

21. HAZARD AND RISK

This chapter describes the updates to the preliminary hazard and risk assessment and preliminary safety management study undertaken to address changes made to the project description since the Arrow LNG Plant EIS (Coffey Environments, 2012) was finalised and exhibited.

The chapter presents the findings of the Update to the Preliminary Hazard and Risk Assessment for the Arrow Energy LNG Plant (update to the PHA) and the Update to the Preliminary Safety Management Study for the Arrow Energy Feed Gas Pipeline (update to the preliminary SMS) conducted by Planager and attached as Appendix 14 (confidential appendix) and Appendix 15, Preliminary Safety Management Study for the Arrow Energy Feed Gas Pipeline.

21.1 Studies and Assessments Completed for the EIS

This section provides an overview of the preliminary hazard and risk assessment (PHA) and preliminary safety management study (preliminary SMS) completed for the Arrow LNG Plant EIS and the main conclusions from these assessments.

Planager was engaged to conduct the PHA and preliminary SMS, which were included as Appendix 24 (confidential appendix) and Appendix 25 of the EIS respectively. Chapter 29 of the EIS presented the findings of these studies.

The PHA identified potential hazards and risks associated with the construction, operation and decommissioning of the LNG plant. It focused on hazards and risks to people and property from potentially significant incidents. The principles of AS/NZS ISO31000:2009, Risk Management, were adopted to identify potential hazards associated with the LNG plant and to analyse the risks. Fatality risk contours were developed to represent the likelihood of fatality to notional individuals at locations outside the LNG plant site in the event of a fire or explosion due to a loss of containment.

The assessment found that the key hazards associated with the LNG plant relate to the production, handling and storage of large quantities of flammable coal seam gas, LNG and refrigerants during operations. The highest risks identified related to a loss of containment of flammable gas or LNG (due to a leak in a pipe or equipment handling LNG or in an LNG storage tank) leading to a fire or vapour cloud explosion. The risk contours developed showed that the project would adhere to the tolerable risk criteria established.

Typical design and safety controls were outlined in the assessment to manage identified risks. The assessment also provided an outline of the emergency management systems and procedures that will be applied to prevent incidents and to safely manage emergencies should they occur.

The preliminary SMS for the feed gas pipeline identified potential health and safety threats associated with the construction, commissioning and operation of the feed gas pipeline including the section of the pipeline that is enclosed in the Curtis Island Link to be bored under Port Curtis. The preliminary SMS was undertaken in accordance with AS2885.1-2007, Pipelines – Gas and Liquid Petroleum – Design and Construction.

The key hazards (threats) and risks identified include generic threats to the feed gas pipeline (e.g., corrosion of the pipeline) and natural events leading to a loss of containment, injury or the

destruction of property and damage to the environment. Risks to the health and safety of personnel working in the Curtis Island Link were also assessed.

All risks were reduced to As Low as Reasonably Practical (ALARP) with the application of design and safety controls.

Table 21.1 presents the commitments to managing hazard and risk made by Arrow Energy in the EIS.

Table 21.1 Hazard and risk commitments

No.	Commitment
C29.01	Undertake qualitative and quantitative hazard and risk assessments (including process safety studies) in accordance with applicable regulations and standards as a part of the ongoing design process and throughout the life of the project.
C29.02	Consult with relevant Queensland government agencies including emergency services organisations and maritime safety authorities on the management of hazards and risks in accordance with relevant legislative requirements, codes and standards.
C28.01	Develop a traffic management plan for the project in consultation with DTMR and Gladstone Regional Council. Methods to ensure public safety at project sites, avoid obstruction to other road users, address seasonal weather influences on transport arrangements and manage any issues including driver fatigue will be detailed in the plan. The traffic management plan will address the movement of oversized loads.
C28.09	Develop a shipping activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port.
C28.11	Ensure that operators of project vessels, Arrow Energy staff and contractors comply with the LNG Marine Operations Maritime Safety Management Plan if/when this plan is agreed between Maritime Safety Queensland, Gladstone Ports Corporation and the other LNG proponents.

21.2 Study Purpose

The updates to the PHA and the preliminary SMS address changes to the project description since the EIS was finalised.

A summary of material project description changes relevant to the preliminary hazard and risk assessments undertaken for the project is presented in this section. These changes arose as a result of design optimisation during front end engineering design (FEED) and were identified as having the potential to affect (increase and reduce) some of the results of the preliminary quantitative and qualitative risk assessments previously undertaken.

Figures 4.2 and 4.3 illustrate these project description changes.

LNG Plant Layout

The layout of the LNG plant has been updated. Updates include changes to the layout of equipment within the LNG trains and changes to the orientation of the air-cooled heat exchangers arrangement to manage congestion within the LNG trains.

Realignment of LNG Loading Lines

The alignment of the LNG loading lines has changed to a more direct route to the LNG jetty. The LNG loading lines are now located on the north side of the Gladstone LNG Project (GLNG) haul road on Hamilton Point and cross the GLNG haul road further north. Previously, they were located south of the GLNG haul road adjacent to the feed gas pipeline. The revised alignment has

resulted in a greater separation from the feed gas pipeline which has been realigned following relocation of the tunnel reception shaft to the east of the GLNG materials offloading facility (MOF).

Propane Import Pipeline

Propane will be supplied by a tanker ship and pumped to the storage tank for first fill via a propane import pipeline. The pipeline will be installed from the Boatshed Point MOF to the refrigerant storage area within the LNG plant site. The pipeline will be used for a 'first fill' of the propane storage tank and potentially during LNG plant operation. Alternatively, top-ups may be undertaken through the use of ISO containers. The PHA assumed that propane would only be supplied to the LNG plant through ISO containers.

Volume of Propane Stored and Relocation of Storage Area

The refrigerant (propane) storage capacity and location have changed. The volume of propane has increased from 2,100 m³ to 3,800 m³ and the location of the storage area has moved from west of the flare to east of the flare.

Update to Minimum Separation Distances

The minimum separation distances from the construction camp to the boundary of the LNG trains and refrigerant storage area have been revised as a result of changes to the layout of ancillary infrastructure.

Feed Gas Pipeline

The reception shaft of the Curtis Island Link has been moved 700 m east (closer to the LNG plant) of the location nominated in the EIS. The feed gas pipeline is now separated from the LNG loading lines (previously adjacent to them).

Update to Equipment and Process Conditions

Information on the equipment and process conditions associated with the LNG plant has been updated during FEED. These updates are considered in the findings of the preliminary quantitative risk assessment undertaken.

21.3 Legislative Update

Since the EIS was finalised, the *Workplace Health and Safety Act 1995* (Qld) has been replaced by the *Work Health and Safety Act 2011*. The new act, which took effect on 1 January 2012, does not influence the findings of the preliminary hazard and risk assessments or alter the health and safety requirements for the project.

21.4 Study Method

This section describes the methods utilised in the updates to the PHA and preliminary SMS. Chapter 29 of the EIS outlines the risk assessment methods utilised in the preliminary hazard and risk assessments for the project.

The updates to both the PHA and preliminary SMS involved a systematic review and assessment of all major changes to the installations, material, safeguards or systems proposed at the time of writing the studies that could potentially influence the assumptions or conclusions made. The specific method of each study is outlined below.

21.4.1 Update to the PHA

The update to the PHA involved:

- Systematic assessment of the project description changes to determine whether they could result in an increase (worsening) or a decrease (amelioration) of hazards and risks identified in the PHA.
- Update to the risk contour figures to reflect the updated quantitative risk assessment and project description changes.
- Identification of any changes (or additions) to the design, safety controls and management measures, as detailed in the PHA, required to manage the potential hazards and risks.
- Identification of any changes to (or additional) recommendations of the PHA to accommodate changes to the project description.

21.4.2 Update to the Preliminary SMS

The update to the preliminary SMS involved:

- Systematic assessment of the project description changes to determine whether they could result in an increase (worsening) or a decrease (amelioration) of hazards and risks identified in the preliminary SMS.
- Identification of any changes (or additions) to the design, safety controls and management measures, as detailed in the preliminary SMS, required to manage the potential hazards and risks.
- Identification of any changes to (or additional) recommendations of the preliminary SMS to accommodate changes to the project description.

21.5 Study Findings

This section outlines the findings of the updates to the PHA and the preliminary SMS.

21.5.1 Update to the PHA

Potentially Hazardous Incidents

The introduction of the propane import pipeline and associated unloading and transport of propane during commissioning and potentially for top-ops during operation introduces new hazards and risks not discussed in the PHA. The realignment of the LNG loading lines and increased separation from the GLNG haul road has minimised the risk associated with an uncontrolled release of flammable gas or LNG as a result of a third-party vehicle accident (or loss of load) on the third-party haul road in the state corridor. Table 21.2 outlines each of these updates to the potentially hazardous incidents outlined in the EIS. Typical design and safety controls are listed for managing these potential hazards.

Table 21.2 Update to LNG plant hazards and safety controls

Potential Hazard	Typical Design and Safety Controls	Residual Risk
Additional hazard: Uncontrolled release of refrigerant (propane) at ship unloading due to failure of preventative maintenance of unloading hose, mechanical impact, leak in supply pipe, valves, and equipment.	<p>Materials and equipment associated with the propane import pipeline will comply with code requirements and be designed to prevent a release of propane.</p> <p>Controlled material transfer activity procedures will be implemented including pre-start protocols, reduced number of personnel on site during the propane transfer and permanent on-site presence of at least one person representing the carrier ship and at least one person representing the LNG plant.</p> <p>Upon completion of a transfer of propane, the pipeline will be cleared with nitrogen and purged with inert gas to ensure that the line is free of hydrocarbons.</p> <p>Potentially flammable areas will be classified as hazardous areas and ignition sources will be controlled in these areas.</p> <p>Gas and fire detectors will be installed to detect any upset operating conditions.</p> <p>The pipeline will be located outdoors and free of places where gas can accumulate.</p> <p>Marine passenger movements will be kept remote from propane tanker operations and module movements.</p> <p>An emergency shutdown system will be put in place.</p> <p>Emergency response procedures will be adopted.</p>	Medium
Additional hazard: Potential to damage the refrigerant (propane) carrier leading to a loss of containment.	<p>Shipping of propane will comply with international standards including the Society of International Gas Tanker and Terminal Operators and the Oil Companies International Maritime Forum.</p> <p>There will be one initial propane carrier unloading for initial fill of the propane storage tank and potentially unloading during LNG plant operation where ISO containers are not used. These will be managed with specific controls in place.</p> <p>Simulations for vessel manoeuvring into Boatshed Point will be completed prior to the initial unloading.</p>	Medium
Road transport – third party vehicle or load falls off third party haul road in the state corridor and leads to uncontrolled release of flammable gas/LNG or significant electrical hazard and injury and/or destruction to property, the environment due to impact at LNG gas and power lines.	<p>The prevention and emergency response procedures listed in the PHA remain valid.</p> <p>The risk of a third-party vehicle accident, or loss of load on the third party Haul Road and resulting in an uncontrolled release of flammable gas or LNG has been reduced due to the separation of the LNG loading lines from the third-party haul road. Electrical hazards associated with this scenario are also reduced through separation.</p>	Medium

The potential cumulative risks identified during the construction, operations and decommissioning phases of the project remain unchanged.

Analysis of Key Risks

The fatality risk contours presented in the EIS have been revised to reflect the updated quantitative risk assessment and project description changes. A key change is that the hazards and risks associated with the LNG loading lines are no longer assessed through the quantitative risk assessment. This change is due to limited data on the failure of LNG loading lines and LNG pipeline incident data in Australia leading to uncertainties on the failure frequencies to be applied

in a statistically based quantitative risk assessment. Instead, risks associated with the LNG loading lines have been assessed through a Bow-tie study to demonstrate and document that the risks associated with the LNG loading lines are As Low as Reasonably Practical (ALARP). The risk contours therefore have reduced compared to those presented in the EIS.

Figure 21.1 presents the revised individual risk contours for the LNG plant and associated LNG carrier loading and unloading.

A comparison of the individual fatality risk results with the established risk criteria indicates that:

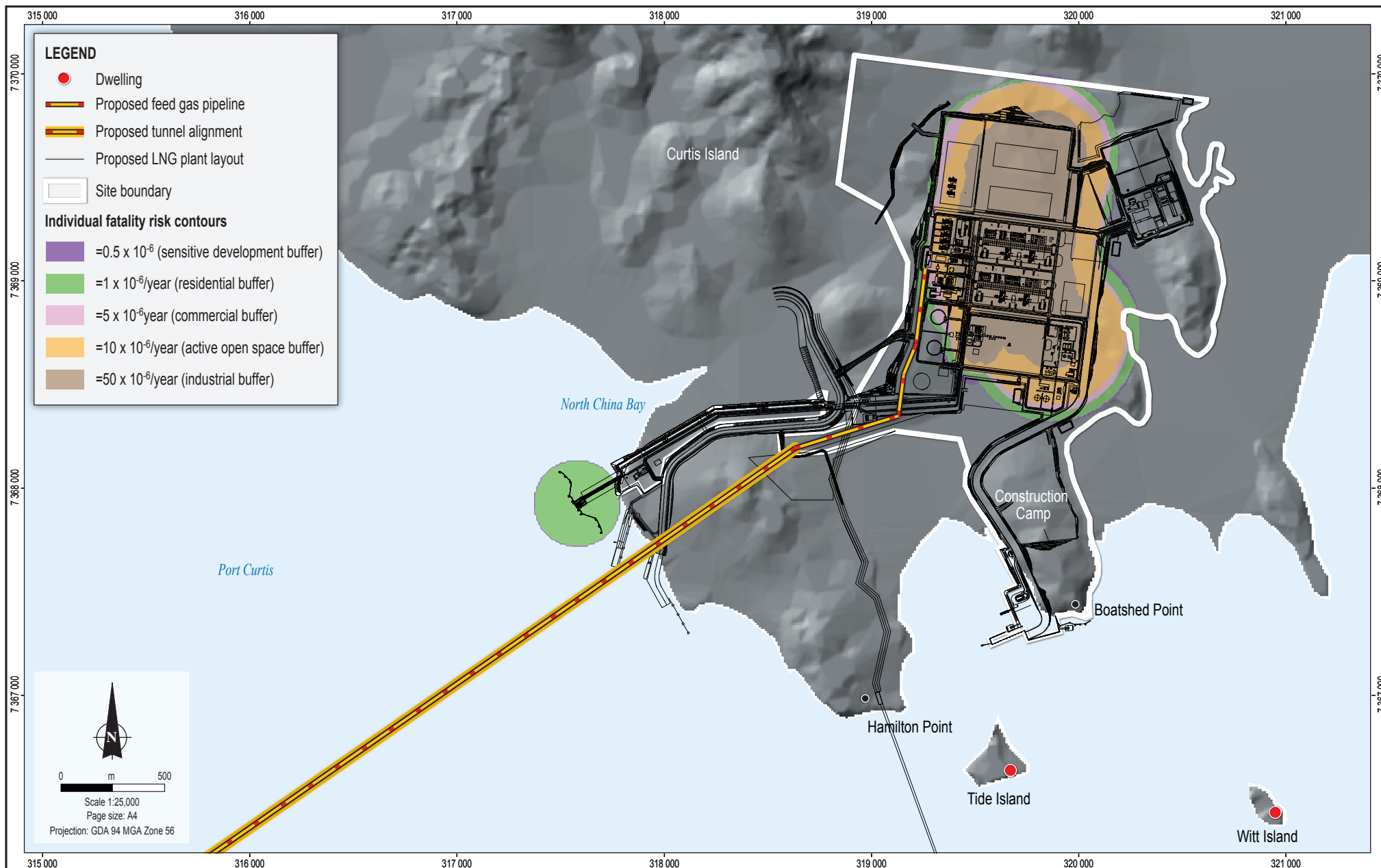
- The risk contour for industrial facilities, 50×10^{-6} per year, remains contained within the boundary of the site.
- The risk contour for active open space, 10×10^{-6} per year, remains contained within the boundary of the site.
- The risk contour for commercial development, 5×10^{-6} per year, remains largely contained within the boundary of the site.
- The risk contour for residential areas, 1×10^{-6} per year, remains largely contained within the boundaries of the site and does not encroach into any residential areas (the nearest residence is on Tide Island, 1,660 m from the LNG plant). The risk of fatality at the nearest residence is very low and well below the maximum tolerability criteria for residential or sensitive development.
- The risk contour for sensitive development, 0.5×10^{-6} per year, remains largely contained within the boundaries of the site. The risk of fatality at the nearest sensitive receiver is very low and well below the maximum tolerability criteria for sensitive development.

These results are consistent with those presented in the EIS.

The fatality risks to process and maintenance workers have been re-calculated and found, as per the EIS, to adhere to the target risk criterion set for the project of 1×10^{-4} per year.

The project description changes have resulted in small incremental increases in the calculated injury risk and propagation risk associated with the LNG plant. The 50×10^{-5} per year injury risk contours from heat radiation and overpressure (4.7 kW/m^2 and 7 kPa respectively) remains contained within the site boundary and well below the criterion for new installations of fifty chances per million years. The 50×10^{-6} per year risk contour for propagation to neighbouring industrial facilities from heat radiation and overpressure (23 kW/m^2 and 14 kPa respectively) also remain contained within the site boundary.

With the addition of the typical design and safety controls included in Table 21.2 for managing potential hazards associated with the unloading and transport of propane, the typical controls identified in the PHA remain valid for managing the potential hazards and risks.



Source:
Place names and roads from DME.
Individual fatality risk contours from Shell.
Study area, pipelines, proposed auxiliary facilities and marine infrastructure from Arrow Energy.
Dwellings, proposed feed gas pipeline and DEM from Coffey Environments.

coffey
environments

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12.12.2012
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File Name:
7033_16_F21.01_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow
go further energy

Updated individual fatality risk

Figure No:

21.1

21.5.2 Update to the Preliminary SMS

The project description changes do not create the need for any change to the hazards and risks identified in the preliminary SMS for the construction, operation and decommissioning phases of the project. The change in alignment of the feed gas pipeline has resulted in the pipeline being further separated from the LNG loading lines and third party haul road, reducing any potential risk to integrity of the feed gas pipeline and subsequently to the health and safety of people in the area.

The typical design and safety controls for managing potential hazards and risks identified in the preliminary SMS remain valid.

21.5.3 Conclusion

The introduction of the propane import pipeline and associated unloading and transport of propane during commissioning and potentially during operation was found to introduce new hazards and risks not discussed in the PHA. Additional typical design and safety controls have been proposed to manage these potential hazards and risks. The typical controls outlined in the EIS otherwise remain appropriate. The realignment of the LNG loading lines was found to minimise a risk identified in the PHA associated with an uncontrolled release of flammable gas or LNG as a result of a third-party vehicle accident or loss of load on the third-party haul road in the state corridor. The updated fatality risk contours were found to be generally consistent with those presented in the EIS and to meet the established risk criteria.

The project description changes have been found to result in only minor changes to the hazards and risks identified in the PHA and preliminary SMS. No increases in residual or cumulative risks were identified as a result of the project description changes.

21.6 Commitments Update

Two of the management measures (commitments) presented in the EIS relevant to hazard and risk have been revised and are presented in Table 21.3. Other measures are unchanged and are included in Attachment 7, Commitments Update.

Table 21.3 Commitments update: hazard and risk

No.	Commitment	Comment
C28.09A	Develop a shipping marine activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port.	Updated with correct plan name
C28.11A	Ensure that operators of project vessels, Arrow Energy staff and contractors comply with the LNG marine Operations Maritime Safety management plan if/when this plan is agreed between Maritime Safety Queensland, Gladstone Ports Corporation and the other LNG proponents.	Updated with correct plan name