Australia Pacific LNG

Volume 4: LNG Facility

Chapter 15: Noise and Vibration

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15. Noise and vibration

15.1 Introduction

15.1.1 Purpose

Construction and operation of the proposed liquefied natural gas (LNG) facility on Curtis Island (and the associated infrastructure on the mainland) will involve emission of noise and vibration to the surrounding land and marine environments. Decommissioning of these facilities at end of LNG facility life will also generate emissions of noise and vibration which are similar to those that occur in the construction phase, so decommissioning noise and vibration are not explicitly addressed in detail in this chapter.

An assessment of the impact of potential noise and vibration emissions has been conducted in accordance with the terms of reference for the Australia Pacific LNG Project (the Project) environmental impact statement (EIS).

The purpose of this chapter is to describe the:

- Potential sources of noise and vibration
- Predicted levels of noise and vibration
- Associated impact of noise and vibration due to the construction, operation and ultimate decommissioning of the LNG facility
- Proposed mitigation measures.

The chapter identifies sensitive receptors, assesses the baseline ambient noise levels within the Gladstone region and quantifies the potential change in the land and marine noise environments due to the construction and operation of the LNG facility.

Australia Pacific LNG is guided by the 12 Australia Pacific LNG sustainability principles when identifying potential impacts from the Project. The Australia Pacific LNG sustainability principles that relate to noise and vibration are:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

These principles have been applied to identify management options to address noise and vibration impacts from the construction, operation and decommissioning of the LNG facility on the Gladstone Region.

15.1.2 Scope of work

The impact of potential noise and vibration emissions was assessed by:

- Conducting baseline noise level surveys at representative sensitive receptor locations above ground and underwater in the vicinity of the LNG facility site

- Applying Queensland noise regulations, guidelines and policies to the predicted noise and vibration levels of the LNG facility construction and operations
- Predicting the cumulative noise levels resulting from the LNG facility in addition to the noise of other proposed industrial projects on Curtis Island and the mainland
- Assessment of predicted marine construction noise against published research data relative to the response of marine fauna.

This chapter reflects the outcomes from a detailed technical noise and vibration impact study (refer Volume 5 Attachment 34).

15.1.3 Legislative framework

Environment Protection (Noise) Policy

The *Environmental Protection Act 1994* (EP Act) provides the framework for the management of the noise environment in Queensland. The Environmental Protection (Noise) Policy 2008 (EPP Noise) is subordinate legislation to the EP Act and identifies the acoustic environmental values to be enhanced or protected within Queensland.

The environmental values are:

- Protection of the health and biodiversity of ecosystems
- Protection of human health and wellbeing by ensuring a suitable acoustic environment for individuals to:
  - Sleep
  - Study or learn
  - Be involved in recreation, including relaxation and conversation
- Protection of the amenity of the community.

The acoustic environment in the context of biodiversity for this EIS includes the underwater acoustic environment as it relates to endangered and protected marine species.

Construction

Construction noise and vibration is managed by local government under the EP Act. The Act specifies audible building work may occur between 6.30am and 6.30pm on any day except Sundays and public holidays. There are guidelines for ground vibration and blasting within the EP Act and within various Australian and international standards, but there are no guidelines for noise limits within or outside of these hours for building works.

The local authority (Gladstone Regional Council) may allow audible noise outside of the allowed hours upon submission of a suitable construction noise management plan. Australia Pacific LNG proposes to develop such a construction noise management plan, as night works and weekend work will be required.

As there are no regulatory noise limits for underwater construction noise, published research data has been used as the basis of marine noise exposure criteria for this assessment. This includes suitable criteria for potential direct physiological impacts such as temporary loss of hearing sensitivity or

permanent auditory tissue damage. Further information on these criteria is provided in Volume 5 Attachment 34.

Operations

The Queensland Government approved planning guideline for determining noise emission limits for new major industrial noise sources is the Ecoaccess Planning for noise control guideline (the Guideline).

The Guideline is intended to manage three aspects of the acoustic environment that may be affected by new developments, namely:

- The control and prevention of 'background noise creep' (i.e. the gradual cumulative increase in minimum noise levels generated by continuously operating equipment)
- The containment of variable noise levels and short term noise events to an 'acceptable level' above the background noise levels
- The setting of noise limits for transient noise events to avoid 'sleep disturbance'.

The night period is generally the most critical daily period for achieving compliance of noise emissions associated with continuously operating equipment. Compliance with the night period criteria for continuous operations will generally ensure compliance in the day and evening periods.

Design planning noise levels (PNLs) recommended for the LNG facility are adjusted levels ($L_{Aeq\ 1\ hour,\ adj}$), with noise character adjustments applied in accordance with the Guideline at the receptor location(s). Table 15.1 shows PNLs for the nearest residential locations.

Table 15.1 Outdoor design planning noise levels for nearest residential receiver areas

Receiver areas	Design PNL (LAeq,1hour,adj – dBA)		
	Day (7.00am-6.00pm)	Evening (6.00pm-10.00pm)	Night (10.00pm-7.00am)
Targinie area	38	38	36
Passage area	49	39	38
Gladstone city	45	35	30
Fisherman's road	55	47	39
South End	40	28	30

The noise criterion to prevent sleep disturbance in accordance with the Guideline is 47dBA (max L_{pA}) assuming wide open windows and a 10% probability of sleep awakening; or 52dBA (max L_{pA}) with window partially closed and a 10% probability of sleep awakening. With windows closed, as would be consistent with an air-conditioned dwelling, the max L_{pA} can be as high as 62~67dBA.

Regulatory assessment criteria have not yet been developed for low frequency noise. However, for the purposes of this assessment, the low frequency (<200Hz) noise limits that will be considered are 60dBC as well as the balanced spectrum ($L_{Ceq} – L_{Aeq} \leq 20$dB). These criteria are based on industry understanding that to minimise the potential for perceived low frequency effects, the difference between A-weighted and C-weighted emissions should be assessed in addition to the maximum predicted noise level.

For further information about operations noise criteria and adjustments or low frequency noise, refer to the technical report in Volume 5 Attachment 34.

15.2 Methodology

The following sections describe the methodology utilised to survey the baseline noise environment both on land and in the marine environment, and the predictive modelling of additional noise emissions into the environment associated with the Project.

15.2.1 Baseline surveys

Baseline monitoring sites were selected to represent known sensitive receptor locations that may be critical with regard to noise emission constraints for the LNG facility.

Further, the baseline noise levels locations, to determine emission limits, were considered to be most significant at isolated residences in the Targinie area. While the isolated dwellings in the Passage islands and Fisherman's Road have similar separation distances from the LNG facility site, the influence of existing industrial noise is much lower in the Targinie area.

Land

Baseline noise levels were monitored for a minimum period of seven days at four sites representing residential locations nearest the proposed LNG facility (Sites 1 through 4). At another two sites, baseline noise levels measured by others – Santos GLNG (Site 5) and QCLNG (Site 6) – were used. Figure 15.1 shows the LNG facility site and the monitoring locations.

Noise levels and spectra were measured continuously and sampled every second in frequency bands from 20Hz to 10kHz. The noise data was post-processed in 15 minute intervals to obtain statistical acoustic parameter levels, such as L_{A01}, L_{A10} and $L_{A90,}$ for day, evening and night-time periods.

Meteorological data was obtained for the monitoring duration from the Gladstone weather station or from temporary weather stations installed at a height of 4m near the noise monitoring locations. Noise data affected by excessive wind speed or precipitation was excluded from the noise level results.

The presence of insect noise was determined from inspection of the spectrograms (a noise level, frequency spectra and time history plot) for the noise monitoring period at each site. When significant evening or night-time insect noise was detected, it was filtered during post-processing so background noise levels with and without insect noise may be reported.

Existing ambient ground vibration levels near the receptor positions are not expected to be significant and so baseline surveys of ground vibration were not conducted.

For further information about the monitoring sites, instrumentation and data processing procedures, refer to the technical report in Volume 5 Attachment 34.

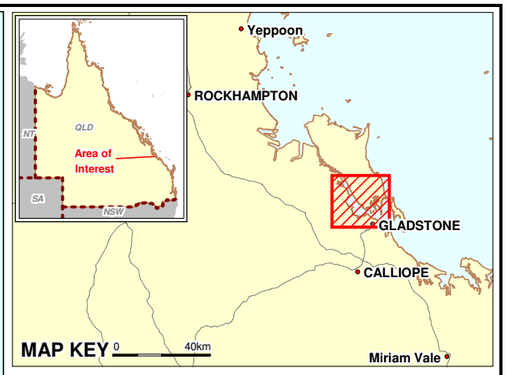
Marine

Underwater noise sampling was conducted in the vicinity of the proposed LNG facility, as well as near existing operational wharfs in the Port of Gladstone. Sampling locations within the Port of Gladstone area are illustrated on Figure 15.2 and locations in the general area of the LNG facility are illustrated on Figure 15.3.

Curtis Island
The Narrows
Graham Creek
Laird Point
LNG facility site
Southend
Site-6 Southend
Southend area
Targinie area
Site-4
Targinie
Fishermans Landing
Hamilton Point
Site-1
Passage Islands
Tide Island
Witt Island
Site-2 Picnic Island
Wiggins Islands
Site-3
No.2 Fishermans Road
Fishermans Road
Site-5 Auckland Street
Gladstone City area
Gladstone
Gladstone - Mt Larcom Road
Yarwun

310000 315000 320000 325000
7375000 7370000 7365000 7360000

0 1 2km
SCALE - 1 : 75,000 (at A3)
Map Grid of Australia Zone 56
Geocentric Datum of Australia 94
N



LEGEND

- Road
- Railway
- LNG facility site
- Reclamation area
- Cadastral boundaries

Gladstone State Development Area Precincts

- Aldoga precinct
- Restricted development precinct
- Clinton precinct
- Stuart oil shale reserve preservation area
- Corridor area buffer precinct
- Targinie precinct
- Curtis Island industry precinct
- Yarwun precinct
- Environmental management precinct
- Gladstone State Development Area corridor
- Materials transportation & services corridor

Sites key

- Noise monitoring location
- Dwelling locations nearest plant site

Source Information

Cadastral boundaries
Department of Natural Resources and Water, Queensland 2009

LNG facility development footprint
Conceptual Site Plan 25509-100-10005.dgn supplied by client 24/07/2009

Reclaim area
Supplied by Origin Energy 21/09/2009

Noise logger sites
Supplied by Savery & Associates 19/01/2010

Gladstone State Development Area
Queensland Department of Infrastructure and Planning 2009

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Figure 15.1 Nearest dwelling and baseline noise monitoring locations

310000
315000
320000
7375000
7370000
7365000

REFER TO INSET

Sensitive receptor

INSET

12A
12B
11
9
8
13A
2
1
3
0
4
15A
13B
D
(Dugong
sighting)
15B
7
0
80m

17A
17B
6
5
18A
18B

0 1 2km
SCALE - 1 : 50,000 (at A3)
Map Grid of Australia Zone 56
Geocentric Datum of Australia 94
N

Yeppoon
ROCKHAMPTON
QLD
NT
SA
NSW
Area of
Interest
GLADSTONE
CALLIOPE
Miriam Vale
MAP KEY 0 40km

LEGEND

- LNG facility site
- Marine sample points
- Sensitive receptor

Source Information

LNG facility site
Extracted from Bechtel. Drawing No. P1-000-20001 2009

Sites
Supplied by Savery & Associates 19/01/2010

Satellite imagery
Captured by GeoEye-1 on 24 March 2009

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Figure 15.2 Whole harbour baseline marine noise sampling locations

311000 312000 313000 314000 315000 316000

7375000 7374000 7373000 7372000 7371000 7370000

Graham Creek

Laird Point

Friend Point

North Passage Island

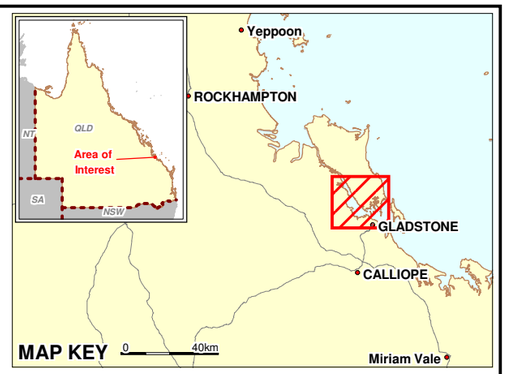
12A
12B
11
9
8
0
1
2
3
4
13A
15A
13B
15B
7
D
(Dugong sighting)

0 750m

SCALE - 1 : 20,000 (at A3)
Map Grid of Australia Zone 56
Geocentric Datum of Australia 94

N

K:\CONOCOPHILLIPS\301001-00752\GIS\Maps\00752-00-EN-DAL-2028-Rev0(Vol4Chp15_TheNarrows_NoiseSampling).wor



LEGEND

LNG facility site

Marine sample points

Source Information

LNG facility site
Extracted from Bechtel. Drawing No. P1-000-20001 2009

Sites
Supplied by Savery & Associates 19/01/2010

Satellite imagery
Captured by GeoEye-1 on 24 March 2009

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Figure 15.3 The Narrows area baseline marine noise sampling locations

Sampling was conducted in low wind conditions with negligible noise from wave-action, and at either high or low tide to reduce flow turbulence noise on the hydrophone. The hydrophone was suspended at approximately mid-depth, as determined from depth sounder records and depth markers on the hydrophone cable. Sampling was conducted from an unpowered drifting boat with the start and finish points of the drift marked by a global positioning system.

Underwater noise measurements of typical dredging operations and vessel pass-bys were conducted in the Port of Brisbane and the Port of Bundaberg in water of similar depth, surface and bottom conditions to the LNG facility area for the purposes of forecasting.

For further information about the underwater monitoring, instrumentation and results, refer to the technical report in Volume 5 Attachment 34.

15.2.2 Predicted noise levels

Land

Future operational noise levels of the LNG facility were predicted from modelling the noise sources and the propagation of noise from these sources into the surrounding aboveground environment.

An environmental noise model of the LNG facility and surroundings was constructed using ISO 9613-2 (1996), Acoustics - Attenuation of sound during propagation outdoors, Part 2: General method of calculation, as implemented in SoundPLAN software using ISO 9613-2 (1996), Acoustics - Attenuation of sound during propagation outdoors, Part 2: General method of calculation. The method predicts A-weighted sound pressure levels under meteorological conditions favourable to sound propagation from noise sources towards receptor locations (mild temperature inversion with slight downwind). The overall model accuracy is estimated as 3dBA.

The graphical noise contours generated by the model represent the predicted noise levels assuming typical maximum case noise propagation in all directions, including over water. Noise contours were modelled 2m above local ground level. The model terrain on the mainland and Curtis Island was based on 5m elevation contours, ground being assumed as 100% sound absorptive and the water assumed as 100% sound reflective.

The sound attenuated source noise level data for the LNG plant was supplied by the construction contractor for the LNG facility and include noise mitigation controls such as enclosures, noise insulation and attenuation devices.

Cumulative noise levels from other proposed facilities in addition to the Project were also modelled based on results as presented in their respective publically available EIS documents. Predicted noise levels from the following potential future sources were modelled:

- Queensland Curtis LNG plant, Curtis Island (adjoining proposed site)
- Santos and Petronas' Gladstone LNG plant, Curtis Island
- LNG Ltd Gladstone LNG plant, Fisherman's Landing
- Wiggins Island coal terminal[1].

The noise levels from existing facilities in the region were not included in the cumulative noise mapping, as the contributions of these projects are implicitly included in the assessment by virtue of

[1] Noise mapping for this project was presented as a continuously graduated colour key

the baseline noise monitoring conducted with these plants operating, and the Queensland Department of Environmental Resource Management's Guideline methodology for determining PNLs.

Marine

Prediction of potential construction underwater noise has been based on a compendium of marine noise levels from underwater piling in water depths relevant to the vicinity of the materials offloading facility (MOF) and jetty.

Marine noise source levels from dredging operations and a range of vessel pass by events has also been monitored as part of the noise and vibration impact assessment to provide source data that is indicative of marine noise generation associated with dredging of inshore areas.

For further information about the noise modelling methodology or noise source data refer to the technical report in Volume 5 Attachment 34.

15.3 Existing environment

15.3.1 Land

The existing noise environment in residential areas nearest the proposed site is dependent on proximity to existing industrial facilities in and around Gladstone, and whether the receptor location under consideration is upwind or downwind of industrial noise sources.

Sites 1 and 2 on Passage islands are generally upwind of existing industrial noise sources during the day during which natural sounds dominate (rustling vegetation, bird calls, insect noise), and downwind of industrial sources at night during which noise from industry is continuously present. Wave noise was not a significant or persistent feature of the ambient noise at either site 1 or site 2.

Site 3 on Fisherman's Road is located relatively close to industrial noise sources and consequently industrial noise is a persistent feature of the ambient noise environment at all times of the day and night at this location. Site 4 to the west of Targinie State Forest is generally free of industrial noise except under certain meteorological conditions favouring sound propagation from Gladstone sources.

The acoustic environment at site 5, near the waterfront in Gladstone city, is generally dominated by urban sounds during the day with industrial noise sources more noticeable at night when traffic noise and other domestic noise is minimal.

Site 6 at South End has similarities to sites 1 and 2 in relation to the diurnal influence of meteorological conditions on the propagation of industrial noise, but the night-time influence of industrial noise is much reduced compared to sites 1 and 2 due to the much greater separation from industrial sources. The proximity of this site to less protected waters increases the influence of wave noise at site 6 relative to sites 1 and 2.

The permissible noise contributions from a new industry depend on the rating background noise levels (RBLs) determined in accordance with the Ecoaccess Guideline. These are presented in Table 15.2. The RBLs can be understood as the typical minimum existing noise levels at a given location.

Table 15.2 Rating background noise levels

Measurement location	Rating background noise level (minL_{A90} – dBA)		
	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
Site 1 – Hamilton Point	41	44	45
Site 2 – Picnic Island	39	41	45
Site 3 – No.2 Fisherman's Road	40	39	40
Site 4 – Forest Road	30	32	31
Site 5 – 1 Auckland Street, Gladstone[2]	42	42	37
Site 6 – Turtle Street, South End	32	35	27

The average noise level per time period may be represented by the equivalent continuous noise level($L_{Aeq,T}$).

The minimum average noise levels ($L_{Aeq,1hour}$) data for the day, evening and night periods existing at each monitoring location are presented in Table 15.3.

Table 15.3 Minimum equivalent continuous noise levels

Measurement location	Minimum equivalent noise level (min$L_{Aeq,1hour}$ – dBA)		
	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
Site 1 – Hamilton Point	44	49	48
Site 2 – Picnic Island	44	46	48
Site 3 – No.2 Fisherman's Road	45	46	44
Site 4 – Forest Road	37	48	38
Site 5 – 1 Auckland Street, Gladstone [2]	47	47	40
Site 6 – Turtle Street, South End	46	40	38

For further information about the baseline background and ambient land noise levels refer to the technical report in Volume 5 Attachment 34.

15.3.2 Marine

Ambient marine noise in the vicinity of the LNG facility was found to be dominated by the 'crackling' sound of Snapping Shrimp with levels consistently in the range of 155-165$dB_{(peak)}$. Some relatively lower level peak noise contributions from distant wharf ship loader activity at Fisherman's Landing were also identified. Fish chorus sound was identified as a transient sound that occurred as fish moved through the monitoring area.

[2] Sourced from Santos GLNG EIS (Santos Limited 2009)

Ambient marine noise levels were also represented as the root mean square (RMS) sound pressure levels with M_{mf} weighting. Snapping shrimp and distant wharf ship loading noise levels were approximately 105-130dB (M_{mf}).

For further information about the baseline underwater noise levels refer to the technical report in Volume 5 Attachment 34.

15.3.3 Vibration

The geographic area relevant to construction vibration is limited to the Curtis Island land area, within which there are no significant existing sources of vibration that contribute to ambient vibration levels.

15.4 Potential sources of noise and vibration

15.4.1 Construction

Land

Increased road traffic and heavy vehicle transportation will occur on feeder roads to the mainland facilities and personnel embarkation point during the construction phases of the LNG facility. The traffic generated will consist of private vehicles and buses for personnel to travel to and from the embarkation point, as well as trucks for delivery of construction materials and equipment. These sources will have very similar noise emissions in character to existing traffic along Gladstone-Mt Larcom Road via Port Access Road and south along the Dawson Highway.

Noise generated on-site during construction of the LNG facility will vary considerably depending on the type of activity being undertaken and the intensity of activity at a specific time. Noise generating activities during construction will include impact hammers, bulldozers, truck operation, concrete batching, concrete mixers, bobcat and crane operation. Apart from pile driving activities for the construction of the LNG tanks, potential noise sources are expected to be lower than the operation of the facility.

Exact pile sizes and piling plant for the Project are not yet known in detail at this time of the design stage. For the purposes of the noise impact study, modelling has been based on noise source levels from a large Delmag D80-32 diesel driven impact hammer rig. A rig of this capacity may be used for driving steel pipe piles for the jetty, or for driving solid concrete piles for the LNG storage tanks.

At the point of pile refusal[3] this equipment may produce an unattenuated source sound power level of 144dBA (L_{Amax}), based on a source sound pressure level for this plant of 116dBA (L_{Amax}) at seven metres[4]. A flat un-weighted spectrum of sound energy has been assumed for the purpose of noise propagation calculations.

Vibratory sheet piling expected for the MOF is not a significant airborne noise source.

Marine

During the construction phase of the Project, there will be a significant increase in the frequency of materials and equipment barges and passenger vessels that travel past Tide Island and Witt Island. Noise generated by these additional movements will be similar to existing marine construction traffic

[3] Refusal is achieved when the pile is unable to be driven any further at maximum impact force

[4] Pileco Technical Data – February 2006

associated with the development of marine facilities for extension of the Fisherman's Landing wharves.

Dredging will also be required for construction of the jetty and the MOF. Noise sources sampled within the inshore areas, to provide noise data indicative of marine noise generation during dredging, may be described as non-pulsed noise sources ranging between 113 and142dB (M_{mf}).

Piling operations will be required for the construction of the MOF and the jetty structures. Sheet piling is proposed for the construction of the MOF and cylindrical steel pipe piling for the jetty structures. Marine piling can be a source of high levels of underwater sound, particularly for percussive pile-driving techniques proposed for the jetty structures.

Vibration

Apart from possible vibration from marine piling activities, it is currently not anticipated that there will be any significant sources of vibration that could affect facilities or structures outside of the immediate construction footprint (<800m). This is due to there being no specific locations where it is known that blasting will be required during site earthworks.

In relation to potential vibration sources from marine piling, any vibrations transmitted to the water column are addressed in the marine sections of this chapter.

15.4.2 Operations

Land

For the purpose of the noise modelling assessment, it has been assumed that for normal operations the LNG plant will operate at 100% capacity, 24 hours a day, seven days a week. The associated mitigated sound power levels for significant noise sources, such as compressors and gas turbines in range of 112-122dBA (L_{Aeq}).

There have also been instances of open cycle gas turbines, such as those planned to be utilised in the LNG plant, producing acoustic pulsations from the exhaust side of the turbine being perceived as low-frequency 'vibration' or 'infra-sound' at frequencies comparable to the cavity resonance of the human body. However, the design of the turbines incorporates silencers on both inlet and exhaust air paths so perceived low frequency noise sources are not anticipated.

Occasionally some parts of the LNG liquefaction process may be interrupted for maintenance purposes, or in response to a process upset. At these times gas is expelled from parts of the process via a ground flare which may burn for a typical duration of a few minutes to several hours. Such flaring events will be infrequent except for during commissioning, start-up and shutdown. During normal operations the flaring rate is minimal and will only be a transient source of noise of about 120dBA (L_{Aeq}).

Audible alarms are another potential transient noise source directly associated with maintenance or upset conditions. They are critical to the safety of personnel on the site. The typical range of sound outputs available for this type of device is dependent on the distance between personnel and hazardous areas and the ambient noise conditions. Generally these devices produce an intermittent tone within the range of 500 to 2000Hz at levels in the range of 100 to 120 dBA (PWL).

Marine

There will be some increase in the frequency of large freighters that travel past Tide Island and Witt Island to export LNG (and to a lesser extent import liquefied petroleum gas) during the operational

phase of the LNG facility. These carriers will be manoeuvred by four pilot tugs within Port Curtis, so noise generated by the additional freighter pass by events will not differ significantly from existing movements of coal and other bulk material freighters that currently utilise the shipping channels.

Vibration

The primary industrial processes within the LNG facility involve high speed rotating machinery, from which vibration transfer to the ground is negligible.

15.5 Predicted Impacts

15.5.1 Land

Construction

The increased regularity of private vehicles on public roads leading to the mainland facilities and personnel embarkation point is not anticipated to significantly increase noise disturbance as such traffic will have very similar noise emissions in character to existing traffic along potentially affected roads. Potential increased annoyance may result from an increase in heavier vehicles such as buses and trucks along the route (refer Volume 4 Chapter 17).

With the exception of possible impact piling noise, construction noise on-site will not be significant at existing residential receptors during the day or night due to the large separation distance between the construction site and residential receptors.

The predicted worst case levels of impact noise from piling operations at residential receptors are summarised in Table 15.4. The night-time criterion is taken from the DERM Guideline sleep disturbance criteria for naturally ventilated dwellings. The daytime and evening criteria are taken from the EPP Noise $L_{A1,\ adj,\ 1hour}$ acoustic quality objectives, allowing for an assumed +2dB impulse adjustment to the propagated piling noise. The $L_{A1,\ 1hour}$ criteria have been evaluated[5] with predicted maximum levels.

The predicted worst case levels of impact noise at the temporary accommodation facility are summarised in Table 15.5 . Evening and night-time criteria are taken from the DERM Guideline sleep disturbance criteria for an air conditioned dwelling that is consistent with the normal air-conditioned accommodation quarters provided for temporary accommodation facilities. Daytime criteria are not applicable at the temporary accommodation facility as shift work (and therefore daytime sleeping shifts) is not proposed during piling activities. Shiftwork for construction activities will not take place until the peak of construction and long after the civil activities are completed.

[5] This is slightly conservative, as $L_{A1,1hour}$ piling levels would be lower than the L_{Amax} level for an individual pile impact. It is not possible however to reliably predict L_{A1} levels over substantial propagation distances based on L_{Amax} source data.

Table 15.4 Worst case piling noise at residential receivers (outdoors)

Receiver		Predicted Delmag D80-32 pile impact noise at refusal (L_{Amax} – dBA)	
		Jetty piling	**LNG tank piling**
Targinie area		52	51
Tide Island		44	44
Gladstone city		38	38
Fisherman's Road		51	52
South End		37	38
Construction noise criteria (L_{Amax})	**Day** (7.00am-6.00pm)	**63**	**63**
	Evening (6.00pm-10.00pm)	**63**	**63**
	Night (10.00pm-7.00am)	**47**	**47**

Table 15.5 Worst case piling noise at temporary accommodation facility (outdoors)

Receiver		Predicted Delmag D80-32 pile impact noise at refusal (L_{Amax} – dBA)	
		Jetty piling	**LNG tank piling**
Site temporary accommodation facility		58	73
Construction noise criteria (L_{Amax})	**Day** (7.00am-6.00pm)	N/A	N/A
	Evening (6.00pm-10.00pm)	67	67
	Night (10.00pm-7.00am)	67	67

It is concluded that noise from piling either the jetty or LNG/LPG tank foundations could potentially produce sleep disturbance in the Targinie area and at Fisherman's Road if conducted at night. Noise from piling of the LNG tank foundations could also be found excessive at the temporary accommodation facility if conducted during the evening and at night. Night-time piling activities are not planned for the Project.

Vibration associated with tank piling would not be significant at the temporary accommodation facility, or at accommodation facilities at adjoining projects. This is due to the facilities being more than 800m from the nearest tank piling activity.

Operations

Noise modelling has assumed that the LNG plant will run with all trains operating at 100% capacity, 24 hours per day. The predicted noise levels at all receivers around the plant site comply with the critical night-time PNLs, as shown in Table 15.6

Table 15.6 Assessment of night-time LNG noise (four trains)

Receiver	Predicted noise level ($L_{Aeq,adj}$ - dBA)	Design PNL ($L_{Aeq,1hour,adj}$ – dBA)
Targinie area	35	36
Passage area (Tide Island)	33	38
Gladstone city	25	30
Fisherman's Road	35	39
South End	25	30

During the initial operating phase with just two of the four LNG production trains operating, noise levels at receivers can be expected to be approximately 3dB lower than the levels shown for all trains operating.

Noise level contours for the LNG plant with four compressor trains operating and proposed mitigation measures are presented as Figure 15.4.

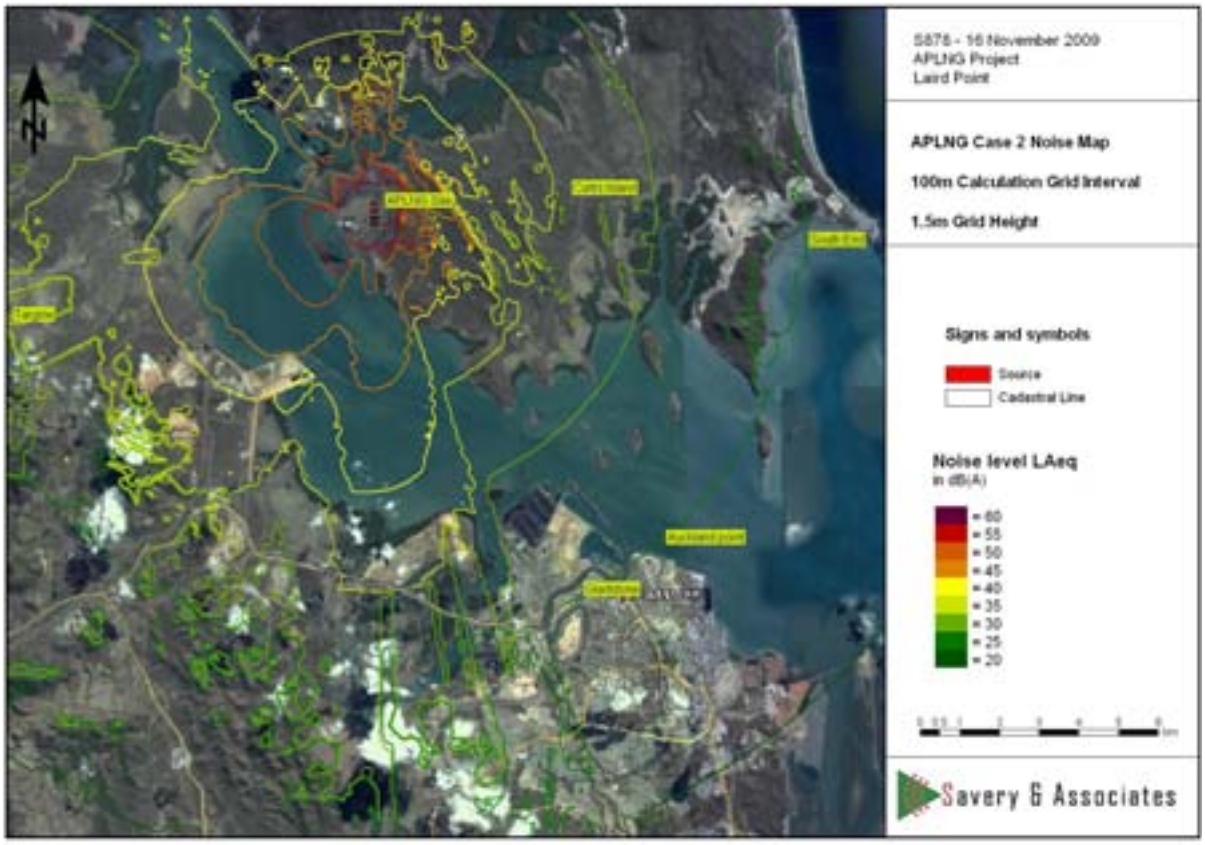

Figure 15.4 Impact of Australia Pacific LNG noise – four compressor trains with noise mitigation

In the unlikely event of short term major ground flaring (equivalent to two process trains), overall LNG plant noise levels inclusive of flare noise would be acceptable during the day or night to residential receptors. There may, however, be some temporary noise disturbance at the temporary accommodation facility or adjoining projects.

Table 15.7 Assessment of night time LNG noise inclusive of ground flare noise (four trains)

Receiver	Predicted noise level (L_{Amax} - dBA)	Design PNL (L_{Amax} – dBA)
Targinie area	41	47
Passage area (Tide Island)	39	47
Gladstone city	34	47
Fisherman's Road	45	47
South End	32	47

Audible process alarms associated with maintenance or upset interruptions to LNG facility processes are also not expected to cause adverse noise impacts at sensitive residential receptor locations due to the large separation distances. There may, however, be some temporary noise disturbance at the temporary accommodation facility or adjoining projects.

15.5.2 Cumulative impacts

The cumulative impact of industrial noise at the nearest receptors from other proposed industrial facilities on Curtis Island or the nearby mainland has been modelled. The cumulative modelling was based on predicted noise contours for the Project added to the noise contours presented in the environmental impact statements of a number of potential future projects. The cumulative impact of industrial noise is presented in Table 15.8 and noise contours are presented as Figure 15.5.

The modelling indicates that the noise contribution from the Project may be a significant component of the cumulative noise level at residential receptors in the Targinie area and at South End. The other projects have lesser contributions at these locations due to acoustic shielding provided by intervening ground topographical features. However, at both of these locations the predicted cumulative noise from all projects will still comply with the Australia Pacific LNG's design PNLs.

Table 15.8 Assessment of cumulative industrial noise levels (L_{Aeq} dBA)

Receiver	Australia Pacific LNG design PNLs	Australia Pacific LNG predicted noise contribution	Other future nearby plant noise contributions	Sum of all noise contributions
Targinie area	36	35	30	36
Passage area (Tide Island)	38	33	55	55
Gladstone city	30	25	35	35
Fisherman's Road	39	35	41	42
South End	30	25	23	27

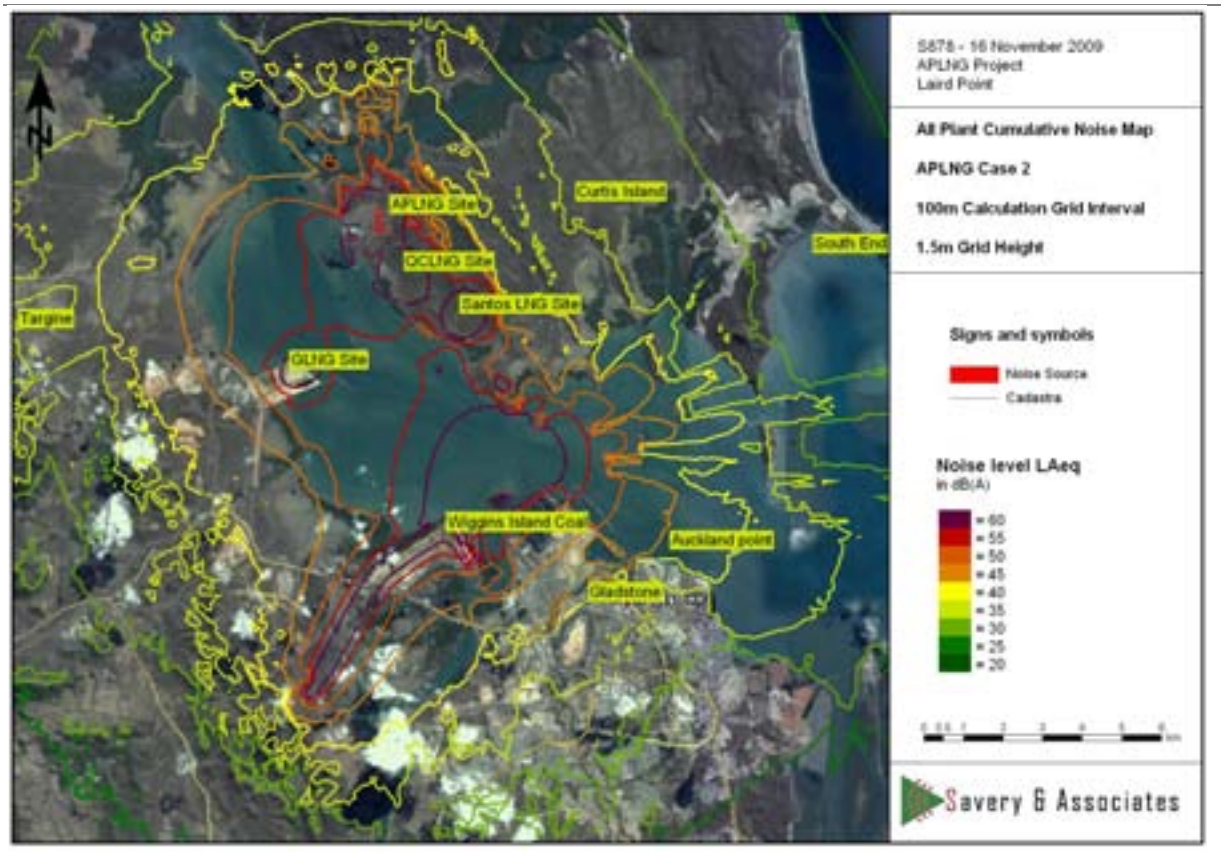

Figure 15.5 Cumulative impact of industrial noise

More information about predicted noise levels and contours is available in Volume 5 Attachment 34.

15.5.3 Noise effects on avifauna

Consideration has also been given to the potential impact of construction and operation noise on avifauna, in particular migratory shorebirds.

The construction period potentially involves a high level of disturbance with increased activity and potentially loud intermittent noises from the operation of construction equipment on the LNG facility site. The majority of migrating shorebirds utilise the shore area from November through to March each year. As such, disturbance as a result of construction activity outside of this period will not significantly impact these shorebirds. The construction of marine facilities is likely to temporarily disrupt this migratory shorebird habitat.

Once operational the LNG facility is not likely to alter the noise characteristics of the shorebird habitat significantly over the long term. The effect of exposure to steady industrial noise levels of less than 50dBA on birds feeding and roosting in nearby tidal areas will be comparable to transient ambient sources of noise, such as the noise generated by wind gusts, bird chorus and insect noise (cicadas). Noise from the operation of the facility is unlikely to impact migratory birds during migratory fly over events. Further, results from the model predictions for operation of the facility above indicate that if near-field noise emissions are maintained at levels appropriate to ground level human hearing conversation (i.e. less than 85dBA at 1m), are unlikely to deter or adversely affect migratory birds that can choose to completely avoid the site, or fly over the site at a significant altitude.

For assessment of other potential impacts on avifauna, refer to Volume 4 Chapter 8.

15.5.4 Marine

The peak pressure and cumulative sound exposure impacts associated with dredging activities and marine piling noise during construction have been assessed for dolphin, dugong, turtles and fish that may be present in the vicinity of the Project.

The risk of physiological damage to marine fauna from peak sound pressure levels resulting from dredging activities or miscellaneous vessel movements is assessed to be very low. The highest peak acoustic pressures associated with dredging occurs when a suction dredge is lifting rocky material, which generates significant impact noise in the hopper arm ($176dB_{(peak)}$ at 45m). For the purposes of this assessment, sound exposure level criteria for dolphins ($224dB_{(peak)}$) has been assumed to also apply to dugong and turtles. Therefore, in comparison of these criteria against source levels, it can be concluded that there is low risk of harm to marine fauna.

A worst case comparison of marine piling noise from impact driving of steel pipe piles for the jetty has demonstrated that piling noise can be successfully managed to minimise the impacted zone to within 50m of piling operations. This is based on a comparison of the peak acoustic pressures associated with piling of the cylindrical piles predicted as $198dB_{(peak)}$ at 50m against exposure level criteria for dolphins as $224dB_{(peak)}$. There is a small residual risk of impact to larger marine fauna that could theoretically venture close to piling operations.

Peak pressure impacts from vibratory sheet piling for the MOF with no source attenuation are assessed as not causing harm to marine fauna with a peak acoustic pressure of $193dB_{(peak)}$ at 10 metres. Therefore, no mitigation is currently necessary to avoid cumulative sound exposure levels preventing physiological damage occurring for larger marine fauna.

No adverse impact upon underwater noise levels from additional shipping in the Port of Gladstone is expected during the operations phase. For further information about the marine noise assessment methodology and results refer to the technical report appended at Volume 5 Attachment 34. For potential impacts on behaviourally responses of marine fauna to underwater noise, refer to Volume 4 Chapter 10.

15.6 Mitigation and management

Noise and vibration will be managed by incorporation of noise mitigation measures into the environmental management plan (EM Plan) for construction and operation of the LNG facility. Part of this EM Plan will include a traffic management plan to minimise, as far as practicable, the potential impacts of road traffic noise from Project construction traffic. This may include speed controls on Project vehicles, management of night-time traffic along roads adjacent to residential or other sensitive land uses (refer Volume 4 Chapter 17).

To achieve compliance with the design planning noise levels at all receptors for the operation of the LNG facility, Australia Pacific LNG will implement the following noise controls:

- Enclosures for gas turbines that drive the process compressors and silencing of gas turbine inlet air paths and exhausts
- Acoustic insulation lagging on large centrifugal compressor inlet, discharge and recycle piping
- Attenuation of gas turbine exhausts
- Low noise air coolers
- Acoustic blankets for refrigerant compressor casings
- Noise hoods for refrigeration compressor gearboxes.

Low frequency noise issues are not expected due to the inclusion of inlet and exhaust noise silencers on open cycle gas turbines. Equipment will be selected during the detail design phase of the Project to minimise the potential for noise complaints relating to perceived low frequency noise emissions from the plant.

Installation of enclosures surrounding the ground flares can have some noise control advantages over elevated flares due to the enclosures offering some acoustic reflection. This is based on ConocoPhillips' experience from other projects and preliminary modelling ground flares.

Noise mitigation for the LNG plant operation beyond the measures outlined above is not required to achieve the noise levels as predicted by the noise and vibration impact study (refer Volume 5 Attachment 34).

Marine noise mitigation measures for piling activities during construction of the jetty may include physical controls such as cushion blocks and pile isolation methods (air-bubble curtain, isolation casing). An air-bubble curtain is created by forcing air from compressors into an enclosure around the noise source. The bubble curtains function by reducing the distance over which percussive sounds from activities such as pile driving are evident.

Using a 'soft-start' technique, when piling commences at low impact or low vibratory energy levels and ramps up to full driving levels over a suitable period of time, provides the opportunity for marine fauna to vacate the piling area. Visual surveillance of a suitable exclusion zone around the piling operations would further mitigate the potential impact to marine fauna that could theoretically venture close to piling operations.

Further details on marine noise mitigation addressing recommended peak-pressure and cumulative noise criteria for large marine fauna and fish will be developed for marine impact piling when detailed information on pile types, sizes, piling equipment and expected piling durations has been developed.

For further information about the marine noise mitigation measures refer to the technical report in Volume 5 Attachment 34.

15.7 Conclusions

15.7.1 Assessment outcomes

This study was undertaken to identify potential impacts of the LNG facility in terms of the land and marine noise environments as a result of the construction, operation and decommissioning of the LNG facility as well as develop mitigation measures in accordance with the Australia Pacific LNG sustainability principles.

A summary of the environmental values, sustainability principles, potential impacts, cause of the impacts and mitigation measures in relation to noise and vibration issues is presented in Table 15.9. A full description of the risk assessment methodology is given in Volume 1 Chapter 4.

Table 15.9 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
Protection of the health and biodiversity of ecosystems Protection of human health and wellbeing by ensuring a suitable acoustic environment for individuals to: • Sleep • Study or learn • Be involved in recreation, including relaxation and conversation • Protection of the amenity of the community	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Increase noise due to road and marine traffic	Increased road and marine traffic from the construction and operation of the LNG facility	Noise management plan - focus on communication of project description	Low
		Sleep disturbance in the Targinie area, at Fisherman's Road and at the Project temporary accommodation facility and adjoining project construction temporary accommodation facilities due to construction noise Disturbance to terrestrial fauna	Construction activities of piling of the jetty and LNG facility	Implement airborne noise management plan for impact piling addressing impact assessment criteria	Low
		Increased noise levels due to LNG facility operation	LNG facility operation of plant and equipment including turbines, compressors, coolers, and flares	Enclosures for gas turbines that drive the process compressors and silencing of gas turbine inlet air paths and exhausts Acoustic insulation lagging Attenuation of gas turbine exhausts Low noise air coolers Acoustic blankets for refrigerant compressor casings	Low

Environmental values	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
				Noise hoods for refrigeration compressor gearboxes Ground flare that incorporates an enclosure which offers some noise control advantages Equipment to be selected with consideration of low frequency noise emissions	
		Increased underwater noise impacting marine ecology	Piling of the jetty Increased marine traffic	Implement marine noise management plan for impact piling including measures such as piling soft starts, cushion blocks and pile isolation methods (bubble curtains and isolation casing) Visual surveillance of a suitable exclusion zone around the piling operations	Low

15.7.2 Commitments

To manage potential impacts of noise and vibration during construction, Australia Pacific LNG will develop and implement construction noise and vibration management plans that address potential impacts including:

- Scheduling of high noise activities during normal working hours, where practicable
- Implementing construction techniques for noise reduction for high noise activities such as piling.

Australia Pacific LNG will further assess design measures for the LNG facility to reduce noise impacts including measures to address low frequency noise.

References

Santos Limited (Santos) 2009, *GLNG: Environmental Impact Statement*, viewed November 2009, <http://www.glng.com.au/Content.aspx?p=90>