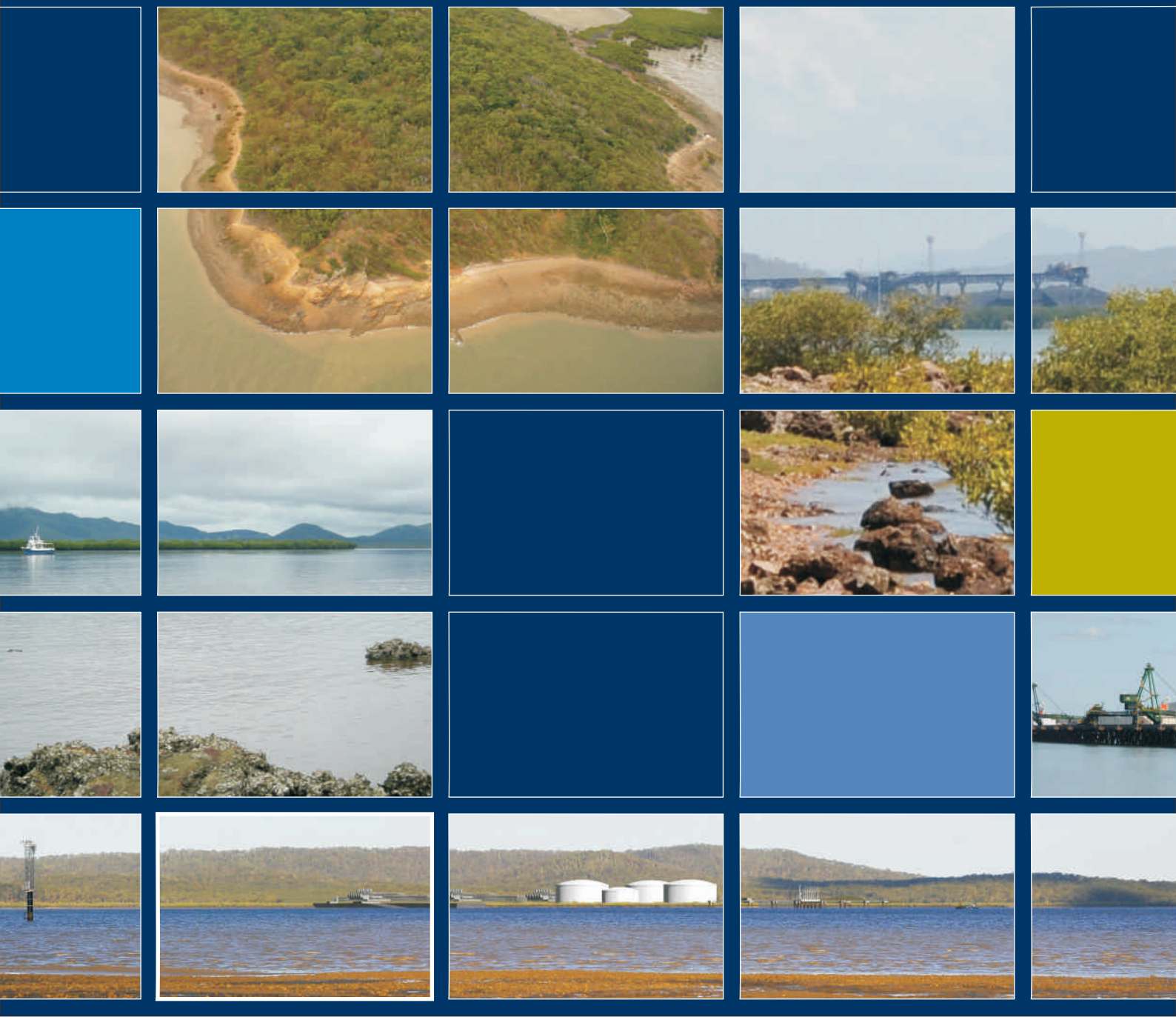


Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure

Noise and Vibration Impact Assessment

for

Queensland Gas Company Limited (QGC)

April 2009

www.erm.com

Delivering sustainable solutions in a more competitive world

ERM

FINAL REPORT

Queensland Gas Company Limited (QGC)

Queensland Curtis LNG Project: LNG Facility &Associated Infrastructure

Noise & Vibration Impact Assessment

April 2009

Environmental Resources Management Australia
Level 1, 60 Leichhardt Street
Spring Hill, QLD 4000
Telephone +61 7 3839 8393
Facsimile +61 7 3839 8381
www.erm.com

FINAL REPORT

Queensland Gas Company Limited (QGC)

Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure *Noise & Vibration Impact Assessment*

April 2009

Reference:
0086165/20_Noise&Vibration_R01.v0

For and on behalf of
Environmental Resources Management Australia

Approved by: David Pope

Signed:

Position: Partner in Charge

Date: 21 April 2009

CONTENTS

CONTENTS

ANNEXURES

EXECUTIVE SUMMARY

BG International Group (BG) and Queensland Gas Company Limited (QGC) (the Proponents) propose to develop an integrated Liquefied Natural Gas (LNG) project in Queensland (the Project, QCLNG). The project includes three components: gasfield, pipeline and LNG plant. This report assesses the potential noise and vibration impacts of the proposed QCLNG facility and associated infrastructure (refer Figure 1.1) during construction and operation.

The site selected for the QCLNG facility is located on Curtis Island off the coast of Gladstone, in a newly designated State Development area (refer Figure 1.2). The site is well located being a substantial distance from residential receptors (5km – 11.5kms), and the natural terrain (ridge running north – south) provides shielding to the eastern site of Curtis Island.

Potential noise sources include:

- *LNG Plant – compressors, power plant, pumps, air coolers, refrigeration, flare;*
- *LNG shipping and ferry or road traffic (if a bridge is built to link Curtis Island to the mainland); and*
- *Construction – construction plant/ equipment/ camp on Curtis Island, laydown areas at Auckland Point, pipeline between the mainland and Curtis Island, ferry terminal, bridge and road to Curtis Island (if it is built), barges from laydown area to Curtis Island.*

Noise levels from the project were predicted based on data provided by BG using a computer model taking into account meteorological conditions for the study area. Results of computer modelling are presented as noise contour maps in Annexes E and F.

Ambient noise monitoring was undertaken at five locations by ERM (including two sites on Curtis Island) and data was obtained from other public studies for a further two monitoring locations, to allow project specific noise criteria to be developed at seven locations representing the nearest noise sensitive receptors to the QCLNG project. Noise criteria were developed using Queensland Environmental Protection Agency, International Finance Corporation and BG documents (the latter two at the request of BG).

Assessment against these criteria indicates that while exceedance of the EPA construction noise criteria may occur on occasions, no significant noise impacts are expected during construction. Noise management practices should be implemented to minimise potential impacts from barges/ ferries and Curtis Island construction noise on Tide Island (NAL5), and Auckland Point laydown area noise and road traffic noise to residents near Flinders Parade (NAL4).

No significant impacts are expected during operation of the QCLNG plant, based on the noise data provided. Under adverse meteorological conditions (which are expected to occur infrequently) Tide Island (NAL5) may experience noise levels from the QCLNG plant above the EPA criteria, and LNG carrier ships are expected to be audible as they pass by. Noise management practices should be implemented to minimise noise impacts. IFC and BG noise criteria are met under all conditions.

Cumulative noise impacts were also investigated by comparing QCLNG levels with five other proposed industrial projects (refer Figure 1.3) in the Gladstone area. This indicated that the predicted noise impact from QCLNG is exceeded by that from other major industrial projects at all locations except Smith St, Targinie (NAL7). The Targinie area is State Development land which will be developed for industrial purposes in the foreseeable future and the total level at NAL7 is well below the current L_{Aeq} noise level. At all locations, the cumulative total without QCLNG is significantly higher than the predicted noise level from QCLNG. Hence QCLNG is not predicted to be a significant contributor to cumulative noise levels. Comparison with current L_{Aeq} noise levels indicates that the most significant change will occur at Tide Island (NAL5) due to projects other than QCLNG. Predicted noise levels at the QCLNG site boundaries are expected to range from 60 to 71 dB(A), which is not expected to cause a noise impact given the plant is located in the State Development Area for Curtis Island, and adjoining uses will be industrial. Cumulative construction noise is not expected to be an issue as it is unlikely that the loudest noise-producing construction activities at different project sites will occur simultaneously.

1 INTRODUCTION

ERM has been commissioned to undertake a noise and vibration impact assessment by Queensland Gas Company Limited (QGC) for the proposed Liquefied Natural Gas (LNG) facility located on Curtis Island, Queensland Australia, and associated infrastructure. This report forms part of an EIS for the proposed development.

This assessment will:

- Outline the project scope as it relates to noise and vibration matters including the proposed construction and operation details;
- Quantify the existing noise environment surrounding the LNG plant based on long term unattended and short term attended noise monitoring;
- Develop noise and vibration criteria as required to assess impacts in accordance with relevant legislation and guidelines;
- Model the construction and operational noise for assessment locations based on anticipated operations;
- Assess potential noise impacts from the QCLNG project;
- Investigate cumulative noise levels for proposed industrial projects in the locality; and
- Propose in-principle management strategies to mitigate impacts where required.

1.1 PROJECT DESCRIPTION

1.1.1 General

BG International Ltd (BG) and Queensland Gas Company Limited (QGC) (the Proponents) propose to develop an integrated Liquefied Natural Gas (LNG) project in Queensland (the Project).

The overall project will comprise three principal Components, as outlined below.

- **Gas Field Component:** expansion of QGC's existing coal seam gas (CSG) operations in the Surat Basin of southern Queensland, to provide feed gas for two of the three LNG trains, and for domestic markets;

- **Pipeline Component:** development, construction and operation of a main gas pipeline, extending approximately 380 km from the gas fields to the proposed LNG Plant at Curtis Island, and capable of supplying gas for three LNG trains. Additionally, a network of gas connection pipelines will be developed, to link QGC's gas fields and to connect other nearby CSG fields to the main gas pipeline; and

- **LNG Component:** development, construction and operation of an LNG processing plant, export terminal and associated infrastructure at Curtis Island, Gladstone, with an ultimate capacity of up to 12 mtpa.

The Project will also incorporate a number of ancillary or additional activities which may be developed by others, including:

- Treatment, transport and use of the associated water produced from the development of the Gas Field Component;

- Dredging of marine access channels and a turning basin to access the LNG terminal in Gladstone harbour (and associated spoil disposal); and

- Provision of road and bridge access, including a services corridor, from the mainland to the LNG Facility at Curtis Island.

This report addresses noise and vibration impacts associated with the LNG Processing Plant Component and associated infrastructure.

The Project will be one of Australia's largest capital projects and will supply up to 12 million tonnes per annum (mtpa) of LNG through the progressive development of three LNG trains. The first LNG train and associated gas fields and pipeline infrastructure is expected to be producing LNG in Q3 2013. The second train is anticipated to be in operation six to twelve months later, with the third train to be commissioned in subsequent years, subject to identification of adequate gas reserves.

1.1.2 LNG Facilities

This report relates to the onshore facilities of the LNG Component of the Project, possible road and bridge to Curtis Island, and shipping/barge/ ferry activities associated with construction and operational stages of the project. Other components of the overall project such as the gas field, pipeline, and dredging will be dealt with in other studies. As identified in *Section 1.1.1*, the LNG Component involves the development, construction and operation of an LNG processing plant, export terminal and associated infrastructure on Curtis Island, Gladstone as illustrated in *Figure 1.1*. It will include the following:

- A multi-train LNG Plant with a production capacity of up to 12 mtpa (each train will have a nominal 3 to 4 mtpa production capacity) designed for continuous 24-hour operation;

- Associated utilities and infrastructure including air, water, nitrogen, refrigerant storage, power generation, fire protection and safety, fuel gas, stormwater management, waste management, flare and telecommunications systems and access roads;

- Associated common buildings, including administration, maintenance and control rooms, and motor control centres;

- Storage tanks including:

    - Two LNG storage tanks with a capacity of up to 200,000 cubic metres each (to service up to two trains) and a third tank to be constructed for the third train; and

    - A Propane storage tank with a capacity of up to 100,000 cubic metres;

- Marine facilities:

    - A marine jetty containing specialised LNG loading facilities and LNG tanker berths;

    - Propane unloading berths and facilities;

    - A ferry terminal near RG Tanna Wharf; and

    - Construction dock and barge/ferry terminal at Auckland Point, Gladstone for construction transportation.

Some additional construction-related infrastructure will be established for the construction phase. During construction, site clearing and bulk earthworks will be required over an area of approximately 300 hectares.

The workforce during the construction of the initial phase of the LNG component is expected to peak at 1500 personnel for 4 months. It is expected that a proportion (around 30%) of the labour will be housed in a construction camp to be established on Curtis Island.

An operational workforce of approximately 200 full-time personnel will operate the LNG Component.

1.1.3 Overview Of Potential Impacts

Potential noise sources include:

- LNG Plant – compressors, power plant, pumps, air coolers, refrigeration, flare;

- LNG shipping and ferry or road traffic (if bridge is built); and

- Construction – construction plant/ equipment/ camp on Curtis Island, laydown areas at Auckland Point, pipeline between the mainland and Curtis Island, ferry terminal, bridge and road to Curtis Island (if it is built), barges from laydown area to Curtis Island.

Flaring Operations

It is understood that there will be no continuous flaring[1] from the LNG plant except for a small pilot flame for ignition purposes. The pilot flame will not impact the noise levels of the facility.

The flare will be required to operate in a number of different scenarios:

Emergency flaring: This will be the maximum flow rate, and noise through the flare system, and is required to ensure the facility is brought to a safe condition as soon as possible. The emergency flare will only occur as a matter of last resort, when other pressure containing safety devices have failed. The emergency pressure relief is expected to be very infrequent. The noise generated during emergency flaring will be intense, but will only last a few minutes (maximum).

Pressure Blowdown: In the event of a confirmed fire at the LNG facility it is necessary to evacuate all pressurised hydrocarbon inventories within the area of the fire. The pressure blowdown will last approximately forty minutes, and the rate at which the gas is released will be similar to the emergency flaring case described above.

Maintenance: There will also be periods of planned maintenance, where a whole train will be de-pressured. This will happen every three years for each train. The amount of gas flared will be minimized by producing LNG to the storage tanks to as low a pressure as possible, before the gas is flared to atmosphere. De-pressuring of a train will be controlled and have less of a noise impact than the emergency blowdown. An LNG train de-pressurisation will take less than eight hours.

Start-Up Flaring: During start-up of a LNG train it will be necessary to flare gas at certain points in the process to ensure the gas specifications are met at all points in the facility. The amount of gas flared is likely to be forty percent of the normal flow rate, and last for up to twenty four hours.

[1] Bechtel comments on Environmental Resources Management Australia, Draft Noise & Vibration report, Feb 2009.

Based on the above details, it is understood that the flare only operates for relatively short periods on rare occasions. While specific noise levels have not been made available for QCLNG flaring, assessment of flaring noise for Gladstone LNG (Fishermans Landing site)[2] indicated that noise impacts were acceptable. This Gladstone LNG project has closer noise sensitive receptors than QCLNG. Hence given the infrequent and short term nature of the flaring events, the impact of the flare is not expected to be significant and has not been assessed further in this report.

Construction Camp

The construction camp is proposed to be located on the QCLNG plant site on Curtis Island. It will be a temporary camp established for the construction workers who stay on site during the construction period. Construction and operation of the camp will not create significant noise, as it has no significant noise sources and it is several kilometres to the nearest noise sensitive receptors. Impact of the construction work on the construction camp should be minimal as most of the occupants would be at work when the construction noise is being produced.

Vibration

Vibration may be caused at various stages during the project including:

- LNG plant and equipment operation; and
- Piling and vibratory rollers during construction of the LNG plant, wharf, bridge and roads.

The LNG plant and equipment primarily involves rotating machinery, which will transfer relatively low level of vibration to the ground. Hence operation of the LNG plant will not produce significant levels of ground vibration.

Construction activities such as pile driving and vibratory rollers can produce significant vibration levels at close range (e.g. 50m). However as the nearest off-site vibration sensitive receptors (i.e. residences) will be several kilometres away from these activities, these activities will not cause a vibration impact. No major blasting is proposed during construction, although some minor light shock blasting[3] may be required to assist with loosening the rock along lines of existing weakness and allow ripping to be undertaken. If required (subject to ongoing detailed geotechnical investigation) this will be a rare occurrence during the first year of construction only.

---

[2] Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.
[3] Information provided by QGC.

1.2 SITE LOCATION

The LNG plant and associated onshore facilities are proposed to be located on the south west area of Curtis Island, near Gladstone on the Queensland (QLD) east coast, as shown in *Figure 1.2*. The site of the LNG onshore investigation area is within the Curtis Island State Development Area which is set aside for industrial development. The site is currently undeveloped. It grades from mud flats to gently undulating rural land, characterised by Eucalypt woodland. A ridge runs along the eastern edge of the State Development Land providing shielding of noise from the QCLNG industrial land across to the eastern areas of Curtis Island.

2 METHODOLOGY

The following sections describe the methodology used for this Noise and Vibration study to address the items in the EIS Terms of Reference and other items as appropriate.

2.1 DESCRIPTION OF EXISTING ENVIRONMENTAL VALUES

2.1.1 Ambient Monitoring

Noise measurements were carried out at a number of locations around Gladstone Harbour. These locations were considered to be representative of the nearest noise sensitive receptors that might be affected by noise from the development and operation of the proposed LNG plant.

Measurements were made with unattended noise loggers, and additional attended measurements were also taken to confirm noise levels and allow further characterisation of the ambient noise environment.

2.1.2 Noise Criteria

Noise criteria were drawn from the relevant state legislation and guidelines, along with the International Finance Corporation World Bank Group (IFC) guidelines and BG International Group standards.

Specific legislation and guidelines drawn upon included:

- The Queensland *Environmental Protection Act 1994*;
- The Queensland *Environmental Protection (Noise) Policy 2008*;
- The Queensland *Environmental Protection Regulation 2008*;
- Queensland Environmental Protection Agency EcoAccess Guideline *Planning for Noise Control*;
- Queensland Environmental Protection Agency EcoAccess DRAFT Guideline *Assessment of Low Frequency Noise*;
- Department of Environment and Conservation's (now EPA) E1 environmental guideline *Noise from Construction, Renovation, Maintenance and Demolition sites*;
- IFC Environmental Noise Management Guideline[4];
- BG Environmental Expectation Standard BGS-HSSE-ENV-ST-1509[5].

[4] This is section 1.7 of the Environmental Health and Safety Guidelines document, 30 April 2007
[5] BG document, 1 July 2007. Sets out minimum environmental requirements.

2.2 POTENTIAL IMPACTS AND MITIGATION METHODS

2.2.1 Noise Modelling

Modelling of noise impacts from the proposed LNG plant was carried out with SoundPLAN software, using the CONCAWE model. The CONCAWE model is an empirical model, specifically developed for the assessment of noise impacts from petrochemical complexes on nearby communities. This model permits the incorporation of meteorological effects into noise calculations.

Noise levels were predicted at the nearest noise sensitive receptors several kilometres distant. Prediction of noise levels at the QCLNG plant boundary (undertaken by the plant engineering design company Bechtel) has also been provided in this report.

Modelling was undertaken for the construction stage based on expected equipment required for the QCLNG plant. Transportation noise during construction and operation was also addressed including: road traffic, bridge, barges, ferries and shipping.

2.2.2 LNG Plant Noise Sources

Noise sources were created based on information supplied by BG. Due to proprietary data restrictions, data for individual items within the plant was not available. Instead, an "aggregate emission" model was developed, where items of plant within an area were grouped and a total noise emission calculated by BG's engineering consultants. These groups were broken down by source height above ground, so that the final noise model contained a number of aggregate sources at various heights, to better reflect the emissions from the LNG plant.

2.2.3 Terrain Model

The base terrain model was produced from ground contours obtained from BG and Department of Natural Resources & Water (NRW). Ground levels for the plant operational stage were provided by BG, and were cut into the natural ground contours for operational phase modelling. Areas of open water (i.e. Gladstone Harbour) were modelled as areas with very low absorption, while land areas were modelled as absorptive. While typical Australian ground surfaces are often relatively hard and not fully absorptive, vegetation above ground was not included in the model, thus it will tend to underestimate the combined vegetation scattering and ground absorption effects.

2.2.4 *Meteorological Effects*

As set out in the EcoAccess guidelines, modelling has been carried out for "Neutral" and "Adverse" weather conditions. Weather and climate data for Gladstone, sourced from the Bureau of Meteorology (BOM) were examined to determine the relevant conditions.

Neutral conditions were assumed to be calm winds, with Pasquill[6] stability class 'D' (neutral). Adverse conditions were considered to be the presence of a moderate temperature inversion[7] (3°C/100m), with calm winds. Due to the flat topography between the project site and the sensitive receptors, no drainage flow[8] was assessed. While this is considered to be a "worst case" meteorological condition, inversions are likely to be infrequent in the Gladstone Harbour area, as they are less likely to form over water, and winds are calm for only 14% of the time, based on BoM windroses (winter 9am data). The EPA EcoAccess Guideline *Planning for Noise Control*, states occurrences of less than 30% of the total night time period during winter are not considered to be significant.

Examination of wind roses for Gladstone indicates that the wind direction is predominantly from the East and South for most of the year (typical sea breezes), with only rare occasions with wind from the North-North-West. Due to the prevalence of these sea breezes, a "Typical" weather condition was also modelled, with an East–South-Easterly breeze.

Meteorological conditions incorporated into the SoundPLAN model for these conditions are as follows.

Table 2.1 Meteorological Conditions Modelled

	Neutral	**Adverse**	**Typical**
Temperature	20°C	10°C	20°C
Relative Humidity	60%	50%	60%
Atmospheric Pressure	1013hPa	1013hPa	1013hPa
Pasquill Stability Class	D	F	B
Wind Speed	calm	calm	2 ms^{-1}
Wind Direction	-	-	ESE

[6] Pasquill stability class is a method of categorising the amount of atmospheric turbulence present, ranging from A (very unstable) to F (very stable). Sound is scattered by turbulence.
[7] Temperature inversions occur under certain meteorological conditions (including calm winds), and usually occur over land during winter. They result in the sound being more clearly heard at greater distances than under non-inversion conditions.
[8] Drainage flows can occur where cooler air flows down a hill or ridge into the valley creating an air movement that can influence sound propagation in a similar way to a light wind.

2.2.5 *Assessment of Noise Impacts*

Predicted noise levels during construction and operation have been compared with the noise criteria to assess potential impacts for the proposed QCLNG project. A discussion of the results has been provided where predicted levels approached or exceeded the criteria. Comments have been made regarding the potential impacts from transport during construction and operational stages including: road traffic, barge, ferries and shipping.

There are presently a number of industrial projects proposed for the Gladstone area, and hence the cumulative effect of these projects has been estimated to provide a view of future noise levels at selected noise sensitive receptors. Industrial projects considered were:

- QCLNG;
- SANTOS LNG (also referred to as Gladstone LNG Project (Curtis Island));
- Gladstone LNG (also referred to as Gladstone LNG (Fishermans Landing));
- Sun LNG;
- Wiggins Island Coal Terminal; and
- Gladstone Nickel.

The locations of these projects are shown on *Figure 1.3*. In addition to these industrial projects, the Fisherman's Landing Port Expansion reclamation project is also being undertaken to provide land for industry and up to 6 additional wharfs[9]. The Central Queensland Port Authority proposes to expand the Fisherman's Landing Port facility by reclaiming an additional area to the north of the existing development. No noise information was available for the reclamation project, and hence it has not been included in the cumulative assessment.

Cumulative noise levels at the boundary of the project site due to the QCLNG compressor and other plant have also been provided.

[9] CQPA, "Proposed Northern Development at Fisherman's Landing Port Facility", Initial Advice Statement, September 2005.

3 EXISTING NOISE ENVIRONMENT

A key element in assessing environmental noise is to quantify the existing ambient and background noise environment. The following section describes the procedure undertaken.

3.1 NOISE ASSESSMENT LOCATIONS

A total of seven (7) residential properties (NAL 1 – 7) have been identified as representative of the nearest potentially affected locations to the proposed QCLNG plant and as such have been designated as noise assessment locations (NAL). The noise assessment locations are described in *Table 3.1* and are illustrated in *Figure 1.1*. The distances indicate that the LNG plant is located a significant distance from the noise sensitive receptors. Locations NAL 7 and NAL 2 are located in or immediately adjacent to State Development Land which has been set aside for future industrial development.

Table 3.1 Noise Assessment Locations

Noise Assessment Location	Address	Approximate Distance from QCLNG Site (km)
NAL 1	Jetty G/H, Gladstone Marina	8.5
NAL 2	Lot 2 Fisherman's Road, Yarwun	6.5
NAL 3	Turtle Street, South End, Curtis Island	11.5
NAL 4	71 Flinders Parade, Gladstone	10
NAL 5	Tide Island	5
NAL 6	12 Lord St, Gladstone	9.5
NAL 7	Smith St, Targinie	9

3.2 AMBIENT NOISE MONITORING

Attended and unattended (noise logging) noise monitoring was undertaken at representative locations in the study area, as discussed below. Details of the monitoring equipment and data are provided in *Annex B*.

3.2.1 Unattended Monitoring

Five noise loggers (M1 - M5) were used to monitor background noise levels at locations that were conservatively selected as having an acoustic climate representative of the noise assessment locations. The loggers continuously recorded and logged noise statistics every hour for the duration of logging. Additional data from previous studies was obtained for locations M6 and M7. Noise logging information is provided in *Table 3.2*, whilst the locations are shown in *Figure 1.1.*

Table 3.2 Unattended Noise Monitoring Locations

Monitoring Location	Address	Start-Finish Date (Duration)	Logging Representative of:	Monitoring Source Company
M1	Jetty G/H, Gladstone Marina	9 - 25 Sept 08 (17 days)	Permanent residents living on boats in the Marina	ERM
M2	Lot 2 Fisherman's Road, Yarwun	9 - 25 Sept 08 (17 days)	Resident	ERM
M3	Turtle Street, South End, Curtis Island	10 - 26 Sept 08 (17 days)	Resident	ERM
M4	71 Flinders Parade, Gladstone	10 - 26 Sept 08 (17 days)	Resident	ERM
M5[1]	Hamilton Point, Curtis Island	10 - 26 Sept 08 (17 days)	Tide Island resident	ERM
M6	12 Lord St Gladstone	5 -19 April 06 (15 days)	Resident	Heggies Australia[10]
M7a[2]	Forest Road, Targinie	12-19 Apr 08 (8 days)	Smith St, Targinie Resident	Savery & Assoc.[11]

1. Monitoring was undertaken at Hamilton Point as access to Tide Island was not available.
2. Monitoring was undertaken at a location representative of the Targinie area.

Noise loggers M4 (Flinders Parade) and M5 (Hamilton Point) also recorded one minute audio samples at the beginning of each hourly statistical sample throughout the duration of noise logging. This data was used in addition to attended noise monitoring to better characterise the existing ambient noise environment.

Weather data including wind speed, direction and rainfall for the sample period was collected from both Gladstone Airport and Gladstone Radar weather stations, which are run by the Bureau of Meteorology (BOM). If wind speeds exceeded 5m/s, or it rained, the affected noise data was disregarded. As the BOM wind data is collected at ten metres above the ground, disregarding logging data when the BOM wind speed is above 5m/s is considered a conservative approach to establishing suitable wind data at the logger microphone height of 1.5m above ground level. The logger data has been separately processed using both sets of weather data, with the lower of the two resulting RBL values being adopted.

The logger graphs and associated daily data are presented in *Annex B.*

[10] Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006.
[11] Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.

3.2.2 *Attended Monitoring*

Day, evening and night time attended monitoring was conducted to supplement the unattended noise monitoring surveys and to quantify the contribution from existing industry, road and other sources at the noise assessment locations. The results are summarised in *Annex B*.

The attended monitoring indicated that industrial, road traffic or rail noise was audible at all locations at various times of the day, with the exception of NAL3 South End Curtis Island.

3.2.3 *Analysis and Summary of Results*

Analysis of logger data was conducted in accordance with EPA's EcoAccess guideline *Planning for Noise Control*. The methodology is prescribed in terms of the measured "Assessment Background Level" (ABL) and "Rating Background Level" (RBL) or min$L_{A90,1hour}$. In accordance with the EcoAccess guideline, a minimum of one week of representative data was then selected for analysis to determine the RBL.

Table 3.3 provides a summary of RBL values for each noise monitoring location. In addition to the Day, Evening, and Night periods, an RBL value was calculated for the 6am-7am morning shoulder period for the locations monitored by ERM and the Savery & Associates data, as this is relevant to the proposed construction work times.

Table 3.3 Unattended Monitoring RBL Results dB(A)

Monitoring Location	Rating Background Level (RBL)[1] – dB(A)			
	Day	Evening	Night	6am-7am
M1	45	47	43	43
M2	36	36	37	39
M3	32	35	27	29
M4	40	36	36	40
M5	30	31	29	37
M6	42	45	36	-[2]
M7a	30	32	31	38

1. RBL or minLA90,1hour represents the background noise level for the given period, and is defined in the glossary in *Annex A*.
2. Data not available from Heggies Australia Report.

3.2.4 Seasonal Variation in Noise Levels

Seasonal variations in ambient noise levels can have significant effects on monitored noise levels and in turn, noise criteria. Seasonal variations in ambient noise levels are typically the result of an increase in insect activity, which usually occurs in the warmer months of the year.

To determine the contribution from insect noise, spectral unattended noise monitoring data has been analysed for NAL 2 (Fisherman's Landing), NAL 3 (South End) and NAL 5 (Tide Island) due to insects being audible at these locations during attended monitoring. Hourly audio recordings taken with unattended monitoring for NAL 5 and were also used to determine insect presence and to correlate spectral data with audible noise sources.

Analysis of the spectra and audio recordings show a contribution from insect noise during the evening period at the three locations. Analysis also shows that whilst insect noise was present during the evening, the contribution to night time noise levels was negligible and as such would not affect monitored RBL levels at these three locations. Evening RBL levels will be increased by insect noise in some cases, however this does not have a significant affect on the noise criteria.

4 NOISE AND VIBRATION CRITERIA

4.1 OPERATIONAL NOISE

4.1.1 Environmental Protection Act, Policy and Regulation

In Queensland the relevant noise legislation under the *Environmental Protection Act 1994*, are the *Environmental Protection (Noise) Policy 2008* referred to as the EPP(Noise) and the *Environmental Protection Regulation 2008* referred to as the EPReg. The legislation is administered by the Environmental Protection Agency (EPA). These documents were amended in late 2008, and the amended documents were in force as of January 2009.

The objective of the Act is to protect Queensland's environment while enabling ecologically sustainable development. The Act enables development of the Protection Policies, and sets criteria for specific noise offences. The EPP(Noise) provides acoustic quality objectives. The EPReg describes the standards for measurement of noise. We understand that the noise information contained in these documents is not intended to set criteria for assessing noise impacts from proposed new industry. The EPA has developed guidelines to assist in the assessment of noise from industrial projects as discussed in the following sections.

4.1.2 EPA EcoAccess Guideline Planning for Noise Control

Noise emissions from the proposed QCLNG plant are assessable under the EPA's EcoAccess guideline *Planning for Noise Control*. EcoAccess has been developed for setting conditions relating to noise emitted from industrial premises, commercial premises and mining operations. The guideline takes into account four factors:

- The determination of planning noise levels which are based on the dominant land use around the receiver in consideration;
- The control and prevention of background creep in the case of steady state noise level from equipment such as that caused by ventilation fans and other continuously operating machinery;
- The containment of variable noise levels and short-term noise events, such as those caused by forklift trucks and isolated hand tools, to an 'acceptable' level above background noise; and
- The setting of noise levels that should not be exceeded to avoid sleep disturbance.

Based on the attended and unattended monitoring data, as described in Section 3, operational project specific noise criteria have been derived and are presented in *Table 4.1*. Supporting calculations have been provided in *Annex C*. Noise from the industry (L_{Aeq}) is to be compared with the relevant operational criteria in *Table 4.1.*

Table 4.1 Operational Project Specific Noise Criteria

Noise Assessment Location	Operational Criteria dB(A) ($L_{Aeq,1hour}$)			Sleep Disturbance Criteria dB(A) ($maxL_{pA}$)[1]
	Day	Evening	Night	
NAL 1	48	47	40	52
NAL 2	39	39	40	52
NAL 3	35	25	27	52
NAL 4	43	39	39	52
NAL 5	33	34	32	52
NAL 6	45	35	38	52
NAL 7	33	35	33	52

Notes:

1. $maxL_{pA}$ is the maximum noise level measured with the sound level meter set to 'fast' response, 'A' weighting network.

2. $L_{Aeq,1hour}$ is the level with the same energy as the actual fluctuating noise level, measured over 1 hour.

The nature of the noise generated by the QCLNG plant is a continuous noise, with no significant impulsive characteristics. Hence the $_{max}L_{pA}$ sleep disturbance criterion is not applicable to this assessment.

The QCLNG plant will contain various noise sources that may produce low frequency tonal noise including power plant gas turbines, compressors, flare, pumps, and fin-fan air coolers. Given the large distances to the nearest noise sensitive receptors and the large number of individual noise sources emitting noise at different frequencies at the LNG facility, it is expected that the industry noise may be heard as a low frequency source, with no distinguishable tonal components. Hence no adjustment for tonal characteristics has been made to the criteria. The predicted noise levels will however be assessed against the low frequency guideline to determine the acceptability of the QCLNG plant noise.

4.1.3 EPA EcoAccess DRAFT Guideline Assessment of Low Frequency Noise

This Draft guideline provides methods to evaluate low frequency noise below 200Hz. It discusses Infrasound in the frequency range below 20Hz, where the sound is often felt (eg. as a pulsating sensation or pressure on the ears or chest) rather than heard, and also low frequency noise from 20 – 200Hz.

The guideline suggests initial screening criteria as follows:

- The overall sound pressure level inside residences should not exceed 50dB(Linear) – this would equate to 55dB(Linear) outside the premises.

If this criterion is met it is unlikely that complaints would occur due to low frequency noise.

If the internal level exceeds 50dB(Linear) and the dB(Linear) level exceeds the dB(A) level by more than 15dB, then a 1/3rd octave band analysis should be undertaken for the measured data.

The guideline centres around measurement of low frequency noise, where accurate noise levels in 1/3rd octave bands can be recorded for analysis. For predicted noise levels (eg. using noise modelling software) the accuracy of the overall dB(A) level can be quite good, however there is significantly less accuracy in octave or 1/3rd octave bands. For predicted noise levels, where the screening criteria are not met the levels could also be compared to the measured ambient noise levels at the noise sensitive receptor. If the predicted noise level is below the existing background (L_{A90}) level, then the low frequency industrial noise will be more difficult to hear.

4.1.4 IFC Criteria

BG have requested that levels also be assessed against IFC noise criteria. IFC General EHS Guidelines for noise specify an outdoor sound pressure level of 55 dB(A) during daytime (7am – 10pm), and 45 dB(A) at night (10pm – 7am). These levels apply for residential, institutional and educational facilities, and are to be measured as a 1 hour L_{eq}. IFC Guidelines state that noise impacts should not exceed these levels, or "*result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site*".

This can be interpreted to mean that the noise from industry should not exceed the background noise level in order that the total noise level does not increase by more than 3dB(A). The IFC Guidelines state that "In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation". Reading the IFC Guidelines in conjunction with the referenced World Health Organisation (WHO) *Guidelines for Community Noise*, it is clear that the IFC Guidelines are based on ambient L_{eq} noise levels, and not L_{90} noise levels, as "background" is normally measured in Australia.

The criteria are presented in *Table 4.2*, based on the ambient L_{eq} levels measured by ERM and others.

Table 4.2 IFC Noise Criteria for QCLNG Curtis Island

Monitoring Location	IFC Criteria dB(A)	
	Day	Night
NAL1	50	45
NAL2	41	43
NAL3	40	38
NAL4	49	45
NAL5	41	43
NAL6	51	45
NAL7	41	45

1. Day time criteria are the lower of the measured day and evening Leq noise levels.
2. Leq levels are averages of logged levels for each time period for NAL1-NAL5, and the lower of ERM attended monitoring and previously reported data for NAL6 and NAL7.

4.1.5 BG Criteria

The BG document, "Environmental Expectation Standard BGS-HSSE-ENV-ST-1509" provides minimum expectations for environmental criteria for BG projects. The noise criteria (based on hourly measurements) are as follows for the nearest residential, institutional or educational building located outside the QGC property boundary.

- Day (7am – 10pm) 55dB(A)
- Night (10pm – 7am) 45dB(A)

4.2 CONSTRUCTION NOISE

The EPA does not prescribe criteria for construction noise in any current guideline or legislation such as the EPP Noise or EcoAccess guideline. Construction noise criteria are however contained in the Department of Environment and Conservation's (now EPA) E1 environmental guideline. The guideline prescribes recommended hours of operation and sets noise level limits for out of hours works. *Table 4.3* outlines the E1 construction noise criteria for areas not adjacent to major thoroughfares.

Table 4.3 E1 Construction Noise Criteria

Period		Construction Noise Criteria
Monday - Friday	7am – 6pm	No criteria, although all equipment must be properly attenuated
	6pm- 10pm	RBL + 10dB(A) $L_{Amax(adj,15min)}$
	10pm – 7am	Inaudible within any habitable room of a residence
Saturday	7am – 12pm	No criteria, although all equipment must be properly attenuated
	12pm- 10pm	RBL + 10dB(A) $L_{Amax(adj,15min)}$
	10pm – 7am	Inaudible within any habitable room of a residence
Sunday/ Public Holidays	7am – 6pm	RBL + 10dB(A) $L_{Amax(adj,15min)}$
	6pm- 10pm	Inaudible within any habitable room of a residence
	10pm – 7am	Inaudible within any habitable room of a residence

1. The E1 guideline uses an $L_{max(adj, 15min)}$ parameter to compare against the Background + 10 (taken as the RBL+10dB(A)) criterion. The L_{A10} parameter is commonly used in place of the $L_{max(adj, 15min)}$ parameter. The L_{A10} and $L_{max(adj, 15min)}$ represent the average maximum noise level measured over a 15 minute time period. The L_{A10} is the noise level exceeded for 10% of the time period.

Construction noise could be taken to be inaudible when the level is equal to or less than the RBL at the receiver location. The personnel are expected to work a 9 day/90 hour per fortnight[12] shift (5 days on, 2 days off, 4 days on, 3 days off). It is understood that construction hours would be generally be from 6am to 6pm weekdays, with no weekend work. Hence as per the E1 construction guideline no criteria would apply for the majority of the day (7am – 6pm), and for the shoulder period of 6am to 7am, the RBL for this period can be used. During continuous construction activities (eg. slipforming of the LNG tanks) and for scheduling reasons, some work may be undertaken outside of these hours and on weekends.

Table 4.4 provides the specific construction noise criteria for weekday and weekend work based on noise monitoring results that will be applied for each noise assessment location.

[12] Bechtel Oil, Gas and Chemicals, Inc. 2008 and 2009, "Queensland Curtis LNG Project: CTR #47.2 – Site Logistics Study – Part 2 (Rev 002)", Unpublished report, Bechtel Doc. No. G0R-1T00-00007, 9 Feb 2009.

Table 4.4 Construction Noise Criteria

Period		Noise Criteria, dB(A)						
		NAL 1	**NAL 2**	**NAL 3**	**NAL 4**	**NAL 5**	**NAL 6**	**NAL 7**
Monday - Friday	7am – 6pm	-	-	-	-	-	-	-
	6pm- 10pm	57	46	45	46	41	55	42
	10pm – 7am	43	37	27	36	29	36	31
Saturday	7am – 12pm	-	-	-	-	-	-	-
	12pm- 10pm	57	46	45	46	41	55	42
	10pm – 7am	43	37	27	36	29	36	31
Sunday/ Public Holidays	7am – 6pm	55	46	42	50	40	52	40
	6pm- 10pm	47	36	35	36	31	45	32
	10pm – 7am	43	37	27	36	29	36	31
	6am- 7am	43	39	29	40	37	36[3]	38

Notes:
1. Criteria are to be compared with L_{10} levels.
2. (-) No criteria applies during this time period.
3. No data available for NAL 6, but conservatively the night period RBL could be used.

5 IMPACT ASSESSMENT

5.1 CONSTRUCTION

Construction of the proposed LNG plant will involve the following noise-emitting activities:

- Earthmoving, plant construction and pile driving on the QCLNG site;
- Pipeline construction;
- Auckland Point laydown area activities; and
- Shipping / transportation of equipment, materials and personnel.

5.1.1 Plant Construction

Construction works will include sheet piling for the landing dock, piling for the wharf and loading facilities, piling beneath LNG and LPG storage tanks (subject to ongoing geotechnical assessment), and LNG train construction (likely to involve assembly of prefabricated plant sections and LNG tanks). The assembly of the plant itself is likely to produce low levels of noise compared to earthmoving and piling activities.

Earthmoving activities (i.e. site clearing, excavation and benching, filling) will be undertaken with typical earthmoving plant, such as bulldozers, excavators, and dump trucks. Piling works will be undertaken concurrently with earthmoving activities, initially for the landing dock, and later for the LNG plant itself. Noise impacts from construction were modelled in SoundPLAN as a series of point sources, representing various items of earthmoving & piling equipment. These sources were placed at a nominal 2m above natural terrain level in various areas of the site.

While most construction activities will take place between 6am and 6pm on weekdays, it is anticipated that during slipforming of the LNG tanks, some activity will be undertaken at night. This will occur for a period of 3-4 weeks, and will take place 2-3 times during the plant construction program. At other times due to scheduling, some work may be required outside the 6am – 6pm hours on weekdays and on weekends.

Two scenarios have been modelled:

- *Plant Construction* scenario including heavy earthmoving equipment, piling equipment, and a concrete batch plant for pouring of foundations. This has been modelled for neutral, adverse and typical sea breeze conditions, as these are representative of day time and occasional night time occurrences; and

- *Tank Slipforming* scenario including the concrete batch plant, concrete pumps, and cranes located in the tank area. This has been modelled for neutral, adverse and typical sea breeze conditions, as these are representative of night-time occurrences.

Noise source levels for these construction scenarios are presented in *Table 5.1* and *Table 5.2*. Octave band sound power level data for the noise sources is provided in *Annex D*.

Table 5.1 Plant Construction Noise Sources

Item	Sound Power Level, dB(A)	Number of sources modelled
Bulldozer	114 dB(A)	2
Front End Loader	110 dB(A)	4
Grader	114 dB(A)	4
Heavy Roller	114 dB(A)	4
Excavator	109 dB(A)	4
Dump Truck	106 dB(A)	10
Piling rig	125 dB(A)	7
Bobcat / loader	106 dB(A)	1
Concrete batch plant	105 dB(A)	1
Concrete mixers	100 dB(A)	12
Crane, 120kW	106 dB(A)	4
1. Sound power levels from AS2436, manufacturer's data, or ERM library		

Table 5.2 Tank Slipforming Construction Noise Sources

Item	Sound Power Level, dB(A)	Number modelled
Concrete batch plant	105 dB(A)	1
Concrete mixers	100 dB(A)	12
Concrete pumps	109 dB(A)	2
Crane, 120kW	106 dB(A)	4
1. Sound power levels from AS2436, manufacturer's data, or ERM library		

Predicted noise levels from construction activities are presented in *Table 5.3* and *Table 5.4*. Noise contour plots for construction scenarios are presented in *Annex E*.

Table 5.3 Predicted Plant Construction Activity Noise Levels

Receptor	Neutral Weather	Adverse Weather	Typical Sea Breeze
NAL1 – Marina	23	34	17
NAL2 – Fishermans Rd	30	40	35
NAL3 – South End[2]	-	3	-
NAL4 – Flinders Pde	19	31	14
NAL5 – Tide Is	31	40	25
NAL6 – Lord St	20	32	15
NAL7 – Targinie	21	32	28

1. All levels in dB(A)

2. Predicted levels at South End are below 0 dB(A) for Neutral and Typical Sea Breeze weather conditions.

Plant construction noise may be just audible at NAL5 (Tide Island) under neutral weather conditions as the levels are 1dB(A) above the daytime RBL. However day-time construction (7am to 6pm) has no set criteria, and the predicted construction noise levels are below the 6am-7am shoulder period levels in *Table 4.4*. Hence the plant construction noise meets the construction criteria at all locations for 6am – 6pm under neutral and typical sea breeze conditions. This is considered to be the most common scenario during plant construction.

Occasional weekend or night plant construction work would result in an exceedance of 2dB(A) above the night time construction noise criteria at NAL5 (Tide Island) under neutral conditions. Given that this exceedance would only occur on occasions when plant construction activities were undertaken after hours and during neutral wind conditions (ie. calm winds), the noise impact is unlikely to be significant.

As discussed in *Section 2.2.4* adverse weather conditions (ie. temperature inversions) are unlikely over water, and would only occur under certain weather conditions most likely to occur at night or in the early morning. Comparison of the adverse weather noise levels in *Table 5.1* with the criteria in *Table 4.4* indicates that the highest exceedances would occur at night as follows: NAL2 (Fishermans Road) 3dB(A), NAL5 (Tide Island) 11dB(A), and NAL7 (Targinie) 1dB(A). The exceedance at NAL5 (Tide Island) indicates that the construction noise would be clearly audible under these unusual conditions. However these levels would only occur for a small percentage of the year on occasions with full plant construction occurring, on a calm night, with a temperature inversion.

Based on the above, plant construction is not expected to cause a significant noise impact.

Table 5.4 Predicted Tank Slipforming Construction Activity Noise Levels

Receptor	Neutral Weather	Adverse Weather	Typical Sea Breeze
NAL1 – Marina	7	16	3
NAL2 – Fishermans Rd	13	22	17
NAL3 – South End[2]	-	-	-
NAL4 – Flinders Pde	5	14	1
NAL5 – Tide Is	12	21	8
NAL6 – Lord St	6	16	2
NAL7 - Targinie	6	16	13

1. All levels in dB(A)
2. Predicted levels at South End are below 0 dB(A)

Tank slipforming construction noise levels are well below the measured Rating Background Levels at all receptors, and would generally be inaudible at all sites, including under adverse meteorological conditions.

5.1.2 Transportation of Plant and Materials

During construction - plant, equipment, materials, and personnel are to be shipped in by barge, initially landed over the beach, then via the landing dock to be constructed during early works. Cargo & personnel will be loaded onto barges & ferries from the Auckland Point lay-down area, and transported to Curtis Island. Some materials (e.g. trees cleared from the site, other waste) will be shipped from the site back to Auckland Point for removal. Access to the lay-down area will be by the Port access road, a designated heavy vehicle route.

No detailed information on barge noise emissions was available, however a noise level of 70 dB(A) at 30m was used to assess impacts, which is understood[13] to be the specified maximum noise level for ships under full power. Predictions of noise levels from a barge travelling between Auckland Point and the site are presented in *Table 5.5*.

[13] Based on correspondence with BG Shipping, 13 December 2008.

Table 5.5 Predicted Peak Noise Levels from Barge/Ferry Movements

Receptor Location	Ship noise at full power	Rating Background Level
NAL1	34	43
NAL2	13	36
NAL3	8	27
NAL4	31	36
NAL5	43	29
NAL6	30	36
NAL7	3	30

1. All noise levels in dB(A)
2. RBLs are the lowest of day/evening/night levels for each site

Noise levels are below the Rating Background Levels and hence would be inaudible at all locations other than NAL5, Tide Island. The average L_{A10} noise level measured at M5, Hamilton Point, was 44 dB(A), which is higher than the predicted barge/ferry noise level. As the noise from barges and ferries would only be present for brief periods as they passed Tide Island, and the predicted peak level is less than typical noise levels measured in the area, barge / ferry traffic is expected to have no significant noise impact on the residence at Tide Island.

5.1.3 Ferry Terminal, Bridge and Road Construction

During operation of the QCLNG plant, personnel would access the site via water taxi, from a new ferry terminal[14] to be built adjacent to the RG Tanna Wharf (refer *Figure 1.1*). Construction works would include building the floating dock, terminal building, and carpark (for around 100 vehicles). Given the small nature of this construction project, its location in an industrial area (eg. ship building facilities, coal terminal) and the distance to the nearest noise sensitive receptors (located in the Gladstone marina some 800m distant), the construction activities are expected to have negligible noise impact.

In the event that a bridge across The Narrows is constructed then transportation of personnel to QCLNG would be by road. The construction of a bridge and associated roadways linking Curtis Island to the mainland would be used for the QCLNG project and other LNG projects proposed on Curtis Island. The Curtis Island Bridge is proposed to cross The Narrows from approximately Friend Point on the mainland to Laird Point on the western side of Curtis Island (south of Graham Creek), whilst the roadway would link the northern end of Landing Road to the bridge, and continue to the industrial precinct of Curtis Island.

[14] Based on concept designs supplied by BG.

The approximate timeframes for construction[15] are as follows:

- Curtis Island Roadwork 2/04/2010 until 14/04/2011;
- Bridgeworks (including finishes) 05/02/2010 until 25/04/2011;
- Mainland roadwork 11/06/2010 until 25/11/2010; and
- Tidal roadwork 26/11/2010 until 27/05/2011.

The nearest noise sensitive receptors to bridge and road construction noise emissions are Targinie residences located approximately 6 kilometres to the South West. Calculations have been undertaken to predict the noise levels from typical bridge and road construction operations to these residential locations.

The resultant residential noise levels are predicted to be inaudible for the majority of construction equipment. For example, a piling hammer with a sound power level of 125dB(A) would result in a residential noise level of 17dB(A) which, when compared to the lowest RBL of 30dB(A) at NAL7 (Smith Street, Targinie), would be inaudible. Therefore bridge and road construction noise impacts at the nearest residential receivers are predicted to be negligible.

5.1.4 Road Traffic Noise

The transportation of personnel and equipment from the mainland to Curtis Island will be undertaken in two phases, as follows:

Construction phases prior to 2013

Transport of personnel and equipment from 2010 to 2013 will rely on barge/ferry services between a newly constructed marine jetty on Curtis Island to the existing terminal at Auckland Point. Construction personnel and equipment will therefore have to use the existing road network to travel to and from the Auckland Point terminal.

The main collector road that will see an increase in vehicle movements is Port Access Road. Existing traffic on Port Access Road has high levels of heavy vehicle usage (the roadway has been designed for this purpose) and as such substantial noise control treatments have been applied to minimise the disturbance to nearby residential and commercial receptors. Discussions with Queensland Department of Main Roads provided the following traffic data for Port Access Road (2008 data): 2,033 vehicles per day, 29% heavy vehicles.

[15] BG, "Project Execution Plan QCLNG Project (Rev 0)", Doc. No. QCLNG-HOU-PMT-GEN-PLN-0121, February 2009.

Indicative equipment[16] expected to be used during the construction process is as follows:

- Transport of cement – 1 truck per day;
- Transport of waste – 1 truck per day;
- Transport of fuel – 1 truck per day;
- Transport of refrigerated food and dry goods – 1 truck per day; and
- Transport of water – 1 truck per day for the first 12 months of construction.

Given the existing heavy vehicle movements on Port Access Road (around 650 heavy vehicles per day), the impacts at the nearest sensitive receptors from equipment transportation would be negligible.

Having the construction camp located on Curtis Island will reduce the traffic movements to and from the Auckland Point terminal as a proportion of the workforce will stay on site during the work "week". It is expected that during the peak in workforce for the project (expected to occur for 4 months) around 1000 local personnel will travel to site and back to Gladstone each day. These personnel will park their vehicles at Auckland point. The personnel are expected to work a 9 day/90 hour per fortnight[17] shift (5 days on, 2 days off, 4 days on, 3 days off). This means that traffic movements for around 1000 personnel will occur daily. Calculations using the CoRTN[18] method indicate that the additional traffic movements (up to 2000 movements) would cause an increase in $L_{10,18hr}$ [19] noise level of 1.6dB(A). This is not a significant increase in noise level over the 18 hour period. The morning movement of up to 1000 vehicles travelling to Auckland point to start work at 6am, is expected to be a noticeable change in movements. Vehicles returning to Gladstone at the end of the shift around 6pm, would be in the city peak traffic period and may be less noticeable. During these personnel traffic movements to and from Auckland Point, sensitive receptors may experience an increase in noise levels. However given the limited duration during construction, and the substantial treatments that have been applied to minimise the disturbance to nearby residential and commercial receptors from the heavy vehicle usage of the existing road, impacts at the nearest sensitive receptors are expected to be low.

---

[16] Halcrow MWT,"Draft - Queensland Curtis LNG project EIS Traffic and Transport Impact Assessment (Rev 0)", Doc. No. 083827r01, 9 February 2009.

[17] Bechtel Oil, Gas and Chemicals, Inc. 2008 and 2009, "Queensland Curtis LNG Project: CTR #47.2 – Site Logistics Study – Part 2 (Rev 002)", Unpublished report, Bechtel Doc. No. G0R-1T00-00007, 9 Feb 2009.

[18] CoRTN which stands for "Calculation of Road Traffic Noise", Department of Transport, Welsh Office, 1988, HMSO. This is the calculation method preferred in Queensland.

[19] $L_{10,18hr}$ is the standard parameter used for assessment of road traffic noise in the CoRTN method. It is the arithmetic average of the L_{10} values over the time period from 6am to 12 midnight.

Construction phase after 2013

In the event that a bridge across The Narrows is constructed, transport of personnel and equipment would be facilitated by a road bridge linking the mainland to Curtis Island (transport via Auckland Point would not occur beyond 2013). Construction personnel would therefore either transit to site via shuttle bus or private vehicles.

The road link from the mainland to Curtis Island will connect into the existing network at the northern end of Landing Road and continue through to the Curtis Island Industrial Precinct. The connecting roads to Gladstone, Landing Road and Gladstone Mt-Larcom Road, are existing routes facilitating the industry north of Gladstone, and have high heavy vehicle movements. The surrounding land use to both roads is industrial and as such there are no sensitive receptors proximate to the connecting or proposed road. Hence there will be negligible noise impact.

5.1.5 Auckland Point Laydown Area

The Auckland Point laydown area is expected to be used for personnel car parking and materials storage. These uses would have no significant noise emissions and as such would not impact on the sensitive receptors to the west, particularly due to the high level of existing industrial activity. The Laydown area may also be used for some prefabrication and preassembly work. *Table 5.6* outlines the predicted noise levels at NAL 4 (which is representative of the nearest residential area) with typical equipment in the event that it is used for prefabrication and preassembly.

Table 5.6 Typical Laydown Area Equipment Noise Levels

Plant/Activity	Sound Power Level dB(A)L_{10}	Noise Level at NAL 4 dB(A) L_{10}	Daytime L_{10}/ 6am-7am RBL NAL 4[1]
Compressor	100	37	
Generator	99	36	
Generator For Welding	95	32	
Tracked Mobile Crane 132kW	92	29	56/40
Wheeled Mobile Telescopic Crane	105	42	
Large Forklift	110	47	
Angle Grinding	108	45	

1. Daytime L_{10} taken from attended monitoring data

During the daytime (7am to 6pm), there are no noise limits (refer *Table 4.3*). For daytime construction activities starting at 6am, the shoulder period RBL noise level at NAL4 of 40dB(A) would be exceeded by louder activities. Hence the noise levels from these activities may be audible at the residents. However, comparison with the daytime L_{10} level of 56dB(A) shows the construction levels would not be excessive compared to the existing ambient

(which includes train shunting and truck noise), and therefore impacts at the nearest sensitive receptors are predicted to be low. Operation on occasions outside these hours or on weekends would exceed the most stringent construction criteria at NAL4 (refer *Table 4.4*) of 36dB(A) for several activities. However occasional exceedances should be acceptable provided they are appropriately managed.

5.1.6 Pipeline Construction

The pipeline component of the Project will transport gas from the Surat Basin to supply three LNG trains on Curtis Island. This report will assess the construction noise emissions for the section of the Main Pipeline from Curtis Island to Targinie Road (approximately 4km inland). This section of pipeline generally lies within the State Development Land (refer *Figure 1.2*) which is intended for future industrial development.

The typical pipeline construction sequence[20] is as follows:

- Clearing of vegetation along an approved construction corridor;
- The delivery of pipe;
- Trenching and construction of the pipe in the trench;
- Burial of the pipe in the ground;
- Reinstatement of the land; and
- Testing and commissioning of the pipelines.

A wheel trencher, rock-saw or excavator will be used to dig the trench in which the pipe will be placed. The length of trench open at any one time will depend on the ground conditions and the rates of construction progress being achieved in given areas. Several work sites may operate at any one time and a variety of excavation methods may be used including open trenching, boring or directional drilling.

Based on the transitory nature of construction and the absence of specific daytime noise limits, construction noise impacts are expected to be low. Construction noise and vibration impacts should be managed during the construction process should higher impacts for certain residences be identified (eg. if pipeline work is in close proximity to houses).

[20] Information provided by QGC.

5.2 OPERATION

5.2.1 Modelled Noise Levels

As discussed in the methodology section above, the SoundPLAN model for operational noise was constructed using a series of aggregate noise sources representing different parts of the LNG plant. These sources are set out in *Table 5.7* below. Octave band sound power level data for the noise sources is provided in *Annex D*.

Table 5.7 Operational Noise Sources

Source	Height above ground	Sound Power Level
4 BOGs	1m	122.5 dB(A)
4 GTGs	12m	117.7 dB(A)
LNG Train at grade	2m	120.2 dB(A)
LNG Train at 10m	10m	124.0 dB(A)
LNG Train at 20m	20m	123.0 dB(A)
LNG Train at 36m	36m	117.1 dB(A)

1. Heights and sound power levels provided by Bechtel

These sources were located at the relevant parts of the plant site, with heights above the bench levels of that area.

Two scenarios were modelled – the first, representing the long-term noise impact, included the BOGs, GTGs, and three LNG trains (each consisting of four sources at different heights as set out above). The second scenario included only one LNG train, representing an early operational stage. Each scenario was run three times, for neutral, adverse, and typical meteorological conditions.

Predicted noise levels from operational noise are set out in *Table 5.8*, and the noise contour plots are presented in *Annex F*.

Table 5.8 Predicted Operational Noise Levels dB(A)

Receptor Location	Criteria D/E/N	Operational Noise, 3-train			Operational Noise, 1-train		
		Neutral	Adverse	Typical	Neutral	Adverse	Typical
NAL1	48/47/40	25	33	22	21	29	18
NAL2	39/39/40	30	38	34	26	34	31
NAL3	35/25/27	11	18	8	-	4	-
NAL4	43/39/39	24	32	21	20	28	17
NAL5	33/34/32	30	**37**	27	26	**33**	23
NAL6	45/35/38	24	32	21	20	28	17
NAL7	33/35/33	24	32	30	20	28	26

1. All levels are L_{Aeq} in dB(A)
2. Levels in bold exceed the lowest criterion for that location
3. Levels shown as "-" were less than zero dB(A)
4. Neutral is calm weather, Adverse is a moderate temp. inversion, Typical is ESE breeze

It can be seen from *Table 5.8* that predicted operational noise levels are below the relevant criteria for all locations under neutral and typical weather conditions. Under adverse conditions, predicted operational noise levels are below the relevant criteria for all locations except NAL5 (Tide Island).

Predicted noise levels at Location NAL5, the residence at Tide Island, exceed the criteria under adverse conditions (temperature inversion and calm wind conditions) due to its proximity (5km) to the proposed LNG plant. While the predicted noise levels are 5 dB(A) above the criteria, inversions are likely to be infrequent in the Gladstone Harbour area, as they are less likely to form over water, and winds are calm for only 14% of the time, based on BoM windroses. As this is less than the 30% referred to in the EPA EcoAccess Guideline *Planning for Noise Control*, this exceedance is not expected to be significant.

In the future it is likely that noise from the proposed QCLNG plant will be masked by noise from other industry, including the proposed Wiggins Island coal terminal (refer *Section 5.3*).

5.2.2 Low Frequency Noise

Noise levels in dB(Lin) have been calculated from the noise modelling and are presented in *Table 5.9*.

Table 5.9 Predicted Operational Noise Levels – Linear Frequency Weighting

	Operation Noise, 3-train			Operation Noise, 1-train		
Location	**Neutral**	**Adverse**	**Typical**	**Neutral**	**Adverse**	**Typical**
NAL1	44	49	42	40	45	38
NAL2	50	54	52	46	50	48
NAL3	29	35	26	17	22	15
NAL4	43	48	41	39	45	37
NAL5	49	53	47	45	49	43
NAL6	43	49	41	39	45	37
NAL7	44	49	48	39	45	44

1. All levels are L_{Aeq} in dB(lin)

None of the predicted linear-weighted noise levels exceed the 55 dB(Linear) criterion, thus no further assessment of low-frequency noise is required at this time as the levels are unlikely to cause complaints due to low frequency noise.

5.2.3 IFC And BG Criteria

Operational noise levels are compared with the IFC criteria in *Table 5.10* below. BG requested that these criteria be considered in the assessment.

Table 5.10 Operation Noise Levels compared to IFC Criteria

Receptor	**IFC Criteria**	**Operational Noise, 3-train**			**Operational Noise, 1-train**		
Location	**D / N**	**Neutral**	**Adverse**	**Typical**	**Neutral**	**Adverse**	**Typical**
NAL1	50/45	25	33	22	21	29	18
NAL2	41/43	30	38	34	26	34	31
NAL3	40/38	11	18	8	-	4	-
NAL4	49/45	24	32	21	20	28	17
NAL5	41/43	30	37	27	26	33	23
NAL6	51/45	24	32	21	20	28	17
NAL7	41/45	24	32	30	20	28	26

1. All levels are L_{Aeq} in dB(A).
2. Levels shown as "-" were less than zero dB(A)
3. Neutral is calm weather, Adverse is a moderate temp. inversion, Typical is ESE breeze
4. Adverse conditions (temperature inversions) would occur only at night, and hence are compared to the night time criterion.

It can be seen from *Table 5.10* that the IFC criteria are met at all locations for all time periods under all meteorological conditions. This indicates that under 'average' conditions, the proposed LNG plant will not be audible, and presents a useful comparison to the EcoAccess Guideline *Planning for Noise*

Control criteria which are based on particularly quiet conditions (the RBL being based on the lowest 10th percentile of the L_{A90} noise levels, which are already the lowest 10th percentile noise level for each monitoring interval).

The BG criteria are 55 dB(A) during the day & evening, and 45 dB(A) at night. Examination of *Table 5.10* indicates that operational noise levels at all receptor locations are below the BG criteria for all time periods under all conditions.

5.2.4 LNG Shipping

Export of LNG from the proposed plant will be via large ocean-going carriers. Ships will travel via a shipping channel that connects the new terminal adjacent to the site to the existing channel through Gladstone Harbour from the R G Tanna coal facility. It is understood that the LNG carriers will be accompanied through the harbour by four bollard pull tugs: two 62 tonne tugs from the existing Gladstone fleet, and two new 80 tonne tugs.

Noise levels from LNG ships moving in-harbour with tugs were not available, however the specified maximum noise level for ships under full power is understood[21] to be 70 dB(A) at 30m. This level was used to conduct a first-pass assessment of potential shipping noise impacts. Actual noise levels from ships are likely to be considerably lower, due to constraints on vessel speed while in the harbour.

Under full power, the predicted noise impacts at the assessment locations were as shown in *Table 5.11*. These levels represent the highest noise level experienced as the ship passes, and would generally occur only for a brief period. For comparison, the Rating Background Levels have been included in the table, representing ambient noise levels during particularly quiet periods.

Table 5.11 Predicted Upper-Bound Ship Noise Levels

Receptor Location	Ship noise at full power	Rating Background Level
NAL1	34	43
NAL2	13	36
NAL3	8	27
NAL4	31	36
NAL5	46	29
NAL6	30	36
NAL7	2	30

1. All noise levels L_{Aeq} in dB(A)
2. RBLs are the lowest of day/evening/night levels for each site

[21] Based on correspondence with BG Shipping, 13 December 2008.

The only location where maximum potential ship noise emerges above background noise levels is NAL5 (by 17dB(A)), the residence at Tide Island. This receptor would only be exposed to noise from LNG carriers for a brief period (no more than a few minutes) as vessels pass by the island. Given that noise levels from ships manoeuvring at low speed in harbour are expected to be lower than the levels listed above, it is likely that noise levels would be below current ambient levels (the average L_{10} noise level measured at night at logger location M5 was 44 dB(A)). Current logistics indicate three ships per week would depart the LNG terminal, leading to six ship movements per week (three arrival, three departure). With the combination of brief exposure, relatively low level, and infrequent occurrence, the noise impact of the LNG carrier movements are not considered to be significant.

In the future it is likely that noise from the LNG ships will be masked by noise from other industry, including the proposed Wiggins Island coal terminal (refer *Section 5.3*).

5.2.5 Personnel Movements

During operation of the QCLNG plant, personnel would access the site via water taxi, from a new ferry terminal to be built adjacent to RG Tanna Wharf (refer *Figure 1.1*). Personnel vehicles and some trucks (a few per day) would access the terminal via Alf O'Rourke Drive. Parking for around 100 vehicles would be provided at the terminal, with up to 80 persons travelling via ferry per operational shift. The area around the ferry terminal is industrial in character and the nearest noise sensitive receptors would be located in the Gladstone marina some 800m distant. Noise from the water taxi movements is not expected to generate significant noise levels at sensitive receptors and the low number of vehicle movements along the largely industrial route would have negligible noise impact.

In the event that a bridge across The Narrows is constructed then transportation of personnel once the plant is operational would be via road from the mainland to Curtis Island. As discussed in *Section 5.1.4 Construction Post 2013*, operational personnel would travel via Landing Road and Gladstone Mt-Larcom Road which would connect to the bridge and Curtis Island. The existing routes presently service the industry north of Gladstone, and have high heavy vehicle movements. The surrounding land use to both roads is industrial and as such there are no sensitive receptors proximate to the connecting or proposed roads, therefore negligible noise impact is expected.

5.3 CUMULATIVE NOISE IMPACTS

5.3.1 Industrial Plant Operations

In order to assess potential cumulative noise impacts, predicted operational noise levels from a number of proposed and approved developments in the area have been compared (refer *Figure 1.3*). The proposed projects considered were as follows:

- Santos LNG: a large LNG plant to be located slightly south-east of the QCLNG plant on Curtis Island. No EIS has been published to date for this project, thus estimates of noise levels have been made based on noise emissions from QCLNG and published information[22] for the Santos proposal (e.g. two LNG trains proposed, each of similar throughput to the QCLNG trains);

- Gladstone LNG: a smaller LNG plant to be located on reclaimed land at Fisherman's Landing. Noise levels were drawn from the EIS report[23];

- Sun LNG: a smaller LNG plant of similar scale to the Gladstone LNG proposal, to be located next to Gladstone LNG at Fisherman's Landing. Predicted noise levels were assumed to be similar to those from Gladstone LNG;

- Wiggins Island Coal Terminal: a large coal shiploading facility to be constructed at Wiggins Island, west of the existing R G Tanna coal terminal. Predicted noise levels were taken from the EIS report[24]; and

- Gladstone Pacific Nickel: A nickel refinery to be constructed south of the Gladstone-Mt Larcom road at Yarwun. Predicted noise levels were drawn from the supplemental EIS report[25].

Table 5.12 lists the predicted noise levels from the QCLNG proposal and several other projects under neutral meteorological conditions. These levels are shown graphically in *Figure 5.1*. *Table 5.12* also includes current minimum daily L_{Aeq} noise levels for comparison purposes.

---

[22] Santos, "Gladstone Liquified Natural Gas Initial Advice Statement", 19 July 2007.

[23] Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.

[24] Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006.

[25] ASK, "Gladstone Pacific Nickel - Response to EIS Submission Queries & Comments", Doc. No. 3600R02, 22 October 2007.

Table 5.12 Noise Levels from Proposed Projects Around Gladstone Harbour

Location	QCLNG	Santos LNG (est)	Gladstone LNG	Sun LNG (est)	Wiggins Island	Gladstone Nickel	Total no QCLNG	Total with QCLNG	Current[5] L_{Aeq}
NAL1	25	29			36		37	37	50
NAL2	30	30	35	35		41	43	43	41
NAL3	11	18					18	19	38
NAL4	24	28					28	29	48
NAL5	30	41	25	25	54		54	54	41
NAL6	24	28			32	19	34	34	45
NAL7	24	21	22	22			27	29	41

1. All levels are L_{Aeq} in dB(A)
2. Levels are for neutral weather conditions.
3. QGC Plant levels are for 3 train operation.
4. Total levels are logarithmic sums of the individual levels, with and without QGC levels
5. Typical minimum daily L_{Aeq} levels at the locations.

Examination of the noise levels in *Table 5.12* reveals that the predicted noise impact from QCLNG is exceeded by that from other major industrial projects at all locations except NAL7 (Smith St, Targinie). The Targinie area is State Development land (refer *Figure 1.2*) which will be developed for industrial purposes in the foreseeable future. Furthermore, the total level at NAL7 is well below the current minimum daily L_{Aeq} noise level.

The cumulative total with and without QCLNG varies by 0 – 2dB(A), indicating that QCLNG does not make a significant contribution to the cumulative noise levels. At all locations, the cumulative total without QCLNG is significantly higher than the predicted noise level from QCLNG.

Comparison of the total noise levels with the current minimum daily L_{Aeq} noise levels indicates that the most significant change will occur at NAL5 (Tide Island) due to projects other than QCLNG. Total noise levels at NAL2 (Lot 2 Fisherman's Road, Yarwun) also slightly exceed the current minimum daily L_{Aeq} noise level due to projects other than QCLNG, however it is understood that this location is on industrial land.

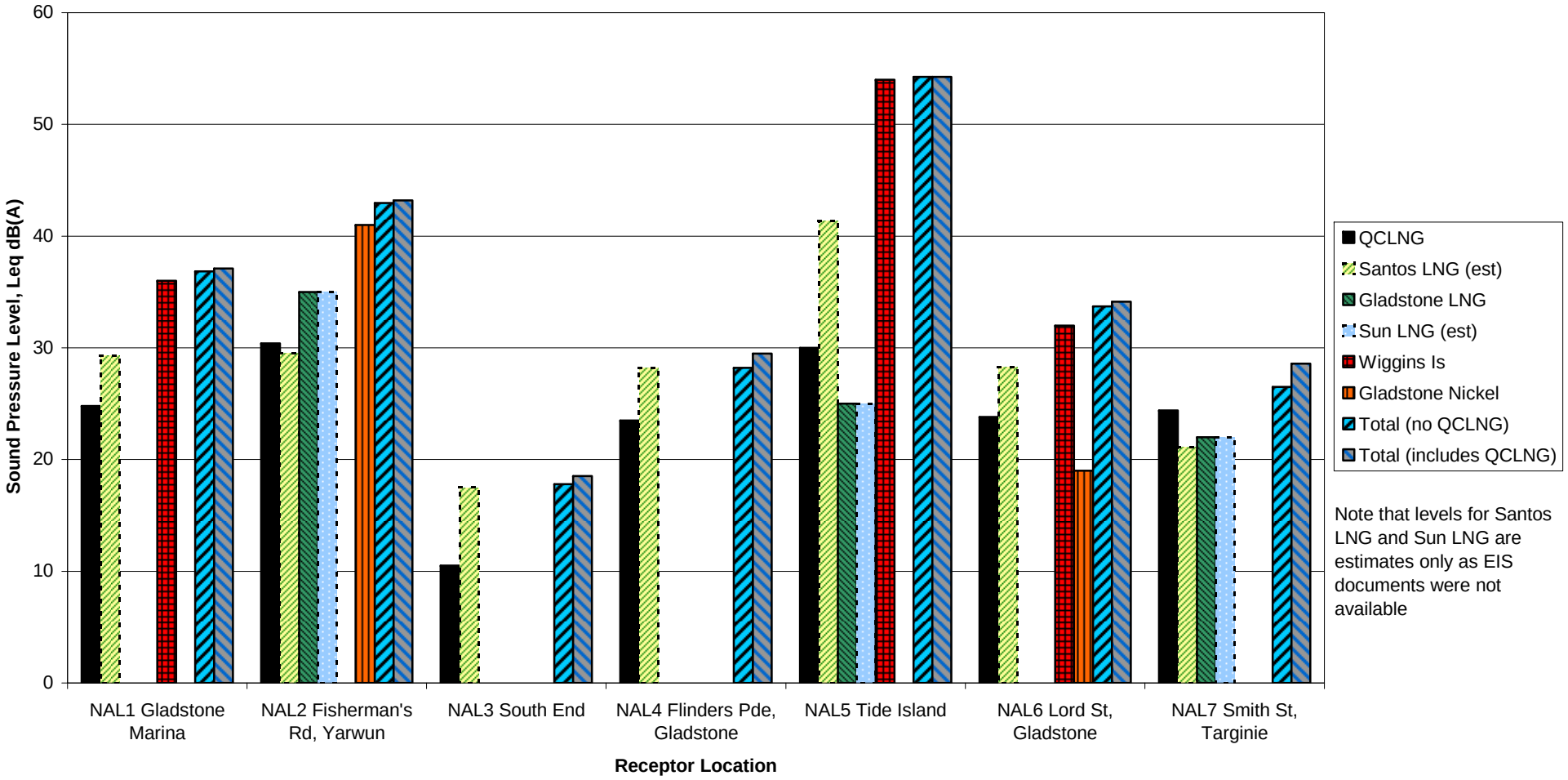


Figure 5.1 Cumulative Noise Levels for Proposed Industrial Projects in Gladstone Area

5.3.2 Cumulative at QCLNG Site Boundary

Cumulative noise levels at the site boundary from QCLNG equipment and plant are provided in *Annex* G. This is based on modelling undertaken by the plant engineering design company[26] for a 4 train scenario (note that only 3 trains are proposed at this stage). The predicted noise contours indicate levels at the site boundaries will range from 60 to 71 dB(A). This is not expected to cause a noise impact given the plant is located in the State Development Area for Curtis Island, and adjoining uses will be industrial.

5.3.3 Cumulative Construction Noise

No assessment has been made of cumulative construction noise, as there is insufficient information to predict construction noise levels from other projects, and it is unlikely that the loudest noise-producing construction activities at different project sites will occur simultaneously. Hence the noise impacts should generally be limited to those of individual projects.

[26] Bechtel Oil, Gas and Chemicals, Inc. 2008, "Queensland Curtis LNG Project: CTR #44 - Noise Modelling Report (Rev 00A)", Confidential, Bechtel Doc. No. NNR-NV00-00001, 28 October 2008.

Construction

No significant noise impacts have been identified during the construction period, however the construction criteria are expected to be exceeded on certain occasions. Standard management practices should be implemented to minimise noise impacts, including the following:

- Plant construction work on Curtis Island outside 6am to 6pm weekdays should be managed to minimise noise impacts on Tide Island (NAL5). This may include limiting the use of high noise activities at night or on Sunday (particularly on a calm, cool night – possible temperature inversion);

- Slipforming for the LNG tanks using limited equipment (eg. concrete batch plant, concrete mixers and pumps, crane) should be acceptable 24 hours, 7 days;

- While some work outside 6am – 6pm weekdays should be acceptable, high noise activities (angle grinding, use of large cranes) for the Auckland Point laydown area should generally be undertaken during busier times of the day;

- Use of transport routes suitable for construction traffic (eg. Port Access Road, and Hanson Road). Educate personnel using Port Access Road to drive quietly and keep vehicles well maintained;

- All equipment (including trucks) to be kept in good repair including mufflers and equipment covers;

- The location of the pipeline and construction methods are not clearly known at this time, and hence construction noise and vibration impacts should be considered and managed during the construction process should higher impacts for certain residences be identified. This should include notification of residents that may be affected;

- Barge and ferry routes and speed should be selected to minimise noise impacts on Tide Island (NAL5). The barge and ferry mufflers and engines should be well maintained to minimise radiated noise levels; and

- If blasting is required during construction works, an assessment and monitoring should be undertaken to manage noise and vibration impacts.

Operation

No significant impacts are expected during operation of the QCLNG plant, based on the noise data provided. Under adverse meteorological conditions (which are expected to occur infrequently) Tide Island (NAL5) may experience noise levels from the QCLNG plant above the EPA criteria, and LNG carrier ships are expected to be audible as they pass by. Standard management practices should be implemented to minimise noise impacts, including the following:

- Noise levels used for the modelling in this report should be used to specify related source noise levels for individual items of plant (air coolers, gas turbines etc.);

- Noise monitoring should be undertaken during start-up of the plant and during early operational stages to confirm noise levels at the nearest noise-sensitive locations;

- Treatments for individual items of plant could be investigated at the detailed design stage if required to reduce noise levels from particular items of plant to meet the composite noise levels used for this assessment;

- The flare should be selected to control noise levels to minimise noise impacts on site and at the nearest noise sensitive receptor (Tide Island NAL5);

- Potential noise mitigation measures that might be considered could include: enclosures around noisy plant, attenuators or mufflers on exhausts and air intakes/ discharges;

- Further ambient noise monitoring could be undertaken just prior to commencement of construction works and just prior to commencement of operations at the QCLNG site, to provide good baseline data for future reference with regard to QCLNG's contribution to cumulative noise levels in the Gladstone harbour area; and

- Shipping (including LNG carriers, tugs and water taxis) routes and ship speed should be selected to minimise noise impacts on Tide Island (NAL5). The ship mufflers and engine should be well maintained to minimise radiated noise levels.

7 CONCLUSIONS

The site selected for the QCLNG plant is appropriate from a noise perspective as it is located well away from residential receptors (5km – 11.5kms), and the natural terrain (ridge running north – south) provides shielding to the eastern site of Curtis Island. This results in low impacts for the nearest noise sensitive receptors.

Based on the monitoring, modelling and assessment undertaken in this study, the following conclusions can be drawn.

Construction

- Construction of the proposed LNG plant should be inaudible under most conditions during the day and under all conditions during tank slipforming works (24 hour work using a reduced amount of construction equipment). Plant construction activity noise meets the construction criteria for 6am – 6pm. Occasional weekend or night plant construction work would result in an exceedance of 2dB(A) above the night time construction noise criteria at NAL5 (Tide Island) under neutral wind conditions. Under adverse weather conditions (ie. temperature inversion) full plant construction at night may exceed the construction criteria by 3dB(A) at NAL2 (Fishermans Road), 11dB(A) at NAL5 (Tide Island), and 1dB(A) at NAL7 (Targinie). The exceedance at NAL5 (Tide Island) indicates that the construction noise would be clearly audible under these unusual conditions. However these levels would only occur for a small percentage of the year on occasions with full plant construction occurring, on a calm night, and with a temperature inversion. Based on the above, plant construction is not expected to cause a significant noise impact;

- During construction barges and ferries will be used to transport plant, materials and personnel to the Curtis Island site. Predicted worst case noise levels from these movements indicate noise levels will be inaudible at all locations other than NAL5 (Tide Island). However the levels at Tide Island will be below existing average L_{A10} noise levels and would only be experienced briefly as the vessels pass by, hence barge/ferry traffic is expected to have no significant noise impact on the residence at Tide Island;

- Construction of a ferry terminal near RG Tanna for the operational stage is a relatively small construction project, and given its location in an industrial area and distance to the nearest noise sensitive receptors (Gladstone Marina, 800m away), it is not expected to cause a significant noise impact;

- Construction of a bridge (if undertaken) and associated roadways linking Curtis Island to the mainland are expected to be inaudible at the nearest noise sensitive receptors;

- Road traffic generated during construction will include vehicles travelling to the Auckland Point laydown areas (from 2010 to 2013) and vehicles travelling via the new road and bridge to Curtis Island after 2013 (if the bridge is built). The number of worker vehicles accessing Auckland point will peak at around 1000 per day, with most movements occurring around 6am and 6pm. The increase in movements particularly in the morning may be noticeable and sensitive receptors may experience an increase in noise levels. The increase in daily traffic noise levels will only be minor (1.6dB(A)). The main road to access the Auckland Point laydown area is Port Access Road which is designed as a heavy vehicle route with substantial noise control treatments, and the roads to Curtis Island currently service Gladstone's industrial areas. Given the limited duration of the construction work, impacts from road transport are expected to be low;

- The Auckland Point Laydown Area is located amongst existing rail and industrial areas and hence while some louder construction activities may be audible from 6am to 6pm, it is expected to have a low impact on the nearest residential areas. Operation on occasions outside these hours or on weekends would exceed the most stringent construction criteria for several activities. However occasional exceedances should be acceptable provided they are appropriately managed;

- The section of the main pipeline from Curtis Island to Targinie Road (approximately 4km inland) will be built in stages, and generally lies within State Development Land which is intended for future industrial development. Based on the transient nature of construction activities, construction noise impacts are expected to be low; and

- Construction activities such as pile driving and vibratory rollers can produce significant vibration levels at close range (eg. 50m). However as the nearest off-site vibration sensitive receptors will be several kilometres away, these activities will not cause a vibration impact. No major blasting is proposed during construction, although some minor light shock blasting[27] may be required to assist with loosening the rock along lines of existing weakness and allow ripping to be undertaken. If required (subject to ongoing detailed geotechnical investigation) this will be a rare occurrence during the first year of construction only.

[27] Information provided by QGC.

Operation

- Predicted operational noise levels are below the relevant EPA criteria for all locations under neutral and typical weather conditions;

- Under adverse conditions (temperature inversion and calm winds), predicted operational noise levels are below the relevant criteria for all locations except NAL5 (Tide Island), the closest receptor to the QCLNG site (5km distant). The exceedance of 5dB(A) under adverse conditions is expected to occur only occasionally as temperature inversions are expected to be infrequent as they are less likely to form over water, and winds are calm for only 14% of the time. As this is less than the 30% referred to in the EPA EcoAccess Guideline *Planning for Noise Control*, this exceedance is not expected to be significant;

- In the future it is likely that noise from the proposed QCLNG plant will be masked by noise from other industry, including the proposed Wiggins Island coal terminal;

- The predicted linear-weighted noise levels meet the EPA Draft criterion for low frequency noise, thus no further assessment is required at this time as the levels are unlikely to cause complaints due to low frequency noise;

- The nature of the noise generated by the LNG plant is a continuous noise, with no significant impulsive characteristics. Hence the EPA ($_{max}L_{pA}$) sleep disturbance criterion is not applicable to this assessment;

- The IFC criteria are met at all locations for all time periods under all meteorological conditions. This indicates that under 'average' conditions, the proposed LNG plant will not be audible, and presents a useful comparison to the EcoAccess Guideline *Planning for Noise Control* criteria which are based on particularly quiet conditions;

- The BG criteria of 55 dB(A) during the day and evening, and 45 dB(A) at night are met at all receptor locations for all time periods, under all conditions;

- Flaring will occur for relatively short periods on rare occasions during plant start-up and operation for maintenance and emergency situations. While specific noise levels have not been made available for QCLNG flaring, assessment of flaring noise for Gladstone LNG (Fishermans Landing site)[28] indicated that noise impacts were acceptable. The Gladstone LNG (Fishermans Landing site) project has closer noise sensitive receptors than QCLNG. Hence given the infrequent and short term nature of the flaring events, the impact of the flare is not expected to be significant;

[28] Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.

- Noise levels from ships moving in-harbour with tugs were not available, however predicted worst case noise levels (based on noise levels for ships under full power) for these movements indicate that noise levels will be inaudible at all locations other than NAL5 (Tide Island). However with the ships under lower speeds in the harbour, the levels are expected to be below existing average L_{10} noise levels and would only be experienced briefly as the vessels pass by nominally six times per week. Hence shipping traffic is not expected to have a significant noise impact on the residence at Tide Island;

- Transportation of personnel once the plant is operational would be via water taxi from a new ferry terminal to be built adjacent to the RG Tanna Wharf (refer *Figure 1.1*). Noise from the water taxi movements and the low number of vehicle movements along the largely industrial route is not expected to generate significant noise levels at sensitive receptors;

- In the event that a bridge across The Narrows is constructed then transportation of personnel via road from the mainland to Curtis Island would be expected to cause negligible noise impacts as the surrounding land use to these roads is industrial; and

- The LNG plant and equipment primarily involves rotating machinery, which will transfer relatively low levels of vibration to the ground. Hence operation of the LNG plant will not produce significant levels of ground vibration.

Cumulative

- Comparison of QCLNG with five other proposed industrial projects in the Gladstone area indicates that the predicted noise impact from QCLNG is exceeded by that from other major industrial projects at all locations except NAL7 (Smith St, Targinie). The Targinie area is State Development land which will be developed for industrial purposes in the foreseeable future. Furthermore, the total level at NAL7 is well below the current L_{Aeq} noise level. At all locations, the cumulative total without QCLNG is significantly higher than the predicted noise level from QCLNG. Hence QCLNG is not a significant contributor to cumulative noise levels;

- Comparison of the total noise levels with the current minimum daily L_{Aeq} noise levels indicates that the most significant change will occur at NAL5 (Tide Island) due to projects other than QCLNG. Total noise levels at NAL2 (Lot 2 Fisherman's Road, Yarwun) also slightly exceed the current minimum daily L_{Aeq} noise level due to projects other than QCLNG, however it is understood that this location is on industrial land;

- The predicted noise contours indicate levels at the QCLNG site boundaries will range from 60 to 71 dB(A). This is not expected to cause a noise impact given the plant is located in the State Development Area for Curtis Island, and adjoining uses will be industrial; and

- Cumulative construction noise is not expected to be an issue as it is unlikely that the loudest noise-producing construction activities at different project sites will occur simultaneously. Hence the noise impacts should be limited to those of individual projects.

REFERENCES

Australian Standard, "AS1055 – Acoustics – Description and Measurement of Environmental Noise".

ASK, "Gladstone Pacific Nickel – Response to EIS Submission Queries & Comments", Doc. No. 3600R02, 22 October 2007.

Bechtel Oil, Gas and Chemicals, Inc. 2008, "Queensland Curtis LNG Project: CTR #44 - Noise Modelling Report (Rev 00A)", Confidential, Bechtel Doc. No. NNR-NV00-00001, 28 October 2008.

Bechtel Oil, Gas and Chemicals, Inc. 2008 and 2009, "Queensland Curtis LNG Project: CTR #47.2 – Site Logistics Study – Part 2 (Rev 002)", Unpublished report, Bechtel Doc. No. G0R-1T00-00007, 9 Feb 2009.

BG, "Environmental Expectation Standard", Doc. No. BGS-HSSE-ENV-ST-1509, 1 July 2007.

BG, "Project Execution Plan QCLNG Project (Rev 0)", Doc. No. QCLNG-HOU-PMT-GEN-PLN-0121, February 2009.

CQPA, "Proposed Northern Development at Fisherman's Landing Port Facility", Initial Advice Statement, September 2005.

Department of Environment and Conservation (now Environmental Protection Agency, Queensland) "E1 environmental guideline - Noise from Construction, Renovation, Maintenance and Demolition sites", 2 May 1989.

Department of Transport, Welsh Office, "Calculation of Road Traffic Noise", HMSO, 1988.

Environmental Protection Agency, Queensland "Environmental Protection Act 1994".

Environmental Protection Agency, Queensland "Environmental Protection (Noise) Policy 2008".

Environmental Protection Agency, Queensland "Environmental Protection Regulation 2008".

Environmental Protection Agency, Queensland "EcoAccess Guideline - Planning for Noise Control", 20 July 2004.

Environmental Protection Agency, Queensland "EcoAccess DRAFT Guideline Assessment of Low Frequency Noise".

Environmental Protection Agency, Queensland "Noise Measurement Manual (Third Edition)", 1 March 2000.

Halcrow MWT, "Draft - Queensland Curtis LNG project EIS Traffic and Transport Impact Assessment (Rev 0)", Doc. No. 083827r01, 9 February 2009.

Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006.

IFC, "Environmental Noise Management Guideline", Section 1.7 Environmental Health and Safety Guidelines document, 30 April 2007.

Santos, "Gladstone Liquified Natural Gas Initial Advice Statement", 19 July 2007.

Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.

Annex A

Acoustic Terminology

Table A.1 provides a glossary of noise related terms used in this assessment.

Table A.1 Glossary of Terms

Term	Description
ABL	The single-figure background level representing each assessment period – day, evening and night. It is determined based on the lowest tenth percentile of the L_{90}.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_{A1}	The noise level exceeded for 1% of a measurement period, 'A' weighted.
L_{A10}	The noise level exceeded for 10% of a measurement period, 'A' weighted. It is approximately equivalent to the average of maximum noise levels.
L_{A90}	Commonly referred to as the background noise, this is the level exceeded 90% of the time, 'A' weighted.
L_{Aeq}	It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period, 'A' weighted.
L_{max}	The maximum root mean squared (RMS) sound pressure level received at the microphone during a measuring period.
$maxL_{pA}$	The maximum 'A' weighted sound pressure level measured on 'Fast' response time.
PPV	The Peak Particle Velocity (PPV) means the maximum rate of ground movement measured by any of the 3 mutually perpendicular components of ground motion.
RBL/$minL_{90}$	The Rating Background Level (RBL) or $minL_{90}$ is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the specific noise level for noise assessment purposes and is the median of the ABLs.
Sound Power Level - L_W	The sound power level is a measure of the total acoustic energy radiated by a source. Sound power is neither room dependent nor distance dependent. Sound power belongs strictly to the sound source.
Pasquill Stability Class	A method of categorising the amount of atmospheric turbulence present, ranging from A (very unstable) to F (very stable). Sound is scattered by turbulence. Class F implies a moderate temperature inversion, and only occurs during calm and clear conditions at night.
Temperature Inversion	A reversal (or inversion) of the normal temperature lapse rate in the atmosphere, usually occurring under calm, cold, and clear conditions over land, most frequently at night in winter. Temperature inversions cause sound waves to be curved downward toward the ground, reducing the normal spreading loss by concentrating sound waves that would otherwise scatter in the atmosphere.
Drainage Flow	A movement of cold air downhill, due to density differences. Drainage flow only occurs in the absence of other wind, and does not occur on flat terrain.

Annex B

Noise Monitoring Data

B.1 MONITORING EQUIPMENT

Measurements were performed with the following calibrated instrumentation:

- 5x Larson Davis 831 Sound Level Meters for unattended monitoring – Serial No. 1639, 1621, 1640, 1620, 1619;
- 1x Rion NA-27 Precision Sound Analyser for attended monitoring – Serial No. 1191143; and
- 1x Brüel & Kjær Type 4230 Sound Level Calibrator – Serial No. 2205468.

The Brüel & Kjær sound level calibrator was used to calibrate all sound monitoring equipment prior to measurement and again checked at the conclusion, with the variation in calibrated levels not exceeding ±0.5 dBA.

All monitoring practices and equipment were guided by Australian Standard AS1055-1997 "*Description and Measurement of Environmental Noise*", and the EPA "*Noise Measurement Manual*".

B.2 ATTENDED NOISE MONITORING RESULTS

Day, evening and night time attended monitoring was conducted to supplement the unattended noise monitoring surveys and to quantify the contribution from existing industry, road and other sources at the noise assessment locations. The results are summarised in *Table B1, Table B2* and *Table B3*.

Table B.1 Daytime Attended Monitoring Results (7:00am – 6:00pm)

Monitoring Location	Date	Start Time[1]	Measured Sound Pressure Level dB(A)				Comments
			L_{max}	L_{10}	L_{eq}	L_{90}	
M1	09/09/08	12:34 PM	56.7	48.1	45.5	42.5	Water lapping on boats & wharf, RG Tanna beepers @ 800Hz 38-42dB linear & low frequency noise, NE wind 0.5-4 m/s, 25^0.
M2	09/09/08	4:39 PM	76.7	50.6	49.7	40.8	Wind in trees, birds 42-65dB(A), truck on Hwy 43dB(A), reverse beepers, light aircraft 45-53, front end loader 42-47dB(A), plant noise <L90, SSE wind calm-light 2m/s.
M3	10/09/08	11:15 AM	67.8	44.1	42.6	35.6	Truck 46-50dB(A), wind in trees, quad bike 47dB(A), constant 50Hz peak ~30dB(A), birds 2 – 8kHz 35dB(A), no industry noise, helicopter/ plane 35-47dB(A), E wind 1.4-6.2m/s, Av. wind 2.2m/s.
M4	10/09/08	5:32 PM	81.1	56.6	54.5	45	Train 52-54dB(A), shunting train wagons pk 78dB(A), rolling wagons 55dB(A), birds 2.5kHz+ 48dB(A), dog 63dB(A), truck on wharf 56-57dB(A) 80Hz pk, cars on road 63dB(A), L90 = train idling + birds, SE wind 0.3-1.5m/s, 20^0
M5	10/09/08	2:36 PM	54.7	47.4	46.1	44.6	Waves on beach and industry ~44dB(A), L90 = waves + tree leaves + industry (RG Tanna & ships), industry ~ L90 – 3 (LF noise industry), insects 6.3kHz+, wind up to 48dB(A), E wind 2.4 – 4.3m/s, 21^0
M6	11/08/09	10:37 AM	70.6	53.9	51	38.6	Birds 40-55dB(A) 1kHz+, chainsaw 40-43dB(A), cars 55dB(A), industry not audible, large boat 45dB(A) LF noise, Calm.
M7	11/08/09	12:15 PM	63.2	43.8	41.1	30.3	Cars 48dB(A), birds 32-45dB(A), industry not audible, E wind 0-3.3m/s, 25^0

Notes: 1. All measurements are 15 minutes in duration unless otherwise noted.

Table B2 Evening Attended Monitoring Results (6:00pm -10:00pm)

Monitoring Location	Date	Start Time[1]	Measured Sound Pressure Level dB(A)				Comments
			L_{max}	L_{10}	L_{eq}	L_{90}	
M1	09/09/08	7:25 PM	65	46.1	46.1	39.2	Reverse beepers 40dB(A), mast tapping noise 45dB(A), aircraft 50-63dB(A), wharf noise against post 38dB(A), SE wind 0.4-4.4m/s, 19^0
M2	09/09/08	6:42 PM	54.5	48.3	47.2	46.1	LF Industry noise from South-East, conveyor from East, road traffic, plant noise ~L90 - insects, Insects @ 2.5 & 3.15kHz 42dB(lin), birds, Calm wind, 20^0
M3	10/09/08	9:48 PM	58	35.9	34.3	31.8	Generator at shop 63Hz 57dB, Insects 2kHz, no industry noise, L90 = insects + generator + waves, Calm wind, 21^0
M4	10/09/08	7:21 PM	69.1	50.5	49.5	38.1	Train (distant) 45dB(A), distant shunt 47dB(A), truck other side of wagons 50dB(A), cars 60-68dB(A), industry 35-40dB(A), insects 4kHz, aircraft 45-50dB(A), L90 industry & possibly ships, Calm wind, 21^0
M5	10/09/08	8:59 PM (5 min)	65	51.5	48.1	40.8	Measurement onboard boat, water lapping on hull of boat dominated 200Hz+, RG Tanna conveyor noise below 200Hz, 30dB @ 80Hz, 2 ship loaders working, industry ~ 40dB(A), reverse beepers.
M6	10/09/08	7:51 PM (10 min)	69	54.8	52.2	39.4	Distant traffic 42-50dB(A), pool pump 36dB(A), karaoke 40dB(A), Calm wind, 21^0
M7	25/10/08	6:34 PM	82.1	48.5	56	43.5	Measurement dominated by wind in the trees and insects, no industry audible, cars 70-82dB(A), Insects @ 3.15kHz – 42dB linear, NE wind 2-3 m/s.
Notes:	1. All measurements are 15 minutes in duration unless otherwise noted.						

Table B3 Night-time Attended Monitoring Results (10:00pm – 7:00am)

Monitoring Location	Date	Start Time[1]	Measured Sound Pressure Level dB(A)				Comments
			L_{max}	L_{10}	L_{eq}	L_{90}	
M1	11/09/08	12:53 AM (5 min)	56.6	51.5	49	45.9	RG Tanna sets L90 & Leq, LF noise from conveyor, alarms @ 800Hz, hammering noise at times mid-frequency, Calm wind.
M2	09/09/08	11:23 PM	48.8	42.2	40.7	39.1	Comalco sets L90, insects @ 4kHz, truck on road 42dB(A), Calm wind
M3	10/09/08	10:59 PM	66.7	29.5	39.4	26.8	Generator off, distant ocean sets L90, animal cry 1.6kHz, Calm, 19^0
M4	11/09/08	1:40 AM	55.5	46	43.7	38.1	Locomotive 50Hz, industry sets L90 & Leq, car 55dB(A), bats 40dB(A), gear whine @ 1kHz, Calm.
M5	11/09/08	12:19 AM (5 min)	57	38.9	38.4	36.8	Measurement onboard boat, RG Tanna sets L90, 1 ship loader working, reverse beepers, animal noise from shore 1.6kHz, water on hull of boat 2kHz, water calm, Calm wind, 19^0
M6	11/09/08	1:12 AM	62.7	48.9	46.7	38.4	RG Tanna dominant sets L90 & Leq, conveyor, reverse beepers and all frequencies, cars on Lord St 55dB(A), aircraft 57dB(A), Calm wind, 19^0
M7	26/10/08	6:10 AM (12 min)	67.7	47.1	45.2	38.3	Broadband industry noise audible – low freq dominant <250Hz - setting L90, birds @ 38-50dB(A), trees 38-50dB(A), SE wind 1-4 m/s.
Notes:	1. All measurements are 15 minutes in duration unless otherwise noted						

B.3 NOISE LOGGING RESULTS – UNATTENDED NOISE MONITORING

The following information provides details of the noise logging undertaken by ERM.

Table B.4 Noise logger M1: Results table, dB(A)

Date	ABL Day	ABL Evening	ABL Night
Tuesday, 9 September 2008	39	36	36
Wednesday, 10 September 2008	39	39	37
Thursday, 11 September 2008	39	44	39
Friday, 12 September 2008	43	48	45
Saturday, 13 September 2008	46	43	46
Sunday, 14 September 2008	45	49	45
Monday, 15 September 2008	46	46	40
Tuesday, 16 September 2008	49	47	45
Wednesday, 17 September 2008	42	42	43
Thursday, 18 September 2008	44	48	39
Friday, 19 September 2008	48	48	49
Saturday, 20 September 2008	45	47	43
Sunday, 21 September 2008	46	48	47
Monday, 22 September 2008	45	49	40
Tuesday, 23 September 2008	47	48	44
Wednesday, 24 September 2008	42	40	42
Thursday, 25 September 2008	-	-	38
Summary Values (RBL)	**45**	**47**	**43**

1. (-) indicates periods with too few valid samples due to weather or logger operation.

Table B.5 Noise logger M2: Results table, dB(A)

Date	ABL Day	ABL Evening	ABL Night
Tuesday, 9 September 2008	41	39	38
Wednesday, 10 September 2008	38	37	39
Thursday, 11 September 2008	36	35	37
Friday, 12 September 2008	36	36	38
Saturday, 13 September 2008	34	33	37
Sunday, 14 September 2008	34	37	37
Monday, 15 September 2008	36	33	36
Tuesday, 16 September 2008	37	39	36
Wednesday, 17 September 2008	37	-	36
Thursday, 18 September 2008	36	38	38
Friday, 19 September 2008	37	37	37
Saturday, 20 September 2008	36	35	37
Sunday, 21 September 2008	34	35	36
Monday, 22 September 2008	37	37	38
Tuesday, 23 September 2008	34	35	37
Wednesday, 24 September 2008	35	-	37
Thursday, 25 September 2008	-	-	-
Summary Values (RBL)	**36**	**36**	**37**

1. (-) indicates periods with too few valid samples due to weather or logger operation.

Table B.6 Noise logger M3: Results table, dB(A)

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 10 September 2008	39	29	28
Thursday, 11 September 2008	28	36	29
Friday, 12 September 2008	34	40	33
Saturday, 13 September 2008	29	33	27
Sunday, 14 September 2008	30	35	29
Monday, 15 September 2008	28	35	27
Tuesday, 16 September 2008	32	33	28
Wednesday, 17 September 2008	32	40	24
Thursday, 18 September 2008	35	35	26
Friday, 19 September 2008	33	33	25
Saturday, 20 September 2008	34	31	27
Sunday, 21 September 2008	32	37	28
Monday, 22 September 2008	33	36	26
Tuesday, 23 September 2008	33	30	27
Wednesday, 24 September 2008	30	44	26
Thursday, 25 September 2008	-	-	44
Friday, 26 September 2008	-	-	40
Summary Values (RBL)	**32**	**35**	**27**

1. (-) indicates periods with too few valid samples due to weather or logger operation.

Table B.7 Noise logger M4: Results table, dB(A)

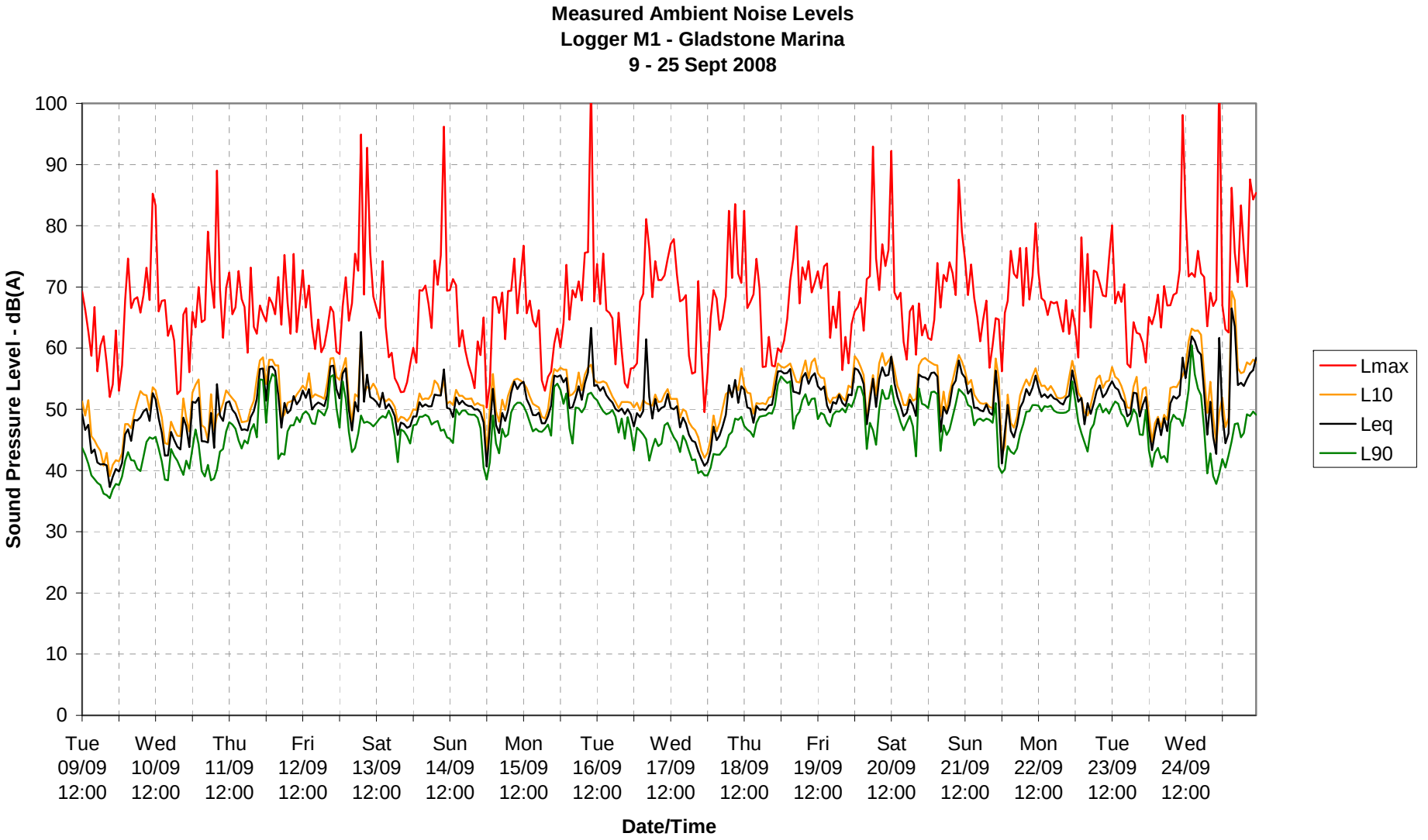
Date	ABL Day	ABL Evening	ABL Night
Wednesday, 10 September 2008	41	34	33
Thursday, 11 September 2008	40	35	33
Friday, 12 September 2008	39	38	36
Saturday, 13 September 2008	39	37	38
Sunday, 14 September 2008	40	36	37
Monday, 15 September 2008	40	39	34
Tuesday, 16 September 2008	41	34	37
Wednesday, 17 September 2008	41	-	32
Thursday, 18 September 2008	41	36	36
Friday, 19 September 2008	41	38	32
Saturday, 20 September 2008	39	36	36
Sunday, 21 September 2008	38	35	35
Monday, 22 September 2008	40	37	36
Tuesday, 23 September 2008	40	38	35
Wednesday, 24 September 2008	40	-	36
Thursday, 25 September 2008	-	-	-
Friday, 26 September 2008	55	-	49
Summary Values (RBL)	**40**	**36**	**36**

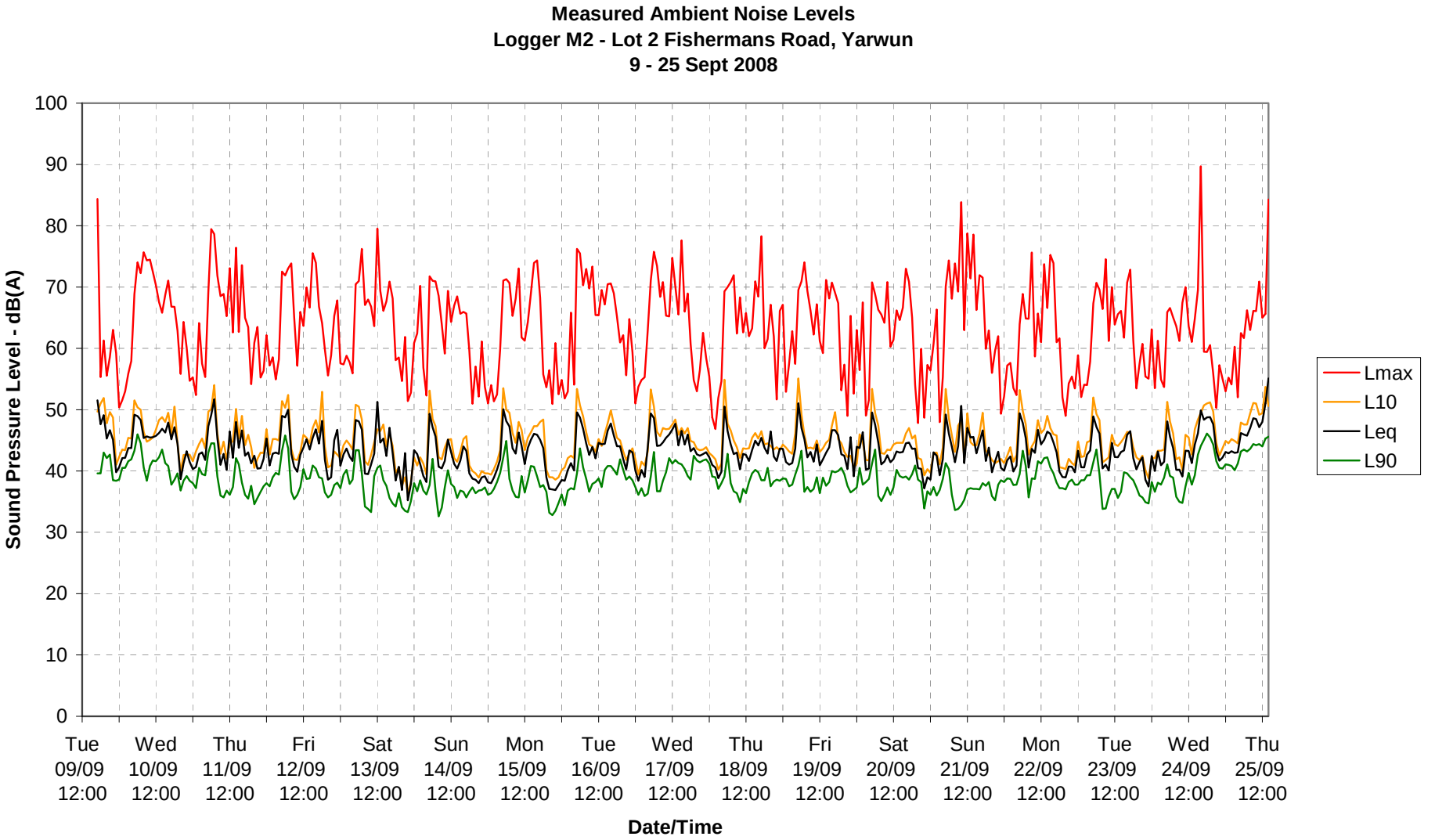
1. (-) indicates periods with too few valid samples due to weather or logger operation.

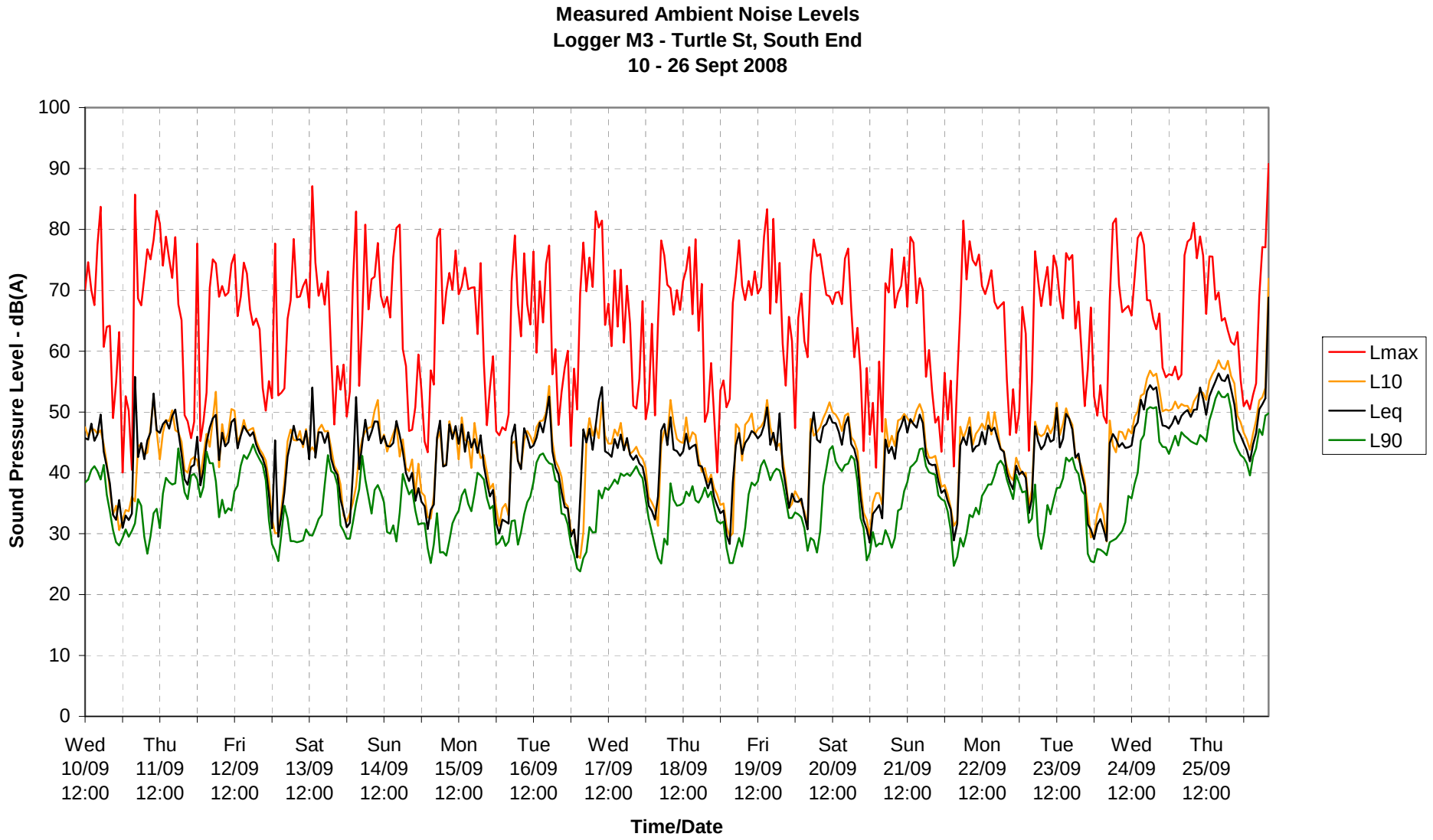
Table B.8 Noise logger M5: Results table, dB(A)

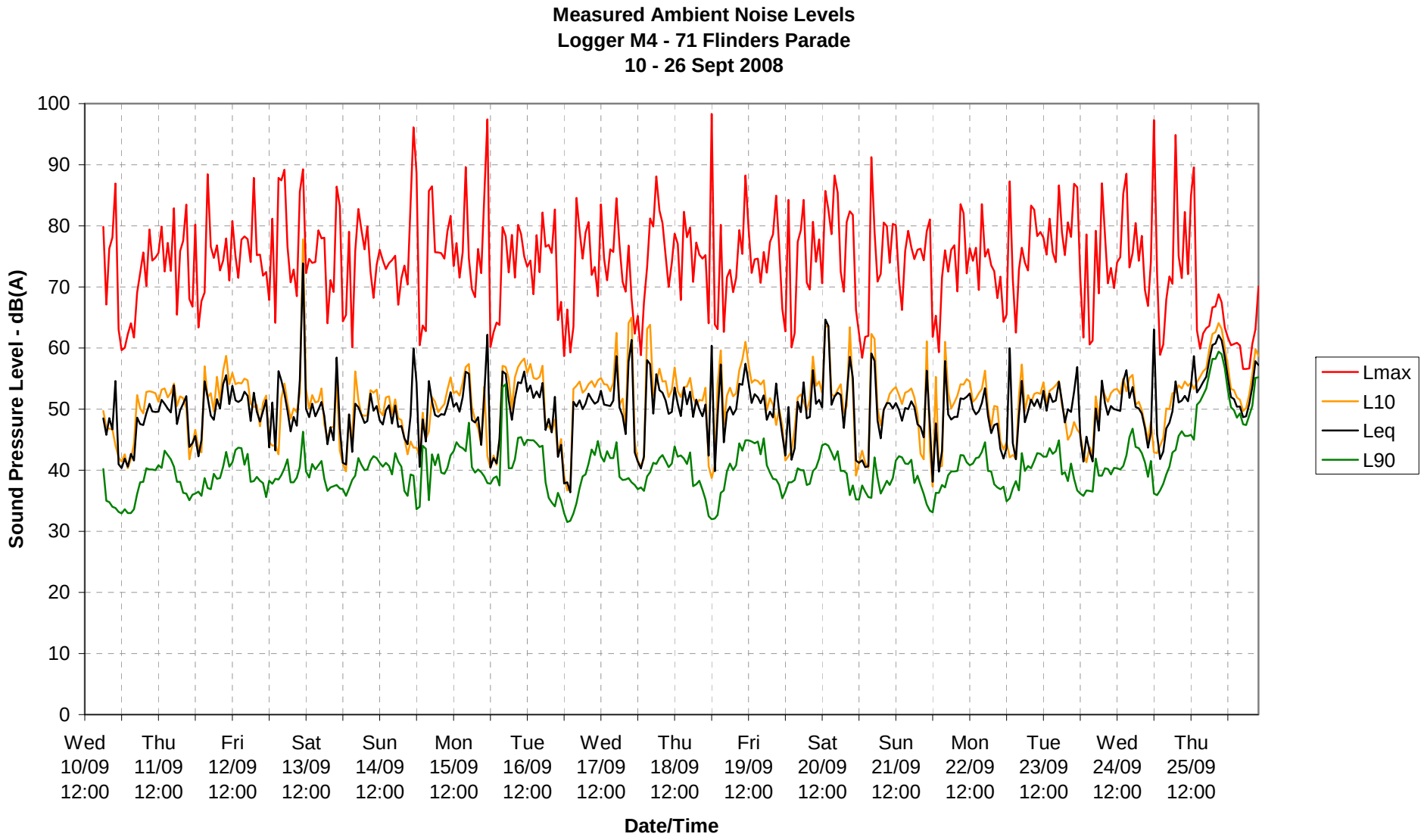
Date	ABL Day	ABL Evening	ABL Night
Wednesday, 10 September 2008	42	40	41
Thursday, 11 September 2008	32	39	29
Friday, 12 September 2008	30	32	26
Saturday, 13 September 2008	32	42	28
Sunday, 14 September 2008	30	44	42
Monday, 15 September 2008	29	31	36
Tuesday, 16 September 2008	30	31	27
Wednesday, 17 September 2008	38	-	27
Thursday, 18 September 2008	30	28	38
Friday, 19 September 2008	28	29	30
Saturday, 20 September 2008	29	26	23
Sunday, 21 September 2008	30	30	27
Monday, 22 September 2008	37	39	34
Tuesday, 23 September 2008	31	29	29
Wednesday, 24 September 2008	38	-	40
Thursday, 25 September 2008	-	-	-
Friday, 26 September 2008	-	-	48
Summary Values (RBL)	**30**	**31**	**29**

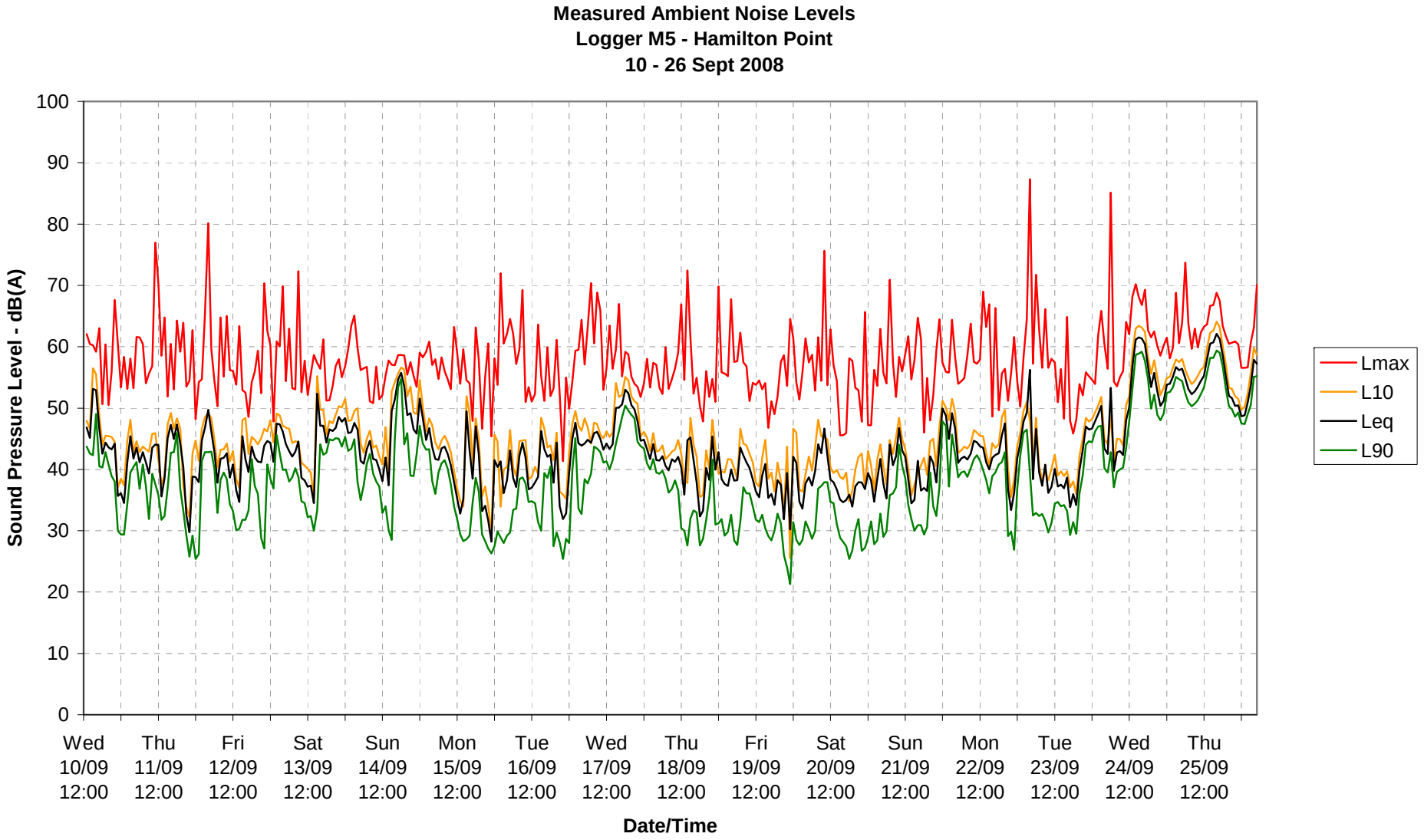
1. (-) indicates periods with too few valid samples due to weather or logger operation.


Measured Ambient Noise Levels
Logger M1 - Gladstone Marina
9 - 25 Sept 2008
Sound Pressure Level - dB(A)
100
90
80
70
60
50
40
30
20
10
0
Tue 09/09 12:00
Wed 10/09 12:00
Thu 11/09 12:00
Fri 12/09 12:00
Sat 13/09 12:00
Sun 14/09 12:00
Mon 15/09 12:00
Tue 16/09 12:00
Wed 17/09 12:00
Thu 18/09 12:00
Fri 19/09 12:00
Sat 20/09 12:00
Sun 21/09 12:00
Mon 22/09 12:00
Tue 23/09 12:00
Wed 24/09 12:00
Date/Time
Lmax
L10
Leq
L90


Measured Ambient Noise Levels
Logger M2 - Lot 2 Fishermans Road, Yarwun
9 - 25 Sept 2008
Sound Pressure Level - dB(A)
100
90
80
70
60
50
40
30
20
10
0
Tue 09/09 12:00
Wed 10/09 12:00
Thu 11/09 12:00
Fri 12/09 12:00
Sat 13/09 12:00
Sun 14/09 12:00
Mon 15/09 12:00
Tue 16/09 12:00
Wed 17/09 12:00
Thu 18/09 12:00
Fri 19/09 12:00
Sat 20/09 12:00
Sun 21/09 12:00
Mon 22/09 12:00
Tue 23/09 12:00
Wed 24/09 12:00
Thu 25/09 12:00
Date/Time
Lmax
L10
Leq
L90


Measured Ambient Noise Levels
Logger M3 - Turtle St, South End
10 - 26 Sept 2008
Sound Pressure Level - dB(A)
100
90
80
70
60
50
40
30
20
10
0
Wed 10/09 12:00
Thu 11/09 12:00
Fri 12/09 12:00
Sat 13/09 12:00
Sun 14/09 12:00
Mon 15/09 12:00
Tue 16/09 12:00
Wed 17/09 12:00
Thu 18/09 12:00
Fri 19/09 12:00
Sat 20/09 12:00
Sun 21/09 12:00
Mon 22/09 12:00
Tue 23/09 12:00
Wed 24/09 12:00
Thu 25/09 12:00
Time/Date
Lmax
L10
Leq
L90


Measured Ambient Noise Levels
Logger M4 - 71 Flinders Parade
10 - 26 Sept 2008
Sound Pressure Level - dB(A)
100
90
80
70
60
50
40
30
20
10
0
Wed 10/09 12:00
Thu 11/09 12:00
Fri 12/09 12:00
Sat 13/09 12:00
Sun 14/09 12:00
Mon 15/09 12:00
Tue 16/09 12:00
Wed 17/09 12:00
Thu 18/09 12:00
Fri 19/09 12:00
Sat 20/09 12:00
Sun 21/09 12:00
Mon 22/09 12:00
Tue 23/09 12:00
Wed 24/09 12:00
Thu 25/09 12:00
Date/Time
Lmax
L10
Leq
L90


Measured Ambient Noise Levels
Logger M5 - Hamilton Point
10 - 26 Sept 2008
Sound Pressure Level - dB(A)
100
90
80
70
60
50
40
30
20
10
0
Wed 10/09 12:00
Thu 11/09 12:00
Fri 12/09 12:00
Sat 13/09 12:00
Sun 14/09 12:00
Mon 15/09 12:00
Tue 16/09 12:00
Wed 17/09 12:00
Thu 18/09 12:00
Fri 19/09 12:00
Sat 20/09 12:00
Sun 21/09 12:00
Mon 22/09 12:00
Tue 23/09 12:00
Wed 24/09 12:00
Thu 25/09 12:00
Date/Time
Lmax
L10
Leq
L90

Annex C

Operational Noise Criteria Calculations

Noise Assessment Location	Measured Rating Background Level (RBL)			Recommended Background Noise Levels (Table 1) Background Creep			Recommended Noise Immissions Planning Levels L90 (Table 2)			Industry Noise levels (Laeq 1hr) (compare values with Max PNL)			Maximum PNL (Table 3)			Max PNL (with modifications) Table 4			Specific Noise Level (RBL +3dB) Equation 1		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
L1	45	47	43	55	50	45	50	47	40	51	50	51	60	55	50	60	53	44	48	50	46
L2	36	36	37	55	50	45	41	41	42	43	41	43	75	70	65	75	70	65	39	39	40
L3	32	35	27	40	35	30	37	25	27	46	40	38	40	35	30	36	30	28	35	38	30
L4	40	36	36	55	50	45	45	41	41	52	49	48	75	70	65	75	70	65	43	39	39
L5	30	31	29	45	40	35	35	36	34	42	43	43	60	55	50	60	55	50	33	34	32
L6	42	45	36	50	45	40	47	35	38	61	59	58	60	55	50	54	49	48	45	48	39
L7	30	32	31	45	40	35	35	37	33	43	51	46	40	35	30	33	41	36	33	35	34

Table 2

Background Noise level is below recommended level	Set Maximum Planning Level:	
1	9	recommended level
2	5	recommended level
3	3	recommended level
4	2	recommended level
5	2	recommended level

Table 4

Total existing noise level from Specific Sources	Maximum Planning Noise Level for Noise from New Sources Alone
-6	-1
-5	-2
-4	-2
-3	-3
-2	-4
-1	-6

Noise Assessment Location		Table 1		Table 3	Project Specific Noise Criteria (Lowest Criteria)		
		Receiver Land Use	Receiver Area Dominant Land Use	Noise Area Category	Day	Evening	Night
L1	Marina	Residential Area on a busy road or near an industrial area or commercial area	Light Industry	Z4	48	47	40
L2	Fishermans	Residential Area on a busy road or near an industrial area or commercial area	Light Industry	Z7	39	39	40
L3	South End	Purely Residential	Rural Residential	Z1	35	25	27
L4	Flinders	Residential Area on a busy road or near an industrial area or commercial area	Light Industry	Z7	43	39	39
L5	Hamilton Point	Residential Area on a busy road or near an industrial area or commercial area	Residential	Z4	33	34	32
L6	Lord	Residential Area on a busy road or near an industrial area or commercial area	Shop or Commercial Office	Z4	45	35	38
L7	Targinnie	Residential Area on a busy road or near an industrial area or commercial area	Residential	Z1	33	35	33

Annex D

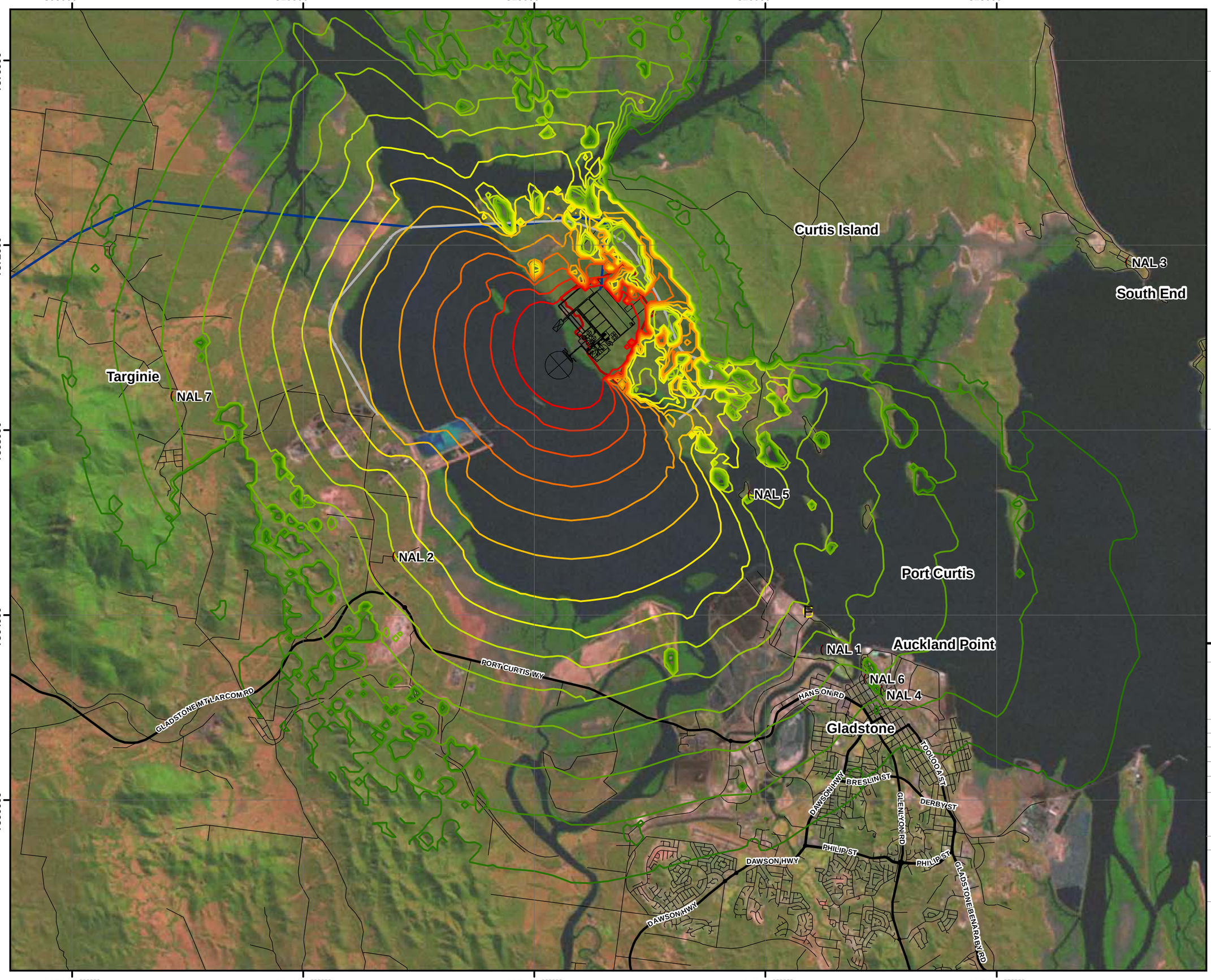
Sound Power Data

Table D.1 Noise Source Sound Power Levels in Octave Bands – dB(A)

Day Construction	**Overall Lw**	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Bulldozer	114.0	96.1	100.1	105.1	109.2	109.1	105.1	98.1	83.1
Dump Truck	105.5	78.9	93.9	96.9	101.0	100.9	94.9	83.9	73.9
Piling Rig	125.0	92.1	102.2	109.7	122.1	119.3	115.5	112.3	105.2
Bobcat	105.5	82.7	96.7	94.7	99.8	99.7	98.7	89.7	79.7
Front End Loader	110.3	77.8	92.9	103.4	103.8	105.0	103.2	97.0	88.9
Grader	114.0	76.3	98.3	106.3	108.4	109.3	105.3	100.3	85.3
Heavy Roller	114.0	96.1	102.1	100.1	109.2	109.1	107.1	98.1	83.1
Excavator	109.3	84.0	98.0	101.0	105.1	104.0	99.0	89.0	76.0
Night Construction	**Overall Lw**	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Concrete Batch Plant	105.0	72.8	87.9	98.4	98.8	99.0	98.2	92.0	83.9
Concrete Mixer	100.0	67.3	87.4	90.9	78.3	86.5	95.7	95.5	86.4
Concrete Pump	109.0	76.3	96.4	99.9	87.3	95.5	104.7	104.5	95.4
Crane, 120kW	106.0	82.0	87.1	100.6	100.0	101.2	95.4	88.2	81.1
Operational Noise	**Overall Lw**	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
BOGs combined	122.5	53.4	78.5	98.1	107.3	114.2	118.2	118.9	102.3
GTGs combined	117.7	103.2	110.6	110.6	111.2	106.8	105.6	107.4	107.9
LNG Train, +2m	120.2	97.9	106.1	109.7	111.5	116.1	113.4	111.0	99.4
LNG Train, +10m	124.0	104.8	109.6	113.6	115.5	118.5	117.6	115.2	112.4
LNG Train, +20m	123.0	100.8	110.1	115.1	116.5	118.8	113.4	110.2	100.9
LNG Train, +36m	117.1	104.1	113.0	111.1	110.7	103.6	97.2	99.2	96.4

Annex E

Noise Contour Maps - Construction



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 1E

Plant Construction Noise Levels, Neutral Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS009_R2		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

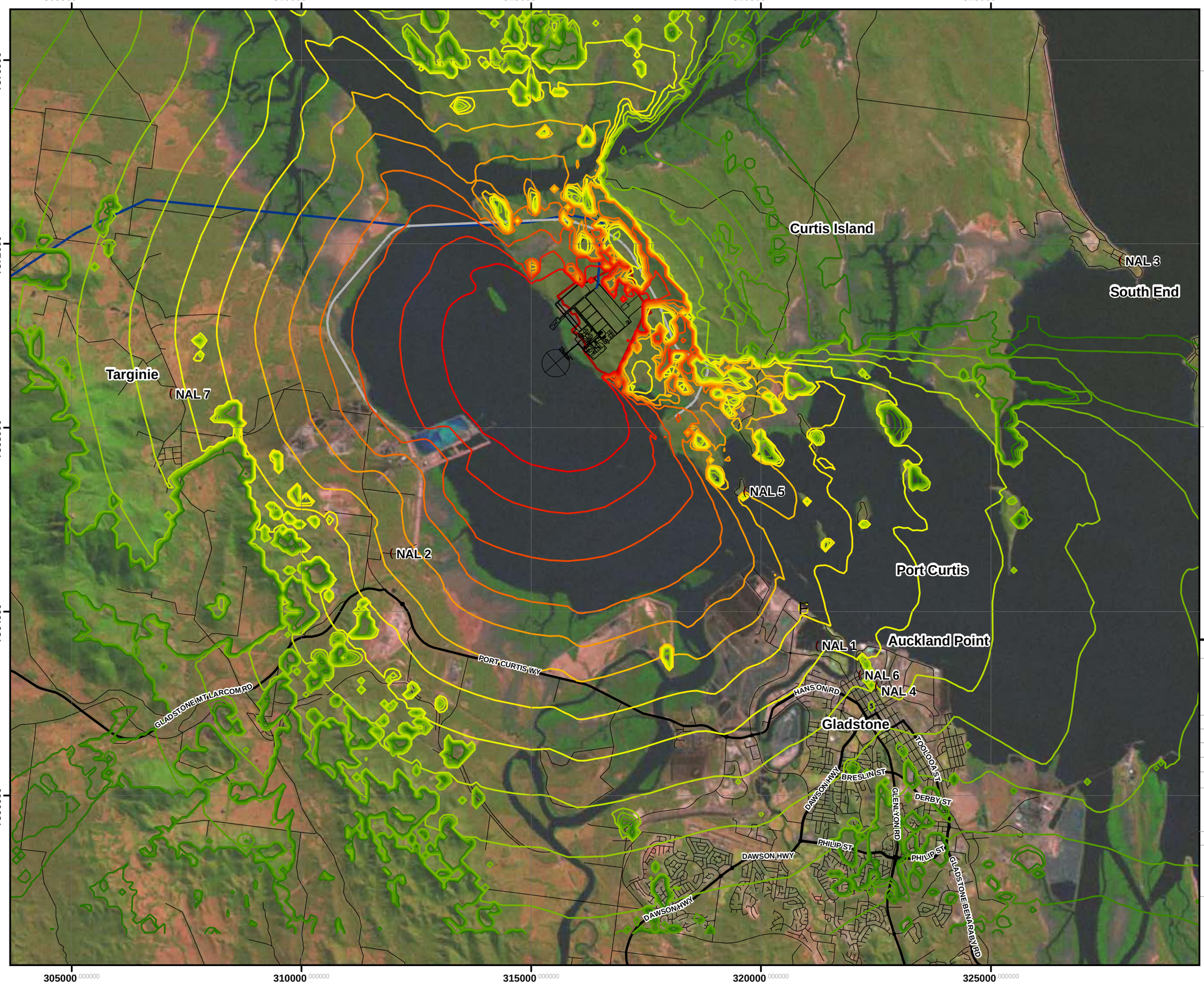
Projection: UTM MGA Zone 56 Datum: GDA 94

Disclaimer:
Maps and Figures contained in this Report may be based on Third Party Data, may not to be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 2E

Plant Construction Noise Levels, Adverse Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS014_R1		
Date:	20/03/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

0 0.5 1 2 km

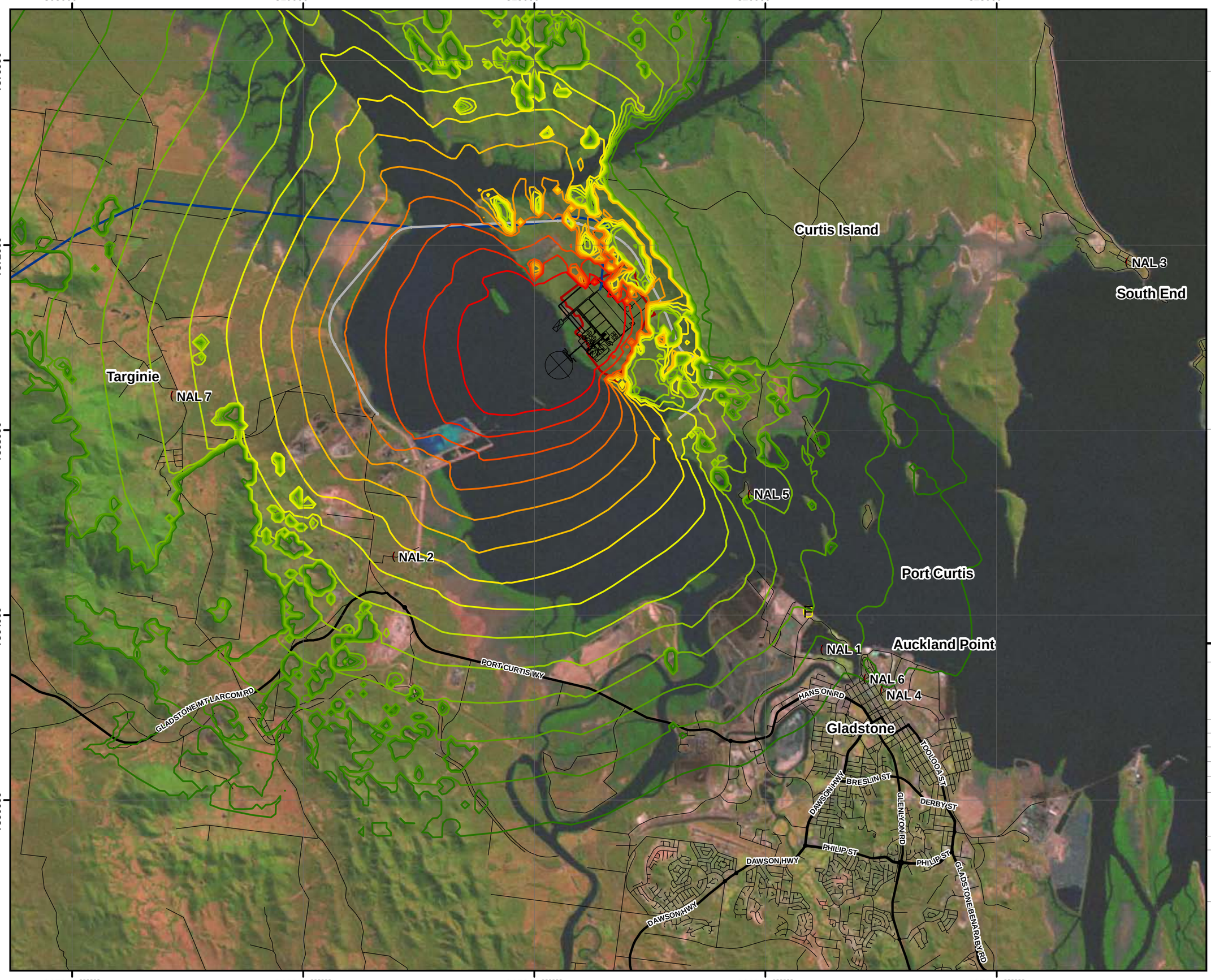
Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 3E

Plant Construction Noise Levels, Typical Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS010_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM

305000 000000 310000 000000 315000 000000 320000 000000 325000 000000

7376000 000000
7372000 000000
7368000 000000
7364000 000000
7360000 000000

Curtis Island
NAL 3
South End
Targinie
NAL 7
NAL 5
NAL 2
Port Curtis
Auckland Point
NAL 1
NAL 6
NAL 4
Gladstone
PORT CURTIS WY
GLADSTONE IMT LARCOM RD
HANSON RD
DAWSON HWY
BRESLIN ST
TOOLOOA ST
GLENLYON RD
DERBY ST
PHILIP ST
GLADSTONE BENARABY RD

QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 4E

Tank Slipforming Construction Noise Levels, Neutral Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS011_R2		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM

305000.000000 310000.000000 315000.000000 320000.000000 325000.000000

7376000.000000 7372000.000000 7368000.000000 7364000.000000 7360000.000000

Curtis Island

NAL 3

South End

Targinie

NAL 7

NAL 5

NAL 2

Port Curtis

NAL 1

Auckland Point

NAL 6

NAL 4

Gladstone

PORT CURTIS WY

GLADSTONE MT LARCOM RD

HANSON RD

TOOLOOA ST

DAWSON HWY

BRESLIN ST

GLENLYON RD

DERBY ST

PHILIP ST

GLADSTONE BENARABY RD

QUEENSLAND CURTIS LNG

A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels

- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 5E

Tank Slipforming Construction Noise Levels, Adverse Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS012_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Disclaimer:
Maps and Figures contained in this Report may be based on Third Party Data, may not to be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM

305000.000000 310000.000000 315000.000000 320000.000000 325000.000000

7376000.000000 7372000.000000 7368000.000000 7364000.000000 7360000.000000

Curtis Island

NAL 3

South End

Targinie

NAL 7

NAL 2

NAL 5

Port Curtis

NAL 1

Auckland Point

NAL 6

NAL 4

Gladstone

PORT CURTIS WY

GLADSTONE MT LARCOM RD

HANSON RD

TOOLOOA ST

DAWSON HWY

BRESLIN ST

GLENLYON RD

DERBY ST

PHILIP ST

GLADSTONE BENARABY RD

QUEENSLAND CURTIS LNG

A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels

- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 6E

Tank Slipforming Construction Noise Levels, Typical Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS015_R1		
Date:	20/03/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

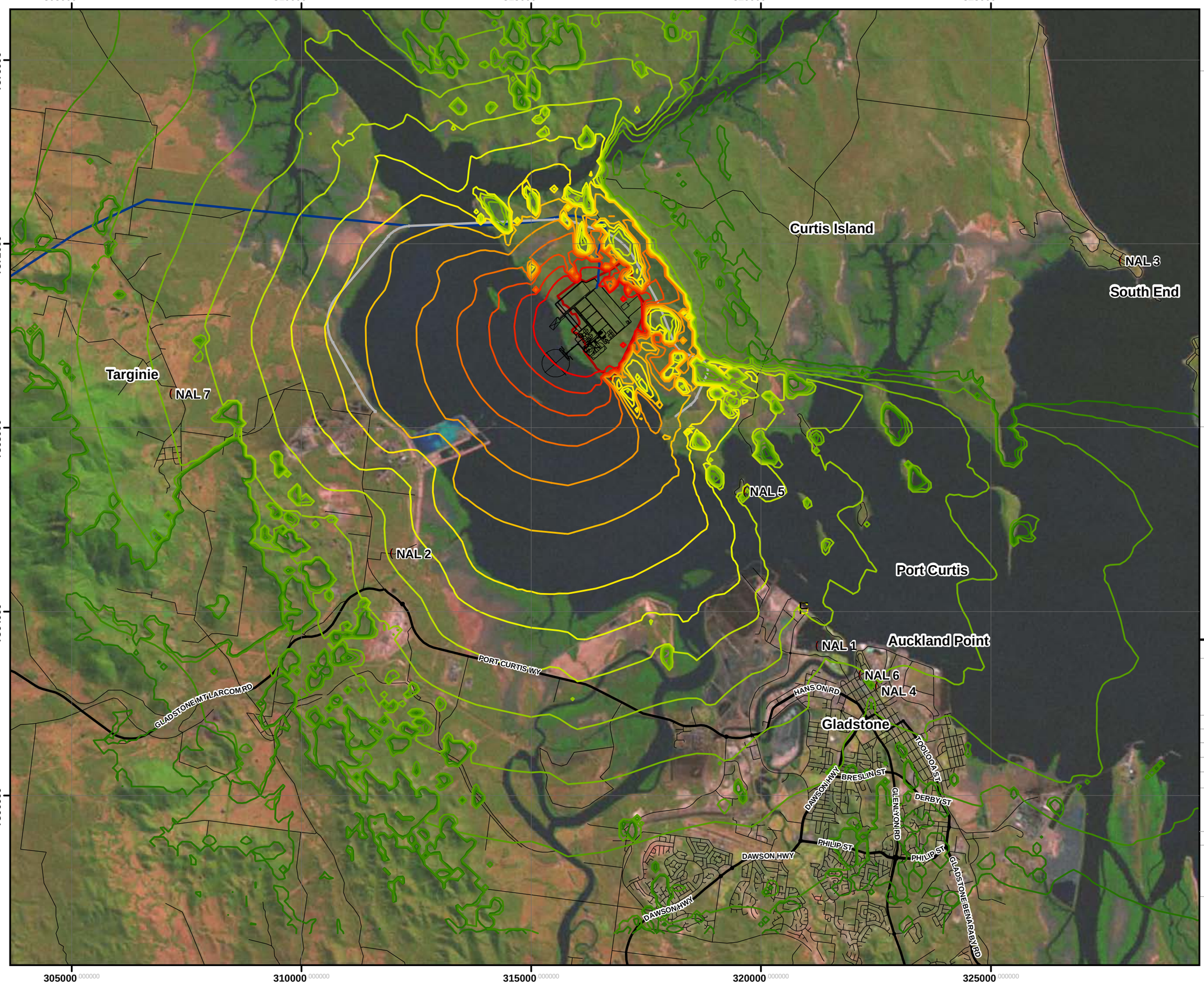
Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM

Annex F

Noise Contour Maps - Operations



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Roads
- Proposed Ferry Terminal

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 1F

Operational Noise Levels, 3-Train Model, Neutral Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS003_R1		
Date:	17/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	DB

N

0 0.5 1 2 km

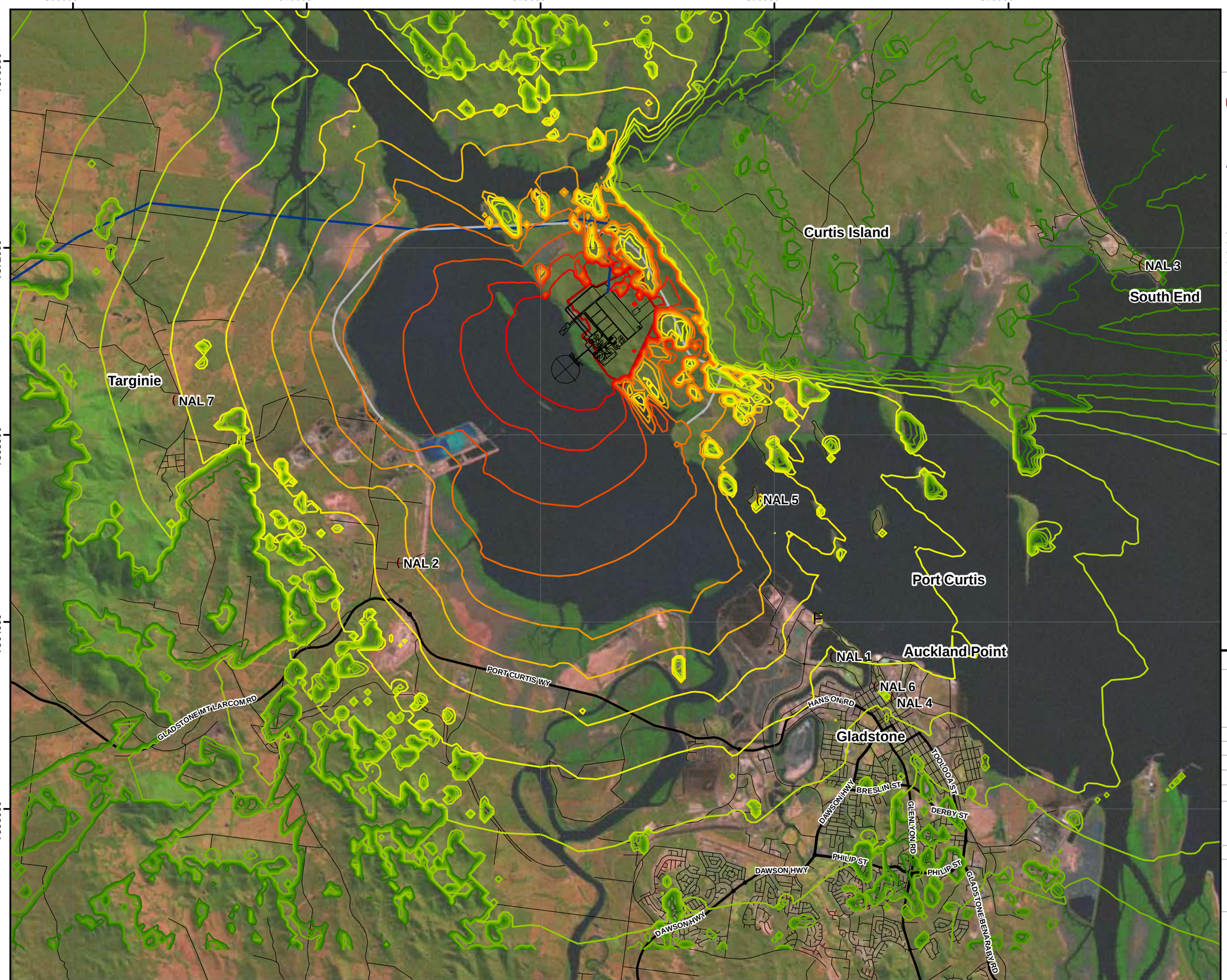
Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 2F

Operational Noise Levels, 3-Train Model, Adverse Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS004_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

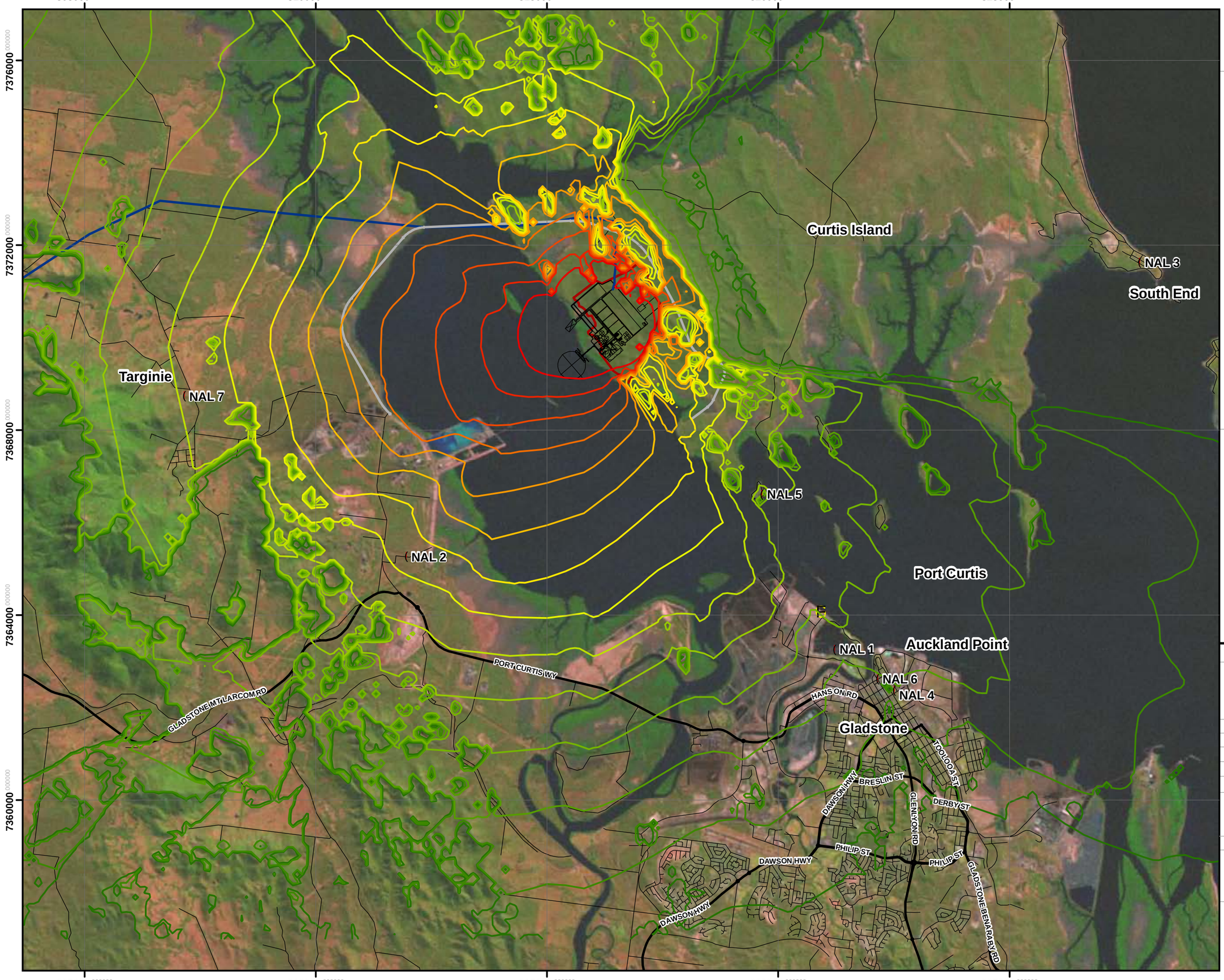
Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 3F

Operational Noise Levels, 3-Train Model, Typical Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS005_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

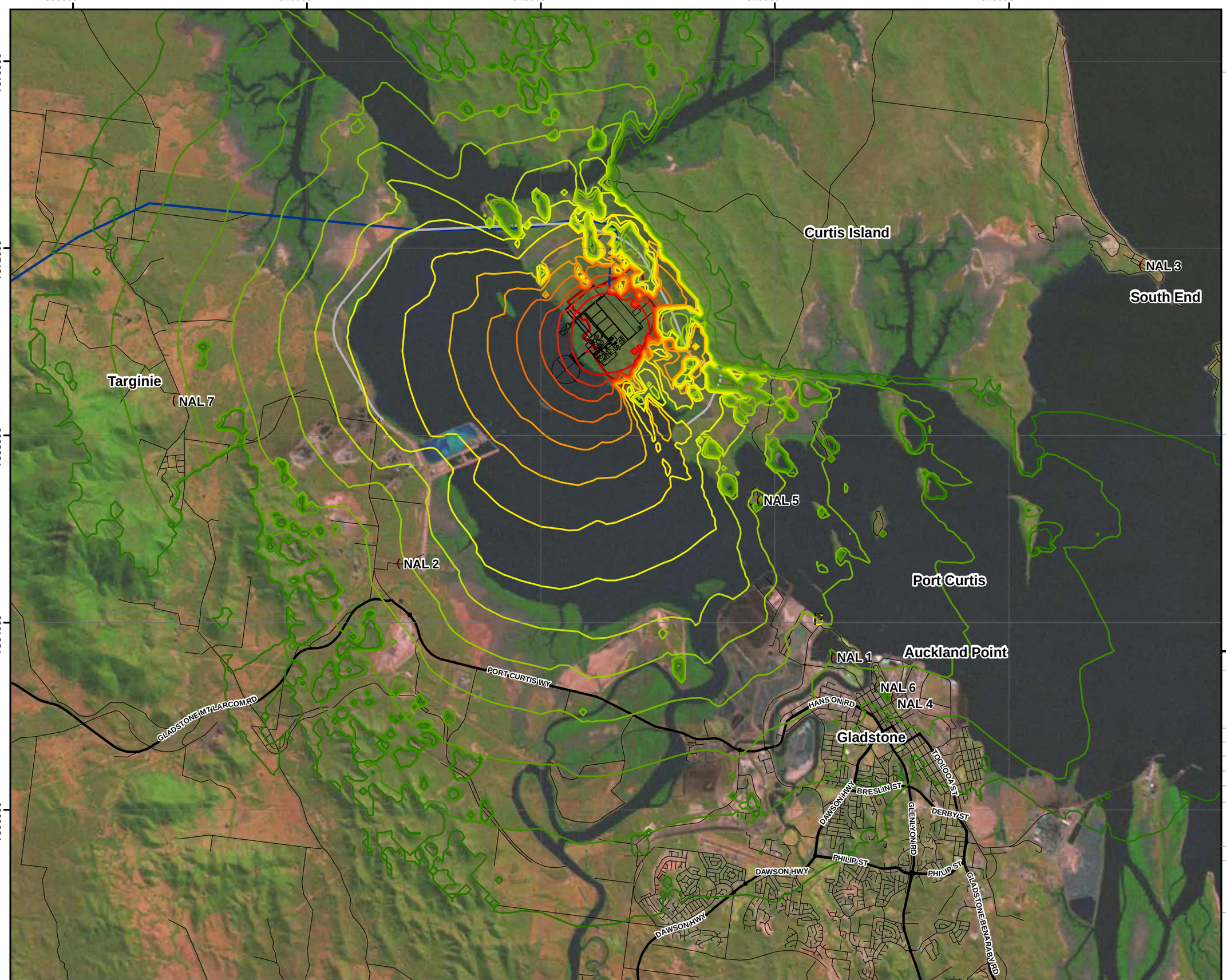
Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 4F

Operational Noise Levels, 1-Train Model, Neutral Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS006_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

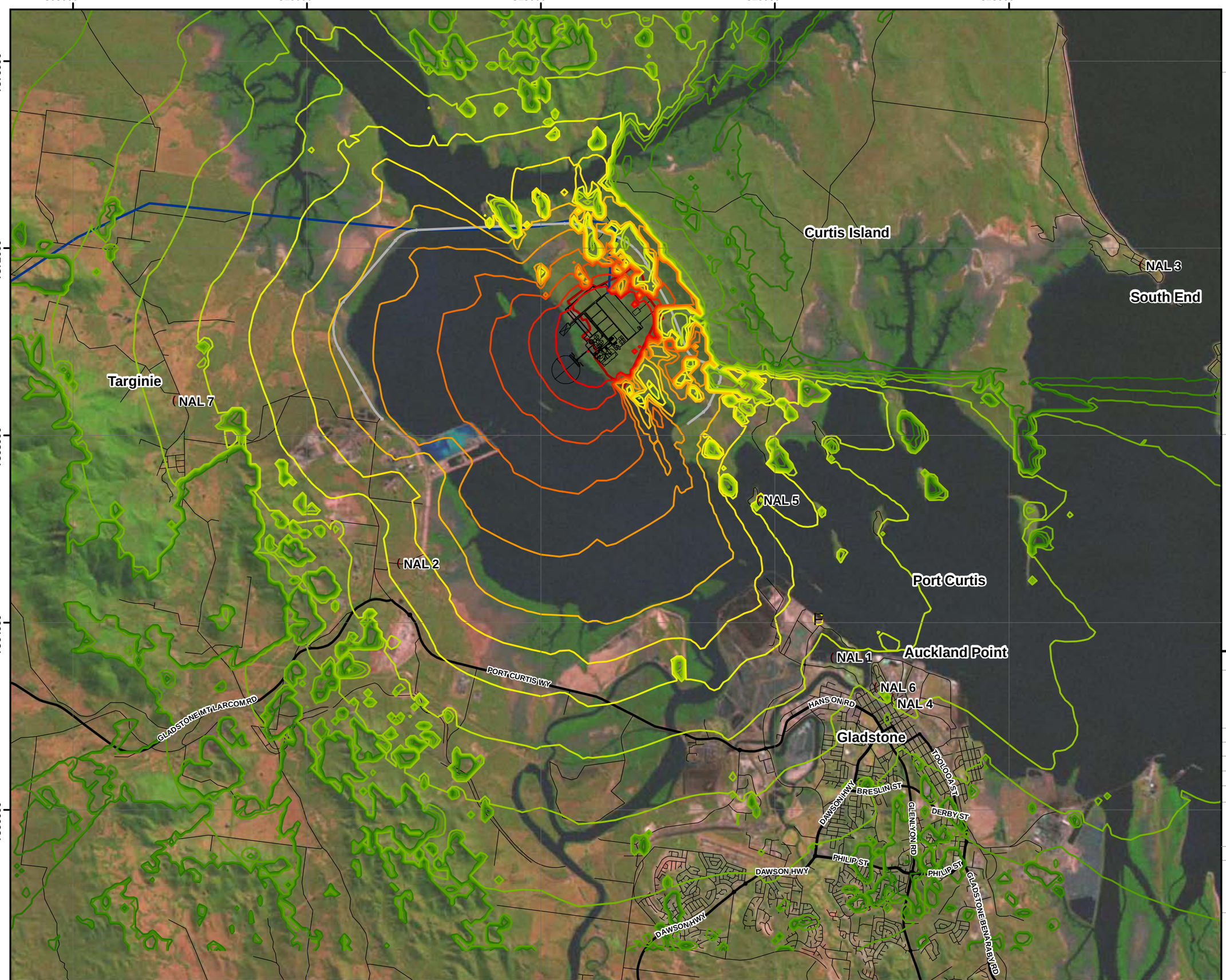
Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM



QUEENSLAND CURTIS LNG
A BG Group – QGC Alliance

Legend

- Approved LNG Site Boundary
- Noise Assessment Locations
- Proposed LNG Plant Layout
- Possible Bridge/Road
- Proposed Pipeline
- Proposed Ferry Terminal
- Roads

Noise Levels
- 15 dB(A)
- 18 dB(A)
- 21 dB(A)
- 24 dB(A)
- 27 dB(A)
- 30 dB(A)
- 33 dB(A)
- 36 dB(A)
- 39 dB(A)
- 42 dB(A)
- 45 dB(A)
- 48 dB(A)
- 51 dB(A)
- 54 dB(A)

Source Note:

Figure 5F

Operational Noise Levels, 1-Train Model, Adverse Weather Conditions

Client:	BG/QGC		
Project:	Queensland Curtis LNG Project		
Drawing No:	0086165s_AC_GIS007_R1		
Date:	13/02/2009	Drawing size:	A3
Drawn by:	JF	Reviewed by:	MS

N

0 0.5 1 2 km

Scale: 1:75,000

Projection: UTM MGA Zone 56 Datum: GDA 94

Disclaimer:
Maps and Figures contained in this Report may be based on Third Party Data, may not to be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.

Environmental Resources Management Australia Pty Ltd

Level 1, 60 Leichhardt St,
Spring Hill, QLD 4004
Telephone +61 7 38398393
Fax +61 7 38398381

ERM

Annex G

Site Boundary Noise Levels

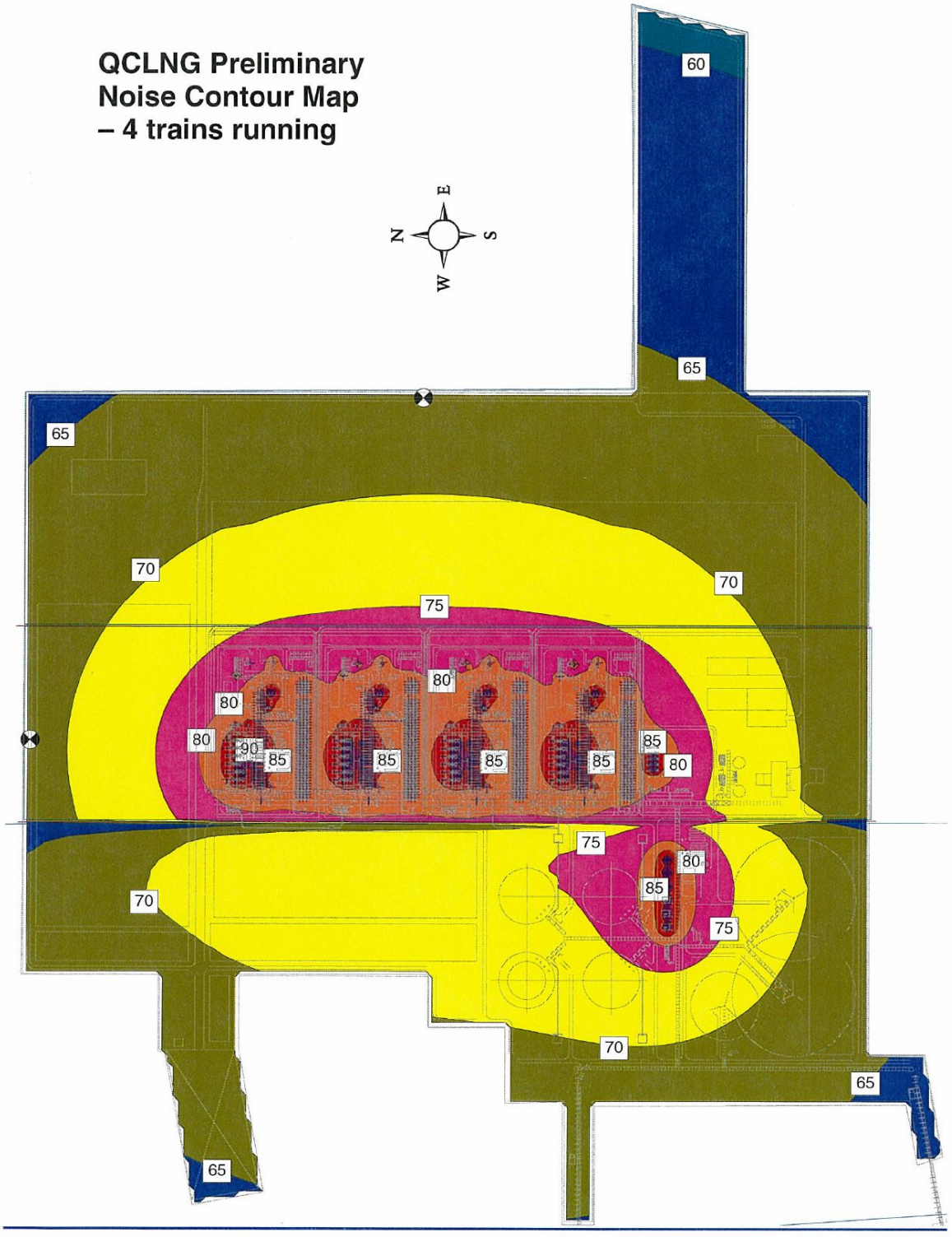


Fig. 1 Overall noise contours in the form of sound pressure levels at 1.5 m above grade (dBA, in 5 dB increments) – with 4 trains operating simultaneously