



# Chapter 25

Hazard and risk



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## Chapter 25 Hazard and risk

The Secretary's environmental assessment requirements for the Narrabri Gas Project include a requirement to assess likely risks to off-site safety including potential bushfire risk and risks associated with the transport, storage, handling and use of dangerous goods. A hazard and risk assessment was undertaken in response to this requirement and is provided as Appendix S. This chapter provides a summary of the hazards and risks associated with the project where they have the potential to impact off-site safety. Environmental risks such as spills and leaks of fuel and chemicals are assessed in Chapter 14 – Soils and land contamination.

The hazard and risk assessment included a preliminary risk screening and preliminary hazard analysis (as required) in accordance with the relevant industry and regulatory guidance being the:

- *Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33)*
- *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning (NSW Department of Planning 2011a)*
- *Hazardous Industry Planning Advisory Paper No. 6 (NSW Department of Planning 2011a).*

Preliminary risk screening identified the classes and quantities of all dangerous goods to be used, stored or produced by the project. This included consideration of natural gas, drilling fluids, and chemicals stored at Leewood and Bibblewindi.

Risks associated with dangerous goods identified by the preliminary risk screening were then assessed through a preliminary hazard analysis as required under the guidelines. The analysis included an assessment of the likelihood and consequence of identified risks regarding potential impacts to people and property.

The risk of a bushfire being caused by the project was also assessed with consideration of project activities and surrounding environmental factors.

The assessment found with regard to off-site impacts to people, property and the environment, and with the implementation of appropriate mitigation and management measures, that the:

- risk of loss of significant quantities of water resulting from failure of a pond wall was very low
- risk of uncontrolled loss of gas leading to a fire or explosion was low to very low
- risk of uncontrolled loss of containment of liquid chemicals or dangerous goods was low to very low
- the likelihood of bushfire ignition from a project related activity was remote; however, the overall risk was assessed to be medium given the potential consequences associated with bushfire.

The assessment identified mitigation and management measures to control the identified risks, including a Bushfire Management Plan prepared in conjunction with landholders, the Forestry Corporation of NSW and the NSW Rural Fire Service. The Plan would formalise and build on measures already in place as informed by the proponent's participation in the Resource Industry Fire Management Group.

## 25.1 Methodology

### 25.1.1 Overview

Hazard and risks were assessed using the compliance assessment methodology and the environmental risk assessment methodology. The compliance assessment methodology determines whether the project complies with published limits or thresholds while the environmental risk assessment methodology considers the likelihood and consequence of a potential impact to assess its level of risk. Further description of these methodologies is provided in Chapter 10.

A systematic approach to planning and assessing proposals for potentially hazardous and offensive development for the purpose of industry or storage is presented in State Environmental Planning Policy (SEPP) 33. The purpose of the hazard and risk assessment, therefore, was to determine if the project would be potentially hazardous or potentially offensive using the SEPP 33 risk screening process.

The need for a preliminary hazard analysis under SEPP 33 is determined by initially undertaking a preliminary risk screening of the project. The preliminary risk screening methodology concentrates on the storage of specific dangerous goods classes that have the potential for significant off-site effects. If a preliminary hazard analysis is not required, the process is completed at this step. For development proposals classified as 'potentially hazardous industry', a preliminary hazard analysis is completed to determine the risk to people, property and the environment surrounding the project in the presence of controls.

A desktop bushfire risk assessment was also carried out based on information provided by the proponent complemented by publicly available information. The assessment considered the risk of a bushfire being started by a project related activity during construction or operation.

### 25.1.2 Preliminary hazard analysis

#### Hazard identification

The threshold to determine if the various facilities represent 'potentially hazardous industry' as defined by SEPP 33 is based on the quantities of dangerous goods and their proximity to the site boundary and sensitive receivers. The classes of dangerous goods identified in the risk screening that have quantity thresholds in SEPP 33 included Class 2.1 flammable gases, Class 3 flammable liquids, Class 6.1 toxic substances and Class 8 corrosive substances.

Class 3 flammable liquids and Class 8 corrosive substances to be used on the project would not meet the thresholds. However, the project is considered to be 'potentially hazardous industry' on the basis of large volumes of Class 2.1 flammable gases being present (methane). In addition, as the specific type of biocide proposed for use in water treatment is yet to be selected, taking a conservative assessment approach, it has the potential to be a Class 6.1 toxic substance if present in volumes exceeding 2.5 tonnes. If this is the case, it would be present in quantities in excess of the SEPP 33 threshold at Leewood, and therefore, trigger the 'potentially hazardous industry' classification—noting that it can remain below the HIPAP 4 risk criteria if appropriately managed.

A preliminary hazard analysis was conducted to assess the risk these dangerous goods pose to surrounding land users as per the requirements of SEPP 33. The preliminary hazard analysis identified potential hazard scenarios or risks that would involve dangerous goods as described above. The analysis did not cover work health and safety hazards such as electrocution, drowning and vehicle accidents as these would be managed through a formal safety management system for the project.

## Level of assessment

*Multi-level Risk Assessment* (NSW Department of Planning 2011) provides a guideline for determining the appropriate level of risk assessment. A level two assessment (semi-quantitative analysis) was determined to be appropriate for the project.

A level two assessment can be justified if the societal risk estimates fall within the middle 'as low as reasonably practicable' zone and the frequency of risk contributors having off-site consequences is relatively low. A level two assessment is semi-quantitative in that it should include sufficient quantification of risk contributors to demonstrate that risk criteria would be met.

## Risk assessment

The risks associated with the identified hazards were assessed as a product of their likelihood and consequence. In accordance with the level of assessment defined in *Multi-Level Risk Assessment* (NSW Department of Planning 2011), the assessment included quantitative aspects such as the reference to appropriate failure likelihood data and consequence modelling outputs.

Likelihood, consequence and risk were ranked in accordance with the environmental risk assessment methodology outlined in Chapter 10.

## Consequence modelling of fire and explosion scenarios

Where the consequences of a fire or explosion were modelled, the effect of heat radiation and explosion overpressure were considered in accordance with *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* (HIPAP 4) (NSW Department of Planning 2011b). The following risk criteria from fires and explosions are suggested in HIPAP 4:

- incident heat flux radiation at residential and sensitive use areas should not exceed 4.7 kilowatts per square metre (kW/m<sup>2</sup>) at a frequency of more than 50 chances in a million per year
- incident explosion overpressure at residential and sensitive use areas should not exceed seven kilopascals (kPa) at frequencies of more than 50 chances in a million per year.

Gas composition will vary between wells and throughout the life of a well. For the purpose of consequence modelling it has been assumed that all gas is 100 per cent methane. This assumption represents the most conservative approach for hazard and risk assessment.

Where the consequences of a toxic release were modelled, HIPAP 4 provides the effect of toxic exposure. The following risk criteria from a toxic release are suggested in HIPAP 4:

- toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year
- toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.

Consequence modelling was undertaken for a number of scenarios. All consequence scenarios were identified as representing situations that could arise from a typical range of operating conditions and process equipment that are utilised at these types of facilities including leak or rupture of a gas pipeline or other vessel.

The consequence modelling may be considered conservative as it was undertaken without consideration of systems to limit gas release that would be incorporated into the design and operation of the project, such as automatic shutdown, blowdown and isolation. These systems would be considered in future detailed consequence modelling during detailed design.

Technical assumptions for the consequence modelling are provided in Appendix S.

### 25.1.3 Bushfire risk

Bushfire risk was assessed as a product of likelihood and consequence in accordance with the environmental risk matrix presented in Chapter 10 – Approach to the impact assessment.

Likelihood was defined as the potential for a bushfire to be ignited by the project as well as the likelihood of that fire expanding, intensifying and affecting at risk values. The assessment of likelihood considered project activities and potential ignition sources along with environmental factors such as climate, vegetation, topography, land management and potential for detection.

Consequence was defined as the potential adverse outcomes on life and property associated with the size and intensity of a bushfire. Consequences considered included loss of life or injury, loss of property and community infrastructure, and impacts on commercial livelihoods including agriculture.

The assessment considered bushfire management activities already undertaken by the proponent as informed by its participation in the Resource Industry Fire Management Group along with further measures to reduce bushfire risk to a level as low as reasonably practicable.

## 25.2 Hazard and risk assessment

### 25.2.1 Preliminary risk screening

#### Dangerous goods screening

Table 25-1 identifies classes of dangerous goods held in quantities exceeding the thresholds for a 'potentially hazardous industry' under SEPP 33 and therefore requiring preliminary hazard analysis.

The results in Table 25-1 are based in a dangerous goods inventory and screening assessment for the project and includes assessment of the typical components of drilling fluid. The complete goods inventory and screening assessment is provided in Appendix S.

The following dangerous goods were found to be held in quantities exceeding the thresholds for a 'potentially hazardous industry' under SEPP 33, therefore requiring preliminary hazard analysis be undertaken:

- Class 2.1 Flammable gases
- Class 6.1 Toxic substances
- Class 8 Corrosive substances.

The preliminary hazard analysis for these substances is presented in Section 25.2.2.

Dangerous goods during transportation were also assessed but were found to be below the relevant thresholds were considered not require a route evaluation study under SEPP 33.



Table 25-1 Dangerous goods screening summary

Facility	Class 2.1 Flammable gases	Class 2.2 Non-flammable, non-toxic gases	Class 3 Flammable liquids	Class 6.1 Toxic substances	Class 8 Corrosive substances
Well pads and gas gathering lines	Present above threshold <sup>a</sup>	Not present	Present below threshold	Present below threshold	Present below threshold
Bibblewindi	Present above threshold <sup>a</sup>	Present below threshold	Present below threshold <sup>b</sup>	Not present	Not present
Leewood	Present above threshold <sup>a</sup>	Present below threshold	Present below threshold <sup>b</sup>	Present above threshold	Present above threshold

<sup>a</sup> Methane would not be pipework and other vessels in quantities that cannot be determined exactly at this stage of project planning.

For the purpose of assessment, methane has been assumed to trigger 'potentially hazardous industry' under SEPP 33.

<sup>b</sup> Class 3 flammable liquids would be stored at Bibblewindi and Leewood but do not trigger 'potentially hazardous industry' under SEPP 33 as storage tanks would be kept at sufficient distance from the facility boundary.

## 25.2.2 Preliminary hazard analysis

### Hazard identification and risk assessment

#### Overview

The preliminary hazard analysis identified hazards with offsite consequences or involving dangerous goods identified through the preliminary risk screening (refer to Section 25.2.1).

The hazards identified can be grouped as follows:

- sudden loss of containment of significant quantities of water resulting from catastrophic failure of a pond wall
- an uncontrolled loss of containment of gas leading to a fire or explosion
- an uncontrolled loss of containment of liquid chemicals or dangerous goods.

These hazards are discussed in the following sections.

#### *A sudden loss of containment of significant quantities of water resulting from catastrophic failure of a pond wall*

The risk of a pond bursting or overtopping resulting in an offsite safety consequence was assessed qualitatively as very low on the basis that the ponds are designed to Australian Standards and in accordance with guidelines set by the Australian National Committee on Large Dams and NSW Dam Safety Committee procedures and guidelines that would be followed.

The additional design and operational controls would be applied include:

- Leewood Ponds being designed to standard including primary and secondary lining, leak detection and collection and engineered spillway
- the NSW Dam Safety Committee to review pond design and confirm construction to specification

- ponds would be multi cell design facilitates, which improves maintenance ability and limits volume released in event of failure
- pond level and collection sump monitoring
- shallow monitoring bores adjacent to ponds
- Work Permit System / Job Hazard Analysis requirements
- regular inspection and monitoring program, and a Dam Safety Emergency Plan to be provided to the NSW Dam Safety Committee in accordance with legislative requirements
- real time monitoring of collection sump levels with telemetry to a control centre.

### *An uncontrolled loss of containment of gas leading to a fire or explosion*

Risks associated with loss of containment of methane gas were assessed semi-quantitatively by determining the likelihood of uncontrolled gas releases using industry data on equipment failure sourced from the UK health and Safety Executive (UK HSE 2011). The likelihood of ignition was assessed in accordance with the industry standard *Purple Book* (TNO 1999). Modelling of the consequences to people, property and the environment in the unlikely event that a fire or explosion were to occur was then undertaken.

Consequence modelling for the preliminary hazard analysis determined that:

- Uncontrolled loss of containment of gas at a well head with ignition would have consequences within about 50 metres and therefore be contained to the well pad area with no off-site impacts, noting the Field Development Protocol requires separation of 200 metres unless agreed with a landholder.
- Uncontrolled loss of containment of gas at a gathering line with ignition could have consequences up to about 165 metres and therefore have the potential for off-site impacts, noting the Field Development Protocol requires a separation distance of 200 metres unless agreed with a landholder. Although effect distances up to 165 metres were identified, this is considered conservative as the modelling software has limited capabilities for underground pipelines, and therefore, the safeguards such as depth of cover are not accounted for in the consequence modelling.
- Uncontrolled loss of containment of gas at Bibblewindi with ignition could have consequences up to about 82 metres and therefore have the potential for off-site impacts, noting the nearest sensitive receiver is about five kilometres distant.
- Uncontrolled loss of containment of gas at the Bibblewindi to Leewood infrastructure corridor with ignition could have consequences up to about 386 metres and therefore have the potential for off-site impacts, noting the nearest sensitive receiver is over two kilometres distant. This assessment is also considered conservative as the modelling results represent the unmitigated impacts of underground pipelines and therefore the safeguards such as depth of cover are not accounted for in the consequence modelling.
- Uncontrolled loss of containment of gas at Leewood with ignition could have consequences up to about 321 metres and therefore have the potential for off-site impacts, noting the nearest sensitive receiver is located around 350 metres east of the site boundary.

In summary, no impacts at sensitive receivers were predicted. The remote probability of an uncontrolled release and ignition combined with the distance from project infrastructure to sensitive places means that an uncontrolled loss of containment of gas leading to a fire or explosion would be well below the risk criteria defined in HIPAP 4 of 50 chances in a million per year for the defined hazard event.

## *An uncontrolled loss of containment of liquid chemicals or dangerous goods*

As per the preliminary risk screening in Section 25.2.1, a preliminary hazard analysis was required for Class 6.1 Toxic substances and Class 8 Corrosive substances at Leewood. Class 6.1 Toxic substances at Leewood derive from biocide used in water treatment, while Class 8 Corrosive substances at Leewood would include chemicals used in carbon dioxide removal from gas, in addition to water treatment chemicals. Risks associated with an uncontrolled loss of containment of these liquid chemicals were assessed qualitatively with reference to quantitative data on equipment failure from the UK Health and Safety Executive (UK HSE 2012).

A release of Class 6.1 Toxic substances or Class 8 Corrosive substances may occur due to mechanical damage, corrosion or equipment failure. The risk of release would be minimised in the first instance by storing and transporting them in accordance with the *Australian Dangerous Goods Code*.

For Class 6.1 Toxic substances or Class 8 Corrosive substances at Leewood to pose an offsite risk, a significant (catastrophic) release must first occur, followed by vaporisation of toxic components from the substance with subsequent dispersion of the toxic gas to sensitive receivers in concentrations that may cause injury or irritation. Considering engineering and operational controls, the combination of events leading such release is very unlikely, in the order of less than a one in one million chance.

The risk of injury or irritation would be minimised further due to the nearest sensitive receiver being around 350 metres distant. Consequence analysis of a large biocide release indicated concentrations sufficient to cause injury or irritation would be contained to 100 metres from the source and would therefore not affect this sensitive receiver. Furthermore, no credible release scenarios were identified for corrosives that would generate consequences at the nearest sensitive receiver. Accordingly, the project complies with the HIPAP 4 criteria for injury or irritation.

### 25.2.3 Bushfire risk assessment

The project area and surrounding landscape contains large area of near contiguous vegetation that have the potential to sustain large bushfires. Bushfires have historically occurred in forested parts of the project area on a decadal basis including year 1951 / 2, 1957 / 8, 1974, 1978, 1982 / 3, 1997 and 2006.

Accordingly, a fire starting within the project area has the potential to become a large scale bushfire. Construction and operation of the project would involve activities that are potential sources of ignition including hotworks and operation of machinery. The likelihood of the project activity causing a bushfire is remote given the range of measures proposed in addition to measures already in place as informed by the proponent's participation in the Resource Industry Fire Management Group. These measures would be collated in a Bushfire Management Plan described in Section 25.3.

A large scale bushfire, whether from project activities or other sources, would present threats including loss of life or injury, loss of property and community infrastructure, and impacts on commercial livelihoods including agriculture. As such, the overall risk associated with a bushfire is considered medium due to the inherent potential consequences, and despite the remote likelihood the project causing a bushfire due to the proponent implementing further measures to reduce bushfire risk to a level as low as reasonably practicable.

## 25.3 Compliance and environmental risk assessment

Table 25-2 summarises the environmental risk assessment undertaken for potential hazard and risk impacts of the project. For each identified potential impact, the assessment considered the:

- potential pre-mitigated impact
- mitigation measures that would be used to manage the potential impacts to reduce the likelihood and consequences of the potential impacts
- residual risk of the potential impact after the implementation of mitigation measures. The residual risk takes into account the potential for impact that remains after the mitigation measures are applied.

The risks assessed in the preliminary hazard analysis would be managed through the design and operation of project components as well as compliance with industry standards such as the *Australian Dangerous Goods Code*. As discussed in Section 25.2.2, the off-site risks of these hazards would be low to very low and compliant with the relevant guidelines including HIPAP 4, the Australian National Committee on Large Dams and NSW Dam Safety Committee procedures and guidelines.

Further detailed risk modelling and consequential design will be undertaken during detailed design of the project, including a pipeline safety management study compliant with *Australian Standard AS 2885.1-2012 Pipelines – Gas and liquid petroleum Part 1: Design and construction*.

Bushfire risk would be made as low as reasonably practicable through the implementation of a Bushfire Management Plan prepared in conjunction with landholders, the Forestry Corporation of NSW and the NSW Rural Fire Service. The Plan would formalise and build on measures informed by the proponent's participation in the Resource Industry Fire Management Group. The Plan would include:

- formal preparedness procedures for staff and contractors
- appropriate work practices and restrictions
- responsibilities and actions in the event of a bushfire outbreak or warning
- asset produced zones and fuel reduced areas
- evacuation procedures and routes
- exercised and drills for staff and contractors.

Bushfire risk would also be reduced through features incorporated into the design of the project include remotely operated well infrastructure with fail safe valves, buried gathering lines and appropriately rated electrical instrumentation and equipment.

Table 25-2 Environmental risk assessment

Potential impact	Phase	Pre mitigated risk			Mitigation and management measures	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Sudden loss of containment of significant quantities of water	Construction	NA	NA	NA	Signage will be installed in accordance with Australian standards to alert of underground infrastructure.	NA	NA	NA
	Operation	Remote	Negligible	Very low		Remote	Negligible	Very low
	Decommissioning	NA	NA	NA		NA	NA	NA
An uncontrolled loss of containment of gas leading to a fire or explosion	Construction	Remote <sup>a</sup>	Major <sup>a</sup>	Medium <sup>a</sup>	A Bushfire Management Plan will be implemented. All facilities will be designed and operated under the applicable Australian safety standards and protocols.	Remote <sup>a</sup>	Minor <sup>a</sup>	Very low <sup>a</sup>
	Operation	Remote	Major	Medium		Remote	Negligible <sup>b</sup> Minor <sup>c</sup> Moderate <sup>d</sup>	Very low <sup>b</sup> Very low <sup>c</sup> Low <sup>d</sup>
	Decommissioning	NA	NA	NA	Dangerous goods will be stored and transported in accordance with the <i>Australian Dangerous Goods Code</i> .	NA	NA	NA
An uncontrolled loss of containment of liquid chemicals or dangerous goods (<100 L)	Construction	Unlikely	Negligible	Very low	Chemicals will be stored and handled in accordance with relevant Australian Standards, including <i>AS 1940-2004 The storage and handling of flammable and combustible liquids</i> .	Unlikely	Negligible	Very low
	Operation	Unlikely	Negligible	Very low		Unlikely	Negligible	Very low
	Decommissioning	Unlikely	Negligible	Very low		Unlikely	Negligible	Very low
An uncontrolled loss of containment of liquid chemicals or dangerous goods (>100 L)	Construction	Unlikely	Minor	Low	Refuelling will occur with suitable containment when volumes greater than 50 litres are involved and not within 40 metres of a watercourse.	Unlikely	Minor	Low
	Operation	Unlikely	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Unlikely	Minor	Low		Unlikely	Minor	Low
Bushfire caused by project activities impacting on life and property	Construction	Remote	Major	Medium	Class 3 Packing Group III Flammable Liquids will be stored appropriate distances from site boundaries.	Remote	Major	Medium
	Operation	Remote	Major	Medium		Remote	Major	Medium
	Decommissioning	Remote	Major	Medium		Remote	Major	Medium

<sup>a</sup> Applies at gas wells during their construction.

<sup>b</sup> Applies at Leewood and Bibblewindi during operation.

<sup>c</sup> Applies at gas wells and gathering lines during operation.

<sup>d</sup> Applies at Bibblewindi to Leewood infrastructure corridor during operation.

NA: Not applicable during this project phase.

## 25.4 Conclusion

The residual risks associated with the assessed hazards are summarised in Table 25-3.

As shown, the off-site risks associated with loss of containment of water, gas, chemicals or dangerous goods assessed in the preliminary hazard analysis are low to very low. The risks would also be compliant with the relevant guidelines including HIPAP 4, the Australian National Committee on Large Dams and NSW Dam Safety Committee procedures and guidelines.

A large scale bushfire, whether from project activities or other sources, would present threats including loss of life or injury, loss of property and community infrastructure, and impacts on commercial livelihoods including agriculture. As such, the overall risk associated with a bushfire is considered medium due to the inherent potential consequences, and despite the remote likelihood the project causing a bushfire.

Bushfire risk would be made as low as reasonably practicable through the implementation of a Bushfire Management Plan prepared in conjunction with landholders, the Forestry Corporation of NSW and the NSW Rural Fire Service. The Plan would formalise and build on measures informed by the proponent's participation in the Resource Industry Fire Management Group.

**Table 25-3** Hazard and risk residual risks

Potential impact	Construction	Operation	Decommissioning
Sudden loss of containment of significant quantities of water	NA	Very low	NA
An uncontrolled loss of containment of gas leading to a fire or explosion	Very low	Low – Very low	NA
An uncontrolled loss of containment of liquid chemicals or dangerous goods (<100 L)	Very low	Very low	Very low
An uncontrolled loss of containment of liquid chemicals or dangerous goods (>100 L)	Low	Low	Low
Bushfire caused by project activities impacting on life and property	Medium	Medium	Medium