

**Appendix F:**  
**Noise and Vibration Modelling  
Study**



**PHASE 2C AGRU AND CCS CONSTRUCTION  
NOISE AND VIBRATION ASSESSMENT**

**INPEX**

Rpt04-AU02122-06-Rev2-12 December 2024



## Disclaimer

*This Report has been prepared for Inpex by Wood, based on assumptions as identified throughout the text and upon information and data supplied by others.*

*The Report is to be read in the context of the methodology, procedures and techniques used, Wood's assumptions, and the circumstances and constraints under which the Report was written. The Report is to be read as a whole, and sections or parts thereof should therefore not be read or relied upon out of context.*

*Wood has, in preparing the Report, followed methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care. However, no warranty should be implied as to the accuracy of estimates or other values and all estimates and other values are only valid as at the date of the Report and will vary thereafter.*

*Parts of the Report have been prepared or arranged by Inpex or third-party contributors, as detailed in the document. While the contents of those parts have been generally reviewed by Wood for inclusion into the Report, they have not been fully audited or sought to be verified by Wood. Wood is not in a position to, and does not, verify the accuracy or completeness of, or adopt as its own, the information and data supplied by others and disclaims all liability, damages or loss with respect to such information and data.*

*In respect of all parts of the Report, whether or not prepared by Wood no express or implied representation or warranty is made by Wood or by any person acting for and/or on behalf of Wood to any third party that the contents of the Report are verified, accurate, suitably qualified, reasonable or free from errors, omissions or other defects of any kind or nature. Third parties who rely upon the Report do so at their own risk and Wood disclaims all liability, damages or loss with respect to such reliance.*

*Wood disclaims any liability, damage and loss to Inpex and to third parties in respect of the publication, reference, quoting or distribution of the Report or any of its contents to and reliance thereon by any third party.*

*This disclaimer must accompany every copy of this Report, which is an integral document and must be read in its entirety.*

# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>5</b>
<b>1 PROJECT OVERVIEW AND STUDY OBJECTIVES.....</b>	<b>6</b>
1.1 Ichthys Project Overview .....	6
1.2 IOAaCP Project- AGRU and CCS at Ichthys LNG Onshore .....	6
1.3 Objectives.....	7
<b>2 NOISE AND VIBRATION CRITERIA .....</b>	<b>9</b>
2.1 Construction Noise Limits.....	9
2.1.1 Northern Territory Noise Management Framework Guideline 2018.....	9
2.1.2 INPEX Phase 2c Onshore Basis of Design.....	10
2.2 Ground Borne Vibration .....	10
2.2.1 Human Comfort.....	10
2.2.2 Structural Integrity.....	11
2.2.3 Inpex's "Lower Priority Concern" Criteria.....	11
<b>3 ASSESSMENT METHODOLOGY.....</b>	<b>12</b>
3.1 Noise Modelling .....	12
3.1.1 Receiver Locations .....	12
3.1.2 Software / Prediction Algorithm .....	12
3.1.3 Topography.....	13
3.1.4 Ground Absorption Properties.....	13
3.1.5 Modelled Scenarios.....	13
3.2 Ground Borne Vibration .....	14
3.2.1 Human Comfort.....	14
3.2.2 Structural Integrity.....	15
<b>4 RESULTS .....</b>	<b>16</b>
4.1 Noise .....	16
4.1.1 Construction Noise Modelling.....	16
4.2 Ground Borne Vibration .....	16
4.2.1 Human Comfort.....	16
4.2.2 Structural Integrity.....	16
4.2.3 Shore Vibration Levels.....	17
<b>5 DISCUSSION .....</b>	<b>18</b>
5.1 Noise and Vibration Compliance .....	18
5.2 Intrusive Noise Characteristics .....	18
<b>6 CONCLUSION.....</b>	<b>19</b>
<b>7 REFERENCES.....</b>	<b>20</b>
<b>APPENDIX A EQUIPMENT SOUND POWER LEVELS.....</b>	<b>21</b>
<b>APPENDIX B NOISE CONTOURS.....</b>	<b>23</b>
Scenario 1 - Bored Piling and Construction Activities.....	24



Scenario 2- Cold Commissioning Activities..... 26

## EXECUTIVE SUMMARY

Inpex has engaged Wood to conduct a noise and vibration assessment of the construction phase of its Ichthys LNG Onshore AGRU and CCS Project (IOAaCP). The IOAaCP project is expected to involve upgrades to the existing AGRU (Acid Gas Removal Unit) Facility and the construction of new CCS (Carbon Capture and Storage) Facilities to supplement Inpex's wider decarbonization strategy.

Predictive noise modelling was undertaken to estimate construction noise levels<sup>1</sup> at selected sensitive receivers in the vicinity of Ichthys LNG Onshore. A construction vibration assessment was undertaken to determine the minimum set back distances for both human comfort and structural integrity of buildings.

The result of the assessment indicates that:

- Noise levels at all receivers are predicted to be below assigned noise limits in all scenarios assessed, and
- All receivers fall outside the minimum setback distances for both human comfort and structural integrity.

The risk of noise and vibration impacts is expected to be low. This is mainly due to the large distance between the project site and sensitive receivers.

---

<sup>1</sup> In accordance with the Northern Territory Noise Management Framework Guideline 2018, noise limits for construction noise exclude the contribution from existing operations at the gas plant.

# 1 PROJECT OVERVIEW AND STUDY OBJECTIVES

## 1.1 Ichthys Project Overview

Ichthys Field is an offshore gas condensate discovery located in the Browse Basin approximately 450km from Broome (Western Australia) and 840km from Darwin (Northern Territory).

The gas from the Ichthys field is transported to the Ichthys LNG Onshore facility located at Bladin Point in Darwin. Once received onshore, the gas is cooled and converted into liquid form suitable for transport.

The Ichthys LNG Onshore facility is depicted in Figure 1-1.



**Figure 1-1 : Ichthys LNG Onshore Facility**

## 1.2 IOAaCP Project- AGRU and CCS at Ichthys LNG Onshore

Upgrades to the AGRU and the construction of new CCS Facilities form the IOAaCP project.

### 1.3 Objectives

Wood was engaged by Inpex to undertake predictive modelling to assess noise and vibration levels at nearby sensitive receivers<sup>2</sup> due to construction activities associated with the IOAaCP project.

Objectives of this assessment were to:

- Predict construction noise levels at the selected receivers associated with:
  - Installation of bored Piles at 3 Locations in addition to general construction activities; and
  - Cold Commissioning- Includes potentially noisy activities such as leak testing, pump system testing, AGRU system cleaning, CO2 compressor testing and deluge testing.
- Assess predicted construction noise levels at the selected receivers against the assigned construction noise limits for residential receivers.
- Assess predicted ground borne vibration levels from construction against relevant criteria for human comfort and structural integrity.

Construction noise and vibration impacts are assessed separately from operational impacts from the existing plant in accordance with the NT *Noise Management Framework Guideline 2018* ) [1]. (Refer section 2).

The site map is depicted in Figure 1-2.

---

<sup>2</sup> The selected locations are representative of noise sensitive residences. Noise impacts on fauna are not considered.

---

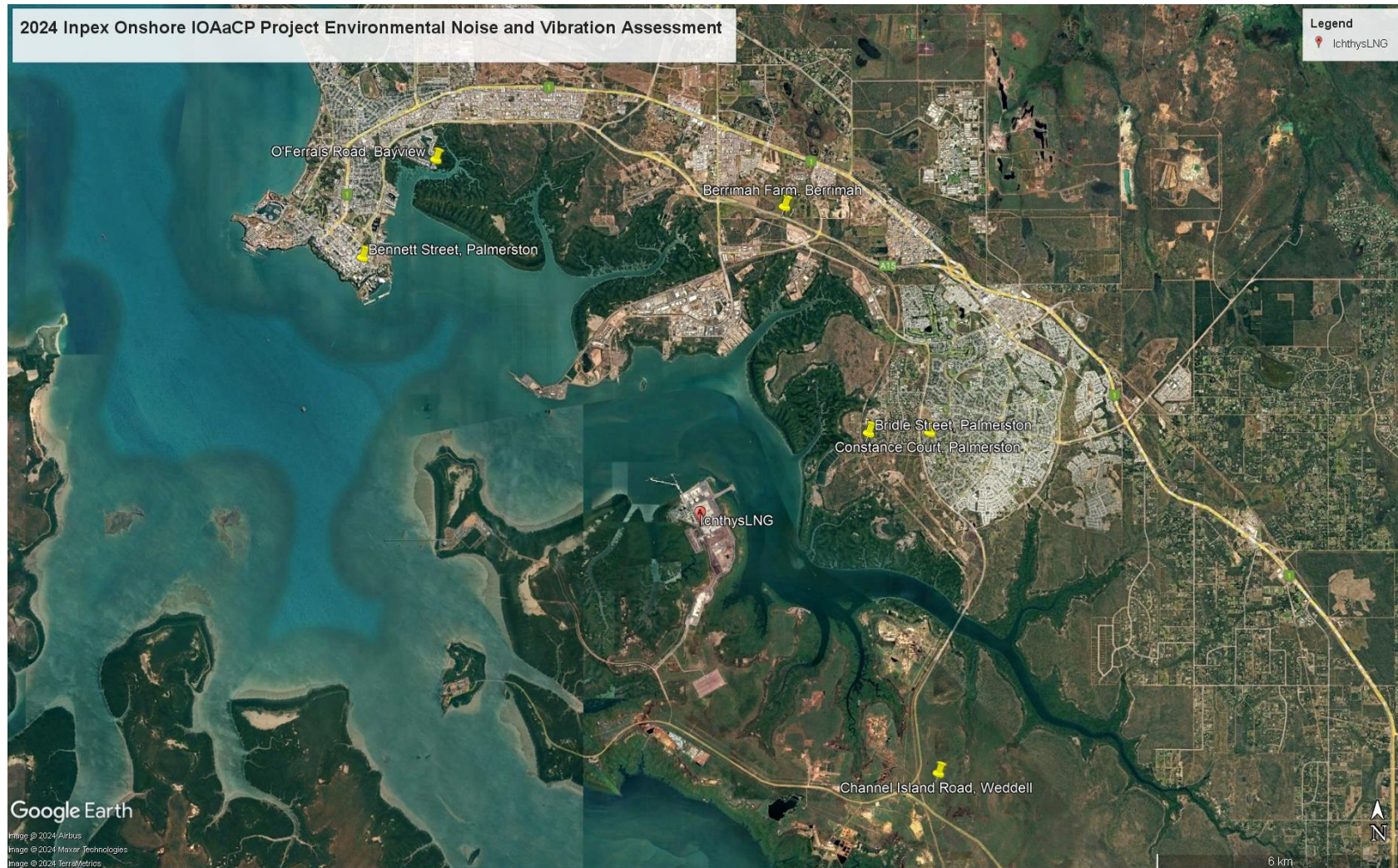


Figure 1-2 : Site and Receiver Map

## 2 NOISE AND VIBRATION CRITERIA

### 2.1 Construction Noise Limits

#### 2.1.1 Northern Territory Noise Management Framework Guideline 2018

Recommended assigned construction noise limits for residential receivers are described in the *Northern Territory Noise Management Framework Guideline 2018* (NT Noise Guideline) [1].

The noise limits apply to construction noise only, excluding the contribution from existing operations at the gas plant. This is evident from the following definition<sup>3</sup> of the  $L_{Aeq,(15min)}$  noise metric used to characterize construction noise:

*“The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the **construction** works under consideration over a 15-minute period and **excludes other noise sources such as from industry, road, rail and the community**”.*

For construction projects of greater than three weeks’ duration, the assigned construction noise limits are:

- Recommended Standard Hours<sup>4</sup>: - RBL (Rating Background Level) + 10 dB
- Outside Recommended Standard Hours: - RBL + 5 dB

The RBL is the single figure background level for the assessment period (day/evening/night) and is determined from measurements of the underlying ambient noise, excluding the noise source under investigation, when extraneous noise is removed.

As the measurement of background noise levels was excluded from the scope of this study, the minimum (most stringent) allowable RBLs of 30 dB(A), and 35 dB(A) have been assumed for evening/night and daytime periods respectively.

Because the works associated with the IOAaCP project are expected to be conducted both inside and outside the recommended hours, a conservative noise limit of 35 dB(A) has been adopted for this assessment (equivalent to nighttime RBL + 5).

---

<sup>3</sup> This definition appears in the *NSW Interim Construction Noise Guideline* from which the construction assessment procedures of the *Northern Territory Noise Management Framework Guideline 2018* have been adopted.

<sup>4</sup> Monday to Saturday 7am to 7pm, Sundays and Public Holidays (9am to 6pm)

## 2.1.2 INPEX Phase 2c Onshore Basis of Design

The Phase 2 C Basis of Design does not provide limits for construction noise but stipulates that the onshore facilities should be designed to meet the noise limits summarised in Table 2-1 as well as those in the NT Noise Guideline .

**Table 2-1 : Onshore Facilities Design Noise Limits**

Condition	Limit dB(A)
At night at residential, institutional and educational areas Nearest such location is Palmerston outskirts at grid reference 712598 E and 8617104 N	45
Along the site boundary	70

## 2.2 Ground Borne Vibration

### 2.2.1 Human Comfort

For assessment of the effects of human exposure to vibration from industry, transportation and machinery; NT Noise Guideline refers to sections 2.3 and 2.4 of the publication *Assessing Vibration: a technical guideline*, DEC (NSW) February 2006 [2].

Table 2.2 of *Assessing Vibration: a technical guideline* specifies preferred and maximum RMS acceleration values for continuous and impulsive vibration. Table 2-2 presents the preferred values in the z-axis for residences. The preferred values represent the most conservative vibration requirements of the publication.

**Table 2-2 : Vibration Levels for Human Comfort**

Location	Assessment period <sup>5</sup>	Preferred values RMS vibration acceleration, m/s <sup>2</sup>
<b>Continuous vibration</b>		
Residences	Daytime	0.01
	Night-time	0.007
<b>Impulsive vibration</b>		
Residences	Daytime	0.3
	Night-time	0.1

<sup>5</sup> Daytime is 7am to 10pm and night-time is 10pm to 7am

The NT Noise Guideline also refers to the *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* [3] in Section 4.2.2 as “other useful references”. *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* specifies minimum setback distances for Human response in relation to the criteria outlined in Table 2-2. Setback distances for relevant equipment are provided in Section 3.2.1.

### 2.2.2 Structural Integrity

The NT Noise Guideline references *BS 7385-1:1990- Evaluation and measurement of vibration in buildings* [4] to assess vibration induced damage to standard structures and building contents. The vibration guide for standard structures is provided in Table 2-3.

**Table 2-3 : Vibration Guide for Standard Structures**

Type of Building	Peak Component Particle Velocity (PPV) in Frequency Range of Predominant Pulse		Peak component particle velocity (PPV) - cosmetic damage screening limits
	4-15 Hz	15 Hz and above	
Reinforced or framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above		25 mm/s
Unreinforced or light framed structures, residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20 mm/s at 15Hz	20mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above	7.5 mm/s

The NT Noise Guideline also refers to the *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* in Section 4.2.2 as “other useful references”. *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* specifies minimum setback distances for Cosmetic damage in relation to the criteria outlined in Table 2-3. Setback distances for relevant equipment are provided in Section 3.2.2.

### 2.2.3 Inpex’s “Lower Priority Concern” Criteria

Wood understands that Inpex has existing criteria for vibration activities. Adopting vibration limits less than 10mm/s correlates to Inpex’s “Lower Priority Concern” criteria.

The vibration criteria for structural integrity in Table 2-3 provides a more stringent assessment of vibration than Inpex’s “Lower Priority Concern” criteria. As such, compliance with the structural integrity vibration criteria is expected to subsequently meet the requirements of Inpex’s “Lower Priority Concern” criteria.

## 3 ASSESSMENT METHODOLOGY

### 3.1 Noise Modelling

#### 3.1.1 Receiver Locations

The locations of the noise sensitive receivers are shown in Figure 1-2. Noise sensitive receiver coordinates are presented in Table 3-1.

**Table 3-1 : Receiver Locations**

Receiver	Easting	Northing
Berrimah Farm, Berrimah	710606	8622547
Bridle Road, Palmerston	712597	8617104
Channel Island Road, Weddell	714220	8608944
Constance Court, Palmerston	714073	8617104
Bennett Street, Palmerston	700403	8621401
O'Ferrals Road, Bayview	702187	8623745

#### 3.1.2 Software / Prediction Algorithm

Noise modelling for the Project noise study was undertaken using the proprietary software package SoundPLAN 8.2. The program calculates predicted sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources.

SoundPLAN provides a range of published noise propagation prediction algorithms that can be selected by the user. The modelling was undertaken using the alternative calculation methodology for A-weighted sound pressure levels (Chapter 7.3.2) under ISO 9613-2 outdoor sound propagation algorithm, which is widely used by industry [5].

The primary inputs required in SoundPLAN are noise source data, barriers/screens, ground topographical, absorption type data, meteorological conditions, and receiver point locations/calculation areas (for noise contours).

Table 3-2 summarises the noise model software and a selection of calculation parameters considered in for the noise study.

**Table 3-2 : Noise Model Parameters**

Model Parameter	Value
Proprietary modelling software package	SoundPlan 8.2

Model Parameter	Value
Calculation Algorithm	ISO 9613-2 outdoor sound propagation algorithm
Temperature	27.9C
Relative Humidity	70.4%
Air Pressure	100.7 kPa
Order of Reflection	3
Grid Resolution	50 metres
Prediction Height, Relative to ground level	+ 1.5 metres

### 3.1.3 Topography

Topographical data for the region was sourced from the Elevation Information System (ELVIS) service provided by Geoscience Australia.

### 3.1.4 Ground Absorption Properties

A conservative ground absorption factor of 0.5 was selected for this study.

### 3.1.5 Modelled Scenarios

Two scenarios were modelled representing the likely worst-case construction noise impacts for the IOAaCP project. Details of the noise sources included in each scenario are provided in Table 3-3. Sound power levels of each of the noise sources listed below have been sourced from Wood's in-house library and are provided in APPENDIX A.

**Table 3-3 : Modelling Scenarios**

Source	Number of Sources	
	Scenario 1	Scenario 2
	Bored Piling & Construction Activities	Cold Commissioning
<b>Piling and Impulsive Noise Sources</b>		
Bored Piling Rig	3	-
Pneumatic breaker	1	-
Hydraulic breaker	1	-
Pneumatic chipper	1	-
<b>Cold Commissioning</b>		
Water Pump	-	2
Compressor	-	2
<b>Earthworks</b>		

Source	Number of Sources	
	Scenario 1	Scenario 2
	Bored Piling & Construction Activities	Cold Commissioning
Front end loader	2	-
Backhoe	2	-
Bulldozer	3	-
Roller	2	-
Scraper	2	-
Grader	2	-
Truck (Loader)	6	-
Paver	2	-
<b>Material Handling</b>		
Concrete mixer	2	-
Concrete pump	2	-
Mobile crane	5	-
Cherry picker / Telehandler	5	-
Derrick Crane	1	-
<b>Power Supply</b>		
Diesel Generator	4	-
Compressor	5	-
<b>Other Equipment</b>		
Poker vibrator	2	-
Compressed air blower	3	-
Power saw	5	-
Electric drill	5	-
Air track drill	3	-
Grinder	3	-

## 3.2 Ground Borne Vibration

### 3.2.1 Human Comfort

Set back distances to comply with the most stringent vibration level have been sourced from *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* and are presented in Table 3-4.

The set back distance for vibratory piling has been used, as no data for bored piling was available. This is expected to provide a conservative estimate of the piling setback distance.

**Table 3-4 : Setback Distances – Human Comfort**

Equipment	Minimum Distance - Human Comfort
Pile Driver- Vibratory	20m
Medium Hydraulic Hammer	23m
Jackhammer	Avoid Contact with Structure

### 3.2.2 Structural Integrity

Safe working distances to comply with the vibration guide values have been sourced from *Transport for NSW - Construction Noise and Vibration Strategy, May 2018* and are presented in Table 3-5.

**Table 3-5 : Setback Distances – Structural Integrity**

Equipment	Minimum Distance – Structural Integrity
Pile Driver- Bored	2m (nominal)
Medium Hydraulic Hammer	7m
Jackhammer	1m (nominal)

## 4 RESULTS

### 4.1 Noise

#### 4.1.1 Construction Noise Modelling

The results of the noise modelling are presented in Table 4-1. Two noise contours for each scenario are provided in APPENDIX B, one showing the wide study area and one focusing on the plant site.

**Table 4-1 : Noise Modelling Results**

Receiver	Out of Recommended Hours Noise Limits (dBA)	Predicted Noise Level (dBA)	
		Scenario 1- Bored Piling	Scenario 2- Cold Commissioning
Berrimah Farm, Berrimah	35	20.9	< 20
Bridle Road, Palmerston		30.3	< 20
Channel Island Road, Weddell		< 20	< 20
Constance Court, Palmerston		26.4	< 20
Bennett Street, Palmerston		< 20	< 20
O'Ferrals Road, Bayview		< 20	< 20

### 4.2 Ground Borne Vibration

#### 4.2.1 Human Comfort

All sensitive receivers are positioned outside the minimum set back distance for human comfort. The nearest sensitive receiver is in Palmerston, approximately 4.2km away from the Inpex LNG Onshore Facility. Nil human comfort vibration impacts at sensitive receivers are expected as a result of the construction activities.

#### 4.2.2 Structural Integrity

All sensitive receivers are positioned outside the minimum safe working distance for structural integrity. The nearest sensitive receiver is in Palmerston, approximately 4.2km away from the Inpex LNG Onshore Facility. Nil human structural integrity vibration impacts at sensitive receivers are expected as a result of the construction activities.



### 4.2.3 Shore Vibration Levels

The nearest shoreline to the construction activities is located approximately 200m away from the facility. At this distance, the vibration levels are expected to be lower than the most stringent structural integrity criteria for this assessment (7.5 mm/s PPV).

## 5 DISCUSSION

### 5.1 Noise and Vibration Compliance

The following points summarise key findings from the noise and vibration modelling:

- Noise levels are predicted to be below the assigned noise limits for both scenarios assessed, and
- Vibration impacts at all sensitive receivers are predicted to be negligible due to large distances between the project site and assessed sensitive receivers.

### 5.2 Intrusive Noise Characteristics

The NSW Interim Construction Noise Guideline<sup>6</sup> suggests that 5 dB should be added to predicted noise levels for a number of activities which have proven to be particularly annoying to nearby residents. Some of the activities / equipment identified for construction scenario 1 in Table 3-3 may exhibit annoying characteristics at source. However, due to the large propagation distances and resultant low predicted noise levels, it is unlikely that these characteristics would be evident at the receptors considered, with the possible exception of the closest noise sensitive receptors in Palmerston. If a 5 dB correction were applied at Palmerston, then the predicted levels, adjusted by adding 5 dB would be very close (+0.3 dB) to the nighttime construction assigned noise level.

---

<sup>6</sup> The NSW Interim Construction Noise Guideline defines the procedures for assessing construction noise which have been adopted by the NT Northern Territory Noise Management Framework Guideline 2018.

## 6 CONCLUSION

A predictive noise and vibration assessment was undertaken to quantify the impact of the Inpex LNG Onshore IOAaCP construction works on sensitive receivers.

The results of the assessment indicate that the predicted noise and vibration levels at all sensitive receivers are compliant with the relevant criteria for all construction scenarios assessed.

There is a small risk that noise received at the closest receivers in Palmerston may exhibit intrusive characteristics which would require a correction of 5 dB to predicted noise levels resulting in a marginal exceedance (0.3dB) of the nighttime construction assigned noise level at this location. However, due to the large propagation distances and resultant low predicted noise levels, it is unlikely that these characteristics would be evident at most receptors.

## 7 REFERENCES

- [1] Northern Territory Noise Management Framework Guideline, September 2018
- [2] Assessing Vibration: a technical guideline, DEC (NSW) February 2006
- [3] Transport for NSW - Construction Noise and Vibration Strategy, May 2018
- [4] BS 7385-1:1990- Evaluation and measurement of vibration in buildings, November 1990
- [5] International Standards Organisation, "Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation," ISO 9613-2:1996.

## APPENDIX A EQUIPMENT SOUND POWER LEVELS

Equipment	Octave Band Sound Power Levels (SWL), dB								Overall Sound Power Level (SWL), dBA
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
<b>Piling and Impulsive Noise Sources</b>									
Bored Piling Rig	102	101	104	106	106	105	92	90	111
Pneumatic Breaker	113	113	111	114	108	108	105	101	115
Hydraulic Breaker	106	106	104	107	101	101	98	94	108
Pneumatic Chipper	69	82	92	98	106	107	105	101	112
<b>Cold Commissioning</b>									
Water Pump	97	98	99	101	101	104	101	97	109
Compressor	78	76	80	86	76	74	71	64	85
<b>Earthworks</b>									
Front End Loader	109	114	105	105	104	102	100	90	109
Backhoe	107	99	97	97	96	93	92	83	101
Bulldozer	81	99	104	112	109	111	102	88	115
Roller	97	100	106	103	99	95	88	80	105
Scraper	111	118	115	107	107	105	101	93	113
Grader	111	118	115	107	107	105	101	93	113
Truck	113	113	106	101	100	96	93	90	105
Paver	98	103	100	98	97	96	93	86	103
<b>Material Handling</b>									
Concrete Mixer	114	103	100	104	105	103	98	92	109

Equipment	Octave Band Sound Power Levels (SWL), dB								Overall Sound Power Level (SWL), dBA
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
Concrete Pump	97	98	99	101	101	104	101	97	109
Mobile Crane	99	101	112	110	113	106	103	97	115
Cherry Picker /Telehandler	82	90	97	97	96	98	97	91	104
Derrick	97	98	99	101	101	104	101	97	109
<b>Power Supply</b>									
Diesel Generator	86	94	101	101	100	102	101	95	108
Compressor	96	91	91	90	93	96	96	94	102
<b>Other Equipment</b>									
Poker Vibrator	87	95	95	89	87	86	84	81	94
Compressed Air Blower	92	100	113	102	99	99	97	93	108
Power Saw	89	106	98	97	97	99	103	102	108
Electric Drill	95	94	95	92	94	95	100	100	105
Air Track Drill	105	104	105	102	104	105	110	110	115
Grinder	95	94	95	92	94	95	100	100	105



## APPENDIX B NOISE CONTOURS

### Scenario 1 - Bored Piling and Construction Activities





### Scenario 2- Cold Commissioning Activities



