13 NOISE

13.1 INTRODUCTION

The development of the Queensland Curtis LNG (QCLNG) Project Gas Field Component will introduce a number of noise sources into a generally quiet rural environment. QGC is focused on managing noise impacts from the Gas Field development and the company intends to reduce to a practicable minimum any nuisance from noise. Since the submission of the QCLNG Project draft environmental impact statement (EIS), investigation of noise mitigation options has proceeded in parallel with the refinement of the Field Development Plan. Information from noise studies and mitigation has to date guided decisions about how the field will be developed and will continue to do so.

This chapter provides responses to submissions received on the draft EIS related to noise within the Gas Field.

Where changes to the Project description, as detailed in *Volume 2, Chapters 7* and *11*, have the potential to alter noise impacts, these impacts and associated mitigation measures are described.

Where reference is made in this chapter to noise criteria in relation to background levels the following qualification is assumed. ‘‘Background’’ refers to measured background except where the measured background lies below 25dB(A). In such a case the background level is deemed to be 25dB(A), as per the Department of Environment and Resources Management’s (DERM) EcoAccess Planning for Noise Control Guideline 2004.

13.2 RESPONSES TO SUBMISSIONS

Table 3.13.1 provides a summary of the submissions received on noise within the Gas Field and a response to those submissions.

Table 3.13.1 Responses to Submissions on the draft EIS

Issue Raised	QCLNG Response	Relevant Submissions(s)
Camps should be considered as sensitive receptors to which the same mitigation measures should be applied as other sensitive receptors.	QGC commits to taking measures to minimise disturbance to sleep of workers staying in camps that may arise as a result of plant noise. A variety of mitigation measures will be used, including site selection, mitigation of noise at source and the use of air conditioning in the habitable spaces of the camp. QGC believes the appropriate noise levels to apply are indoor noise levels as defined in AS2107.	10
The night time noise limit should be 3 dB(A).	A noise limit of 3 dB(A) lies below measured background levels and is thus not	12, 9

Issue Raised	QCLNG Response	Relevant Submissions(s)
Operations should be ‘‘inaudible’’. Detail the number of residents that will experience noise levels greater than 28 dB(A). Describe noise mitigation measures.	achievable. There will always be a zone around noise-producing equipment within which the noise is audible. As illustrated in this EIS, the zone within which the plant is audible is extensive and, given the density of residents in the field, it will be impracticable to make the plant inaudible at all residences. Refer to *Sections 13.5 and 13.6 and Table 3.13.15 f*or the number of residents that will experience noise levels greater than 28 dB(A) and noise mitigations proposed.	
The impact of continuous operations should be assessed based on a deemed background of 25 dB(A) and include a limit of background plus zero during evenings, nights and on Sundays and public holidays.	QGC does not believe, at this time, that these limits can be practicably achieved. Proposed noise limits are presented in *Section 13.4.1*. that will allow the Project to proceed while minimising noise disturbance. The operating scenario for fixed plant will be 24 hours per day, seven days per week.	32, 9
Describe the number of drilling operations and duration and noise levels of drilling activity.	Refer to *Sections 13.3.5, 13.4.4.5 and 13.5.6*	9

13.3 CHANGES TO PROJECT DESCRIPTION

Changes to the Project description are described in *Volume 2, Chapters 7* and *11.* The following changes in the Project description have resulted in a change to the assessment of noise impacts:

- power sources for field compression stations (FCSs) and central processing plants (CPPs) in the South East Development Area (SEDA) and Central Development Area (CDA), changing from gas to electric drive
- a change in the type of screw compressor and greater detail on the noise components of an FCS, including coolers and substations
- a change from reciprocating to centrifugal compressors at CPPs and greater detail on the noise components of a CPP, including coolers and substations
- greater detail on the noise components of water treatment plants (WTPs), including pumps and compressors
- water pumps and associated gas-drive engines
- introduction of flares rather than vents at wells
- greater detail on the noise levels of drill rigs
- potential for the use, later in field life, of compressors and associated gas-drive engines at certain well sites in order to reduce well pressure.

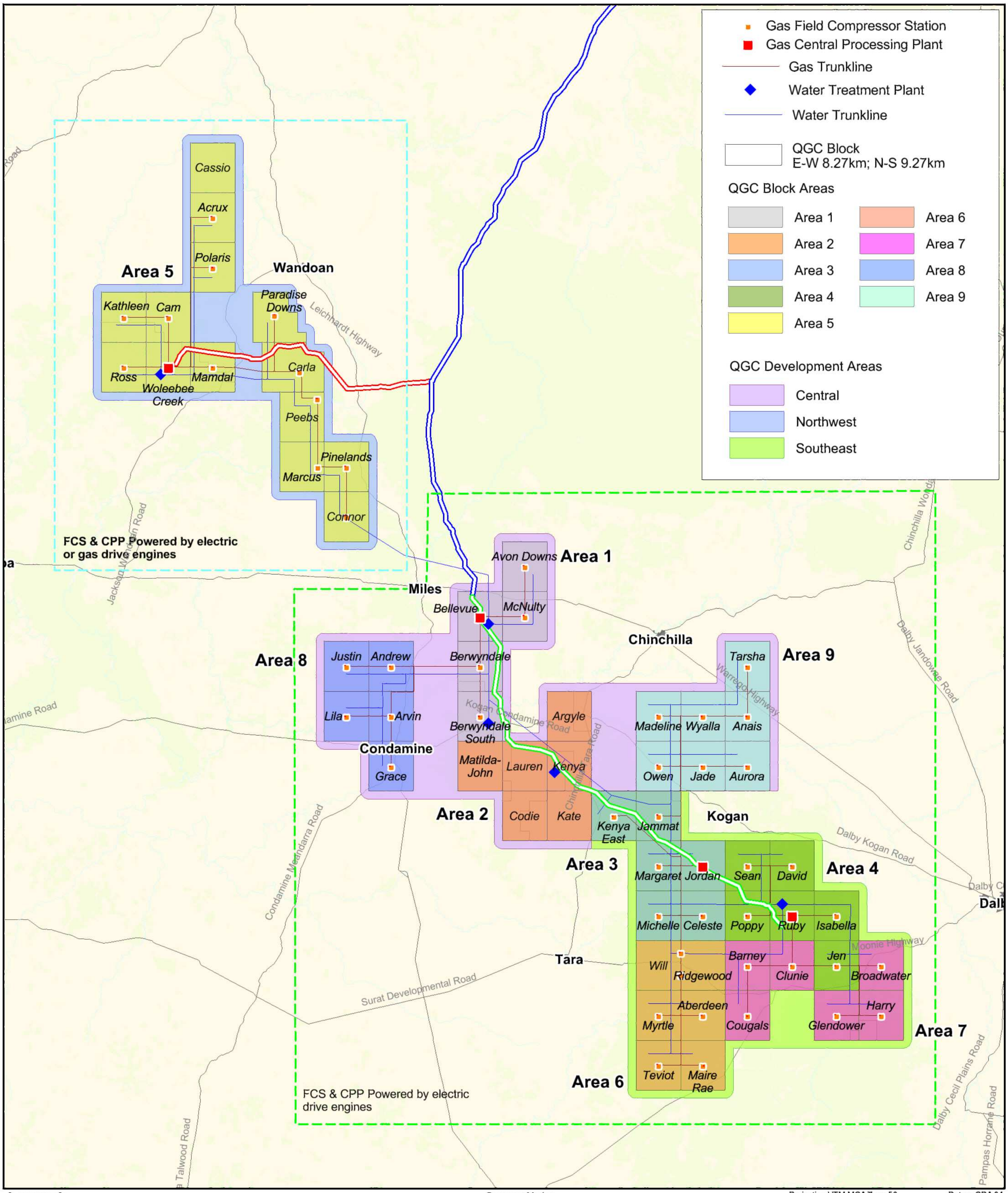
Where changes to Project description have been considered insignificant in relation to noise impacts, the changes have not been assessed in this section of the supplementary EIS.

The precise locations of plant are still being determined. For the purposes of the impact assessment therefore, notional locations of the equipment have been assumed. It is expected the impact assessment will tend to err on the conservative side therefore.

13.3.1 *Field Compressor Stations and Central Processing Plants*

The draft EIS assumed that all screw compressors at FCSs and reciprocating compressors at CPPs would be powered by gas-drive engines. The sEIS assumes that:

- all compressors at FCSs and CPPs in the CDA and SEDA will be powered by electric-drive engines or turbines connected to the electricity transmission grid
- all compressors at FCSs and CPPs in the North West Development Area (NWDA) will be powered by gas-drive engines or turbines
- *Figure 3.13.1* shows the Development Areas and the nominal locations of FCSs, CPPs and WTPs in the Gas Field.



Legend:

- Export Pipeline & Kilometre Point
- Upstream Infrastructure Corridor & Kilometre Point
- Woleebee Creek Route & Kilometre Point

Source Note:
1:250,000 Topographic vector copyright Geoscience Australia

Projection UTM MGA Zone 56 Datum GDA 94

0 10 20 30 40
Kilometres

N

QUEENSLAND CURTIS LNG A BG Group business	Project Queensland Curtis LNG Project		Title **Gas Field Areas and Major Facilities**
	Client QGC - A BG Group business		
ERM Environmental Resources Management Australia Pty Ltd	Drawn Unidel	**sEIS Volume 3 Figure S3.13.1**	Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.
	Approved CDP	File No: QC02-T-MA-00163	
	Date 20.01.2010	Revision Supplementary	

QGC is also investigating an alternative to supply power to the NWDA through electric motors, with power sourced from a connection to the grid or decentralised gas-powered turbines.

For the purposes of preparing a noise impact assessment, the maximum number of components of an FCS contributing to the overall sound power level of the FCS are:

- eight Aerial screw compressors
- eight CAT 3516 gas-drive engines in the NWDA only
- eight air cooled heat exchangers with fan
- two air compressors
- one nitrogen generation unit
- three transformers in the CDA and SEDA only.

For the purposes of preparing a noise impact assessment, the maximum number of components of a CPP contributing to the overall sound power level of the CPP are:

- three centrifugal compressors in the NWDA, 2 centrifugal compressors in the SEDA and 1 centrifugal compressor in the CDA
- three GE LM2500 gas-drive turbines in the NWDA only
- six, four and two air-cooled heat exchangers with fan and aftercooler in NWDA, SEDA and CDA respectively
- two air compressors
- two nitrogen generation units
- six transformers in the CDA and SEDA only.

For the purposes of noise modelling, 53 FCSs have been located near the centre of the majority of blocks and four CPPs have been located near the centre of Woleebee Creek, Bellevue, Jordan and Ruby blocks (refer to *Figure 3.13.1*).

The noise impact of flares at FCSs and CPPs has been assessed in the draft EIS.

13.3.2 Water Treatment Plants

The components of a WTP, including pre-treatment facilities, reverse osmosis (RO) plant, brine concentrator, amendment and blending plant and chemical storage, are as described in the draft EIS.

The final locations, configuration and design specifications for WTPs are being determined. For the purposes of assessing noise impacts from WTPs, it has been assumed that there will be three WTPs as follows: (refer to *Figure 3.13.1*)

- the WTP in NWDA will have 35 ML per day capacity, be co-located with the CPP in the Woleebee Creek block and be powered by a gas-drive engine
- the WTP in the CDA will have capacity of approximately 75 ML per day, be located with existing ponds in Kenya block and be powered by a gas-drive engine
- the WTP in the SEDA will have 65 ML per day capacity, be co-located with the CPP in the Ruby block and be powered by an electric-drive engine connected to the grid.
- The components of the WTPs contributing to the overall sound power levels are blowers, centrifuge, multiple pumps, air conditioners and compressors. For modelling purposes QGC has used available noise data for a WTP with a 63 ML per day capacity.

13.3.3 Flaring at Wells

Flaring will occur during certain planned maintenance activities and also in the event of an unplanned emergency. There is a range of potential flaring scenarios occurring between once every four years and twice per year. Flaring events range between five minutes and six hours. It is estimated that each well will flare 1 mmscf (28,300 m^3) per annum.

In addition to the above, flaring may occur during workover rig activities up to once every two years for a duration of approximately three days. Each workover flaring event will flare approximately 0.5 mmscf (14,150 m^3) per day.

During the exploration and appraisal program, certain wells in each area of the Project will be designated as “pilot’’ wells. Flaring will occur during testing of gas-flow rates of these wells with the test period lasting for up to six months. On average approximately 0.5 mmscf (14,150 m^3) will be flared per day. It is expected that up to 5 per cent of wells drilled may be tested as a pilot well.

The stack for well-site flares will be between 2 and 6 m high and between 150 and 250 mm diameter and designed to comply with all relevant standards.

13.3.4 Water Pumps

Each infield storage, regional storage, collection header and raw-water pond is likely to require a water pump. Over the life of the Project, approximately 150 to 200 water pumps will be required across the Gas Field, with approximately 40 per cent of pumps operating simultaneously at peak water flows. The noise components of water pumps have been modelled on the Cummins C1540 pump and the Waukesha L5794 gas-drive engine. There will be approximately three water pumps per block.

13.3.5 Drill Rigs

QGC has obtained source noise level measurements for drill rigs currently in use in the field on other QGC projects. Noise levels for the Ensign 34 and Wild Desert 65 drill rigs have been used for modelling noise impacts. It is probable that these, or similar, drill rigs will be used by QGC for the Queensland Curtis LNG (QCLNG) Project. Drill rigs will be required to drill each of the 6,000 wells, with up 500 wells drilled in any one year.

13.3.6 Wellhead Pressure Reduction

The following options (described in *Volume 2, Chapter 7*) to reduce wellhead pressure are under investigation:

- use of the installed compression capacity of screw compressors at the FCSs
- individual compressors with gas-engine drivers at wellheads, where required.

Wellhead pressure reduction will:

- be installed after approximately five to 10 years of well operation
- operate for the remaining life of the well (approximately 10 to 20 years).

Where screw compressors at FCSs are used to lower wellhead pressure, this will result in a greater number of screw compressors operating at an FCS towards the end of life of a group of wells. This is because a portion of the potential energy that could be used to compress gas is used to lower wellhead pressure. There will be a maximum of eight screw compressors at an FCS at any stage.

Individual wellhead compression provides an alternative mechanism to lower wellhead pressure, by installing a compressor and gas-drive engine at an individual well. In a local area where specific well productivity, the gas resource and configuration characteristics require it, up to 75 per cent of the local wells might have wellhead compression.

Final wellhead compressor specification, power sources, necessity at each well and period required at each well have not been determined. A screw compressor, the Howden XRV 204-193 and gas-drive engine, the caterpillar G3304 have been selected for assessing noise impacts from compression at the wellhead. For the purposes of impact assessment it has been assumed that wells will be located approximately 750 m apart.

13.3.6.1 *Scenarios for Impact Assessment*

Under the assumption that screw compressors at the FCS supply the majority of wellhead pressure reduction, then there would be a maximum of eight screw compressors at each FCS. Noise modelling of FCSs considers the worst case scenario of eight screw compressors at each FCS for all modelling.

It is expected that the majority of wellhead pressure reduction will be supplied by screw compressors at the FCS. Modelling of wellhead compression has considered a hypothetical worst case scenario for localised impacts from a group of 16 wellhead compressors located in a grid and spaced 750 m apart. Under this assumption the noise levels experienced at the centre of grid of wellhead compressors would be indicative of the maximum cumulative noise levels that could be experienced from a grid with 16 or more wellhead compressors. Any additional wellhead compressors to the grid of 16 would not contribute to noise levels experienced at the centre of the grid.

In addition the noise levels experienced from a single wellhead compressor and engine are modelled.

13.4 MODELLING INPUTS

13.4.1 Noise Limits

13.4.1.1 Operational Noise Limits

The operational noise limit criteria used in the draft EIS were:

- daytime (0700 to 1800 hours): 40 dB(A)
- evening (1800 to 2200 hours): 35 dB(A)
- night-time (2200 to 0700 hours): 28 dB(A)
- The noise limit is expressed as the $L_{Amax,adj,T,}$ which is approximated by the $L_{A10,adj,T}$ – the A-weighted sound pressure level, adjusted for tonality and/or impulsiveness, and exceeded for 10 per cent of the sample period T.

The noise criteria, used for modelling in the sEIS, are significantly lower than those used in the draft EIS and also those in many existing conditions on industrial development in rural Queensland.

In developing the noise criteria QGC considered:

- the Environmental Protection Act 1994
- the Environmental Protection Regulations 2008
- the Environmental Protection (Noise) Policy 2008 (EPP Noise)
- the EcoAccess Planning for Noise Control Guideline 2004 (Guideline)
- Australian Standards AS1055.1-1997 to AS1055.3-1997 (Acoustics – description and measurement of environmental noise)
- the Environmental Protection Agency Noise Measurement Manual (3rd Ed, 2000).

During night-time (10pm to 7am) the key environmental value to be protected under the EPP Noise is human health and wellbeing in relation to the ability to sleep. The EPP Noise states an acoustic quality objective for sleeping of

30 $L_{Aeq,adj,1\ hr}$ indoors during night-time. This equates to an outdoor limit of approximately 35-40 $L_{Aeq,adj,1\ hr}$.

Application of the Guideline to the study area, which is generally very rural, would result in a night-time limit of 3 dB(A) above background, with the background deemed to be 25 dB(A) where measured background levels are below 25 dB(A). As the measured background levels in the study area are likely to be below 25 dB(A), the Guideline would typically result in a night-time noise limit of 28 dB(A) which is well below the acoustic quality objective stated by the EPP Noise and considered reasonable to achieve an acoustic environment suitable for sleep. Therefore QGC does not consider it necessary to depart from the night-time limit applied in the draft EIS of 28 dB(A).

In relation to the daytime and evening, the qualities of the acoustic environment for learning and recreation become more important than sleep for human health and well being. The EPP Noise states an acoustic quality objective of 50 $L_{Aeq,adj,1\ hr}$ outdoors for the daytime and evening.

By applying the management hierarchy in the EPP Noise, including using best available technology, QGC considers that it can achieve significantly lower limits than the acoustic quality objective. These limits would be 10 dB(A) above background during the daytime and 5 dB(A) above background during the evening, resulting in limits of 35 dB(A) and 30 dB(A) respectively. These limits are well below the acoustic quality objective and the limits modelled for the draft EIS and are considered to result in a suitable acoustic environment for learning, recreation and the protection of community amenity.

The difference in the noise criteria between day, evening and night is because, using best available technology, the speed of cooling fans at CPPs and FCSs (and hence the noise from cooling fans) decreases from day to evening to night as ambient temperature declines.

Based on the above considerations, QGC has modelled the following noise criteria:

- daytime (0700 to 1800 hours): 35 dB(A)
- evening (1800 to 2200 hours): 30 dB(A)
- night-time (2200 to 0700 hours): 28 dB(A).

13.4.1.2 Construction Noise Limits

In contrast to operational activities, construction activities are transient at any one location. This is reflected in the proposed noise objectives.

Consistent with Section 440R of the *Environment Protection (EP) Act 1994*, in relation to building works, no noise limit is proposed for construction activities from Monday to Saturday, excluding public holidays, between 6:30am and 6:30pm.

Currently there are no Queensland guidelines for construction noise which is audible outside of the above times. At all other times (i.e. Sundays, public holidays and Monday to Friday 6:30pm to 6:30am) a construction noise objective of 50 dB(A) $L_{Aeq,adj,1\ hr,}$ measured outdoors at a sensitive receptor, has been adopted. This objective is not considered to be absolute in permitting construction activities. A construction noise management plan will be implemented to minimise and manage audible construction noise and address any complaints.

Construction noise includes noise from drilling.

13.4.2 Sensitive Receptors

Through ongoing analysis of spatial data, QGC has identified approximately 1,563 sensitive receptors in the Gas Field. This data has not been ground truthed and may include non-sensitive receptors such as sheds, barns or other unoccupied buildings.

13.4.3 Atmospheric and Ground Conditions

Atmospheric and ground conditions assumed in the model are the same as presented in *Volume 3, Chapter 13* of the draft EIS. The modelled conditions represent a worst case scenario without the inclusion of actual topographical data, as the final, exact location of infrastructure is not known.

13.4.4 Sound Power Levels

Sound power levels for the selected equipment were estimated using a variety of sources, including vendor data considered to be a reasonable representation of potential equipment, and assumptions about equipment dimensions and frequency bands. Refer to *Appendix 3.4* for details.

13.4.4.1 Field Compression Stations and Central Processing Plants

Sound power levels for FCSs and CPPs include standard noise mitigation measures such as acoustic enclosures around compressors and motors. An enclosure would be of an industrial type, typically constructed with a sheet metal outer, and an absorptive inner, faced with perforated sheet metal. Modelling has assumed a 100 mm thick acoustic enclosure around compressors and motors. The reduction in sound power levels of 100 mm enclosures at compressors and motors is approximately 35 dB(A) per component.

One of the components of the overall sound power level of FCSs and CPPs is a cooling fan. The sound power level of the cooling fans declines from day to evening to night as the ambient temperature declines and the intensity of cooling fan operations declines.

Sound power levels across frequency bands for the FCS are presented in *Table 3.13.2* for electric and gas drive engines and for day, evening and night.

Table 3.13.2 FCS Sound Power Levels

Drive	Time	FCS Noise Level SWL (dB) @ Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Electric	Day	118	117	117	113	108	106	100	94	88
Electric	Evening	114	112	112	108	102	100	94	89	93
Electric	Night	113	111	111	106	101	98	93	87	82
Gas	Day	118	117	117	113	108	107	102	97	94
Gas	Evening	114	112	112	108	103	103	99	95	94
Gas	Night	113	111	111	106	102	102	98	95	93

Sound power levels across frequency bands for the CPPs are presented in *Table 3.13.3* for electric and gas drive engines and for day, evening and night.

Table 3.13.3 CPP Sound Power Levels

Drive	Time	CPP Noise Level SWL (dB) @ Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Electric	Day	116	116	115	112	107	106	103	98	95
Electric	Evening	111	111	111	108	103	102	101	98	94
Electric	Night	110	109	110	107	102	101	101	97	94
Gas	Day	116	116	115	112	108	108	105	101	99
Gas	Evening	111	111	109	107	105	106	104	101	99
Gas	Night	110	110	108	105	104	105	104	101	99

13.4.4.2 *Water Treatment Plants*

The noise components of a WTP include pumps, engines and compressors. The overall sound power level for the WTP selected for noise modelling is 102.0 dB. The estimated sound power level frequency band for the modelled WTP is presented in *Table 3.13.4*.

Table 3.13.4 WTP Sound Power Level

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB	95.2	94.1	96.1	92.0	94.7	93.2	89.6	84.1	76.8

13.4.4.3 *Water Pumps*

Water pumps are assumed to be housed in an acoustic enclosure that provides approximately 26 dB(A) reduction in noise levels. The overall sound power level for an enclosed water pump is 95.2 dB(A). The estimated sound power level frequency band for an enclosed water pump is presented in *Table 3.13.5*.

Table 3.13.5 Water Pump Sound Power Level

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB	77.7	94.7	87.7	88.7	88.7	87.7	90.7	88.7	83.7

13.4.4.4 Flares at Wells

Pilot well flaring represents that only flaring event that is a continuous noise source. All pilot well flares will have a shroud to reduce noise levels. The overall sound power level for a shrouded flare that is flaring 0.5 million standard cubic feet (mmscf) (14,150 m^3) per day is 91 dB(A). The estimated sound power level frequency band for a pilot well flare is presented in *Table 3.13.6*.

Table 3.13.6 Pilot Well Flare Sound Power Level

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB	57.7	66.1	68.4	66.3	71.8	85.8	74.9	80.4	75.6

13.4.4.5 Drill Rigs

QGC has assessed the sound power levels of drill rigs currently in operation in the Gas Field. The drill rigs assessed, the Ensign 34 and Wild Desert 65, are expected to provide a reasonable representation of the noise of drill rigs to be used for the QCLNG Project. The overall sound power levels are 121.2 dB and 111.4 dB(A) for the Ensign 34 and 125.1 dB and 113.9 dB(A) for the Wild Desert 65. Noise-generating components include cranes/carriers, pumps, generators and compressors. Sound power level frequency bands for the two types of drill rigs are presented in *Table 3.13.7*.

Table 3.13.7 Drill Rig Sound Power Levels

Noise Source	Drilling Rig Noise Level SWL (dB) @ Frequency (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Ensign 34	118.9	111.5	112.6	107.2	108.0	107.3	104.2	99.3	91.2
Wild Desert 65	110.6	124.0	113.3	112.8	107.8	109.5	107.5	102.4	98.2

13.4.4.6 Wellhead Pressure Reduction

The sound power levels of eight screw compressors at the FCS are described in *Section 13.4.4.1.*

The overall sound power level for the combined wellhead compressor and engine is 108.5 dB. The estimated sound power level frequency band is presented in *Table 3.13.8*.

Table 3.13.8 Wellhead Compressor and Engine Sound Power Levels

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Noise level SWL dB	-	94.8	97.0	99.7	101.5	102.0	101.8	98.4	92.6

13.5 NOISE IMPACT ASSESSMENT

The noise levels (sound pressure levels) that would be experienced at certain distances from each type of infrastructure item in isolation are presented below. The impact of the combination of major facilities has then been modelled to assess the number of sensitive receptors that may exceed certain noise levels.

All noise sources modelled are tonal, except where stated below. A correction factor of +3 dB(A) has been added to the results for tonality, in accordance with Australian Standard AS1055.1-1997. In addition a correction factor, for the accuracy of the computer modelling, of +2 dB(A) has been added to the results, giving a total correction of +5 dB(A).

13.5.1 CPP in Isolation

For a CPP in isolation, *Table 3.13.9* provides the estimated distance, in metres, from the CPP that is required to achieve various sound pressure levels under the modelled conditions. There are six modelled scenarios; gas- or electric-drive engines operating during the day, evening or night.

Table 3.13.9 Noise Levels for a CPP in Isolation

Scenario	Period	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Electric drive	Day	3300	2750	2300	1650	1050	450
Electric drive	Evening	2400	1950	1700	1150	800	300
Electric drive	Night	2200	1800	1550	1100	750	300
Gas drive	Day	3400	2750	2400	1700	1200	500
Gas drive	Evening	2600	2200	1900	1400	1000	400
Gas drive	Night	2400	2050	1800	1300	900	400

13.5.2 FCS in Isolation

For an FCS in isolation, *Table 3.13.10* provides the estimated distance, in metres, from the FCS that is required to achieve various sound pressure levels under the modelled conditions. There are six modelled scenarios, gas- or electric-drive engines operating during the day, evening or night.

Table 3.13.10 Noise Levels for an FCS in Isolation

Scenario	Period	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Electric drive	Day	3600	2900	2450	1650	1100	500
Electric drive	Evening	2400	1900	1600	1050	650	250
Electric drive	Night	2100	1700	1400	900	600	200
Gas drive	Day	3600	2900	2500	1700	1150	500
Gas drive	Evening	2500	2000	1750	1200	800	300
Gas drive	Night	2300	1900	1600	1100	750	300

13.5.3 Water Treatment Plant in Isolation

For a WTP in isolation, *Table 3.13.11* provides the estimated distance, in metres, from the WTP that is required to achieve various sound pressure levels under the modelled conditions.

Table 3.13.11 Noise Levels for a WTP in Isolation

Scenario	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Single WTP	1150	900	800	500	300	100

13.5.4 Water Pump

For a water pump, with an acoustic enclosure, in isolation, *Table 3.13.12* provides the estimated distance, in metres, from the water pump that is required to achieve various sound pressure levels under the modelled conditions.

Table 3.13.12 Noise Levels for a Water Pump in Isolation

Scenario	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Single WTP	900	700	600	400	250	100

13.5.5 Flares at Wells

For a shrouded pilot well flare in isolation a sound pressure level of 28 dB(A) would be experienced at approximately 300 m.

13.5.6 Drill Rigs

For a drill rig in isolation, *Table 3.13.13* provides the estimated distance, in metres, from the drill rigs that is required to achieve various sound pressure levels under the modelled conditions.

Table 3.13.13 Noise Levels for a Drill Rig in Isolation

Drill Rig	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Ensign 34	2950	2450	2150	1550	1100	500
Wild Desert 65	4700	3600	3000	2000	1400	600

13.5.7 Wellhead Compressor in Isolation

For a wellhead compressor (including engine) in isolation, *Table 3.13.14* provides the estimated distance, in metres, from a wellhead compressor with and without noise attenuation measures that are required to achieve various sound pressure levels under the modelled conditions. Using an acoustic enclosure around the compressor and engine would be expected to attenuate noise levels by 20 dB(A).

Table 3.13.14 Noise Levels for a Wellhead Compressor in Isolation

Scenario	25dB(A)	28 dB(A)	30 dB(A)	35 dB(A)	40 dB(A)	50 dB(A)
Wellhead compressor (no attenuation)	1950	1650	1450	1050	700	300
Wellhead compressor with 20 dB(A) attenuation	500	400	300	200	100	< 100

13.5.8 Group of Wellhead Compressors

For the reasons described in *Section 13.3.6.1,* a group of 16 wellhead compressors spaced in a grid where each wellhead compressor is 750 m apart, has been modelled. It has been assumed that noise attenuation has been applied to the wellhead compressor and engine resulting in a 20 dB(A) reduction in noise levels.

For a residence centrally located within the grid of 16 attenuated wellhead compressors and engines, the noise level at this residence would be 26.6 dB(A). This is a purely hypothetical scenario for a conservative maximum number of wellhead compressors in a grouping with a residence in the worst possible location relative to the grouping. Even under this worst case scenario, noise limits experienced are less than 28 dB(A).

13.5.9 Noise Impacts for the Gas Field

Potential noise impacts for multiple noise sources, the CPPs, FCSs and WTPs in combination, were modelled across the Gas Field area and are presented below. Modelling was conducted for 53 FCSs, four CPPs and three WTPs operating in the nominal locations presented in *Section 13.3*.

For the purposes of the impact assessment, the location of each FCS, CPP or WTP has not been optimised for noise impacts at sensitive receptors.

The model defines the number of sensitive receptors that are located within the required separation distance to achieve various noise limits. As per *Section 13.4.2,* QGC has identified approximately 1,563 sensitive receptors in the Gas Field. The number and percentage of sensitive receptors in excess of noise limits is *Table 3.13.15*.

Table 3.13.15 Number and Percentage of Sensitive Receptors Exceeding Noise Limits

	Day	Evening	Night
dB(A)	35	30	28
Number of sensitive receptor exceeding criteria	87	86	97
Percentage exceeding criteria	5.6	5.5	6.2

No attempt has been made in the above modelling to locate FCSs, CPPs and WTPs at any location other than a nominal location at the centre of each block. This has resulted in CPPs, FCSs and WTPs being located at a distance to sensitive receptors that is insufficient to meet noise criteria, as there may be sensitive receptors located in close proximity to the centre of each block. The actual location of FCSs, CPPs and WTPs will be selected after considering proximity to sensitive receptors. It is expected that all FCSs, CPPs and WTPs can be located at the required separation distance to achieve noise limits stated in *Section 13.4.1*.

13.6 MITIGATION MEASURES

Considerable further work has been conducted in parallel to the Project design to investigate the potential and usefulness of noise mitigation measures. QGC will apply a range of noise mitigation measures, as described in *Volume 3, Chapter 13* of the draft EIS. In addition, mitigation measures for particular equipment or activities are presented below.

13.6.1 FCSs, CPPs and WTPs

Modelling of FCSs and CPPs assumed that certain noise attenuation measures were applied as standard. These comprise 100 mm acoustic enclosures for the engines and compressors.

The objective of modelling performed to date and presented above is to understand the extent of potential impact, give a constraint baseline on which to base initial site selection and to understand the extent of mitigation required to meet nominated limits.

In detailed design, more detailed noise modelling will be conducted at each location, once proposed, to account for topographical conditions and proximity to sensitive receptors. In addition, the practicability of low-noise cooling fans at FCSs and CPPs is being investigated as a mitigation measure. Detailed noise modelling may therefore result in a required separation distance to sensitive receptors that differs to the modelled separation distances presented above.

13.6.2 Water Pumps

QGC has modelled water pumps with standard noise attenuation measures. At distances greater than 700 m from an attenuated water pump, noise levels modelled will not exceed 28 dB(A). QGC considers that all water pumps will be located at least 700 m from the nearest sensitive receptor or, where this is not possible, additional mitigation measures will be applied.

13.6.3 Drill Rigs

Drill rig noise, at any one location, will last approximately three weeks. QGC considers that, as this is a temporary noise source of limited duration the construction noise objective of 50 dB(A) is appropriate. Modelling suggests this equates to a distance between rig and receptor of about 500 to 600 m. QGC will not conduct drilling activities within 200 m of a residence or other sensitive receptor. There may be instances where drilling occurs in closer proximity to sensitive receptors than 600 m (but not closer than 200 m). QGC will consult with landholders and neighbours potentially affected by drill-rig noise to seek agreement on measures that will minimise nuisance during the transitory drilling period.

13.6.4 Well Site Flares

Flaring at each production-well site will be infrequent and of short duration. The majority of flaring events will be planned maintenance activities and will occur during the day. Where the noise from such flaring may impact on sensitive receptors scheduling of activities will, as far as is practicable, avoid Sundays and public holidays. In addition, landholders and local residents will be consulted during the well construction about whether they wish to be informed in advance of planned maintenance activity.

Flaring at pilot-well sites is of longer duration and thus has a higher potential to cause nuisance if located close to sensitive receptors. Pilot-well flares will be shrouded to reduce the noise levels of the flare. With a shroud, it is estimated that sound pressure levels of 28 dB(A) will not be exceeded at approximately 300 m. Landholders and local residents who may be affected by pilot-well flare noise will be consulted in order to minimise the potential for nuisance.

13.6.5 Wellhead Pressure Reduction

Where reduction in wellhead pressure is supplied by screw compressors at FCSs, the measures described to mitigate FCS noise in *Section 13.6.1* will be applied.

If wellhead compressors are to be used as the means of reducing well pressure, site selection and use of acoustic enclosures for the noise sources will be applied to achieve required noise criteria at sensitive receptors.

Where distances from sensitive receptors allow, the need for mitigation would be less and QGC would not propose to use full enclosures.

13.6.6 General Mitigation Measures

For all ongoing operational activities, QGC will adopt a hierarchy of noise management based on the EPP for noise. This is:

Avoid

Site selection that indicates sensitive receptors are not affected using nominal noise criteria achieved through:

- mapping the locations of sensitive receptors
- modelling predicted noise separation distances for equipment
- undertaking detailed design stage modelling to include topographic features which may improve or compound noise effects.

Minimise

- Orientate equipment/facilities to:
    - select a location within a development area with features which do not compromise engineering but improve attenuation
    - undertake detailed design-stage modelling to include topographic features which may improve or compound noise effects
- best available technology for fixed facilities by selecting low noise equipment and attenuation measures which deliver the predicted separation distances required to meet nominal noise criteria.

Manage

- identify potentially affected receptors and engage in pre-development discussions
- undertake transitory activities by agreement with potentially affected receptors
- undertake mitigation at receptor for potentially affected receptors where nominal noise criteria cannot be met through other methods.
- monitor predicted noise versus actual for equipment operating within marginal locations and maintain contact with potentially affected receptors.

13.7 CONCLUSION

Further detail on noise sources associated with the QCLNG development has been presented in this chapter. Since the publication of the draft EIS, further design work has resulted in an overall increase in the number of noise sources and further investigation of noise mitigation measures has been conducted. This work is continuing and will be refined during detailed design.

For permanent noise sources such as FCSs, CPPs, WTPs, pumps and compressors, QGC will apply a combination of options presented in the draft EIS and sEIS to mitigate nuisance to sensitive receptors. Since the publication of the draft EIS further design and investigation of mitigation options has enabled more stringent noise criteria to be applied in the assessment of the Project. With the necessary mitigation measures, modelling indicates that the day, evening and night-time noise criteria (refer *Section 13.4.1*) are achievable. Noise mitigation measures will consider, where necessary, best practice engineering design. This includes:

- Electric-drive compressors at CPPs and FCSs
- enclosures around engines and compressors
- variable-speed fans
- low-speed fans.

For temporary activities at well sites and construction activities the proposed operational noise criteria, if applied, would seriously constrain development and prevent full recovery of the gas resource. Where site selection and physical mitigation measures at the noise source are not appropriate QGC proposes to manage the impact of noise through open engagement with those potentially affected.