispersion or explosion scenarios have been identified that require technical analysis. Dispersion and fire studies are a requirement for major hazard facilities where leaks or fires can impact on neighbouring properties and the acceptability for these facilities is based on quantitative risk levels to surrounding land users.

Definitions

- Risk – The effect of uncertainty upon objectives. (ISO31000); and
- Hazard – A source or a situation with a potential for harm in terms of human injury or ill-health, damage to property, damage to the environment, or a combination of these. (AS/NZS4801: 2001).

Note: Australia/ New Zealand Standards AS/NZS 4360:1990 & 2004 (mentioned in the ToR), were superseded by AS NZS ISO 31000:2009 Risk Management – Principles and guidelines in November 2009.

26.1. Regulatory framework

Statutory legislation establishes the minimum standard by which activities must be undertaken. The relevant pieces of legislation are listed in Table 26-1 along with a high level compliance strategy. It must be noted that each Act will have related subordinate legislation such as Regulations, Codes of Practice, Standards and other guidance materials.

Table 26-1 Legislative compliance

Relevant Legislation	Legislative Requirements	Compliance
Explosives Act 1999 and AS 2187, 1998 'Explosives—Storage, transport and use'.	The Act sets out the requirements for the handling, storage, transport and manufacture of explosives.	The use and handling of explosive materials/ substances will be in compliance with the Explosives Act.
Workplace Health and Safety Act 1995, Regulation 2008 and Codes of Practice.	The objective of this Act is to prevent a person's death, injury or illness being caused by a workplace, by a relevant workplace area, by work activities, or by plant or substances for use at a workplace.	Work practices will be in compliance with this Act.
Building Act 1975, *Building Fire and Safety Regulations 2008* and *Building Regulation 2006.*	Permit required for the storage of flammable and combustible liquids from the relevant local Council.	A Permit to store flammable and combustible liquids will be obtained.

Relevant Legislation	Legislative Requirements	Compliance
Dangerous Goods Act 2001 and Dangerous *Goods Safety Management Regulation 2001*. Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG 20/ 07)	Sets standards for the transport and storage of substances and the systems to be adopted based on these substances.	Comply with DGA Code and Australian Standards and implement management systems as defined for the storage and use of substances.
Water Supply (Safety and Reliability) Act 2008	Sets the legislative framework for dam safety in Queensland	The design, construction, maintenance and operation of the dam will be in compliance with this act and applicable guidelines.

The Proponent is required to implement health and safety systems and standards that will provide for effective management of employee and public health and safety. The constructor of the dam must also comply with these Standards and have appropriate health and safety systems.

26.1.1. Queensland legislative framework for dam safety

Nathan Dam will be a referable dam and is therefore subject to the provisions of the *Water Supply (Safety and Reliability) Act 2008*.

Under the *Water Supply (Safety and Reliability) Act 2008*, a proposed dam is classed as a *referable dam* if:

- a failure impact assessment (FIA) is required to be carried out for the dam; and
- the proposed dam will have a category 1 or 2 failure impact rating.

The *Water Supply (Safety and Reliability) Act 2008* mandates that a FIA must be undertaken for the proposed Nathan Dam, as after construction:

- it will be more than 8 m in height; and
- it will have a storage capacity of more than 500 ML.

However, the FIA is not required to be undertaken during the EIS phase of the Project. Detailed design information is required to undertake a full failure impact assessment. Therefore this will be undertaken during the detailed design phase for the dam. A FIA is used to assign a failure impact rating to a dam based on the Population at Risk (PAR) downstream of the dam. Based on a preliminary assessment, the dam will have a *category 2* failure impact rating as the potential PAR downstream of the dam is estimated to be greater than 100.

Under the *Water Supply (Safety and Reliability) Act 2008* and under common law, dam safety is the responsibility of dam owners in Queensland. The *Water Supply (Safety and Reliability) Act 2008* also provides for the Chief Executive to impose safety conditions on a referable dam. For a proposed dam, these safety conditions are taken to be part of the development permit to construct the dam.

26.1.2. Dam safety guidelines

The *Water Supply (Safety and Reliability) Act 2008* empowers DERM to designate guidelines under the Act. Owners of referable dams in Queensland must operate and maintain their dams in accordance with these guidelines. The designated guidelines are:

- Queensland Dam Safety Management Guidelines (DNRM, 2002a);
- Guidelines for Failure Impact Assessment of Water Dams (DERM, 2010); and
- Guidelines on Acceptable Flood Capacity for Dams (DNRW, 2007).

The Queensland guidelines discussed above state that except for where otherwise specified, dam safety risk assessment procedures should be carried out in accordance with the following Australian National Committee on Large Dams (ANCOLD) guidelines:

- ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams (ANCOLD, 2000a);
- ANCOLD Guidelines on Assessment of the Consequences of Dam Failure (ANCOLD, 2000b);
- ANCOLD Guidelines on Dam Safety Management (ANCOLD, 2003a); and
- ANCOLD Guidelines on Risk Assessment (ANCOLD, 2003b).

26.1.3. Risk assessment and risk analysis

The risk assessment for the construction and operation of the Project is based on criteria developed in accordance with Australia/New Zealand ISO/AS/NZS 31000:2009 Risk Management: Principles and guidelines and HB436:2004 Risk Management Guidelines. The risk analysis criteria developed specifically for the EIS provides a semi-quantitative analysis.

The level of risk associated with each hazard is determined by taking into account the potential consequences and the likelihood of occurrence and the current control as nominated in the Description of Project or as required by legislation. Consequence and likelihood were ranked using the assessment criteria shown in Table 26-2 and Table 26-3.

The consequence and likelihood ratings were then used to classify the level of risk using the risk matrix shown in Table 26-4. The consequence and likelihood criteria are used to assess the unmitigated and mitigated risk levels for each hazard.

Table 26-2 Consequence scale

Category	Health and safety	General Environmental
Catastrophic	Multiple worker fatalities	Impact on environmental values over a wide area (e.g. at the scale of the Dawson River catchment) or impact results in the extinction of a population or community or recovery periods of greater than 20 years likely.
Major	Single worker fatality.	Significant impact (as defined by legislation) on environmental values within the Project area or to a species or community on a population scale. May lead to a local extinction or recovery periods of 10 - 20 years are likely.
Moderate	Long term medical or health issue.	Significant impact (as defined under legislation) on environmental values extending locally or to a species or community, but not on a population scale. Would not lead to an extinction at any scale. Recovery periods of 5 - 10 years anticipated.
Minor	Short term medical or health issue.	Impact is present but not to the extent that it would impair the overall environmental values, population or community.
Insignificant	Minor medical treatment.	No impact or, if impact is present, then not to an extent that would draw concern from a reasonable person.

Table 26-3 Likelihood Scale

Category	Description	Probability
Absolute	Part of the scope of work and will occur	1
Likely	Likely that the risk will occur and that the control measures will fail resulting in the stated consequence level.	0.1
Possible	Possible that the risk will occur and that the control measures will fail resulting in the stated consequence level.	0.01
Unlikely	Unlikely that the risk will occur and that the control measures will fail resulting in the stated consequence level.	0.001
Rare	On a rare occasion that the risk will occur and that the control measures will fail resulting in the stated consequence level.	0.0001

Table 26-4 Risk matrix

	CONSEQUENCE RATING				
LIKELIHOOD	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
ABSOLUTE	Low	Medium	High	Extreme	Extreme
LIKELY	Low	Medium	High	High	Extreme
POSSIBLE	Low	Medium	Medium	High	Extreme
UNLIKELY	Low	Low	Medium	Medium	High
RARE	Low	Low	Medium	Medium	Medium

Chapters 3 to 23 provide a description the potential hazards and risks that may be associated with other aspects of the Project. Refer to the risk assessment tables located at the end of each chapter for details of the considered risks and controls.

The dam safety risk assessment method is based on the relevant guidelines set out by Queensland legislation and the Australian National Committee on Large Dams (ANCOLD) as described in Section 26.1.2.

26.1.3.1. Dam safety risk assessment

This section details the risks and mitigation measures relating dam safety including potential modes of dam failure and dam safety requirements throughout the life of the dam.

26.1.3.2. Dam safety risks

Dam safety is regulated for referable dams so that the community is protected from dam failure. There are three major loading conditions that can cause dam failure. These are discussed here.

- Hydrologic

Hydrologic failure modes for dams are those associated with rainfall events. Failures not associated with rainfall events are classified as 'sunny day' failures. Hydrologic risks for dams can be classified into four main groups as follows:

- overtopping erosion - erosion of the material of the dam itself by overtopping, for which the design does not protect;
- flood induced piping - the elevated reservoir level during a flood event causing erosion through the embankment;
- overturning or sliding - destabilising of the dam by hydraulic loads that exceed the structural capacity of the dam; and
- erosion of abutments - erosion of the abutments or foundations by overtopping flows to the extent that support for the dam is removed.

The dam is proposed to be an earth and rockfill dam with a mass concrete ogee crest spillway. Overturning/sliding and foundation/abutment erosion are typically associated with concrete dams not earth and rockfill embankment dams.

To ensure embankment overtopping does not occur, the Nathan Dam spillway will be designed to safely pass the Probable Maximum Flood (PMF) which is defined as "the limiting value of the flood that can reasonably be expected to occur" and has an Annual Exceedance Probability (AEP) of less than 1 in 43,000. Current research undertaken by the Bureau of Meteorology indicates that there is no evidence that the Probable Maximum Precipitation (PMP) will increase with climate change (Smalley *et al.*, 2006; Jakob *et al.*, 2008; 2009). Therefore the probability of the dam overtopping due to flooding, even under potential climate change conditions, is very low and consistent with the prevailing guidelines.

Embankment erosion and piping tends to be progressive and irreversible once initiated, and failure of the dam is the typical outcome. The cause of embankment erosion is generally due to inadequate design and construction. The clay core of the embankment will be protected by a series of filters that hold the clay within the wall structure.

To ensure the embankment does not erode the following measures will be taken:

- use defensive design methods that are performed by experienced engineers;
- have backup filters;
- strict quality assurance of supplies; and
- strict supervision of construction performed by experienced engineers.

Hydrologic risks also arise that are not associated with failure of the dam. These may involve limited damage to dam and spillway structures, threats to downstream life and property due to large floods routed through the spillway or over the dam, and threats to upstream life and property due to high surcharge levels. These risks are discussed in section 26.1.4.

Seismic

Dams are designed to withstand seismic activity (earthquakes). Historically, some dams have been subjected to strong seismic loads. While damage has occurred, comparatively few dams have failed due to earthquakes in comparison to hydrologic or static causes.

The main risks to dams from earthquake are:

- cracking with loss of section strength (mainly concrete dams);
- cracking with potential for internal erosion (embankment dams);
- sliding of foundation (mainly concrete dams);
- sliding of the dam material (mainly embankment dams);
- liquefaction of foundations (mainly embankment dams);
- liquefaction of dam material (certain types of embankment dams such as hydraulic fill or tailings dams);
- landslide induced wave that results in overtopping (mainly concrete gravity dams and embankment dams); and
- cracking or collapse of ancillary structures such as outlet towers leading to loss of control of outflows which can contribute to other failure modes described above.

Properties of the rocks present at the dam site relevant to the Project and which need to be considered as part of the dam design include:

- rock type – sandstones, siltstones, shales and mudstones are common;
- degree of weathering – this ranges from extremely weathered to fresh rock; and
- jointing and other weaknesses – vertical and horizontal jointing is present in the rocks at the site (SunWater, unpublished data).

The geology at the Nathan Dam comprises sandstones and siltstones with varying degrees of weathering from extremely weathered to fresh rock. Some vertical and horizontal jointing is present in the rocks at the site. Further information relating to the geology and soils at the site is presented in Figure 6-2.

The risk of dam failure due to seismic activity is increased with the presence of the fine-grained clays and silts as these strata can liquefy during seismic activity thus reducing the support that the earth provides to the dam structure. Reducing the support to the dam will place extra loads on the embankment. However, the dam site is underlain by sandstone at shallow depth so the hazard is less than would be the case if it were underlain by deep, unconsolidated materials.

There is no record of seismic activity at the dam site; the closest recorded earthquake was 22 km to the north-east (Section 6.1.4.1). Design of the dam will include stability analysis incorporating seismic loads. The preliminary dam design has been reviewed by a technical review panel of internationally recognised dam experts: Emeritus Professor Robin Fell of the University of New South Wales and Mr Graeme Bell, formerly of the Snowy Mountains Engineering Corporation. Furthermore, provision will be made in the design such that rapid drawdown of the storage can be undertaken in the event of damage to avoid catastrophic failure and effect repairs if appropriate.

- Static

Approximately two thirds of all dam failures are caused by piping or slope instability, two forms of static failure. Other static failures include failure due to outlet conduit leaks, overturning or sliding not associated with floods or earthquakes or a massive land slide within the impoundment area which displaces the water in the reservoir.

The primary cause of static failures is poor design and/ or construction. To ensure static failure is minimised the following measures will be taken:

- design according to rigorous design standards appropriate to the dam type;
- extensive peer review of the design and construction methods;
- rigorous construction supervision provided by experienced engineers;
- rigorous quality control of supplied material; and
- regular dam inspections and safety reviews throughout the life of the dam.

The landscape around the water storage area is generally stable except for the two situations which extend above and below FSL. Areas of appreciable active erosion in and around the water storage area are restricted to sheet and gully erosion. Stream banks in the Glebe Weir storage area show no evidence of slumping as a result of rapidly falling water levels during downstream releases. A massive land slide within the water storage area is therefore considered unlikely. To ensure this is so, a quality assured geotechnical survey will be conducted and taken into account during any excavation. There is a risk of land slip in steeper areas around water level and erosion from wave action around the edge of the water storage area is possible. Slopes that are at risk of eroding will be appropriately stabilised and maintained. Further information relating to soils within the water storage, and specifically to the risk of eroding soils, is located in Section 6.2.1.2.

26.1.3.3. Dam safety risk mitigation

The recommendations specific to ensuring that the Project is constructed and operated safely to minimise the risk of dam failure are summarised in this section.

The dam is being designed by experienced engineers to meet both the Queensland Dam Safety Management guidelines and ANCOLD guidelines. The dam design and construction will be subject to independent peer review to ensure that these guidelines and objectives are met. This peer review will continue throughout the life of the Project.

FIA and hazard category

Dams are assigned a hazard category based on the Population at Risk (PAR) downstream of the dam and the potential consequences of dam failure. The potential severity of damage and loss is assessed based on a range of factors including:

- cost of damages to infrastructure downstream including residential, commercial, agricultural and roads;
- cost of damages to the dam itself;
- social impacts; and
- impacts on the natural environment.

During detailed design a FIA including dam break analysis and inspection of potential PAR locations must be undertaken to accurately assess the PAR and severity of damage and loss downstream. However, as discussed in Section 26.1.1 this will be finalised during the detailed design phase with results provided to the reviewer and regulator prior to approval.

During an early phase of the Project, a FIA was undertaken for a larger, gated concrete dam at the Nathan Dam site. Results from this assessment provide a conservative estimate of the potential consequences of failure of the currently proposed structure. This assessment estimated a PAR of approximately 650 under a Sunny Day Failure scenario. Based on this estimate, Nathan Dam is expected to be assigned a *High A* sunny day failure hazard. In the absence of a formal dam break assessment, it is difficult to assign an incremental flood hazard category. However, it is not expected that the incremental flood hazard category will exceed the sunny day failure hazard category.

The acceptable flood capacity for a dam is based on the assigned hazard category. In Queensland, this must be undertaken according to the Guidelines on Acceptable Flood Capacity for Dams (DNRW, 2007) which deviates slightly from the comparable ANCOLD requirements.

The fallback option for a *High A* hazard category dam is that it is required to have adequate spillway capacity to safely pass the Probable Maximum Precipitation Design Flood (PMPDF) with an AEP of 1 in 43,000 for the dam. However, due to the uncertainty of the hazard category at this time, the Nathan Dam spillway has been designed to pass the Probable Maximum Flood (PMF) which significantly exceeds this requirement.

The final design should include a quantitative risk assessment consistent with the requirements of the ANCOLD Guidelines on Risk Assessment (2003b). This will involve demonstrating compliance with ANCOLD societal and individual risk criteria as well as demonstrating that the risks posed by the dam are As Low As Reasonably Practicable (ALARP). In practice this means that the risks have been reduced to a point that further risk reduction is impracticable or the cost is grossly disproportionate (depending on the level of risk) to the improvement gained.

Dam safety management program

As a referable dam, additional conditions for dam safety management will be required under Queensland Legislation. These requirements are likely to be those defined in the *Queensland Dam Safety Management Guidelines* (DNRW, 2002a) and consistent with the comparable ANCOLD guidelines.

The Queensland guidelines define a 'dam safety management program' as '*a system that incorporates dam safety values as part of the culture of the organisation and the day-to-day operation'.* It should incorporate all phases of investigation, design, construction, operation, monitoring, modification and decommissioning.

The guideline requires that a dam safety management program should ultimately result in six levels of documentation being available for each dam. These are:

- Investigation, Design, and Construction Documentation;
- Standard Operating Procedures (SOPs);
- Detailed Operating and Maintenance Manuals (DOMMs);
- Inspection and Evaluation Reports;
- Dam Safety Review Report; and
- Emergency Action Plan (EAP).

Dam owners must ensure that appropriate training of personnel engaged in dam operations and dam safety is undertaken. Furthermore quality management of the dam safety management program must be undertaken.

Continuous surveillance including remote monitoring and periodic visual inspection must be undertaken. Periodic dam safety reviews must be completed according to DERM requirements.

Further information on the requirements for Emergency Action Planning is provided in Section 26.3.1.

26.1.4. Unmitigated and mitigated risk details

This section provides tabulated data for the hazards, causes, consequences and risk mitigations relevant to the construction and operation of the dam.

Table 26-5 Risk assessment – construction and decommissioning

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Impacts on access and egress for emergency services.	Dam changes the travel routes for response.	Delayed response times to critical assets and people.	Roads will be relocated to provide required access. Discussions are required with emergency services to identify any route access issues. Helipad provided.	Moderate	Rare	Medium			Moderate	Rare	Medium
On site spill of fuel or chemicals	Spill or leakage of fuel or lubricating oil	Short term degradation of river water quality	Construction activities to operate to approved Environmental Management Plan. Provide spill cleanup kits. Provide means and guidelines for responsible disposal.	Minor	Unlikely	Low			Minor	Unlikely	Low
Chemical exposure	Grouts Cements Fuels Construction compounds	Personal exposure during application.	MSDS information is reviewed for correct PPE and controls. Users trained in the safe handling and use of chemicals.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Explosive incident	Inadequate supervision	Fly rock hitting nearby structures or personnel.	Exclusion limit applies to the proximity of blasting near structures.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
	Poor procedures		Adequate signage and security to warn and protect the public.								
	Poor signage and security		Persons to have completed a magazine operators course.								
Interaction between vehicles	Heavy/heavy	Worker safety impacts.	Security to limit the access to the site by normal vehicles.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
	Heavy/light		Traffic management plan to be developed to outline traffic rules, vehicle safety equipment, parking, isolations, routes, communications, sight distances, speed, prestart checks, hot tyres and vehicle access.								
	Parking areas		Induction of all delivery drivers and/or escort provided								
	Maintenance activities										
	Loss of control on slopes										

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Equipment roll over	Slopes on stockpiles	Worker safety impacts.	Equipment is fitted with FOPS and ROPS as required for clearing operations.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
Vehicle collision or highway congestion	Highway route for material delivery is inadequate or collision with other vehicle/obstacle	Loss of life	Development of a Traffic Management Plan.	Minor	Unlikely	Low			Minor	Unlikely	Low
		Loss of equipment	Upgrade of roads.								
		Project disruption									
Road tanker spill	Run off road	Accident with no spillage through to tanker failure.	All tanker vehicles will carry Hazchem Identification and responses for use by emergency personnel attending accident. (Also see below)	Moderate	Rare	Medium			Moderate	Rare	Medium
	Collision with other vehicle/ obstacle	Accident is serious and tank fails.	Local roadways to the construction site will be adequate for bulk transport vehicles.								
		Dangerous goods escape tanker and contaminate environment.	Company emergency response plan will be developed to handle such incidents.								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
			All tankers conform to the Australian Code for the Transport of Dangerous Goods by Road and Rail, and Australian Standard AS 2809.4-1986 road tank vehicles for dangerous goods.								
Construction zones inaccessible.	Construction staging may not provide for access around each site.	Damage to local environment by forced access to the site.	The construction schedule and site planning will allow for access.	Minor	Unlikely	Low			Minor	Unlikely	Low
Personal injury gaining access to the site.	Difficult terrain. Traffic and vehicle issues.	Worker safety impacts.	Traffic management plan to be developed to outline traffic rules, vehicle safety equipment, parking, isolations, routes, communications, sight distances, speed, prestart checks, hot tyres and vehicle access.	Minor	Unlikely	Low			Minor	Unlikely	Low

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Injury traversing ground	Rough terrain	Muscle strains or other trip slip injuries.	Appropriate PPE for foot wear is worn for traversing rough terrain.	Minor	Unlikely	Low			Minor	Unlikely	Low
			Ground and working areas to be finished to a reasonable surface to reduce machinery breakdown and employee injury.								
Injury of person working alone.	Surveyors and other specialist teams/persons.	Exacerbation of initial injury.	Radio supplied.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
			All remote operating light vehicles to have first aid kits and personnel are trained in first aid.								
			Consider providing EPIRB to staff working in remote locations.								
			Ensure adequate budget allowance for PPE including hearing protection, respiratory protection, footwear and hearing conservation program, etc.								
			High visibility clothing required for worker identification								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Falls from height	Unprotected edges.	Potential for fatality.	Ensure adequate barricades and standard of barricades.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
Trench collapse	Trenching required for pipeline construction.	Serious injury or death to worker.	Ground survey to identify ground conditions in advance of construction works.	Major	Unlikely	Medium			Major	Unlikely	Medium
	Poor ground.		Shorting, benching or battering to industry standards.								
	Inadequate ground support.		Work is only to occur in controlled ground condition areas.								
Uncontrolled ground failure at creek crossings	Existing erosion conditions.	Localised damage to the environment.	Work method statements are to consider local conditions.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Poor ground stability.	Construction worker exposure to falling ground or equipment.									
	Excess loads from construction equipment.										
Welding injury	Inexperienced welders or assistants.	Welding flash.	Experienced welders to be used.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Inappropriate equipment.	Burns.	Correct equipment for welding.								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Crane incident	Unstable ground.	Falling object.	Crane selection to be undertaken by a competent person.	Major	Unlikely	Medium			Major	Unlikely	Medium
	Failure of crane footings or pads.	Crane collapse.	Licensed and competent operators.								
	Incorrect crane selection.	Safety incident to worker(s).									
Sun exposure	Outside work.	Sunburn.	Portable shade structures.	Minor	Unlikely	Low			Minor	Unlikely	Low
		Contribution to skin cancer	Sun protection lotions.								
			Clothing policy.								
Dust	Vehicles	Environmental impacts.	Ensure adequate water trucks are provided for dust suppression.	Minor	Possible	Medium			Minor	Possible	Medium
	Blasting	Eye injury									
Excessive noise	Dozer operations	Hearing impairment or hearing loss.	Adequate budget allowance including hearing protection and hearing conservation program.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Drill rigs										
Construction fires	Diesel exhaust	Equipment or asset damage or loss.	Extinguishers fitted to equipment.	Moderate	Likely	High	Water trucks may double as fire truck.	Moderately	Moderate	Unlikely	Medium
	Sparks from blades hitting rocks.	Burns to personnel.									

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Rock falls	Rock fall from benches	Worker safety impacts.	Adequate allowance for pre-shift inspections of rock faces and benches.	Major	Unlikely	Medium	Rock faces to be shotcreted, rock bolted or meshed in required locations.	Moderately	Major	Unlikely	Medium
	Rock fall off surfaces prior to completion.		Machinery to clean the face of the bench to prevent subsequent rock falls.								
Landslide	Inadequate excavation.	Construction safety impacts	Excavation with stable slopes.	Major	Unlikely	Medium			Major	Unlikely	Medium
Dam wall failure during construction.	Flood during construction period.	Downstream public may be affected.	Emergency action plan to be development.	Moderate	Rare	Medium			Moderate	Rare	Medium
			Programming of works outside of high risk periods.								
Failure of diversion works.	Inadequate construction planning.	Uncontrolled release but manageable	Construction timed to occur during dry season.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
			Sizing of coffer dams and diversion tunnels need to be optimised using the probability of flooding.								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Major flood during construction resulting in 'wash out'.	Unpredicted heavy rainfall event.	Loss of coffer dam and abutments	Construction timed to occur during dry season. Monitoring of the weather.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
Dam overtops before construction is complete.	Seasonal weather conditions.	Potential dam integrity compromised.	Prepare a flood plan in case the dam over tops before construction is complete. RCC to be placed on DS face of dam to protect against overtopping during construction. Adequate pumping capacity provided for clearing flood water. Diversion conduit to have capacity to pass small floods, reducing likelihood of occurrence	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium
Health exposure from disease vectors.	Mosquitoes	Worker health and hygiene impacts.	There are no disease vectors other than mosquitoes identified in the area. Mosquito controls for high breading areas.	Minor	Possible	Medium			Minor	Possible	Medium

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
			Personal insect repellents.								
Attack by pest animals such as wild dogs	Wild Dogs may be attracted to work sites if food or scraps are available.	Worker health	Pest Management Plan will be prepared. Management measures will be consistent with recommendations in the Biosecurity Queensland's pest animal fact sheets. Measures to be implemented could include disposal of food scraps in designated areas and laying of poisoned baits for Dingoes / Wild Dogs.	Minor	Unlikely	Low			Minor	Unlikely	Low
Health issues with food safety.	Poor food waste control.	Worker health and hygiene impacts.	Semi-permanent construction sites to have crib rooms with adequate refrigeration.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Inadequate refrigeration.		Workers at mobile and temporary sites to have portable coolers or non-perishable foods suitable to the weather conditions.								
Health issues with contaminated water.	Lack of clean water supply.	Worker health and hygiene impacts.	Semi-permanent construction sites to have crib rooms with adequate clean water supply.	Minor	Unlikely	Low			Minor	Unlikely	Low

Table 26-6 Risk assessment – dam operation and maintenance

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Impacts on access and egress for emergency services.	Dam changes the travel routes for response.	Delayed response times to critical assets and people.	Roads will be relocated to provide required access. Discussions are required with emergency services to identify any route access issues.	Moderate	Rare	Medium			Moderate	Rare	Medium
Damage to existing road infrastructure.	Construction equipment movements. Deliveries to site.	Environmental impacts. Road safety impacts. Construction issue risk.	Identifying the make good requirements.	Moderate	Rare	Medium			Moderate	Rare	Medium
Public access during maintenance periods.	Interest of general public.	Public safety impacts.	Security fencing to restrict public entry to dangerous areas during maintenance periods.	Major	Rare	Medium			Major	Rare	Medium

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Drowning in the dam.	Public access	Injury/Loss of life	Provide adequate signage to warn public of any dangers.	Major	Unlikely	Medium			Major	Rare	Medium
Sudden "sunny day" failure of dam.	Structural Failure	Delayed release of water followed by a surge downstream with wall of water and subsequent loss of life.	Design according to category of installation determined by Failure Impact assessment according to ANCOLD standards.	Catastrophic	Rare	Medium			Catastrophic	Rare	Medium
	Poor maintenance		Use of failsafe design principles								
	Inadequate design/ construction		Regular maintenance								
	Foundations eroding		Develop Emergency Action Plan								
Dam overtopping	Design estimation of the Probable Maximum Flood (PMF) too low - resulting in flood bigger than design parameters occurring	Dam rim erosion, leading to dam failure, sudden release and loss of life	Design estimation of the Probable Maximum Flood (PMF) too low - resulting in flood bigger than design parameters occurring	Moderate	Unlikely	Medium	Emergency action plans to cater for around 18 hours of inundation warning and include flood warning devices such as upstream river	Significantly	Moderate	Rare	Medium

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
	Cyclonic activity leading to flood		Use guidelines on Selection of Acceptable Flood capacity for Dams, by ANCOLD Hydrological modelling. Develop Emergency Action Plans in conjunction with Emergency Departments.				level and rainfall gauges in order to increase warning time.				
Water seepage beneath dam	Geology beneath dam contains permeable strata	Increase water flow downstream of dam	Construction to involve foundation works to create impervious seal.	Moderate	Rare	Medium			Minor	Rare	Low
Reservoir landslide	Slope too steep Lack of stability Inadequate geotech investigation	Wall of water over top of dam, dam rim erodes, dam failure leading to loss of life	Quality assurance performed on geotech investigations Ensure slopes are stable with rocks/vegetation	Minor	Unlikely	Low			Minor	Unlikely	Low

Table 26-7 Risk assessment – pipeline operation and maintenance

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
High Pressure	Pump operating against closed valve(s).	Pipe line failure	Operating procedures.	Moderate	Rare	Medium			Moderate	Rare	Medium
	Water hammer from closure of vacuum after a pump stoppage.	Water hammer may over pressurise the pipe.	Design to consider the safety system (such as key interlock for the valve and pump start system) to ensure valves are open prior to restarting the pump after maintenance.								
			Pipeline design can consider surge tanks at high points with non-return valves to fill the pipe when under vacuum.								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Water Contamination	Loss of pipeline lining materials.	Pump damage	Adequate operating and maintenance procedures.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Commissioning, maintenance debris.		Design to consider screens at inlet to pumps to catch deposits and foreign objects.								
Ground contamination along the pipeline	Maintenance activities.	Environmental impact	Maintenance procedures and testing.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Oil spills		Controls as noted elsewhere in the EIS.								
	Poor weed control										
Leaks/Rupture	Chaffing of pipes from rocks.	Long term failure of pipe.	Site survey undertaken.	Moderate	Rare	Medium			Moderate	Rare	Medium
	Corrosion from soil type.	Land erosion from water flows.	Permits and safety by design risk studies.								
		Potential impacts to road infrastructure at road crossings.	Potential to use cathodic protection for the pipeline.								
			Independent welding QA checks as defined in the design.								

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
Fire/explosion	Transformer stations and control room fires.	Building damage	Smoke detection in buildings	Minor	Unlikely	Low			Minor	Unlikely	Low
	Grass fires.	Ignition source for bushfire.	Adequate clearance of vegetation around the switch yards.								
			Confirming that all fire fighting equipment is provided to support the use of water from the pump stations.								
Maintainability issues	Lack of access to inside of tanks.	Poor reliability and asset utilisation.	Maintenance manuals are required.	Minor	Unlikely	Low			Minor	Unlikely	Low
	Lack of visibility of site.	Manual handling issues	Trouble shooting guide included in the specification.								
	Lack of access to inside of the pipe.	Environmental water release.	Design considers the requirements for pigging.								
	Lack of pigging operations access.										
Public access during	Interest of general public.	Public safety impacts.	Locking out of public during maintenance.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with Controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				C	L	Current Risk			C	L	Mitigated Risk
maintenance periods.			Security fencing to restrict public entry to dangerous areas during maintenance periods.								
Discharge during commissioning	First fills of pipeline. Removal of first flush.	Large quantity of water involved at each stage.	Commissioning plan required for the pipeline to support the description of project information.	Moderate	Unlikely	Medium			Moderate	Unlikely	Medium

26.1.5. Project Controls and Mitigation Measures

26.1.5.1. Equipment

Construction vehicles and equipment will be operated within the manufacture's specifications. All vehicles and equipment will be maintained and serviced on a regular basis. Records of maintenance and servicing will be retained on-site for the duration of the construction phase. Machinery and equipment operators will be trained and carry current and appropriate licenses, where necessary.

26.1.5.2. Vehicle collision and driving conditions

Vehicles on the construction site are likely to include front-end loaders, graders, rollers, cranes, water trucks, dump trucks, buses and light vehicles (four-wheel drives) that operate on roads and access roads around the Project. Collisions between these have the potential to cause serious injury to operators and passengers.

Construction workers operating vehicles on-site will be trained and licensed so that these vehicles are driven in a safe and appropriate manner. Speed control (signage), driving to conditions, and prescribed driving etiquette on the site will be used to control the risk. All vehicles will be fitted with radios for two-way communication and high visibility flags for ease of identification.

Watering of roads and access areas will be undertaken regularly to suppress dust and improve visibility. Adequate night lighting through the provision of lighting towers and vehicle headlights will be provided to ensure night operating and driving conditions are safe.

26.1.5.3. Blasting and misfires

Blasting creates a number of potential risks such as dust, noise, vibration, fly-rock and air-blast effects. Fly-rock and air-blast effects can cause serious personal injury if not properly controlled and therefore create a high risk to the workers.

Mitigation measures include the use of blasting experts to undertake safe blast design, control of access (including temporary road closure) and evacuation warnings before blasting. Personnel in the vicinity of a blast will wear Personal Protective Equipment (PPE) and all personnel will observe safe distances during blasting activities.

Proper stemming will be used in the preparation of charges and appropriate charge ratios will be used to limit the amount of fly rock produced by a blast. Blasting operations will be carried out by a person qualified and experienced in the use of explosives.

Blasting misfires include incomplete detonation of the blast. This may reduce or confine the blast impact, and may pose safety issues to personnel re-entering the area of blast misfires. Training and management of personnel involved in blasting activities will be required to ensure appropriate knowledge.

Safety procedures will be developed and strictly adhered to on site to limit the probability of the hazard occurring and identify appropriate means for identifying and mitigating a misfire should one occur.

26.1.5.4. Personnel interaction with machinery

Personnel may be at risk of interacting with construction machinery, parts from vehicles, earth moving equipment or portable plant and equipment resulting in the potential for serious injury. Strict adherence to the Project's workplace health and safety rules and established safety systems will reduce the likelihood of occurrence. Appropriate guarding of fixed and portable equipment will be in accordance with AS4024:2006 Safety of Machinery.

26.1.5.5. High voltage exposure

Power lines may be affected by the Project and will require temporary or permanent relocation. Relocating electricity infrastructure may expose personnel to potentially lethal levels of voltage and amperage. Specialist electrical engineers will undertake this task using approved codes of practice and procedures.

There will be specific and detailed standard operating procedures implemented that deal with high voltage. The residual high risk can be managed by ensuring the preventative controls are well implemented and monitored.

26.1.5.6. Working at height and falling objects

There will be instances where workers are required to work at height during the construction phase. The Proponent will plan activities to minimise the requirement to work at heights where practical. However, where working at heights is unavoidable, SOPs for working at height will be used to control this risk.

Mandatory PPE on a construction site that protects persons against objects falling includes hard hats and steel capped boots. Fall of persons will be controlled through appropriate elevated work platforms and the proper use of harnesses.

During operations, there will also be instances where operators are required to work at height during maintenance or repair duties.

26.1.5.7. Food Hygiene

Areas involved in the provision and supply of food, such as the construction mess or meal rooms, will operate in compliance with current food and hygiene legislation. The catering contractor will hold the relevant licence under the *Food Act 1981*.

26.1.5.8. Odour

The Project is not expected to produce any odour that may be detrimental to the health and safety of employees, visitors or the general public.

26.1.5.9. Dust

The Project will implement current particulate and gas/vapour exposure standards and procedures that will apply to dust, fibres, mist and fume (ie. particulates), and gas and vapour exposures in the workplace, (with emphasis on inhalation as the prime route of exposure).

The standards and procedures will cover, amongst other things, evaluation of particulate and gas/vapour hazards, and development of a control program to ensure that employees and contractors will not suffer adverse health effects from

particulates or gas/vapours, either used or generated by the Project. Where required, the dust control program will include engineering controls such as water trucks or sprays and use of respiratory protection devices.

The health risks are expected to be low. Dust from earthmoving machinery will be controlled by water trucks. The nearest residences are not expected to be adversely affected by dust during construction with the implementation of appropriate dust control measures (Chapter 6 – Air Quality).

26.1.5.10. Noise

All equipment (both fixed and mobile) will comply with the relevant Australian Standard in regard to design and operating noise levels.

The Project will implement current hearing conservation standards and procedures during construction and operation to ensure that employees and contractors will not suffer adverse health effects from noise generated in the workplace. These standards and procedures will cover, amongst other things, the identification and evaluation of occupational noise hazards and development of noise control programs to minimise noise levels and protect employees and contractors from adverse exposure. Where required the noise control programs will include use of hearing protection devices.

26.1.5.11. Pests

The Project is not expected to lead to an increase in the number of pests during construction or as a result of site operations. Requirements for fire ant control will be identified prior to commencement. Pests and weeds have been identified as a moderate risk with the planned controls in place which include plant and equipment wash down and the maintenance of the existing weed management program.

26.1.5.12. Waste

Waste will be managed to avoid adverse impacts on the health of the workforce and minimise risk of impact on land, air and water.

There will be small amounts of wastes generated during the construction of the power station. This waste will consist of scrap steel, timber, concrete, general waste, recyclable waste and some hazardous waste from the operation and service of equipment.

During the construction phase, food wastes, paper and recyclables will be generated in communal areas. Colour-coded, signed bins will be used to segregate and collect these wastes. The bins will be located throughout offices and canteen areas to achieve maximum economic waste recovery. Waste materials that are known to attract vermin will be stored and handled in a hygienic manner. General wastes will be transported for disposal to the nearest landfill.

Standard procedures will be in place during construction to contain and limit damage from accidental release of waste materials, such as oil spillages.

Operational activities are also expected to produce small quantities of hazardous (regulated) wastes such as hydrocarbons and hydrocarbon contaminated products (oily wastes and oil filters). Waste materials which are known to attract vermin will be stored, handled in a responsible manner and removed from site by a licensed waste management firm.

Standard procedures for the storage, containment, disposal and spill response for potentially hazardous waste materials will minimise potential impacts associated with these materials/substances. The health risks presented by operational wastes are low.

26.1.5.13. Security

The dam construction area will be enclosed with suitable fencing. Other fencing will protect selected areas with high risk of a security breach or unauthorised public access such as at pump stations along the pipeline and signs will be erected to delineate such areas. Prior to being given access to the Project site, visitors will complete mandatory registration and an environmental, health and safety induction. The scope of induction will reflect those areas of the Project site that the visitor will be permitted to access. Access to the construction site will be denied to any site staff/visitor not wearing mandatory personal protective equipment (PPE).

For the construction phase, public liability will be managed by the constructor with closure of the construction zone to the public.
A safety risk assessment will be undertaken to identify areas of increased risk to the public once the construction phasing and final design are established. For land that surrounds the water storage, such as that leased back to landholders, public liability for access onto that land will be with the landholder.

Protection of infrastructure will be maintained by ensuring the constructor has identified all assets and undertakes construction in a way that does not damage this infrastructure or cause a reduction in service provided by the dam and associated infrastructure.

The operators of the Project will have adequate public liability insurances.

26.1.5.14. Natural Disasters

The exposure of the dam to climate change and natural disasters is partly discussed under dam safety in relation to seismic events in Section 26.1.3.2.

Additionally, the dam could be exposed to severe storm events that exceed the existing probable maximum flood level. The dam design and construction reduces the likelihood of structural impacts from over topping and is considered to mitigate this risk.

Access and egress to the dam during bushfires will require the consideration of safety zones and or management plans that prevent or mitigate the exposure to construction and operation staff.

26.1.5.15. Community safeguards

It is vitally important that the Project have minimal impact on local communities. The community safeguards will be implemented through a 'defence in depth' approach where there exists a multi-layered approach to public and environmental impacts. These safeguard layers come in two principal forms:

- the design of processes to 'good engineering practice' standard; and
- the implementation of safety management systems and emergency planning appropriate for the hazards involved in the operations.

Good engineering practice involves, as a minimum, designing in accordance with Australian Standards and industry codes of practice as well as using formal safety in design practices for reviews and issue management. The safety systems of the approach can include:

- traffic management plans;
- behaviour codes;
- community engagement sessions;
- monitoring and control;
- security systems;
- fire detection, alarm and suppression systems; and
- emergency procedures.

26.1.5.16. Monitoring

Monitoring will be undertaken to assess whether Project health and safety measures are being implemented and effective. Monitoring will involve the compilation and assessment of data relating to health and safety issues, such as reported near misses, accident reports and any health surveillance data. Outcomes from this monitoring may trigger the need for additional safety and health risk control actions.

Accident and near hit data will be monitored to identify where:

- common themes occur;
- PPE is being incorrectly used/abused;
- corrective actions have not been strictly implemented;
- corrective actions are ineffective;
- procedures/practices need to be reviewed;
- retraining may be required; and
- health surveillance data will be monitored to identify common themes.

26.1.5.17. Safety management systems

The safety management system adopts an integrated approach to risk management of the dam construction and operations, recognising the hazards at all points in the operations and how these are controlled. Australian Standards AS 4801:2001 and AS4804:2001 will be complied with in developing and operating the safety management system.

The safety management system should include the following:

- policy statements for health and safety management objectives and goals;
- responsibility statements and accountabilities;
- review of modification and design procedures;

- policies for managing change (new technology, new procedures);
- assessment of human factors in the design and operation;
- training programs for operators;
- internal standards and codes of practice;
- process and equipment integrity including preventative maintenance and procedures;
- incident investigation procedures;
- enhancement of safety knowledge and its dissemination to staff;
- risk and compliance auditing; and
- corrective action procedures.

Details of the safety management system are legally required to be provided by the operator.

26.2. Hazardous chemicals

Some of the key hazards for the Project are associated with the substances being stored and used. The Project will potentially use hazardous substances which are regulated by the Australian Dangerous Goods Code.

Table 26-8 lists the principal dangerous goods, by name, classification, raw and storage concentration, UN number, and packaging group.

Table 26-8 Indicative list of dangerous goods and hazardous substances

Chemical Name/ Shipping Name	DG Class	Raw conc. (wt%)	Storage conc. (wt%)	UN Number	Packaging group	Purpose/ Use
Diesel Fuel Oil	3 (Class C1)*	N/A	N/A	1202	III	Fuel for mobile equipment
Unleaded petrol	3	N/A	N/A	1203	II	Fuel for mobile equipment
Lubrication Oils (hydraulic oil)	3 (Class C2)**	N/A	N/A	N/A	N/A	Lubricate plant and equipment
Solvents (eg. acetone)	3	99.5	99.5	1090	II	Plant maintenance
Paints	3	N/A	N/A	1263	III	Paint
Hydrochloric Acid	8	30%	30%	1789	II	Rinsing of concrete
Ammonium Nitrate Emulsion	5.1	N/A	N/A	3375	II	Blasting

* Class C1—a combustible liquid that has a flashpoint of 150°C or less.

** Class C2—a combustible liquid that has a flashpoint exceeding 150°C.

26.2.1. Risk assessment

26.2.1.1. Construction

During dam and pipeline construction there will be hazards associated with substances stored and used for motor vehicle and machine operation and associated construction activities. Table 26-9 provides an indicative list of dangerous goods and hazardous substances and materials, which may be used during construction. The table details the relevant rate of use and indicative maximum amount of the substance/material stored on site during construction. Table 26-9 describes the physical properties of these materials. Material Safety Data Sheet (MSDS) information will be obtained and communicated to all site personnel involved in the storage, handling, use and disposal of dangerous and hazardous substances and materials.

Table 26-9 Indicative list of dangerous goods and hazardous substances – construction

Chemical Name/ Shipping Name	Rate of Use	Indicative maximum inventory
Diesel Fuel Oil	10 000 litres/day	150 000 litres
Unleaded Petrol	200 litres/day	3000 litres
Lubrication Oils (hydraulic oil)	200 litres/day	10 000 litres
Solvents	As required	<200 litres
Paints	As required	<200 litres
Hydrochloric Acid	As required	300 litres
Ammonium Nitrate	Dependent on ground conditions	10,000 kg

All fuel storage will be designed and constructed according to the AS1940-2004, the storage and handling of flammable and combustible liquids.

Storage and handling of corrosive substances, such as hydrochloric acid, will be done in accordance with AS 3780:2008, the storage and handling of corrosive substances.

26.2.1.2. Operation and Maintenance

During operation there will be hazards associated with chemicals being stored and used for maintenance activities. However, the use of these is expected to be minimal when compared to the construction phase. Table 26-10 lists the rate of use and the maximum amount stored on-site during operations. Refer to Table 26-8 for the physical properties of these materials. MSDS information will be obtained and communicated to all site personnel involved in the storage, handling use and disposal of hazardous substances and materials.

Table 26-10 Indicative list of dangerous goods and hazardous substances – operation

Chemical Name/ Shipping Name	Rate of Use	Indicative maximum inventory
Diesel Fuel Oil	As required	3000 L
Lubrication Oils (hydraulic oil)	As required	3000 L

The major dangerous/hazardous substances shown in Table 26-10 are diesel and fuel oils. It is vital that approved separation distances are maintained during the storage of these materials/substances as defined respectively in Australian Standard AS 1940-2004.

Also, the storage, handling and use of these materials/substances will be in accordance with current Australian Standards (AS), industry codes of practice and best environmental management practices (BEMP). Given the implementation of appropriate controls for these materials there is negligible risk to employees, adjacent land users, general public and the environment.

26.2.1.3. Transportation

Off-site transportation of chemicals to and from the site could result in accidental release or exposure to hazardous materials. As an example, if a tanker shell became damaged in an incident, the full contents of one tank compartment (5 000-8 500 litres) or greater (up to 20 000 litres) could spill onto an off-site roadway, and escape into the soil profile or nearby waterway. The environmental damage caused by such a spill is dependent on the area in which the incident occurs.

All dangerous goods will be transported in accordance with the Australian Code for the Transport of Dangerous Goods by Road & Rail 7th edition.

The expected frequency of deliveries of hazardous materials that have the potential to spill is summarised in Table 26-9 and Table 26-10. The largest requirement for delivery of chemicals to the site during construction is for diesel fuel oil.

26.2.2. Mitigation measures

26.2.2.1. Construction, Operation and Maintenance

The chemicals used during the construction, operation and maintenance phases will be relatively benign. Fuel (predominantly diesel), lubricants, oils, minor quantities of solvents, degreasers and domestic cleaning agents will form the majority of chemicals on site.

All hydrocarbons will be stored and handled in accordance with:

- AS 1940: 2004 The storage and handling of flammable and combustible liquids;
- AS 4897: 2008 The Design, installation and operation of underground petroleum storage systems; and
- contained within each Standard there is a list of references for other applicable Australian Standards and other related documents.

The following standards will apply for electrical installations in hazardous zones: AS 3000, AS 2381, AS 2381.1, AS 2430, AS 2430.3.

Chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm. All chemicals will be stored, handled and used according to provisions in their Material Safety Data Sheet (MSDS). The health risk presented by these chemicals is relatively low.

26.2.2.2. Fuel storage (mobile and static)

Fuel storage on-site will be predominantly diesel, which presents a relatively low combustion risk and a moderate environmental risk. Ignition sources will be controlled to avoid fire involving bulk fuel oil. Fire fighting facilities will be provided at fuel storage facilities.

All hydrocarbons will be stored and handled in accordance with Australian Standard 1940. Chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm.

Standard operating procedures for the delivery, storage, containment, disposal and spill response for potentially hazardous materials will be developed. The use of Australian Standards (AS 1940) for the management of fuel storage (bunding and containment) will reduce this risk to a low level.

The hazard associated with the storage of fuel oil arises from leaks/ failures in the system. To minimise the hazards associated with fuel oil leaking during tanker unloading, the following measures will be in place:

- a program of regular equipment inspection and testing will be continued to ensure reliable performance;
- operators will continue be trained in the safe operation of the system and emergency procedures in the event of fuel oil leakage;
- spill containment equipment will be available at the unloading pad for use in the event of spillage;
- a sump will be provided to collect any spillage and allow recovery;
- ignition sources will be strictly controlled and limited to avoid a fire;
- appropriate fire fighting materials and equipment will be available to suppress fires; and
- an approved fire protection system will be installed around new hydrocarbon storage areas.

The following measures will be taken to minimise the potential for the leakage of fuel oil from storage tanks:

- adequate bunding will be constructed to contain spills, in accordance with AS 1940:2004;
- tank level indicators will be installed on fuel oil tanks for monitoring of fuel oil levels;
- maintenance of fuel oil tanks will be undertaken, to ensure safe and effective operation of all components; and
- tanks will be designed in accordance with AS 1692: 2006 *Steel tanks for flammable and combustible liquids* to minimise the potential for failure of the diesel storage vessel.

26.2.2.3. Explosives

A specialist explosives company will provide the explosives, detonators and boosters to be used during blasting operations. The Contractor's personnel will be licensed and trained in the transport, handling, mixing and use of explosive materials. Blasting operations will comply with the *Explosive Act 1999 and Explosives Regulation 2003.*

Note that the location of the explosives will take into consideration:

- public risk;
- enhancing physical protection to the public by the use of natural ground features;

- vehicular access routes and junctions with public roads;
- security;
- other activities within the proximity of the site; and
- protection from flood, fire, landslide, lightning or other natural incidents.

26.2.2.4. Transportation

Licensed transporters operating in compliance with the Australian Dangerous Goods Code will undertake the transport of dangerous goods to the construction site.

The transport of ammonium nitrate will be undertaken in compliance with the requirements of AS 1678.5.1.002-1998: *Emergency procedure guide - Transport - Ammonium nitrate.*

Off-site transport accidents have the potential to occur but that potential is low. Most of the transport occurs along major roadways. The increased exposure of the public to this hazard due to the construction activity is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Project.

The potential for a diesel transport accident to occur is also low. Tanker drivers are trained to such a level, and are sufficiently experienced that single vehicle accidents do not regularly occur. An accident involving a road tanker would most likely require a second vehicle to collide with the tanker. The increased exposure of the public to a diesel transport hazard is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Project.

To control the damage that may occur, several measures will be put in place for transport operations. These measures include:

- dam constructor to liaise with emergency services to develop an emergency plan to deal with tanker incidents off-site;
- all vehicles to carry Hazchem Identification and response guidelines for use by emergency personnel attending the scene of the accident;
- tankers to incorporate internal valves on all outlets to prevent spills, in the event of vehicle damage; and
- all tankers to conform with the Australian Code for the Transport of Dangerous Goods by Road and Rail, and Australian Standard AS 2809.

26.3. Emergency management

Each phase of the Project will require the person in control to develop an emergency management plan for their scope of work.

Emergency planning represents the outer layers of the ‘defence in depth’ approach to community safeguards. Any emergency planning must be based on the following components:

- an assessment of what constitutes ‘an emergency’ for the particular operation, pertaining to hazards cited in the risk assessment, Table 26-5, Table 26-6 and Table 26-7, and on-site plan to handle incidents;

- an off-site plan with reference to emergency services needed;
- communication, emergency responsibilities, control centre establishment;
- post emergency procedures including recovery, debriefing and review of plan; and
- test the plan under emergency-scenario conditions.

General guidance for preparing emergency plans can be obtained from the Queensland Government, Department of Community Safety. In particular, the State Planning Policy 1/03: Mitigating the adverse impacts of flood, bushfire and landslide, along with recent Australian-New Zealand code of practice for emergency planning will form the basis for the detailed development of the plans covering the individual areas.

Plans will assess the access for emergency services. Discussions will be held with emergency services to identify any route access issues.

The final detailed plans should be developed by the dam construction company as the detailed engineering design takes shape. This might involve local emergency services such as police, fire brigade and State Emergency Services personnel as well as the local emergency response groups.

The dam operator will also require a plan that addresses the specific emergencies that could arise during operations.

Two specific levels of emergency response planning are required under the Queensland Dam Safety Guidelines:

- an Emergency Action Plan (EAP) which prescribes activities at the dam (prepared and operated by the dam owner; and
- a Counter Disaster Plan (CDP) which prescribes activities downstream of the dam (prepared and operated by the local Disaster District Co-ordination Committee with significant input from the dam owner).

26.3.1. Emergency action plan

The EAP must be developed for the dam in accordance with the Queensland Dam Safety Guidelines (DNRM, 2002). It should be fully reviewed and updated at least every 5 years and annual emergency exercises should be undertaken. Notification details should be updated at least every year.

The EAP should include the following:

- roles and responsibilities – of the dam owner, operator and dam personnel during emergency situations;
- notification listing or flowchart – identifying responsibility for notification, the order of notification and who is to be notified;
- area map – showing the access routes to the storage during fair and adverse weather conditions, including distance and travel times;
- a drawing of the storage catchment area;
- emergency events and actions list, including:
- identification of emergency conditions which could endanger the integrity of the dam;

- description of typical problems, problem characteristics and when/ what to check for during inspections;
- dam operation procedures to follow in the event that such emergency conditions are identified;
- dam failure inundation maps – these should identify: downstream inhabited areas subject to danger, inundated areas, a narrative description of areas affected by dam break; and
- any other charts, rating tables, considered by the dam owners as necessary.

26.3.2. Emergency response

Each phase of the Project will require the person in control to develop an emergency response plan for their scope of work. The dam constructor, pipeline constructor and operator will liaise with local State Emergency Services and local ambulance and hospital services with respect to planning for Emergency Response. SunWater acknowledges the requirement to include all emergency services in the development of emergency plans. This specifically includes Queensland Police Service (QPS), Queensland Fire and Rescue Service (QFRS), State Emergency Services and Queensland Ambulance Service (QAS) and hospital services. Emergency planning will be undertaken during detailed design, when a construction contractor has been appointed. This is because aspects of the Project that are particularly relevant to such planning are strongly influenced by the contractors work practices, policies and procedures.

Designated first aid and emergency rescue facilities and equipment (including a helipad) will be available during the construction and operation phases. Appropriately trained personnel will be available throughout the life of the Project to provide first aid and emergency response to on site emergencies. First aid response and provision will be included in site induction training that will be provided to all staff members. Fire drills will be undertaken on a regular basis.

SunWater acknowledge that due to the Project's relative isolation from immediate emergency service response, it is essential that staff working at the construction sites are fully conversant with the Emergency Management, Action Plan and Response procedures including the use of installed fire fighting equipment along with any other on site equipment that is primarily for their use.

Stores, workshops and offices will be fitted with approved and certified fire detection (smoke detectors) and sprinkler systems. Permanent facilities, such as fuel storage areas, will have a dedicated fire alarm, suppression and fire fighting systems. First aid and fire fighting equipment (hand held extinguishers and fire hoses) will be installed at strategic points within each building. Fire fighting equipment and exit locations will be suitably signed. All work areas will be within the required distance to reach emergency exits.

Site fire fighting capabilities also will be addressed in the Emergency Response Plan. The dam construction site will have a fire truck or suitably equipped water truck or trailer that can support fire response requirements during construction and operation.

Evacuation and access maps of the construction camps, including the identification of a possible helicopter landing site if required, will be provided during the emergency planning process to emergency services.

The construction camps will be designed and built in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide. It is noted that QFRS has a legislative jurisdiction to provide input into the design of a building or a structure's fire safety systems as an advice agency.

26.4. Decommissioning phase

A decommissioning date for the Project has not been determined at this stage. The dam will be maintained to meet dam safety requirements. A possible decommissioning date is likely to be too far in the future to allow effective planning for decommissioning to occur at this point in time. When this does occur, consideration of matters such as potential impacts on terrestrial and aquatic ecology and surrounding land use, and the resultant changed hydrology will need to occur.

Decommissioning will be required to comply with the requirements of the Standing Operating Procedures specific to the dam as prepared by the Queensland Dam Safety Regulator.

26.5. Summary

The failure hazard category has important impacts on the design work to be undertaken to achieve the required reliability of the structure under the various failure modes.

The risk assessment shows that the residual risks are no higher than moderate with most being related to common construction and decommissioning activities that are regularly managed through the contractor selection process and implementation of current health and safety practices. Operational risks relate to public safety at the dam and public access to the pipeline especially during maintenance activities.

The remainder of the assessed risks relies heavily on the information provided in the other parts of the EIS under which a scientific assessment of the risks has been undertaken. References to these areas were provided at the start of this section.

Provided competent construction, operation, maintenance and decommissioning of the dam and pipeline is in place there are no identified residual risks that are abnormal or pose an increased level of uncertainty in achieving the objectives for this project.