Santos
GLNG

Attachment 2 - Supporting Information for an Environmental Authority (EA) amendment application

Petroleum Facility Licence (PFL) 10 EA (EPPG00712213)

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Abbreviations and Units

Acronym	Description
AHD	Australian Height Datum
APLNG	Australia Pacific Liquefied Natural Gas
BPEM	Best Practice Environmental Management
CCTV	Closed-circuit television
CEMS	Continuous Emissions Monitoring System
CO	Carbon Monoxide
CSG	Coal Seam Gas
DES	Department of Environment and Science, Queensland
EA	Environmental Authority
EDV	Emergency Depressuring Valve
EGF	Enclosed Ground Flare
EIS	Environmental Impact Statement
EO Act	*Environmental Offset Act 2014*
EO Reg	*Environmental Offset Regulation 2014*
EPP Air	*Environmental Protection (Air) Policy 2019*
EP Act	*Environmental Protection Act 1994*
GAMSv3	Gladstone Airshed Modelling System Version 3
GHG	Greenhouse gas
GLNG	Collectively, Santos GLNG Pty Ltd, Total GLNG Australia, KGLNG Liquefaction Pty Ltd and PAPL (Downstream) Pty Limited
LNG	Liquefied Natural Gas
MOF	Materials offloading facility
MPGF	Multi-Point Ground Flare
MW	MegaWatt
NO	Oxides of Nitrogen
PAH	Polycyclic Aromatic Hydrocarbons
PFL	Petroleum Facility Licence
PIN	Penalty Infringement Notice
PLF	Product loading facility
$PM_{2.5}$	Particulate matter less than 2.5 microns
PM_{10}	Particulate matter less than 10 microns
QCLNG	Queensland Curtis Liquefied Natural Gas
SDPWO Act	*State Development and Public Works Organisation Act 1971*
SEIS	Supplementary Environmental Impact Statement
SMS	Santos Management System

Acronym	Description
TCEQ	Texas Commission on Environmental Quality

1.0 Introduction

Santos GLNG Pty Ltd, TOTAL GLNG Australia, PAPL (Downstream) Pty Limited and KGLNG Liquefaction Pty Ltd (collectively, **GLNG**) are applying to amend the GLNG Liquefied Natural Gas (**LNG**) Facility Environmental Authority EPPG00712213 (**EA**) for Petroleum Facility Licence 10 (**PFL 10**).

PFL 10 is located on Curtis Island, within the Curtis Island Industry Precinct of the Gladstone State Development Area, Queensland. The LNG Plant comprises of two trains, Train 1 and Train 2 which were commissioned in 2015 and 2016 respectively. The LNG Plant processes coal seam gas to produce LNG.

This application is in response to correspondence received from the Department of Environment and Science (**DES**) requiring GLNG to apply for an amendment to the EA by 26 August 2020 to address an alleged non-compliance with condition B2 of the EA. This application seeks to amend Schedule B – Air emissions of the EA to expressly authorise the duration and frequency of visible smoke emissions associated with flaring from the LNG Plant during planned and unplanned plant maintenance (start-up/shutdown), plant upsets and plant emergencies.

Pursuant to section 224 of the *Environmental Protection Act 1994* (Qld) (**EP Act**), a holder of an EA may make an application to the assessing authority seeking an amendment to an EA.

GLNG has prepared this document in accordance with sections 226 and 226A of the EP Act and considered the DES '*Guideline – Application requirements for petroleum activities'* (DES, 2013).

GLNG considers that the proposed amendment satisfies all requirements of the definition of a minor amendment (threshold) (in accordance with section 223 of the EP Act) (refer to Section 5.1.4).

2.0 Application Description

The EA authorises visible smoke and particulate emissions associated with flaring for no more than five minutes in any two hour period during normal operating conditions (condition B18).

> *B18 Visible smoke and particulate emissions must not be permitted for more than five minutes in any two hour period during normal operating conditions.*

'Normal operating conditions' is defined in the EA as *'the ongoing operation of the LNG plant following commissioning and excludes start-up, shut-down, maintenance or calibration of emission monitoring devices'*.

The release of visible smoke from the LNG Plant outside of the definitions of condition B18 has been considered to cause an environmental nuisance at a nuisance sensitive or commercial place by DES on two occasions, resulting in the issuing of two separate Penalty Infringement Notices (**PIN**). PINs for the alleged breach of condition B2 have been received for operations associated with the commissioning of Train 1 in 2015 and major planned maintenance shutdown of Train 1 conducted in 2019.

> *B2 The release of dust and/or particulate matter resulting from the activities must not cause an environmental nuisance at any nuisance sensitive or commercial place.*

Based on the above, it is apparent there is a gap in the EA for visible smoke emissions from flaring generated as part of other types of common plant operational scenarios that are critically important to ongoing plant operations (i.e. outside of 'normal operating conditions'). These scenarios include flaring associated with plant start-up and shut-down for planned and unplanned plant maintenance, plant upset conditions and in emergency situations.

To rectify this gap, this application seeks to amend Schedule B – Air emissions of the EA to expressly authorise the duration and frequency of visible smoke emissions associated with all operational flaring scenarios at the LNG Plant. This includes visible smoke from flaring associated with 'normal operating conditions' as well as that necessary for planned and unplanned plant maintenance (start-up/shut-down), plant upsets and emergency situations.

To support this amendment application GLNG:

- engaged KBR to perform a third-party review and endorsement of operational scenarios identified by GLNG which have historically produced visible smoke emissions from the LNG Plant flaring system. The report *'GLNG Environmental authority visible smoke allowance review, prepared by KBR, dated July 2020'* (KBR Third Party Review) (Appendix A) presents the findings of this third party review. The findings are referenced throughout this report; and
- engaged Katestone Environmental Pty Ltd (**Katestone**) to undertake an air quality assessment to quantify the air emissions from the release of visible smoke from the LNG Plant flares, and to describe the potential impact of the emissions on the receiving environment. The report *GLNG: Air Quality Assessment of Dry and Wet Flares, prepared by Katestone, dated July 2020* (Appendix B) presents the findings of this assessment. The findings are referenced throughout this report.

The proposed EA conditions are contained in section 2.5.3.

2.1 Flaring Operations

A flaring system is in place at the LNG Plant to allow excess gas to be burnt off in a safe and controlled way for maintenance activities, unplanned repairs, plant upsets or emergency situations.

Flaring is a standard process for safe operations, ensuring hydrocarbons are safely combusted and are not directly emitted to the atmosphere. The LNG Plant flare system includes four separate flaring stacks: the Wet Process Flare, Dry Process Flare, Back-up Wet and Dry Flare, and the Marine Flare:

- the Wet Process Flare (authorised contaminant release point A13 common to Train 1 and Train 2) is designed to handle warm hydrocarbon streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water;
- the Dry Process Flare (authorised contaminant release point A15 common to Train 1 and Train 2) is designed to handle cryogenic hydrocarbons, both vapour and liquid;
- the Back-up Wet and Dry Flare (authorised contaminant release point A16 common to Train 1 and Train 2) is a spare which can be either used as a wet or dry flare; and
- the Marine Flare (authorised contaminant release point A14 common to Train 1 and Train 2) is designed to handle LNG vapours from the LNG Storage Tanks in the event of Boil Off Gas Compressors failure and/or ship loading.

During normal operating conditions, natural gas flows continuously through the LNG Plant. A small quantity of this gas is combusted in the flares in a pilot flame, designed to provide a continuous ignition source such that any gas sent to the flare is immediately combusted. The pilots produce a small smokeless flame which emits small volumes of carbon dioxide, nitrogen oxides and water vapour. Additionally, a flare purge is in place to prevent any air ingress into the flare system. The flare purge involves a small injection of low pressure fuel gas (or nitrogen) at the extremity of the flare headers to provide a continuous sweep of gas. This is a necessary safety requirement and reduces the risk of an explosive mixture forming in the flare system.

During normal flaring conditions, flared gas from the LNG Plant is primarily methane (~98%) with small amounts of nitrogen, carbon dioxide, ethane and traces of heavier hydrocarbons (C3+) such as propane and ethylene (~2%). Combustion of these gases does not produce visible smoke. Under certain conditions, and outside of normal operating conditions, such as during plant shutdown/start-up, maintenance, upset conditions, and in certain emergency situations, there is a requirement to flare refrigerants (ethylene and propane) that are used in the liquefaction process. The combustion efficiency of the flare may be reduced by the presence of the refrigerants and nitrogen (used for purging gas lines in the facility) during flaring events. The flaring of these refrigerants can result in visible smoke. This predominantly occurs from the Wet and Dry Process Flares.

The flaring of refrigerants and nitrogen results in the emission of Oxides of Nitrogen, Carbon Monoxide, Total Hydrocarbons (Methane, Ethane, Ethylene, Acetylene, Propane and Propylene), particulates in the form of $PM_{2.5}$ and PM_{10} and trace Polycyclic Aromatic Hydrocarbons (PAH's). Emission rates from flaring events are typically variable.

Flaring which results in visible smoke is unavoidable as it is required to maintain plant safety. Flaring of this nature is normally infrequent, and of short-duration. The following sections describe flaring scenarios where visible smoke is reasonably expected during daylight hours. Please note for the purpose of this application, the following definitions have been used for the terms 'daylight hours', 'flaring event', 'normal operating conditions', 'plant maintenance activities' and 'visible smoke':

"daylight hours" *means those between sunrise and sunset times as shown on the Australian Government Geoscience Australia webpage < http://www.ga.gov.au/geodesy/astro/sunrise.jsp>.*

"flaring event" *means an event where flammable gas is combusted through a flare and produces visible smoke either: (i) continuously for more than 5 minutes; or (ii) multiple instances of visible smoke occurring consecutively with a total duration of more than 5 minutes, provided that the consecutive instances of visible smoke occur due to the same underlying cause, discharges through the same valve or flare source and occurs within a two hour window.*

"normal operating conditions" *means the ongoing operation of the LNG plant, excluding start-up, shutdown, maintenance, upset conditions, an emergency and LNG ship management.*

"plant maintenance activities" *means the maintenance shutdowns (and subsequent start-ups) where equipment at the plant is inspected and, if needed, repaired or replaced to ensure the ongoing safe operation of the plant.*

"Ringlemann number" *means a visually comparative scale used to define levels of opacity, where clear is 0, black is 5 and 1 through 4 are increasing levels of grey as used in describing smoke from combustion of hydrocarbons.*

"visible smoke" *means a visible suspension of carbon or other particles in air measured by a Ringelmann number greater than 2.*

2.1.1 Normal Operating Conditions

Visible smoke is generally not expected at the LNG Plant during normal operating conditions as outlined in section 2.1. However, where flaring events resulting in visible smoke are required for normal operating conditions, these flaring events are scheduled to be undertaken at night as much as possible so as to ensure compliance with EA condition B18 and to minimise any impacts to visual amenity. Refer to section 4.0 of Appendix A for a description of the types of activities which may result in flaring events from normal operations.

2.1.2 Planned Maintenance

Flaring events may occur when conducting planned maintenance, including routine maintenance activities and during major plant shutdowns/start-ups. These maintenance activities ensure the safe and efficient operation of the LNG Plant. Some maintenance activities require de-inventory of the gas process lines and/or refrigerant lines to enable safe access for maintenance/inspection purposes. As far as practicable, refrigerant is recovered by transferring inventory to storage, with the remaining refrigerant vapours requiring flaring. Additionally, during start-up following maintenance and/or shutdown events, the refrigerant circuits are charged with propane and ethylene. Some flaring events will occur as nitrogen and dry fuel gas are displaced by the refrigerants. Refrigerant is expensive and takes a long lead time to arrive on site. Therefore, GLNG makes every effort to re-inventory refrigerant and minimise refrigerant losses via the flare.

Planned flaring events to facilitate routine maintenance activities occur approximately 4 times each year. These maintenance activities tend to be based on short to medium-term planning in response to plant condition monitoring and not from long-term planning (like for a major shutdown). Given the short lead time for such maintenance activities, it is not always possible to undertake the flaring event during

the night, particularly when plant safety is under threat. Refer to section 5.0 of Appendix A for a description of the types of routine maintenance activities which may result in flaring events.

Major plant shutdown maintenance is typically conducted on each LNG train once every 4 years and involves complete removal of hydrocarbons from the train for internal inspection and maintenance. These are safety mandated inspections, which also enable preventative maintenance to be carried out which minimises the need to undertake additional train shutdowns and additional major flaring events. Refer to section 6.0 of Appendix A for a description of the types of activities during a major shutdown which may result in flaring events. Due to the scheduled nature of these activities, flaring that can result in visible smoke is planned to occur during the night as far as practicable. However, some flaring processes may still carry over into daylight hours.

2.1.3 Unplanned Flaring Events (GLNG Plant upsets and emergencies)

2.1.3.1 GLNG Plant Upsets

Unplanned flaring events can occur at any time during plant upset conditions on either or both LNG trains. Upset conditions may result from instrumentation failure, poor response of the control system to a particular event or inadvertent action by an operator or maintenance personnel and are not intentionally planned by GLNG. Flaring associated with upset conditions is generally the result of the programmed actions taken by control or safety systems in response to the upset in order to preserve the integrity and safety of the facility. Upset conditions do not include emergency events.

Most unplanned flaring events are of a relatively short duration (approximately 15 minutes), however, in some cases, the duration is extended due to the time for detection and potential complications occurring with the event. Upset conditions cannot be mitigated by planning for night-time operation. Because upset conditions are not scheduled, GLNG has accounted for the possibility of there being up to 7 upset events in any 12 month period. Refer to section 7.0 of Appendix A for a description of the types of unplanned activities which may result in flaring events.

2.1.3.1 GLNG Plant Emergencies

Consistent with section 466B of the EP Act, emergency situations are those where:

(a) the health and safety of personnel and/or the broader community is threatened; or
(b) environmental harm is threatened.

Flaring and subsequent visible smoke emissions at the LNG Plant may be necessary to prevent or minimise harm to people and the environment. Examples of an emergency event at the LNG Plant include the lifting of a pressure safety valve or where hydrocarbon is being released to the atmosphere from damaged plant infrastructure and depressurisation to the flare is initiated to minimise the hydrocarbon release. GLNG cannot plan or schedule emergency situations. As such, the flare system acts as a safety relief system during such situations and therefore needs to operate as designed and not be restricted in any way.

Given the above, GLNG is of the view that the frequency and duration of visible smoke resulting from emergency flaring events should not be limited by the conditions of the EA. As such, an emergency event is not considered to be subject to flaring limits as proposed by new condition (B20) (refer to section 2.5.3), nor should it be considered an environmental nuisance in accordance with existing Condition B2.

2.2 Flaring Event Mitigation Measures

GLNG has implemented the following measures, in accordance with the *Environmental Protection (Air) Policy 2019* (EPP Air), to reduce the frequency of flaring and duration of visible smoke from flaring events. These include:

(a) the implementation of plant optimisation measures (see section 2.2.1); and
(b) the development of a Flaring Contingency Management Plan (Appendix C) (see section 2.2.2).

2.2.1 Plant Optimisation

The efficient operation of the LNG Plant is the best mitigation available to reduce the number of unplanned flaring events. The following plant optimisation measures are in place which aid in minimising the frequency and duration of visible smoke from flaring events:

- appropriate training of personnel in plant operating procedures to ensure the plant is operated in accordance with the LNG Plant design;
- process control and safety instrument systems for the safe and efficient operation of the plant within normal parameters;
- performance monitoring for process improvement and optimisation;
- a plant maintenance campaign to ensure integrity and reliability of plant equipment;
- a plant trip reduction campaign, whereby every trip is investigated and mitigations implemented to prevent/minimise future trips of the same nature;
- refrigerant (the principal cause of visible smoke) recovery rather than flaring;
- detailed planning and scheduling of maintenance activities so necessary flaring can occur at night; and
- deferring unplanned (not upset nor emergency) flaring until night-time, where practicable and safe to do so.

These measures are further explained in sections 4 to 7 of Appendix A.

GLNG is investigating additional plant optimisation measures to further reduce incidences of visible smoke. These are to be considered on their practicality for implementation and feasibility. These measures include (refer sections 4 to 7 of Appendix A):

- high rate flare purging to minimise lingering visible smoke after a release of heavier hydrocarbons to the flare system; and
- planning simultaneous flaring where feasible from multiple sources rather than separately to reduce the total duration of flaring events.

2.2.2 Flaring Contingency Management Plan

GLNG has developed a Flaring Contingency Management Plan which includes management measures to reduce the frequency and duration of gas being flared and any associated visible smoke. The management measures include:

- appropriate training of personnel in plant operating procedures to minimise flaring as far as practicable;
- routine monitoring of the flare to ensure the flare is operating satisfactorily;
- installation of process alarms to advise operators of upset conditions within the plant prior to gases being flared. This may provide operators adequate time to react, and as such minimise the possibility of the operational upset resulting in a flaring event;

- reporting of all flaring in monthly operations meetings so as to review and investigate causation, response and mitigation;
- monitoring of refrigerant compressors and turbines to ensure equipment is operating at optimal performance;
- development of emergency procedures for non-routine situations to deal with foreseeable risks and hazards including corrective responses to prevent and mitigate environmental harm; and
- recording of all planned and unplanned flaring events, their cause, and where required, the corrective actions implemented into a Flaring Register. This provides learnings to prevent and mitigate future flaring events.

These management measures are *"…in accordance with industry practice."*[1] as ratified by the HRL Technology Group as part of the independent environmental audit commissioned by DES in 2016.

To ensure the Gladstone community remains informed, as part of the Flaring Contingency Management Plan, GLNG also advises key community stakeholders, including DES, of planned maintenance activities and forecast flaring events. Notification is provided a minimum of 24 hours in advance of activities commencing.

2.3 Flare System Monitoring

The GLNG flare system is monitored in several ways. Plant operators can observe live plant data, including data trends, plant set points and plant alarms. Continuous monitoring systems currently in place comprise the following:

- ultrasonic flowmeters are installed on each flare to monitor the flare gas flow rate which allows for a total flare volume to be calculated;
- a temperature detector and transmitter is installed on each flare header to measure the temperature of gas to the flare; and
- CCTV of the flare tips, which show the size of the flame and any associated smoke (during daylight hours).

GLNG also implements the Procedure for Recording Flaring Events (Appendix D) which defines the requirements for the recording of flaring events at the LNG Plant. The procedure includes a Flaring Event Register for the recording of flaring events whether planned (i.e. normal operations, routine maintenance or planned shut-down / start-up) or unplanned (i.e. upset). When a flaring event has been identified, the following information is recorded in the Flaring Event Register:

- time flaring commenced;
- nature of operations at the time of flaring;
- specific cause of flaring;
- Ringelmann Score (1-5);
- actions taken to minimise flaring intensity and duration; and
- time flaring stopped.

[1] Page 46, *'Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*

2.4 Operational Alternatives to Current Flaring Regime

Whilst mitigation and management measures are effective at minimising flaring events and the occurrence of visible smoke, the events cannot be eliminated from the existing plant flare system. Table 1 evaluates the feasibility of flare design alternatives and changes in operations that may further minimise or eliminate the incidence of visible smoke emissions. Feasibility is considered from the perspectives of technical implementation, effectiveness of operation and capital cost. Whilst a number of the options presented in Table 1 may be technically feasible and/or effective at minimising flaring events, some options have excessive financial implications and are not deemed feasible at this point in time.

Table 1: Evaluation of alternatives to current operations and flare design

Option	Option Details	Technically Feasible	Effective	Capital Cost (Note 1)	Implementation Feasibility
Reduced rate of flaring of refrigerants	Reduction in refrigerant flow to the flare so that visible smoke is not produced.	Yes	No A significant flow reduction is considered impractical to implement given the system volumes and likely operational delays. Per the HRLTG Environmental Audit "*it is highly unlikely that flaring of ethylene and propane via the current flaring system can be done without producing smoke.*"[2]	N/A	No. While this option is technically feasible, it is not considered effective. As such this option is not considered suitable for implementation by GLNG.
Dilution of refrigerants sent to the flares	Dilute flared refrigerants with fuel gas in order to reduce visible smoke production from the flares.	Yes	No Dilution is highly unlikely to be an effective means of reducing visible smoke with the current flaring system, requiring substantial wastage of fuel gas and reduction in refrigerants flow rate. Per the HRLTG Environmental Audit "*it is highly unlikely that flaring of ethylene and propane via the current flaring system can be done without producing smoke.*"[3]	N/A	No. While this option is technically feasible, it is not considered effective. Additionally this option: • will result in significantly increased GHG emissions, combustion emissions, loss of valuable product and additional light pollution; and • requires large volumes of fuel gas during start-up and shutdown activities, when refrigerant purging and charging activities are underway.

[2] Page, 106, *'Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*
[3] Page, 106, *'Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*

Option	Option Details	Technically Feasible	Effective	Capital Cost (Note 1)	Implementation Feasibility
					Given the above, this option is not considered suitable for implemented by GLNG.
Reduced frequency of refrigerant flaring	Trip reduction campaign, with trips investigated and mitigations implemented to prevent/minimise future trips. Strategies to avoid/minimise requirement for plant defrosting outside of major shutdowns. Plan simultaneous flaring where feasible from multiple sources rather than separately. Plan for necessary flaring at night.	Yes (methods employed by GLNG where practicable)	Partial Planned flaring events are managed by reducing flaring frequency as far as practicable through the application of the strategies listed in the option details, however, unplanned flaring events cannot be controlled.	N/A	Yes - methods employed by GLNG where practicable.
Transfer of increased amount of remnant refrigerant vapour from one LNG train to another	Reduction in the amount of refrigerant released to the flares during major plant shutdowns, by transferring remnant refrigerant vapour from one LNG train to another and therefore reducing the duration of the flaring event.	Yes	Partial (dependent on achievable vapour recovery rates) Expected to be partially effective depending on transfer rates that can be achieved (affected by system operating pressures). There is a risk that extended vapour recovery operations may prolong shutdown operations – this can have safety implications.	Nil	Yes. The feasibility of this option is currently being investigated, however it is noted that this option if implemented will be partially effective and may have safety implications.
Replace Existing Flare Tips	Install new tip to increase velocity and entrain additional air	No.	No	N/A	No. This option is not technically feasible nor considered effective. As such, this option is

Option	Option Details	Technically Feasible	Effective	Capital Cost (Note 1)	Implementation Feasibility
		Insufficient flare backpressure	Low confidence in performance during low-rate events and in ethylene service		not considered suitable for implementation by GLNG.
Retrofitting Flare with Fuel Gas Assist: Inject fuel gas into the flare stream, creating turbulence and entraining combustion air	Retrofit of the existing flare for fuel gas injection line and replacement of the existing flare tip. Extended plant shutdown for installation.	Yes. Uncommonly used in industry and feasibility is dependent on availability of fuel gas during start-up and shutdown activities, when refrigerant purging and charging activities are underway. More commonly seen in cases where flare gas stream has an energy content that is too low for combustion requirements.	Partial Significant volumes of fuel gas would be required and would be unlikely to be effective to reduce visible smoke production.	N/A	No. While this option is technically feasible, and considered partially effective, this option will result in significantly increased GHG emissions, combustion emissions. Given the above, this option is not considered suitable for implemented by GLNG.
Retrofitting Flare with Steam Assist: Inject high pressure steam into the flare stream, creating	Installation of a new steam generation system requiring additional plot space as well as steam lines and flare tip modifications requiring a major shutdown for an extended duration.	No. Steam assist can be an effective means of achieving smokeless burning with the potential for improved effectiveness compared to an air assist system.	Partial. Requires additional fuel, GHG emissions and combustion emission for steam generation	N/A	No. Whilst this option is partially effective, it is not technically feasible as GLNG does not produce steam on site. As such, this option is not considered suitable for implementation by GLNG.

Option	Option Details	Technically Feasible	Effective	Capital Cost (Note 1)	Implementation Feasibility
turbulence and entraining combustion air		More momentum can be supplied from high-pressure steam to enhance ambient air entrainment and mixing. However, large quantities of steam are required and GLNG does not current produce steam on site.			
Retrofitting Flare with Air Assist: Inject air at the flare tip to create turbulence and entrain additional combustion air	Retrofit of the existing flare with installation of a large air duct (approximately 4m in diameter) or high-pressure air supply line and replacement of the existing flare tip, requiring a major shutdown for an extended duration. At least two new low pressure blowers or high pressure compressors would be required.	No. An air assisted design is not considered technically feasible for the existing system as there is no space available for changes in the design. Installation of air ducts would also lead to increased wind loading on the existing structure, in excess of current design limits.	Partial. While technically possible to install this technology on a new flare system, there are performance risks associated with flame stability and the potential risk of internal combustion due to the large flare tip (likely > 3m) required to achieve smokeless flaring. To the Vendor / GLNG's knowledge, a flare tip of this size has not been demonstrated in industry.	>$50M	No. While this option is partially effective, this option is not technically feasible. Additionally, this option: • will require additional power demand, with associated fuel burn, GHG emissions and combustion emissions; and • is cost prohibitive

Option	Option Details	Technically Feasible	Effective	Capital Cost (Note 1)	Implementation Feasibility
Enclosed flare: Install a new partial capacity enclosed ground flare (EGF)	New installation of enclosed ground flare with capacity limit of 100 t/hr. EGF conceals flames inside the chamber and minimises light and noise emissions.	Yes. Automated flare diversion required (rupture disk safeguard).	Partial (90% of events). Effective for the majority of flaring events except if the EGF is undergoing maintenance or in emergency high flow flaring events. In an emergency high flow flaring event, flaring would be from both EGF and existing elevated flares with smoke emissions expected.	>$120M	No. While this option is effective and is technically feasible, this option is overly cost prohibitive. Additionally, this option will result in small increases in GHG emissions for additional EGF purge/pilot gas.
Ground flare: Install a new walled multi-point ground flare (MPGF)	Expect no visible smoke produced under most scenarios including emergency high flow scenarios	Yes. Potential for installation without an additional shutdown. Installed on some other Australian LNG facilities (APLNG, Darwin LNG)	Yes (close to 100%)	>$200M	No. While this option is effective and is technically feasible, this option is overly cost prohibitive. Additionally, this option requires a large plot space (estimated area of 40,000m^2 with consideration of radiation clearances required) which is not available on the PFL tenure.

Note 1 = Capital costs are presented in Australian Dollars and are estimates only. Costs are not based on vendor quotations and do not include the cost of lost production during shutdown for installation.

2.5 Proposed Change to EA EPPG00712213

2.5.1 Number of flaring events

GLNG reviewed the total number of flaring events from the LNG Plant over a one year period (4 May 2019 to 3 May 2020) which was considered to be reflective of typical LNG Plant operations. 188 events were identified, however the majority of these events occurred at night or otherwise with a non-visible smoke emission (i.e. Ringleman 0 – 1).

The prediction of flaring events per annum can be indicative only. The actual number of flaring events will vary significantly from year to year, depending on the maintenance and shutdown work planned for that year, actual plant experience with malfunctioning valves or other equipment, and the number of plant upsets experienced. The KBR review (Appendix A) found that a reasonable number of permitted flaring events with visible smoke would be 15 per annum with an approximate total of 8 hours of visible smoke per annum (refer to Table 2) to allow safe and efficient management of the LNG Plant.

Table 2. Frequency and duration of flaring events with visible smoke

Category	Events/yr	Duration/yr
Normal Operations	0	0
Planned Maintenance	4	160 minutes
Major Shutdown/Start-up	4	180 minutes
Plant Upsets	7	130 minutes
Total	15	470 minutes (7.8 hrs)

Upon further review of the flaring events, GLNG has concluded that with careful management and detailed planning of scheduled events, GLNG can likely comply with the number and duration of visible smoke events as currently prescribed on the QCLNG EA EPPG00711513 for planned and unplanned maintenance. That is 14 events with a total duration of 7 hours per annum. GLNG recognises that the QCLNG visible smoke conditions were the product of a comprehensive assessment process involving the DES and QCLNG which commenced in May 2017 and concluded on 29 June 2018. Appendix E presents the QCLNG flaring conditions in full.

Adoption of the QCLNG authorisations for the GLNG LNG Plant is considered appropriate as:

- the QCLNG environmental authority conditions contemplate visible smoke allowances for operating scenarios other than ‘normal operating conditions’. They also recognise the likelihood of additional visible smoke being generated during plant shut-down and start-up by allowing a longer duration of visible smoke for these activities;
- the QCLNG Plant is of a similar design to the GLNG LNG Plant as such, it is appropriate to apply the same visible smoke conditions to both facilities. This will ensure consistent regulation and community expectation between the facilities and will streamline the oversight of flaring activities by DES;
- the conditions will provide GLNG with an identifiable flaring framework, providing clear limits on the production of visible smoke during operational activities; and
- the public will benefit by having consistent flaring expectations of QCLNG and GLNG and will minimise impacts to the visual amenity of the Gladstone community.

Compliance with the proposed condition set (refer section 2.5.3) will have cost implications for GLNG, as there will be increased standby times and longer non-operational periods, particularly during large scale maintenance events. Additionally, detailed and careful planning of scheduled events will be required to comply with the proposed conditions. Despite this, GLNG is committed to strong environmental management and to respecting the interests of the communities in which GLNG operates. Therefore, to ensure visible smoke emissions from the GLNG LNG Plant associated with planned and unplanned plant maintenance (start-up/shutdown), plant upsets and during emergencies, are expressly authorised, GLNG seeks the inclusion of new conditions in Schedule B – Air emissions of EA EPPG00712213 as outlined in section 2.5.3 below and presented in Appendix F.

2.5.2 Existing conditions/definitions

(B2) The release of dust and/or particulate matter resulting from the activities must not cause an environmental nuisance at any sensitive or commercial place.

(B18) Visible smoke and particulate emissions must not be permitted for more than five minutes in any two hour period during normal operating conditions.

Existing definitions:

***"normal operating conditions"** means the ongoing operation of the LNG plant following commissioning and excludes start-up, shutdown, maintenance or calibration of emission monitoring devices.*

2.5.3 Proposed conditions/definitions

(B2) The release of dust and/or particulate matter resulting from the activities must not cause an environmental nuisance at any sensitive or commercial place, unless the release occurs as a result of an emergency, or is authorised by this environmental authority or the EP Act.

*(B20) **Flaring events**, except for those resulting from an emergency, occurring outside of **normal operating conditions** must not exceed:*

- *a) 7 hours per annum during **daylight hours**; and*
- *b) 14 times per annum during **daylight hours**; and*
- *c) 30 minutes of continuous **visible smoke** during **daylight hours** except as authorised under condition (B21).*

(B21) Notwithstanding condition (B20)(c), flaring events must not exceed 90 minutes of continuous visible smoke at any one time in the following circumstances:

- *a) A flaring event associated with a plant maintenance activity that was planned to be completed outside of **daylight hours**, but was required to be undertaken during **daylight hours** to ensure the safe operation of the plant; or*
- *b) A flaring event associated with a plant maintenance activity that was not planned and was required to be undertaken during **daylight hours** to ensure the safe operation of the plant*

(B22) The holder of this authority must keep records of each flaring event to determine compliance with condition (B20) and (B21) and provide these records to the administering authority on request. Records must include, but not be limited to:

- *a) The duration of each flaring event; and*
- *b) The operational planning that was implemented to minimise flaring; and*
- *c) The operational controls that were implemented during flaring; and*
- *d) If the flaring event exceeds 30 minutes, the circumstance under condition (B21) which caused this exceedance.*

Proposed Definitions:

"daylight hours" *means those between sunrise and sunset times as shown on the Australian Government Geoscience Australia webpage < http://www.ga.gov.au/geodesy/astro/sunrise.jsp>.*

"emergency" *means (a) either— (i) human health or safety is threatened; or (ii) serious or material environmental harm has been or is likely to be caused; and (b) urgent action is necessary to— (i) protect the health or safety of persons; or (ii) prevent or minimise the harm; or (iii) rehabilitate or restore the environment because of the harm.*

"flaring event" *means an event where flammable gas is combusted through a flare and produces visible smoke either (i) continuously for more than 5 minutes or (ii) multiple instances of visible smoke occurring consecutively with a total duration of more than 5 minutes, provided that the consecutive instances of visible smoke occur due to the same underlying cause, discharges through the same valve or flare source and occurs within a two hour period.*

"normal operating conditions" *means the ongoing operation of the LNG plant, excluding start-up, shutdown, maintenance, upset conditions, an emergency and LNG ship management.*

"plant maintenance activities" *means the maintenance shutdowns (and subsequent start-ups) where equipment at the plant is inspected and, if needed, repaired or replaced to ensure the ongoing safe operation of the plant.*

"Ringelmann number" *means a visually comparative scale used to define levels of opacity, where clear is 0, black is 5 and 1 through 4 are increasing levels of grey as used in describing smoke from combustion of hydrocarbons.*

"visible smoke" *means a visible suspension of carbon or other particles in air measured by a* ***Ringelmann number*** *greater than 2.*

2.5.3.1 Variations to QCLNG conditions

Minor variations to the conditions of the QCLNG environmental authority have been proposed, as described below. These are to provide clarity in their implementation only. The duration and frequency of visible smoke allowances have not been altered.

Condition B2 and definition of emergency

(B2) The release of dust and/or particulate matter resulting from the activities must not cause an environmental nuisance at any sensitive or commercial place, unless the release occurs as a result of an emergency, or is authorised by this environmental authority or the EP Act.

"emergency" *means (a) either— (i) human health or safety is threatened; or (ii) serious or material environmental harm has been or is likely to be caused; and (b) urgent action is necessary to— (i) protect the health or safety of persons; or (ii) prevent or minimise the harm; or (iii) rehabilitate or restore the environment because of the harm.*

This variation expressly excludes visible smoke emissions generated in accordance with the conditions of the EA, EP Act or in emergency situations. The inclusion of the definition of emergency replicates that prescribed in section 466B of the EP Act.

Definition of flaring event

"flaring event" *means an event where flammable gas is combusted through a flare and produces visible smoke either (i) continuously for more than 5 minutes or (ii) multiple instances of visible smoke occurring consecutively with a total duration of more than 5 minutes, provided that the consecutive*

instances of visible smoke occur due to the same underlying cause, discharges through the same valve or flare source and occurs within a two hour window.

The variation to the definition of a 'flaring event' is important to ensure events that result in sporadic flaring are not considered multiple flaring events. For example, when conducting valve testing or repairs, valves may need to be stroked, cycling through an open and closed position, multiple times in order to confirm functionality. The required frequency and duration of each valve stroke cannot always be pre-determined. As far as possible, blocked in valves are utilised to avoid flaring and these activities are planned for night time when visible smoke is expected, however, this may not always be feasible in the case of an upset event such as a leaking valve or inadvertent valve operation. The valve testing/stroking/repair event listed in Table 5.1 of Appendix A makes reference to multiple valve stroking being classified as 1 flaring event. GLNG considers that such occasions should be considered a single event, from a single initiating cause. This clarity is important to ensure the proposed allowance of 14 events per annum in condition (B20)(b) is not unreasonably exhausted.

Definition of normal operating conditions

"normal operating conditions" *means the ongoing operation of the LNG plant, excluding start-up, shutdown, maintenance, upset conditions, an emergency and LNG ship management.*

The variation to the definition ensures that an emergency is excluded from the definition of 'normal operating conditions'.

Definition of plant maintenance activities

"plant maintenance activities" *means the ~~major~~ maintenance shutdowns (and subsequent start-ups) where equipment at the plant is inspected and, if needed, repaired or replaced to ensure the ongoing safe operation of the plant.*

This variation is to ensure that both routine maintenance and major maintenance activities are captured by the definition of plant maintenance activities as both types of maintenance activities can result in a flaring event/s. As outlined in section 2.1.2, some maintenance activities require de-inventory of the gas process lines and or refrigerant lines. Where the refrigerant cannot be de-inventoried to storage tanks, the refrigerant is flared which can potentially result in flaring events. Additionally, during start-up following maintenance and/or shutdown events, the refrigerant circuits are charged with propane and ethylene. Routine maintenance activities tend to be based on short to medium-term planning in response to plant condition monitoring and not from long-term planning (like major shutdowns). Therefore, it is not always possible to undertake the flaring event during the night, particularly when plant safety is under threat. Flaring events may occur approximately 4 times per annum from routine maintenance and 4 times per annum from major plant shutdowns (refer to Table 2).

3.0 Site Description

PFL 10 is located in the south-west section of Curtis Island, Gladstone. It covers approximately 378 ha across lot 1 on SP 235007, lot 7 on SP 39683, lot 1 on SP 228184, lot 4 on SP 235936 and a portion of lot 4 SP 235007, located within the Curtis Island Industry Precinct of the Gladstone State Development Area. The facility is adjacent to the QCLNG and APLNG LNG facilities, with heavy industry being a key land use across the wider Gladstone and Gladstone Harbour region (refer to Figure 1).

The LNG Plant is comprised of two LNG trains, two LNG tanks and a flare system, as well as other associated infrastructure. LNG Plant Train 1 and LNG Plant Train 2 are fully commissioned and operational.

The topography of the LNG Plant comprises low rounded hilly land (20 – 45 m AHD), intermediate steep hilly land (50 – 75 m AHD) and steep high hilly lands (>120 m AHD). Undulating slopes extend towards the coast and merge with estuarine supra-tidal flats, which are fringed by tidal mangrove flats along the coastline.

An Environmental Management Precinct also adjoins the LNG Plant – a precinct created as part of the approval and development of the three Curtis Island LNG Facilities. The northern section of the island is predominantly comprised of State Forest, Conservation Park and National Park, as well as the LNG industry proponent's joint Monte Christo Offset area.

Gladstone harbour and its surrounds (including the southern end of Curtis Island) is a major industrial centre with a number of major industrial and mineral processing facilities located in the region, which all contribute to the industrial value identified for the area including:

- Australia Pacific LNG;
- Boyne Smelters Limited;
- Cement Australia;
- Fisherman's Island Northern Expansion;
- Gladstone Pacific Nickel Refinery;
- Gladstone Power Station;
- Orica Chemical Complex;
- Queensland Alumina Limited;
- Queensland Curtis LNG;
- Rio Tinto Aluminium Yarwun;
- Wiggins Island Coal Export Terminal; and
- Wiggins Island Rail Project.

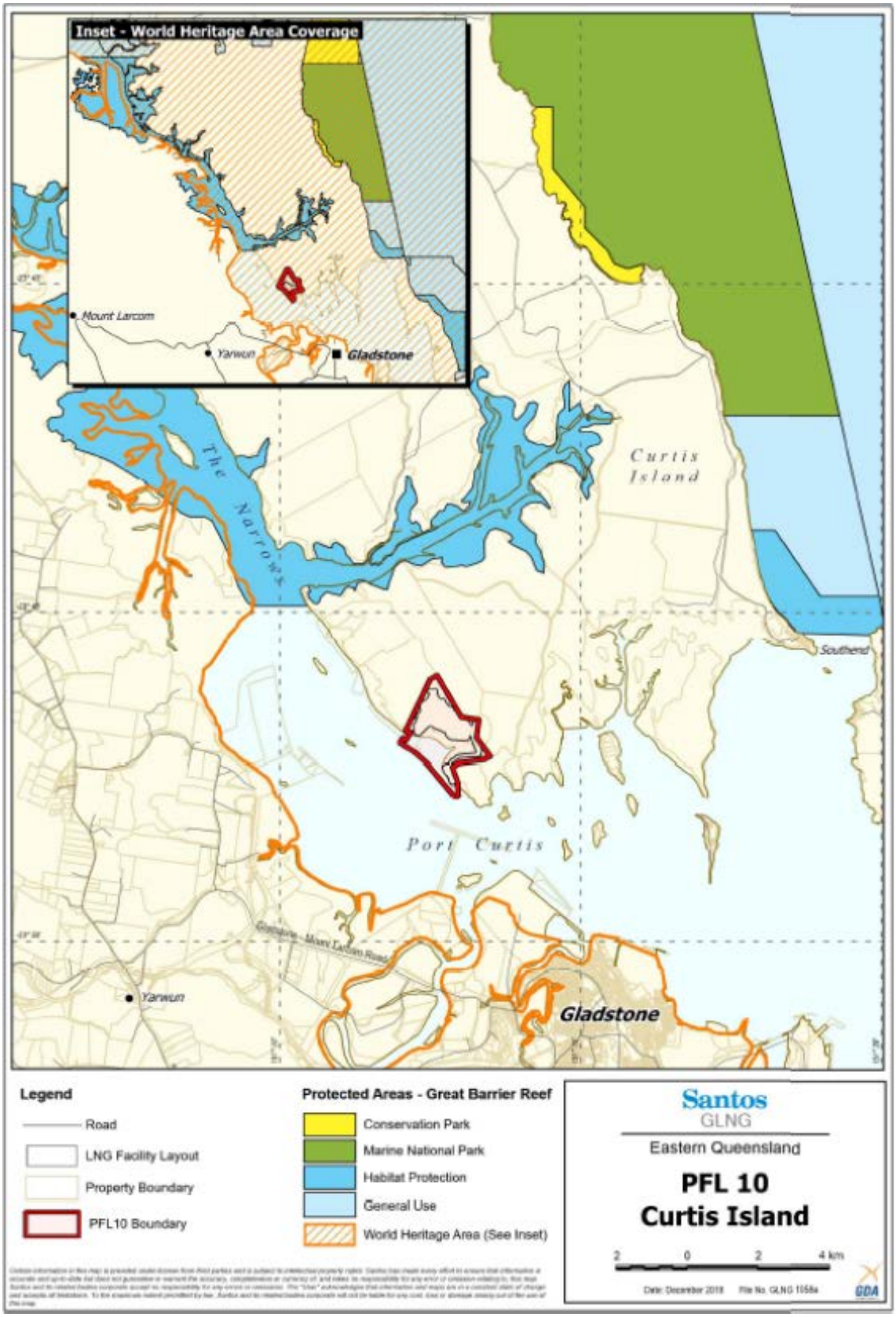

Figure 1. Site location

4.0 Environmental Values and Potential Impacts

As described in Section 2.0, the scope of this amendment is limited to the release of contaminants to the atmosphere in the form of visible smoke, including the visual amenity of the aesthetic environment within the vicinity of the GLNG LNG Plant. As such, air is the only identified environmental value that is described in this application. The activity is not expected to result in any new or different impacts to the environmental values of water, biodiversity, land, acoustic, land, rehabilitation and waste and are therefore not discussed further.

4.1 Air

Katestone carried out an air quality assessment to quantify the visible smoke emissions from the LNG Plant flares during flaring events and the potential impacts of those emissions on the receiving environment. The results of this assessment are summarised in section 4.1.4. The air quality assessment is attached in full as Appendix B.

4.1.1 Background Air Quality

The LNG Plant is located within the Curtis Island Industrial Precinct of the Gladstone State Development Area. The use designation of the industrial precinct includes high impact industry limited to natural gas (liquefaction and storage). The greater Gladstone Harbour region is a major industrial centre and a significant influence on the air quality of Gladstone airshed.

DES maintain a network of eight air quality monitoring stations throughout Gladstone to check compliance with ambient air quality guidelines, identify long-term trends in air quality, investigate local air quality concerns and assess the effectiveness of air quality management strategies (DES 2020). The location of the monitoring stations within the Gladstone region and contaminants monitored by each are indicated in Figure 2.

Gladstone	Nitrogen dioxide	Sulfur dioxide	Carbon monoxide	Ozone	Benzene	Toluene	Total xylenes	Formaldehyde	PM_{10}	$PM_{2.5}$	Visibility-reducing particles
Targinie	✓	✓							✓	✓	✓
Fisherman's Landing	✓	✓							✓	✓	✓
Boat Creek	✓	✓							✓	✓	✓
Clinton	✓	✓							✓	✓	✓
Auckland Point									✓		
Memorial Park	✓	✓		✓	✓	✓	✓	✓			
South Gladstone	✓	✓							✓	✓	✓
Boyne Island	✓	✓	✓						✓	✓	✓

Figure 2. Air contaminants monitored at the Gladstone monitoring stations

Despite the industrial nature of the locality, environmental impact assessments show that, apart from the close proximity to the Gladstone Power Station and during regional scale pollution events such as bushfires and dust storms, the air quality of the region meets the *Environmental Protection (Air) Policy 2019* (EPP Air) criteria for the protection of human health, wellbeing and the health and biodiversity of ecosystems.

For the assessment of impacts to air quality, background concentrations of CO and, $PM_{2.5}$ and PM_{10} were sourced from DES monitoring data from the Gladstone air monitoring stations. For NO_X emissions, a two-level approach was adopted by Katestone to predict the cumulative effect of emissions from the

LNG Plant sources other than the flares, and existing, approved and other potential industrial developments in the Gladstone region. This assessment utilised the Gladstone Airshed Modelling System Version 3 (GAMSv3), a regional airshed dispersion modelling tool developed by Katestone for the Department of State Development, Tourism and Innovation, for use in planning studies. GAMSv3 incorporates observed meteorological information from the network of Bureau of Meteorology (BoM) and DES meteorological stations across the Gladstone region into both The Air Pollution Model (TAPM) and CALMET meteorological models. The GAMS emissions sources for NOx are as follows:

- Hourly variable emissions of oxides for nitrogen for the Gladstone Power Station for the period 1 April 2006 to 31 March 2007;
- Annual average emissions of oxides of nitrogen for:
  - Rio Tinto Alcan Boyne Smelter – Aluminium smelter;
  - Queensland Alumina Limited (QAL) Alumina refinery;
  - Cement Australia (QCL) – Cement manufacturing plant;
  - Rio Tinto Alumina Yarwun – Alumina refinery; and
  - Orica Australia Pty Ltd.
- Approved and proposed LNG facilities (emissions of NOx based on EIS and SEIS):
  - Australia Pacific LNG;
  - Queensland Curtis LNG;
  - LNG Limited Fishermans Landing; and
  - Arrow LNG.

No background concentrations were assumed for the assessment of hydrocarbons or PAHs in accordance with conventional practice.

Table 3 provides a summary of the source of the background levels used in the assessment.

Table 3. Background concentrations used in modelling assessment

Pollutant	Value	Source
Carbon monoxide (CO)	Modelled GLNG plant plus 250 µg/m3	DES monitoring data from Beacon Avenue, Boyne Island
Nitrogen dioxide (NO_2)	GAMS – existing and approved industries in the Gladstone region plus other LNG plants as listed above	GAMSv3 - existing and approved industries in the Gladstone region plus other LNG plants as listed above
$PM_{2.5}$	Modelled GLNG plant plus 17.7 µg/m3	DES monitoring data for South Gladstone, 95th percentile 24-hour for 2019
PM_{10}	Modelled GLNG plant plus 36 µg/m3	DES monitoring data average 95th percentile 24-hour from South Gladstone, 2019
Hydrocarbons	N/A – in accordance with conventional practice	N/A – in accordance with conventional practice
PAHs	N/A – in accordance with conventional practice	N/A – in accordance with conventional practice

4.1.2 Sensitive Receptors

The potentially sensitive receptors (including protected areas) located within approximately 10km of the LNG Plant include (refer to Figure 3):

- Tide Island (Note: this is leased by GLNG);
- Witt Island;
- Compigne Island;
- Turtle Island;
- The Curtis Island Environmental Management Precinct;
- the industrial, commercial and residential areas of Gladstone, Yarwun, Targinie and Fishermans Landing;
- Yarwun State School;
- Gladstone State School;
- the residential areas of Curtis Island (Southend);
- Quoin Island;
- Curtis Island National Park;
- Curtis Island Conservation park;
- Curtis Island State Forest; and
- Targinie State Forest.

4.1.3 Environmental Values and Quality Objectives (Air)

Section 6 of the EPP Air prescribes potential environmental values relevant to the air environment. The environmental values relevant to this amendment application include:

a) the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and
b) the qualities of the air environment that are conducive to human health and wellbeing; and
c) *the qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property;*

Section 7 and Schedule 1 of the EPP Air prescribes air quality objectives for protecting or enhancing environmental values. The relevant air quality indicators for the amendment application are:

- Oxides of nitrogen (NO_X);
- Carbon monoxide (CO);
- Hydrocarbons including: Methane, Ethane/ethylene, Acetylene, Propane, Propylene;
- Particulate matter in the form of $PM_{2.5}$ and PM_{10} (flare gases containing propane and ethylene);
- Polycyclic Aromatic Hydrocarbons (PAHs) (flare gases containing propane and ethylene); and
- Visibility reducing particles.

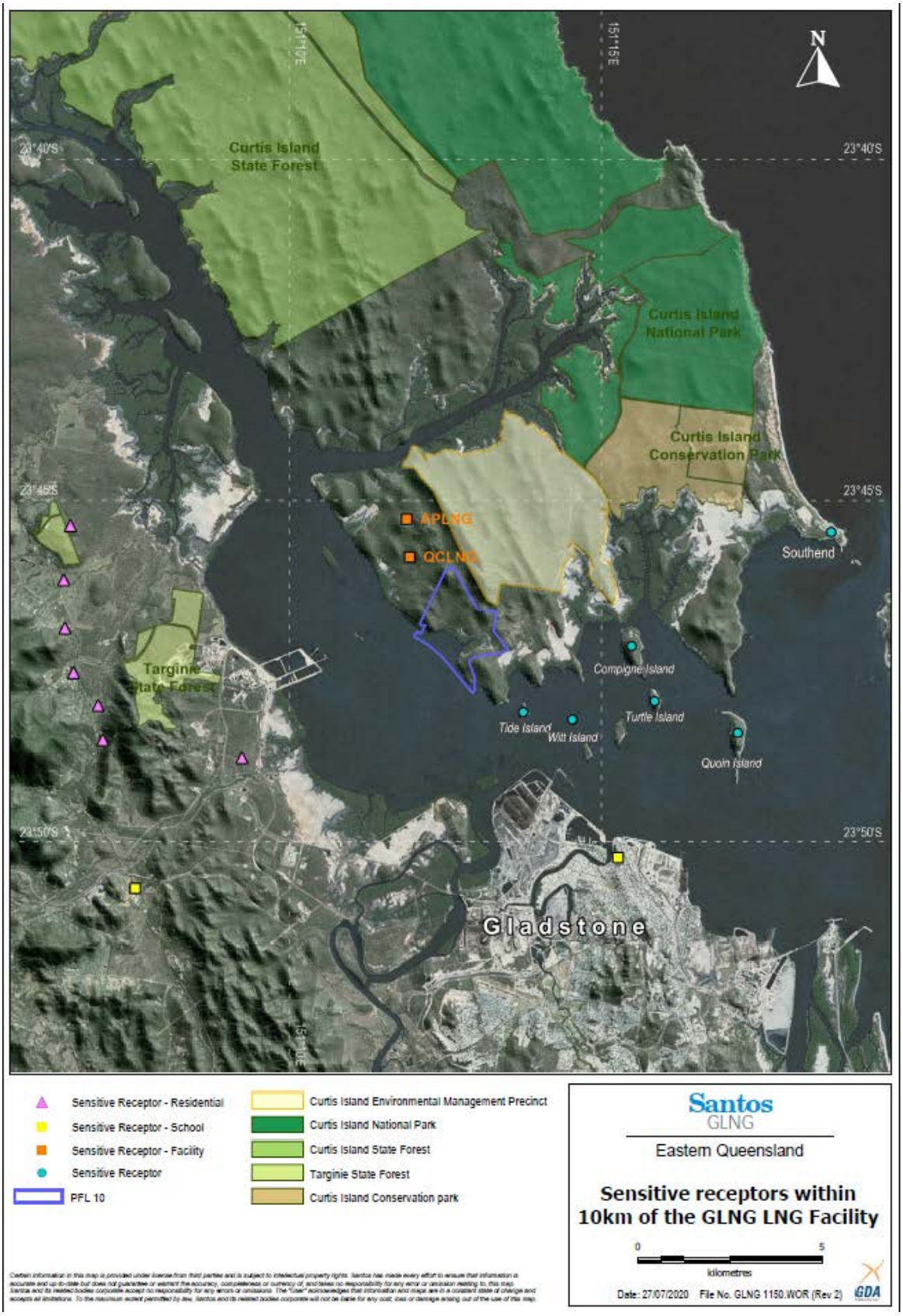

Figure 3. Sensitive receptors within a 10km radius of the LNG Plant

The EPP Air quality objectives relevant to the key air pollutants that may be generated from the LNG Plant flares are presented in Table 4.

Table 4. Environmental values and air quality objectives (Schedule 1of the *Environmental Protection (Air) Policy 2019)*

Air Quality Indicator	Environmental Value	Air Quality Objective			
		µg/m3	ppm	Averaging Period	Allowable Exceedance
Carbon monoxide (CO)	Health and wellbeing	11,000	9	8 hours	1 day/year
Nitrogen dioxide (NO_2)	Health and wellbeing	250	0.12	1 hr	1 day/year
		62	0.03	1 year	
	Health and biodiversity of ecosystems	33	0.016	1 year	
$PM_{2.5}$	Health and wellbeing	25		24 hours	
		8		1 year	
PM_{10}	Health and wellbeing	50		24 hours	
		25		1 year	
Visibility reducing particles	Protecting aesthetic environment	20km visibility in the air environment		1 hour	

As described above, hydrocarbons are also a relevant air quality indicator for the amendment application. The combustion of methane, propane or ethylene in the flares is likely to produce small quantities of hydrocarbons. The EPP Air does not provide any assessment criteria for the hydrocarbons listed above, as such it is common practice to consider, and where appropriate adopt, an air quality objective for a specific substance from another jurisdiction. As a result, air quality objectives from the following guidelines and standards have been adopted for the hydrocarbons identified in the air quality assessment:

- National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (NOHSC:1003(1995)); and
- Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels 2008.

The hydrocarbon emissions likely to be emitted from the flares are presented in Table 5 with their respective air quality objective.

Table 5. Relevant ambient air quality objectives and standards for hydrocarbons

Air Quality Indicator	Environmental Value	Air Quality Objective		
		µg/m3	Averaging Period	Source
Acenaphthylene (as acenaphthene)	Health	1	1 hour	TCEQ
Acetylene	Health	26,600	1 hour	TCEQ

Air Quality Indicator	Environmental Value	Air Quality Objective		
		µg/m3	Averaging Period	Source
Anthracene	Health	0.5	1 hour	TCEQ
Benz(a)anthracene	Health	0.5	1 hour	TCEQ
Benzo(g,h,i)perylene	Health	0.5	1 hour	TCEQ
Chrysene	Health	0.5	1 hour	TCEQ
Dibenzo(a,h)anthracene (as acenaphthene)	Health	0.5	1 hour	TCEQ
Ethane	Health	12,000	1 hour	TCEQ
Ethylene (Ethene)	Health	13.9% by volume [3]	Simple Asphyxiant	NOHSC:1003/TECQ
Fluoranthene (Benzo(j,k)fluorene)	Health	0.5[1]	1 hour	TCEQ
Fluorene	Health	0.5[2]	1 hour	TCEQ
Methane	Health	13.9% by volume [3]	Simple Asphyxiant	NOHSC:1003/TECQ
Phenanthrene	Health	0.5	1 hour	TCEQ
Propane	Health	18,000	1 hour	TCEQ
Propylene	Health	8,750	1 hour	TCEQ
Pyrene	Health	0.5	1 hour	TCEQ

[1] Air quality objective not found: Fluoranthene (or Benzo(j, k)fluorene) is a polycyclic aromatic hydrocarbon (PAH) and a structural isomer of the alternant PAH pyrene. Consequently, the same 1-hour average air quality objective of 0.5 µg/m3 has been applied for this assessment.

[2] Air quality objective not found: Fluorene is a PAH, and consequently, in line with other PAHs referenced by the TCEQ Effects Screening Levels an air quality objective of 0.5 µg/m3 has been applied for this assessment.

[3] To maintain oxygen content in air greater than 18% by volume

4.1.4 Dispersion Modelling Assumptions

A dispersion modelling assessment using the dispersion model CALPUFF was conducted to determine the potential impacts due to the flaring operations. Modelling was based on the following three real GLNG flaring scenarios:

- Scenario 1 – 2019 major shutdown: single train propane system de-inventory for planned maintenance activities. This scenario resulted in high propane emissions.
- Scenario 2 – 2016 major shutdown: single train propane system de-inventory for planned maintenance activities. This scenario resulted in high propane emissions.
- Scenario 3 – Upset event: Emergency Depressuring Valve (EDP) valve failed to open. This event resulted in worst case methane emissions due to a plant upset. Whilst the flaring of methane is unlikely to produce particulate matter, elevated methane levels were modelled to result in elevated levels of other contaminants (e.g. carbon monoxide and oxides of nitrogen).

These three scenarios were identified as having the maximum potential for impact and as such represent worst-case emissions potential. As outlined in section 2.1 the flaring of refrigerants (e.g. propane) may result in visible smoke.

The impact assessment is considered to be conservative given the application of the following assumptions:

- flaring events were modelled to occur continuously for a 24-hour period. In reality, a flaring event may occur over a number of minutes or up to 24-hours; and
- all other plant and equipment at GLNG operates at the same time as the flaring event. In reality, the visible smoke emissions are typically associated with the shutdown of one processing train and, therefore, emissions from other plant and equipment will be reduced (refer to Appendix B for an overview of the operating plant for the various flare scenarios). A summary of other plant equipment included in the assessment and pollutants emitted from them is summarised in Table 11 of Appendix B.

The dispersion modelling provided predictions of nitrogen dioxide, $PM_{2.5}$, PM_{10}, carbon monoxide and hydrocarbon concentrations at sensitive receptors. Ground-level concentrations for short-term 1-hour and 24-hour averaging periods were determined as the releases from the flares are expected to range from minutes up to 24-hours. An assessment against longer term averaging periods was therefore not undertaken.

4.1.4.1 Source characteristics, emission factors and rates

Because of their nature, flares cannot be practically measured in the field. Consequently, Katestone applied emission factors to estimate the emissions. Flare emissions were based on US EPA AP-42 documents (Chapter 13.5, Industrial Flares), other literature information (McEwen et al. (2012)) and process information supplied by GLNG. Section 2.4 of Appendix B prescribes the emission factors and rates applied by Katestone for each of the air pollutants: NOX, CO, total hydrocarbons (in methane equivalents), $PM_{2.5}$, PM_{10} and PAHs.

Additionally, due to the large amount of heat and buoyancy generated by the flare, it could not be modelled as a stack source. To model the flare emissions appropriately, the US EPA Screen 3 methodology was used to generate the pseudo stack characteristics (effective height and diameter) for the flare. The source characteristics used in the dispersion modelling are provided in Table 10 of Appendix B.

4.1.5 Potential Impacts and Mitigation Measures

The potential impacts from flaring events has been considered with regards to the release of contaminants to the atmosphere, and the visual amenity of the aesthetic environment.

4.1.5.1 Air Quality Impacts

The assessment conducted by Katestone quantified the visible smoke emissions from the LNG Plant flares during flaring events and the potential impacts of those emissions on the receiving environment.

For the three scenarios modelled, the predicted ground-level concentration for the relevant air quality indicators was modelled for the flare in isolation; and for the flare in isolation, flare with other plant equipment and the flare with other plant equipment plus background. The results of the dispersion modelling conducted by Katestone for the potential three worst case emissions demonstrate that the predicted ground-level concentrations of NO_2, CO, $PM_{2.5}$, PM_{10}, hydrocarbons and PAHs were well below the relevant air quality objectives (EPP Air and/or relevant standards and guidelines) at all sensitive receptors (including residential receptors and protected areas).

The results of the modelling are presented in sections 4.1.5.1.1 and 4.1.5.1.2.

4.1.5.1.1. Dispersion modelling results – Flare in isolation

The results of the three flare scenarios modelled are presented in Table 14 to Table 19 of Appendix B. The predicted ground-level concentrations are the maximum predicted and are due to the flare in isolation. The results show that the predicted ground-level concentrations of pollutants are well below the relevant air quality objectives, as follows:

- Maximum 1-hour average ground-level concentrations of NO_2 predicted at a receptor less than 3% of the objective
- Maximum 8-hour average ground-level concentration of CO predicted at a receptor less than 1% of the objective
- Maximum 24-hour average ground-level concentrations of PM_{10} predicted at a receptor less than 5% of the objective
- Maximum 24-hour average ground-level concentrations of $PM_{2.5}$ predicted at a receptor less than 9% of the objective
- Maximum 1-hour average ground-level concentrations of hydrocarbons (ethane, ethylene, acetylene, propane and propylene) predicted at a receptor less than 0.4% of the relevant objectives
- Maximum ground-level concentrations of PAHs are well below (less than 0.7% of) the relevant objectives.

4.1.5.1.2. Dispersion modelling results – Flare including background

Table 20 to Table 22 of Appendix B summarise the cumulative maximum concentrations of NO_2, CO, PM10 and PM2.5 for the three scenarios. Table C1 to Table C3 in Appendix C of Appendix B present the predicted ground-level concentrations for each modelled dry and wet gas flare scenario as well as a breakdown of predicted concentrations due to flare in isolation, flare with other plant equipment and flare with other plant equipment plus background. The results show that the predicted ground-level concentrations NO_2, CO, $PM_{2.5}$ and PM_{10} are well below the relevant air quality objectives, as follows:

- Maximum 1-hour average ground-level concentrations of NO_2 predicted at a receptor less than 30% of the objective
- Maximum 8-hour average ground-level concentration of CO predicted at a receptor less than 4% of the objective
- Maximum 24-hour average ground-level concentrations of PM_{10} predicted at a receptor less than 84% of the objective

4.1.5.2 Visual Amenity

As demonstrated above, while the visible smoke produced during flaring events maintains air quality objectives in the Gladstone region visual aesthetics of Gladstone may be impacted by visible smoke. Section 15 of the EP Act defines environmental nuisance as an "*unreasonable interference or likely interference with an environmental value*…"

The visible smoke emissions generated from flaring events may be acute for a short period, however the plume does not affect the visibility of the whole air shed as would bush fires or dust storms. Visibility is only affected in the direct line of site of the plume.

GLNG is proposing (by way of the proposed EA conditions) to have a maximum total of 14 flaring events per annum, for a duration of 7 hours during daylight hours and with a maximum release time of 90

minutes at any one time. When considering these events over the period of a day and a year, the proposed visible smoke emissions are for a short duration, are intermittent in nature and occur infrequently. Should GLNG utilise the full proposed 7 hours allowance in a year, this represents 0.08% of hours in a year whereby the community may be impacted by visible smoke. Further, the highest potential for visible smoke to be generated (and of longer duration) is during plant shutdowns and start-ups for plant maintenance. These are scheduled to occur once every 4 years per train and will be limited to a maximum 90 minute release. In context of these events over a year, this is considered minimal and reasonable and should not constitute a nuisance. Further, these allowances represent worst case scenarios – flaring events will vary year to year, dependent on plant operations required during a given period.

As outlined in section 2.1 and verified by KBR as a third party, all flaring events "*are considered reasonable and reflect a balance between enabling safe and efficient operation of the LNG plant and a strong drive to minimise visible smoke emissions affecting public visual amenity*". Further, the DES imposed the visible smoke authorisations for the QCLNG Plant on the QCLNG environmental authority. Given the similarity between the QCLNG and GLNG flare designs, this outcome has set a precedent for what is a reasonable compromise between plant operability, plant safety and visual impact to the community.

4.1.5.3 Mitigation Measures

GLNG already implements a series of mitigation and management measures to reduce the frequency and duration of visible smoke from flaring events. These have been described in section 2.2 and include:

- the implementation of plant optimisation measures (see section 2.2.1); and
- the development a Flaring Contingency Management Plan (Appendix C) (see section 2.2.2);

Flaring resulting in visible smoke is unavoidable to maintain plant safety. However, avoidance of circumstances necessitating flaring is the best mitigation measure available to GLNG. This can be archieved through personnel training, implementation of detailed plant operating procedures, undertaking of regular plant maintenance and through detailed event investigation. GLNG is continually working to minimise the frequency of flaring wherever possible.

The results of the air quality impact assessment demonstrate the flaring events are not significantly contributing to the Gladstone airshed and that GLNG are able to maintain the protection of the health of the community as well as other nature-based sensitive receptors. The cap on frequency and duration of visible smoke proposed as part of this EA amendment should also assist in alleviating impacts to visual amenity. GLNG will make every possible effort to plan for flaring events to occur during the night.

GLNG is committed to good environmental management and to protecting and promoting the interests of the communities in which it operates. GLNG will continue to engage with key community stakeholders prior to undertaking forecast flaring and will continue to seek operability improvements to minimise impacts to the visual amenity of the community, whilst maintaining plant safety and efficiency.

4.1.5.4 Monitoring

Flare system monitoring undertaken by GLNG is described in Section 2.3. The existing monitoring regime is focused on the measurement of the frequency, duration and visibility (Ringelmann Score) of visible smoke. This includes visual monitoring captured via CCTV and assignment of a Ringelmann Score as well as gas temperature and gas flow rate measurements. In GLNG's view, this monitoring is sufficient to demonstrate compliance with the proposed conditions in section 2.5.3 (namely conditions B20 - B22). A determination of the cause of the flaring event and actions taken to minimise the flaring is also recorded as part of GLNG's Procedure for Recording Flaring Events. This information is what is

necessary for GLNG to understand why and how a flaring event occurred and to identify a root cause and corrective actions to prevent future recurrences wherever practicable.

5.0 Legislative Considerations

5.1 *Environmental Protection Act 1994* (Qld)

5.1.1 Requirements for an EA Amendment Application (s226 and s226A EP Act)

Section 226 and 226A of the EP Act specifies the requirements for an EA amendment application. Table 6 contains a summary of the EP Act requirements assessed against this proposed amendment application.

Table 6: Requirements EA Amendment Application (s226 and s226A EP Act)

Section of the EP Act	Relevance to amendment application
s226(1)(a) be made to the administering authority	The EA amendment application has been lodged with DES who is the administering authority for the EP Act.
s226(1)(b) be made in the approved form	Refer to Attachment 1 of the application package, which includes the *Application to amend an environmental authority.*
s226(1)(c) be accompanied by the fee prescribed under a regulation	The application fee of $340.90 was paid upon lodgement of this application.
s226(1)(d) describe the proposed amendment	Refer to Section 2.0.
s226(1)(e) describe the land that will be affected by the proposed amendment	Refer to Section 3.0.
s226(1)(f) include any other document relating to the application prescribed under a regulation.	Refer to the information provided throughout this supporting report.
s226A(1)(a) describe any development permits in effect under the Planning Act for the carrying out of the relevant activity for the authority; and	The following development permits have been obtained for the Materials offloading facility (MOF) and Product loading facility (PLF): • Development Approval - Prescribed Tidal Works – Materials Offloading Facility (DA/264/2011) (modified DA/264/2010); • Development Approval Operational works that is the removal, destruction or damage of marine plants associated with the MOF, the Pioneer MOF and haul road (DA 2011DB0082); • Development Approval - Prescribed Tidal Works – Product Loading Facility (DA/603/2012); and • Development Approval for Prescribed Tidal Works – Curtis Island Temporary Pioneer Barge Ramp Facility (DA/258/2010).
s226A(1)(b) state whether each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity	Not applicable – There are currently no eligibility criteria relevant to the activities proposed by the amendment application.
s226A(1)(c) if the application states that each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity— include a declaration that the statement is correct	Not applicable – There are currently no eligibility criteria relevant to the activities proposed by the amendment application.

Section of the EP Act	Relevance to amendment application
s226A(1)(d) state whether the application seeks to change a condition identified in the authority as a standard condition	Not applicable - The respective EA does not contain any standard conditions.
s226A(1)(e) if the application relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit—state whether the applicant seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit	Not applicable - The application does not relate to a new resource tenure.
s226A(1)(f) include an assessment of the likely impact of the proposed amendment on the environmental values, including—	
(i) a description of the environmental values likely to be affected by the proposed amendment;	This amendment is limited to the release of contaminants to the atmosphere. As such, air is the only identified environmental value described in Section 4.0 of this application.
(ii) details of any emissions or releases likely to be generated by the proposed amendment;	The amendment does not seek to authorise any new emissions, but seeks to amend the conditions that relate to flaring authorised by the conditions of Schedule B - Air. Katestone have conducted an air quality assessment to quantify the visible smoke emissions from the LNG Plant flares during flaring events and the potential impacts of those emissions on the receiving environment. The results of this assessment are summarised in Section 4.1.5 and included as Appendix B.
(iii) a description of the risk and likely magnitude of impacts on the environmental values;	The assessment conducted by Katestone quantified the visible smoke emissions from the LNG Plant flares during flaring events and the potential impacts of those emissions on the receiving environment. For the three scenarios modelled, the predicted ground-level concentration for the relevant air quality indicators was modelled for the flare in isolation; and for the flare in isolation, flare with other plant equipment and the flare with other plant equipment plus background. The results of the dispersion modelling conducted by Katestone for the potential three worst case emissions demonstrate that the predicted ground-level concentrations of NO_2, CO, $PM_{2.5}$, PM_{10}, hydrocarbons and PAHs were well below the relevant air quality objectives (EPP Air and/or relevant standards and guidelines) at all sensitive receptors (including residential receptors and protected areas). The results of the modelling are presented in sections 4.1.5.1.1 and 4.1.5.1.2. The aesthetics of the environment have the potential to be impacted from visible smoke emissions caused by the flaring events. The impact on the aesthetics of the environment from visible smoke emissions is for a short duration, is of an intermittent nature and happens infrequently.

Section of the EP Act	Relevance to amendment application
(iv) details of the management practices proposed to be implemented to prevent or minimise adverse impacts;	GLNG's existing air quality management will continue to be implemented in accordance with the management hierarchy for air emissions, including: • **Avoid/Minimise** – o Implementation of plant optimisation measures including the following: ▪ A trip reduction campaign, whereby every trip is investigated and mitigations implemented to prevent/minimise future trips of the same nature; ▪ Where practical, the transfer of refrigerant (the principal cause of visible smoke) to an on-line compressor string (including to another train if necessary) rather than flaring; ▪ Development of strategies to avoid/minimise the requirement for plant defrosting (required for hydrate/heavier hydrocarbon removal which can result in visible smoke) outside of major shutdowns to minimise the total duration of flaring events; ▪ Detailed planning and scheduling of maintenance activities so necessary flaring can occur at night; and ▪ Deferring unplanned flaring until night-time, where practicable and safe to do so. o GLNG is investigating additional plant optimisation measures to further reduce incidences of visible smoke. These are to be considered on their practicality for implementation and economic feasibility. These measures include: ▪ High rate flare purging to minimise lingering visible smoke after a release of heavier hydrocarbons to the flare system; and ▪ Planning simultaneous flaring where feasible from multiple sources rather than separately to reduce the total duration of flaring events. o GLNG has developed a Flaring Contingency Management Plan (Appendix C) which includes management measures to reduce the frequency and duration of gas being flared and any associated visible smoke. The management measures are presented in Section 2.2.2. The management measures are in, *'…in accordance with industry practice."*[4] As ratified by the HRL Technology Group as part of the independent environmental audit commissioned by DES in 2016. • **Manage –** o The GLNG flare system is monitored in several ways. Plant operators can observe live plant data including CCTV of the flare tips which show the size of the flame and smoke (during daylight

[4] Page 46,*'Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*

Section of the EP Act	Relevance to amendment application
	hours), data trends, plant set points and plant alarms. o GLNG has implemented the Procedure for Recording Flaring Events which defines the requirements for the recording of flaring events at the LNG Plant. The management of flaring events assists in ensuring compliance with the conditions of EA EPPG00712213 and in minimising the potential for community complaints relating to visible smoke. The procedure includes a Flaring Event Register which is a requirement of the Flaring Contingency Management Plan whether the flaring event is planned (normal operations or planned shut-down/start-up) or unplanned (i.e. upset). o Air emissions monitoring will continue in accordance with the existing conditions of the EA. o Air monitoring is undertaken by a suitably qualified and experienced person and in accordance with the conditions of the EA and the *Environmental Protection Regulation 2019* (Qld). GLNG is committed to good environmental management and to protecting and promoting the interests of the communities in which it operates. GLNG will continue to engage with key community stakeholders prior to undertaking forecast flaring and will continue to seek operability improvements to minimise impacts to the visual amenity of the community, whilst maintaining plant safety and efficiency.
(v) details of how the land the subject of the application will be rehabilitated after each relevant activity ceases;	Rehabilitation of the LNG Plant will be undertaken in accordance with the requirements of the conditions of the EA, namely Schedule H - Petroleum Infrastructure.
s226A(1)(g) include a description of the proposed measures for minimising and managing waste generated by any amendments to the relevant activity;	It is not expected the proposed amendment will result in the generation of new types of waste. The current avoidance and management practices will continue to be used and the conditions of Schedule E will be complied with.
s226A(1)(h) include details of any site management plan or environmental protection order that relates to the land the subject of the application;	Not applicable – There is no relevant site management plan or current Environmental Protection Orders relating to land located within PFL 10.

5.1.2 CSG Activities Requirements for EA Amendment Applications (s227 EP Act)

Section 227 of the EP Act specifies requirements for an amendment application for coal seam gas (**CSG**) activities where the application:

(a) relates to an EA for a CSG activity; and

(b) the proposed amendment would result in changes to the management of CSG water; and

(c) the CSG activity is an ineligible ERA.

This amendment application is for the LNG Plant and associated infrastructure which are not CSG activities under the EP Act. This section of the Act is not applicable.

5.1.3 Underground Water Rights - EA Amendment Applications (s227AA EP Act)

Section 227AA of the EP Act specifies the requirements for an amendment application where the application involves changes to the exercise of underground water rights for a petroleum lease. This amendment application relates to PFL 10 and is therefore not applicable.

5.1.4 Assessment Level Decision for Amendment Application (s228 EP Act)

GLNG considers this amendment application to be a minor amendment. Refer to Table 7 for further information concerning the determination of this application being a minor amendment.

Table 7: Minor Amendment (Threshold) Assessment

Minor amendment (threshold), for an environmental authority, means an amendment that the administering authority is satisfied -		Relevance to amendment application
(i) is not a change to a condition identified in the authority as a standard condition, other than	✓	The EA does not identify any standard conditions.
(i) a change that is a condition conversion; or	✓	
(ii) a change that is not a condition conversion but that replaces a standard condition of the authority with a standard condition for the environmentally relevant activity to which the authority relates; and	✓	
(ii) Does not significantly increase the level of environmental harm caused by the relevant activity; and	✓	The application does not seek an increase to the release of visible smoke at the LNG Plant. The EA presently contains conditions which authorise flaring. Further the EA contemplates exceptions for periods outside normal operating conditions, such as for start-ups, shut-downs and maintenance. In GLNG's view, this application principally seeks greater clarity and transparency for GLNG's operations with respect to flaring. The air quality assessment GLNG: Air Quality Assessment of Dry and Wet Flares, July 2020 (Appendix B), demonstrates that the predicted ground level concentration of the key air pollutants from flaring events are well below the relevant air quality objectives defined by the EPP Air and the relevant guidelines and standards at all sensitive receptors (including residential receptors and protected areas) (refer to section 4.1.5). Therefore, according to the results of the air quality assessment undertaken by Katesone, in GLNG's view the proposed amendment would not result in an increase in the level of environmental harm caused by the activity.
(iii) Does not change any rehabilitation objectives stated in the authority in a way likely to result in significantly different impacts on environmental values than the impacts previously permitted under the authority; and	✓	The proposed amendment does not seek to change any rehabilitation objectives.
(iv) Does not significantly increase the scale or intensity of the relevant activity; and	✓	The amendment seeks to amend Schedule B – Air emissions of the EA to expressly authorise the duration and frequency of visible smoke emissions associated with flaring from the LNG Plant during planned

Minor amendment (threshold), for an environmental authority, means an amendment that the administering authority is satisfied -		Relevance to amendment application
		and unplanned plant maintenance (start-up/shutdown), plant upsets and plant emergencies. The scale and intensity of the relevant activity approved by the EA has not changed. We say this because: • there is no change to size or throughput of the facility; and • there are no additional release locations or emissions proposed from that which is authorised by the EA. Further, dispersion modelling has shown that flaring events have no significant impact on air quality at all sensitive receptors (including residential receptors and protected areas) and air quality remains well below the relevant air quality objectives of the EPP Air and the relevant guidelines and standards.
(v) Does not relate to a new relevant resource tenure for the authority that is – *(iii) a new mining lease; or* *(iv) a new petroleum lease; or* *(v) a new geothermal lease under the Geothermal Energy Act; or* *(vi) a new GHG injection and storage lease under the GHG storage Act; and*	✓	The proposed amendment does not relate to a new resource tenure for the authority.
(vi) Involves an addition to the surface area for the relevant activity of no more than 10% of the existing area; and	✓	No additional surface area is proposed as part of this amendment.
(vii) For an environmental authority for a petroleum activity – *(i) if the amendment involves constructing a new pipeline – the new pipeline does not exceed 150km; and*	✓	The amendment does not involve constructing a new pipeline more than 150km in length or extending an existing pipeline.
(ii) if the amendment involves extending an existing pipeline – the extension does not exceed 10% of the existing length of the pipeline; and	✓	The amendment does not involve extending an existing pipeline.
(viii) If the amendment relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit - the amendment application under section 224 seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority to the extent it relates to the permit.	✓	The amendment does not relate to a new relevant resource tenure that is an exploration permit or GHG permit.

5.1.5 The Standard Criteria (EP Act)

The standard criteria (as defined by Schedule 4 of the EP Act) are required to be considered by the administering authority for deciding site-specific applications (Table 8).

Table 8: Standard Criteria (EP Act)

Schedule 4 EP Act	Relevance
a) the following principles of environmental policy as set out in the Intergovernmental Agreement on the Environment – *(i) the precautionary principle;* *(ii) intergenerational equity;* *(iii) conservation of biological diversity and ecological integrity; and*	The proposed amendment was contemplated within the context of intergenerational equity and sustainable development. The amendment will not result in significant or permanent impact to the existing environmental values of Curtis Island as demonstrated in section 4.1.5. Flaring events will be: o minimised through the implementation of the plant optimisation measures outlined in section 2.2.1 to comply with the conditions of the LNG EA and the amendments sought by this application to conserve biological diversity and ecological integrity; o managed in accordance with the management measures stated in the Flare Contingency Management Plan (refer to section 2.2.2); and o recorded in accordance with the Procedure for Recording Flaring Events (refer to section 2.3); The proposed amendment was contemplated within the context of the precautionary principle. The release of contaminants to air from flaring events as sought by this amendment application do not pose a threat of serious or irreversible environmental harm, and scientific uncertainty does not exist as to the level of potential environmental harm as demonstrated in the supporting information provided with this amendment application. Compliance with the existing and proposed conditions of the LNG EA relating to the release of contaminants to air from flaring events will continue to be met during the conduct of the authorised activities to achieve best practice environmental management (BPEM).
b) any Commonwealth or State government plans, standards, agreements or requirements about environmental protection or ecologically sustainable development	The proposed activities would be undertaken in accordance with the applicable requirements of the following: • EP Act; • *Environment Protection and Biodiversity Conservation Act 1999* (Cth); • *Nature Conservation Act 1992* (Qld); • *Vegetation Management Act 1999* (Qld); • *Environmental Offsets Act 2014* (Qld); • *Fisheries Act 1994* (Qld); and • *Planning Act 2016* (Qld). The relevance of these Acts to this application is referenced throughout the supporting information.
c) any relevant environmental impact study, assessment or report	N/A
d) the character, resilience and values of the receiving environment	The character, resilience and values of the receiving environment are described in Section 4.0.
e) all submissions made by the application and submitters	The amendment application seeks to amend Schedule B – Air emissions of the EA to expressly authorise the duration and frequency of visible smoke emissions associated with flaring from the LNG Plant during planned and unplanned plant maintenance (start-up/shutdown), plant upsets and

Schedule 4 EP Act	Relevance
	plant emergencies. Based on the threshold assessment completed in Table 7, GLNG is of the opinion that the EA amendment application is considered to be a minor amendment and as such, would not be subject to public notification.
f) Best Practice Environmental Management (BPEM) for activities under any relevant instrument, or proposed instrument, as follows- *(i) an environmental authority;* *(ii) a transitional environmental program;* *(iii) an environmental protection order;* *(iv) a disposal permit;* *(v) a development approval;*	The HRLTG Environmental Audit states: • *"..the flare has been designed to meet the best practice design standards as outlined by the US EPA Code of Federal Regulations (ref. 40 CFR 60.18 and 40 CFR 63.11)."*[5] • *The "..Flaring Contingency Plan which maintains Management Measures that HRLTG consider to be in accordance with industry practice."*[6] • *"During process upsets or emergencies HRLTG considers Santos' operations to be in line with industry practice."*[7]
g) Financial implications of the requirements under an instrument, or proposed instrument, mentioned in paragraph (g) as they would relate to the type of activity or industry carried out, or proposed to be carried out under the instrument;	GLNG will continue to provide adequate funds, equipment and staff time to comply with the conditions of the amended EA.
h) Public Interest	The proposed amendment is in the public interest. The activities proposed under this amendment will allow for flaring events to occur outside of normal operating conditions and as such allow for safe and efficient continued operation of the LNG Plant. The LNG Plant has been approved as an infrastructure facility that is of significance, particularly economically or socially, to Queensland and the Fitzroy and South West Statistical Divisions being the region in which the facility is located, under section 125(1)(f) of the SDPWO Act. The generation and sale of LNG provides key royalties for the State of QLD. Further gas produced by the LNG Plant play an important role as a cleaner and lower-carbon emitting alternative to coal. The amendment application seeks to amend Schedule B – Air emissions of the EA to expressly authorise the duration and frequency of visible smoke emissions associated with flaring from the LNG Plant during planned and unplanned plant maintenance (start-up/shutdown), plant upsets and plant emergencies. Dispersion modelling has shown that flaring events have no significant impact on air quality at all sensitive receptors (including residential receptors and protected areas) and air quality remains well below the

[5] Page 25, *Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*
[6] Page 46, *Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*
[7] Page 46, *Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*

Schedule 4 EP Act	Relevance
	relevant air quality objectives of the EPP Air and the relevant guidelines and standards. The amendments will provide certainty to the local community around the parameters for visible smoke generation and will ensure consistent regulation and community expectations between the like LNG facilities. They will also assist in minimising visual amenity impacts to the Gladstone community.
i) Site management plan (SMP)	There are no SMPs applicable to the application.
j) Integrated environmental management system (IEMS) or proposed IEMS	The Santos Management System (**SMS**) will be implemented for the proposed activities.
k) Other matters prescribed under a regulation	The *Environmental Protection Regulation 2019* (Qld) prescribes an environmental objective assessment relating to an environmental management decision as an additional matter for the standard criteria. Sections 2.0 to 4.0 address the matters raised in the environmental objective assessment.

5.2 Environmental Protection Regulation 2019 (EP Reg)

Section 235 of the EP Act (major amendment) and section 241 of EP Act (minor amendment), both require the administering authority to consider any relevant regulatory requirement in deciding an amendment application. However, in accordance with section 48(2)(b) of the EP Regulation, an amendment application is not considered an environmental management decision if it relates to an application for a minor amendment of an environmental authority. Notwithstanding, the sections of the EP Regulation potentially relevant to the application are provided below.

5.2.1 Environmental Objective Assessment

Section 51 of the EP Regulation describes the matters to be considered by the administering authority in making an environmental management decision. For the purposes of this amendment application, sections 51(1)(a) and (b), require the administering authority to:

- carry out an environmental objective assessment against the environmental objective and performance outcomes mentioned in Schedule 5, Part 3, Tables 1 and 2. The objective assessment is also prescribed as an additional matter for the standard criteria (section 53A); and
- consider the environmental values declared under the EP Reg.

The air quality components of Schedule 5, Part 3, Table 1 of the EP Reg, provided in Table 9, are considered relevant to this amendment application.

Table 9: Schedule 5, Part 3, Table 1- Air

Schedule 5, Part 3, Table 1 EP Reg	Relevance to amendment application
Air	
Environmental Objective	
The activity will be operated in a way that protects the environmental values of air	Refer to Section 4.1.3
Performance Outcomes	

1 There is no discharge to air of contaminants that may cause an adverse effect on the environment from the operation of the activity.	Refer to Section 4.1.4 and 4.1.5
2 All of the following- (a) fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;	The proposed amendment would not result in additional storage, handling, processing, or transport of materials within PFL 10 that may cause fugitive emissions.
(b) contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shut down and start up emissions of contaminants to air;	Flaring events will be: o minimised through the implementation of the plant optimisation measures outlined in section 2.2.1 to comply with the conditions of the LNG EA and the amendments sought by this application to conserve biological diversity and ecological integrity; o managed in accordance with the management measures stated in the Flare Contingency Management Plan (refer to section 2.2.2); and o recorded in accordance with the Procedure for Recording Flaring Events (refer to section 2.3). Dispersion modelling has shown that flaring events have no significant impact on air quality at all sensitive receptors (including residential receptors and protected areas) and air quality remains well below the relevant air quality objectives of the EPP Air and the relevant guidelines and standards.
(c) releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.	Refer to Section 4.1.4 and 4.1.5

5.2.2 Prescribed matters for particular resource activities (s24AA EP Reg)

Section 226 of the EP Act, specifies the general requirements for an EA amendment application. This includes item (1)(n) which specifies any other documents relating to the application prescribed under a regulation. Section 24AA of the EP Regulation describes the prescribed documents for an application for environmental authority for a CSG activity.

This amendment application is for the LNG Plant and associated infrastructure which are not CSG activities under the EP Act. This section of the Act is not applicable.

5.2.3 Environmental Protection Policies (EPP)

Section 51(1)(c) of the EP Regulation requires consideration of the management hierarchy, the environmental values, the quality objectives and the management intent of all EPPs. The *Environmental Protection (Air) Policy 2019* is considered relevant to this amendment application (refer to the assessment provided in Table 10) and has been assessed in detail in Section 4.1.

5.2.3.1 *Environmental Protection (Air) Policy 2019*

Table 10: *Environmental Protection (Air) Policy 2019*

Legislative considerations	State how the legislation has been considered and any conditions proposed
Environmental values to be enhanced or protected a) Health and biodiversity of ecosystems b) Human health and wellbeing c) Aesthetics of the environment (appearance of buildings, structures and other property) d) Agricultural use of the environment	Refer to Section 4.1.3
Air Quality Objectives: a) Consideration of the objectives as stated in schedule 1, column 3 and how these will be achieved for the activity/s.	GLNG considers that the air quality objectives in Schedule 1, column 3 will be met for the flaring events through compliance with proposed and existing EA conditions and implementation of the management measures outlined in Sections 2.2 and 4.1.5
Management hierarchy: a) Avoid; b) Recycle c) Minimise; d) Manage.	GLNG's existing air quality management will continue to be implemented in accordance with the management hierarchy for air emissions, including: • **Avoid/Minimise** – o Implementation of plant optimization measures including the following: ▪ A trip reduction campaign, whereby every trip is investigated and mitigations implemented to prevent/minimise future trips of the same nature; ▪ Where practical, the transfer of refrigerant (the principal cause of visible smoke) to an on-line compressor string (including to another train if necessary) rather than flaring; ▪ Development of strategies to avoid / minimise the requirement for plant defrosting (required for hydrate/heavier hydrocarbon removal which can result in visible smoke) outside of major shutdowns to minimise the total duration of flaring events; ▪ Detailed planning and scheduling of maintenance activities so necessary flaring can occur at night; and ▪ Deferring unplanned flaring until night-time, where practicable and safe to do so. o GLNG is investigating additional plant optimisation measures to further reduce incidences of visible smoke. These are to be considered on their practicality for implementation and economic feasibility. These measures include: ▪ High rate flare purging to minimise lingering visible smoke after a release of heavier hydrocarbons to the flare system; and ▪ Planning simultaneous flaring where feasible from multiple sources rather than separately to reduce the total duration of flaring events. o GLNG has developed a Flaring Contingency Management Plan (Appendix C) which includes

Legislative considerations	State how the legislation has been considered and any conditions proposed
	management measures to reduce the frequency and duration of gas being flared and any associated visible smoke. The management measures are presented in Section 2.2.2. The management measures are in, *'…in accordance with industry practice."*[8] As ratified by the HRL Technology Group as part of the independent environmental audit commissioned by DES in 2016. • **Manage –** o The GLNG flare system is monitored in several ways. Plant operators can observe live plant data including CCTV of the flare tips which show the size of the flame and smoke (during daylight hours), data trends, plant set points and plant alarms. o GLNG has implemented the Procedure for Recording Flaring Events which defines the requirements for the recording of flaring events at the LNG Plant. The management of flaring events assists in ensuring compliance with the conditions of EA EPPG00712213 and in minimising the potential for community complaints relating to visible smoke. The procedure includes a Flaring Event Register which is a requirement of the Flaring Contingency Management Plan whether the flaring event is planned (normal operations or planned shut-down/start-up) or unplanned (i.e. upset). o Air emissions monitoring will continue in accordance with the existing conditions of the EA. o Air monitoring is undertaken by a suitably qualified and experienced person and in accordance with the conditions of the EA and the *Environmental Protection Regulation 2019.* GLNG is committed to good environmental management and to protecting and promoting the interests of the communities in which it operates. GLNG will continue to engage with key community stakeholders prior to undertaking forecast flaring and will continue to seek operability improvements to minimise impacts to the visual amenity of the community, whilst maintaining plant safety and efficiency.

5.2.4 Additional Regulatory Requirements

Chapter 4, Part 3 of the EP Regulation includes additional regulatory requirements, which must be considered by the administering authority in making an environmental management decision where the management decision relates to an activity mentioned in either section 58 or 63 of the EP Regulation.

The amendment application does not relate to an activity mentioned in section 58 or 63 of the EP Regulation.

[8] Page 46, *'Environmental Audit of Flaring at Santos Gladstone Liquefied Natural Gas (GLNG) Plant, prepared by HRL Technology Group Pty Ltd, dated May 2017*