

22

NOISE AND VIBRATION

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22 Noise and Vibration

22.1 Introduction

Noise and vibration from operational and construction activities associated with the Project have the potential to cause adverse impacts on the environment.

This section of the EIS aims to identify the environmental values of typical sensitive receptors, investigate the potential impact on the existing acoustic environment and recommend mitigation measures, as required by the ToR for the Project.

This assessment has been performed in accordance with the terms of *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities*, other relevant Queensland Government guidelines, Australian Standards and the *Environmental Protection (Noise) Policy 2008* (EPP (Noise)).

Full details of the noise and vibration impact assessment, methodology and results can be seen in the Noise and Vibration Technical Report (Appendix S) of the EIS. A cross reference to the locations where each of the requirements of the ToR has been addressed is given in Appendix B which references both the study chapters (Sections 1 through 34) and/or the Appendices (A through EE).

22.2 Assessment Methodology

To satisfy the aims of this study the following methodology has been adopted.

22.2.1 Determine Environmental Values

The environmental values for the receptor types located in the study area have been identified from Schedule 1 of the EPP (Noise). A baseline noise survey was performed at 10 locations (see Figure 22-1).

22.2.2 Meteorological Conditions

A review of the predominant meteorological conditions was performed to determine the appropriate conditions for noise modelling. This was done using data obtained and modelling performed as part of the Air Quality chapter (Section 9) and Air Quality Technical Report (Appendix H) of this EIS.

22.2.3 Establish Criteria

Criteria have been established primarily using the guideline *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities* (EHP, 2012). Additional criteria are proposed to address low-frequency noise, blasting, and vibration.

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22.2.4 Noise Modelling

Noise modelling has been performed to determine the necessary setback distances where the Project criteria can be achieved without mitigation. Similarly, the modelling has determined indicative mitigation packages for a series of different distances where the setback distance is not practicable.

As the sites have not been selected, the noise model has been used to predict emissions from conceptual layout designs of typical noise-producing facilities, without any terrain screening, assuming maximum operational capacity and meteorological conditions favourable to sound propagation.

The following production and processing facilities were assessed:

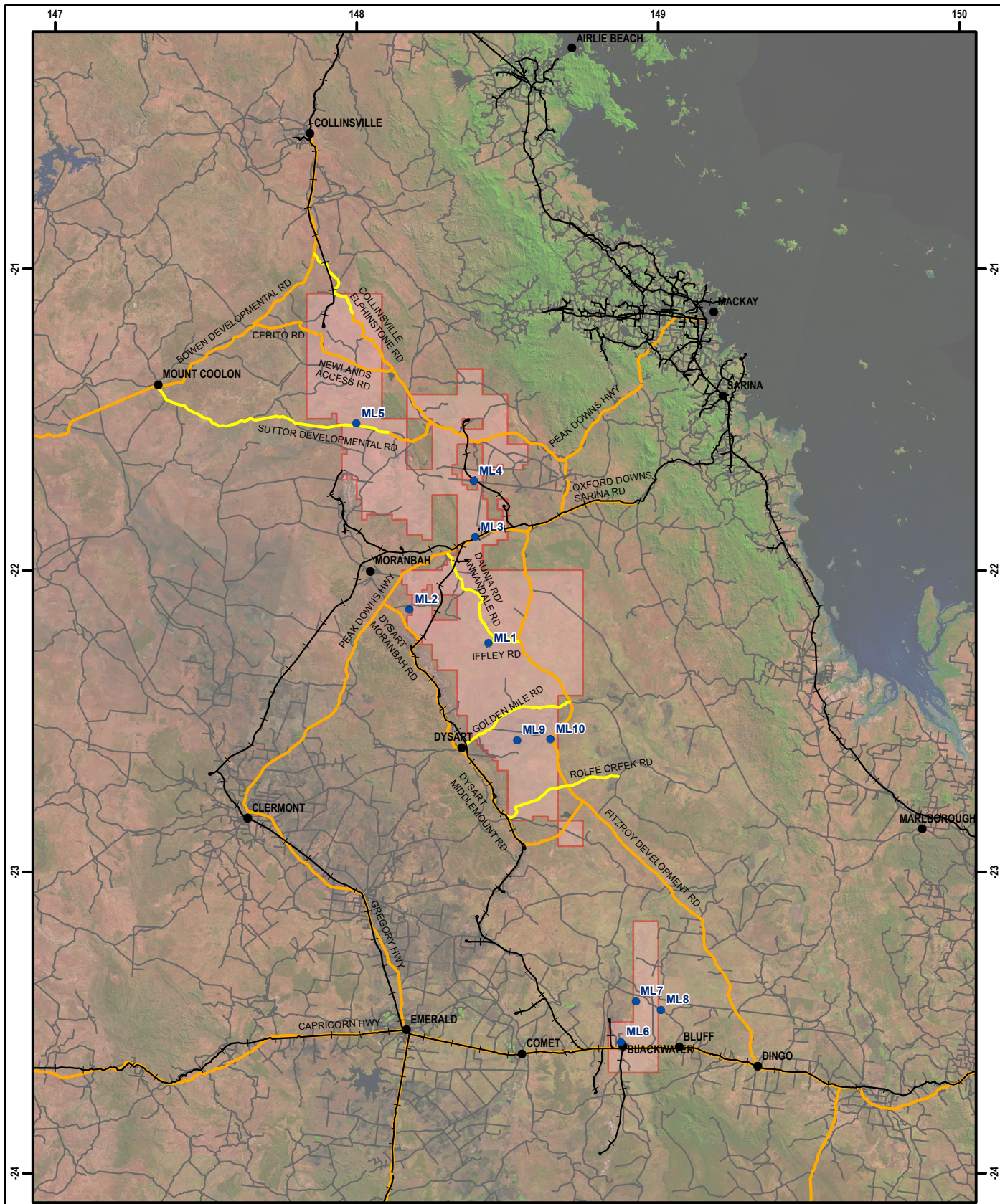
- Well sites (initial drilling, completion, work over, hydraulic stimulation and ongoing operation);
- Field compression facilities (FCFs) at a production capacity of 120 terajoules per day (TJ/d) (expected largest FCF capacity);
- Central gas processing facilities (CGPFs) at a production capacity of 210 TJ/d (expected largest CGPF / integrated processing facilities (IPF) capacity); and
- IPFs at a production capacity of 210 TJ/d.

22.2.5 Develop Mitigation Packages

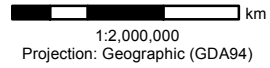
A series of mitigation packages were developed for the Project, whereby source noise levels are reduced through engineering treatment. Where required, these mitigation packages will be used and a matrix of indicative mitigation requirements and distances from nearest receptors has been prepared. The mitigation packages are detailed in Tables 5–8, 5–9 and 5–10 of the Noise and Vibration Technical Report (Appendix S) of this EIS.

22.2.6 Assess Residual Impact

The residual noise impact after mitigation has been assessed by comparing these to the likely background noise levels and the environmental values from the EPP (Noise).



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- | | |
|---|---|
| Bowen Gas Project Tenements | Road Type |
| ● Noise Monitoring Location | Sealed |
| Railway | Mostly Unsealed |

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BOWEN GAS PROJECT EIS

NOISE MONITORING LOCATIONS



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Figure: **22-1**



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22.3 Environmental Values

The environmental values stated in the EPP (Noise) aim to preserve or enhance qualities of the acoustic environment in order to protect human health and wellbeing, ensure suitable environments to sleep, study or learn, be involved in recreation, relaxation and conversation, and protect the amenity of the community.

The quality objectives considered in this assessment for sensitive receptors (dwellings), set to preserve the environmental values are:

- 50 decibels – A – weighted (dB(A)) $L_{Aeq,adj,1h}$ externally and 35 dB(A) internally during daytime or evening (07:00-22:00h); and
- 30 dB(A) internally at night (22:00-07:00).

Baseline survey

A field noise survey was completed in April 2012 to describe the existing acoustics environment at typical sensitive receptors across the study area. Additional information from a survey carried out by URS during April and May of 2011 for the Bow Energy CSG Project (URS, 2011) was considered in this assessment (the previous Bow Energy tenements now form part of the Project).

Ten monitoring locations were used to describe different conditions of sensitive receptors in the Project area where the great majority are located within rural settings with very low background noise levels. The monitoring locations are listed in Table 22–1 and Figure 22–1 shows a plot of the locations on a map in reference to the study area.

Table 22-1 Noise Monitoring Locations

Monitoring Location	Locality	Coordinates (GDA94, Zone 55K)	
		Easting	Northing
Arrow Energy, April 2012			
ML1	Vermont Park Road, Valkyrie	648134	7539696
ML2	Winchester	621221	7552340
ML3	Coppabella	643982	7578821
ML4	Kemmis	643708	7599368
ML5	Lenton Downs, Burton	603421	7620804
Bow Energy, April-May 2011			
ML6	6 Hunter Street, Blackwater	691571	7392580
ML7	New Caledonia Homestead, Bluff-Jellinbah Rd, Bluff	696878	7407608
ML8	Dunluce Homestead, Bluff-Jellinbah Rd, Bluff	705214	7404337
ML9	Picardy Homestead, Golden Mile Rd, Dysart	657516	7504016
ML10	Cosmos Homestead, Fitzroy Developmental Rd, Dysart	668935	7504249

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The measurements were undertaken in accordance with the *Noise Measurement Manual* (Qld EPA, 2000) and the assessment periods are those from *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities* (EHP, 2012).

The determined representative daily background and ambient noise levels during the daytime, evening, night-time and early morning shoulder periods for each location are summarised in Table 22–2.

Table 22-2 Summary of Unattended Monitoring Results

Monitoring Location	Background Noise Levels L _{A90} (dB(A))				Ambient Noise Levels L _{Aeq} (dB(A))			
	Day (0700-1800)	Evening 1800-2200	Night 2200-0600	Early Morning 0600-0700	Day (0700-1800)	Evening 1800-2200	Night 2200-0600	Early Morning 0600-0700
ML1: Valkyrie	26	23	20	25	49	42	36	42
ML2: Winchester	26	27	22	27	40	46	33	39
ML3: Coppabella	31	32	28	42	47	50	52	56
ML4: Kemmis	23	32	25	29	39	51	42	40
ML5: Lanton Downs	23	29	18	25	42	47	39	39
ML6: Hunter Street, Blackwater	35	34	28	41	55	52	46	54
ML7: New Caledonia Homestead, Bluff	28	29	27	31	45	42	34	47
ML8: Dunluce Homestead, Bluff	31	31	27	28	52	43	38	49
ML9: Picardy Homestead, Dysart	30	30	23	30	50	48	41	54
ML10: Cosmos Homestead, Dysart	31	28	23	29	51	40	35	53

Full details of the noise measurements at each location, including daily plots can be seen in the Noise and Vibration Technical Report (Appendix S) of the EIS.

Background noise levels were found to be consistently low and typical of rural areas. The exception applies near towns such as Blackwater, Moranbah, Middlemount, Dysart, Coppabella and Glenden where typical suburban noise levels are observed during the daytime.

Operator-attended noise measurements were undertaken during the field visits to verify the unattended measurements. The attended measurements confirmed that the background noise levels at all receptors were very low and consistent with the unattended monitoring.

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22.4 Criteria

22.4.1 Noise Criteria

Numerous CSG projects have been assessed in recent years, and to encourage a consistent approach to the assessment of noise from the CSG industry, specific guidance has been prepared in the form of the document *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities* (PGA Noise Guideline). The recommended noise limits in the PGA Noise Guideline are designed to comply with the objectives of the EPP (Noise).

The guideline identifies three broad noise event classes:

- Short-term: Eight hour noise exposure. Does not re-occur for a period of at least seven days;
- Medium-term: Five day noise exposure. Does not re-occur for a period of at least four weeks; and
- Long-term: Longer than five day noise exposure. Includes intermittency, when the event re-occurs within seven days.

The guideline recommends the adoption of the best practice noise limits set out in Table 22–3.

Table 22-3 Best Practice Measured Noise Emission Limits

Time Period	Metric	Short-Term Noise Event	Medium-Term Noise Event	Long-Term Noise Event
Day 0700-1800h	$L_{Aeq, adj, 15min}$	45 dB(A)	43 dB(A)	40 dB(A)
Evening 1800-2200h	$L_{Aeq, adj, 15min}$	40 dB(A)	38 dB(A)	35 dB(A)
Night 2200-0600h	$L_{Aeq, adj, 15min}$ $max L_{pA, 15min}$	28 dB(A) 55 dB(A)	28 dB(A) 55 dB(A)	28 dB(A) 55 dB(A)
Early Morning 0600-0700h	$L_{Aeq, adj, 15min}$	40 dB(A)	38 dB(A)	35 dB(A)

Where the existing background noise levels are above the deemed values in Table 22–4 the standard procedure for setting noise limits from Planning for Noise Control can be applied, whereby the noise limit at night is set 3 dB(A) over the background noise level.

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Table 22-4 Deemed Background Noise Levels (BNL)

Time Period	Deemed BNL
Day	35 dB(A)
Evening	30 dB(A)
Night	25 dB(A)
Early Morning	30 dB(A)

As discussed in Section 22.3, the background noise levels in the Project study area are below the deemed levels of Table 22–4, with the exception of the townships of Blackwater and Coppabella. The PGA guide states that noise conditions will not be prescribing an unspecified background value (i.e. a limit of ‘Background + X dB(A)’) on project approvals. In the two townships, the measured BNLs during the night period were not significantly above the deemed BNL. Therefore there is minimal benefit in establishing alternate criteria so the current best practice criteria in Table 22–4 was adopted.

Penalties apply when noise emissions from the operations contain tonality or impulsiveness. Noise predictions in this assessment assume that noise sources do not contain these characteristics and no corrections have been applied.

The Ecoaccess Draft Guideline *Assessment of Low Frequency Noise* (Queensland EPA, 2002) provides a method to assess low frequency noise and infrasound impacts. Infrasound assessment could not be completed in this assessment as source noise data in the 1 hertz (Hz) to 100 Hz range is not available to undertake further investigation. Further low frequency noise (LFN) assessment may be required during the detailed design stage of the Project. An operational LFN criterion of 20 dB(A) (internal) has been adopted for this assessment.

Off-site traffic noise impacts were assessed against the department of *Main Roads’ Road Traffic Noise Management Code of Practice* (CoP, 2008), which recommends a road traffic noise level limit of 68 dB(A) $L_{A10(18\text{hour})}$.

22.4.2 Vibration Criteria

To assess human comfort and building damage, the vibration criteria by British Standard BS 5228.2-2009 is proposed in this assessment. The following tables summarise the vibration criteria.

Table 22-5 Human Response to Construction Vibration

Vibration Level	Response
0.14 millimetres per second (mm/s)	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

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Table 22-6 Guide Vibration Values for Cosmetic Damage

Type of Building	Component ppv	
	4 to 15 Hz	15 Hz and above
Reinforced or framed structure Industrial and heavy commercial buildings	50 mm/s	50 mm/s
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz

22.4.3 Other Acoustics Criteria

Blasting is not anticipated to occur at any stage in the Project. If blasting does occur, overpressure and vibration limits will apply in accordance to the *Environmental Protection Act 1994* (Section 440ZB).

There is no standard guideline to assess impacts on livestock or avifauna. The approach of this assessment is therefore to compare predicted noise levels at sites where livestock may be kept with typical levels from other noise sources.

22.5 Acoustics Modelling

Noise levels from the production facilities have been predicted using a computer acoustics model, which takes into consideration meteorological effects. Results of two propagation algorithms have been compared (ISO 9613-2 and CONCAWE Category 6) with the CONCAWE algorithm selected. This decision was guided by Sonus (2012). Meteorological factors of the study area were reviewed from the Air Quality chapter (Section 9) and Air Quality Technical Report (Appendix H) of this EIS, including wind speed and atmospheric stability, to incorporate prevailing conditions into the noise predictions.

22.5.1 Operational Noise

Operational noise was predicted for all the production facilities, with and without mitigation measures. Noise mitigation packages were developed for the Arrow Surat Gas Project and they have been consistently used in this assessment.

The modelling prediction scenarios considered all plant within the facilities working to the following nominal capacities:

- FCF: 120 TJ/d;
- CGPF: 210 TJ/d; and
- IPF: 210 TJ/d.

The detailed list of equipment for each facility can be read from the Noise and Vibration Assessment Technical Report (Section 5.2.1 of Appendix S of this EIS). The equipment was also classified in terms

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of the noise events classes (short, medium or long-term). Furthermore, the acoustic treatment packages are detailed in Section 5.2.1 of the Noise and Vibration Technical Report (Appendix S) of this EIS, including their assumed noise attenuation ratings.

The results were compiled based on setback distances from the production facilities. Table 22-7 presents the predictions for long-term noise sources with no mitigation included. It can be observed that the most stringent noise criterion of 28 dB(A) for night-time operations would only be achieved at distances of over 5 km.

Table 22-7 Noise from Long-Term Sources at Production Facilities – No Mitigation

Distance (km) from Centre of Facility	Noise Criterion (dB(A))	Modelled Noise Level (dB(A)) from the Production Facility		
		FCF	CGPF	IPF
1	28	51	53	53
2	28	39	41	41
3	28	31	34	34
5	28	22	24	25

Table 22-8 summarises the predictions after the implementation of the acoustic treatment packages. Mitigation packages have been selected for each component to achieve the Project criteria at distances of one, two and three kilometres. Details of these configurations can be read from Tables 5-8, 5-9 and 5-10 of the Noise and Vibration Technical Report (Appendix S) for FCFs, CGCFs and IPFs respectively. The predicted noise levels with these packages implemented are detailed in Table 22-8.

Table 22-8 Noise from Long-Term Sources at Production Facilities – with Mitigation

Distance (km) from Centre of Facility	Noise Criterion (dB(A))	Modelled Noise Level (dB(A)) from the Production Facility		
		FCF	CGPF	IPF
Mitigation to achieve criterion at 1 km				
1	28	28	31*	31*
2	28	18	20	21
3	28	12	15	16
Mitigation to achieve criterion at 2 km				
1	28	36	37	36
2	28	27	28	26
3	28	21	22	20
Mitigation to achieve criterion at 3 km				
1	28	42	40	41
2	28	32	31	31
3	28	26	25	25

* Screening required to achieve criterion at nearest receptor

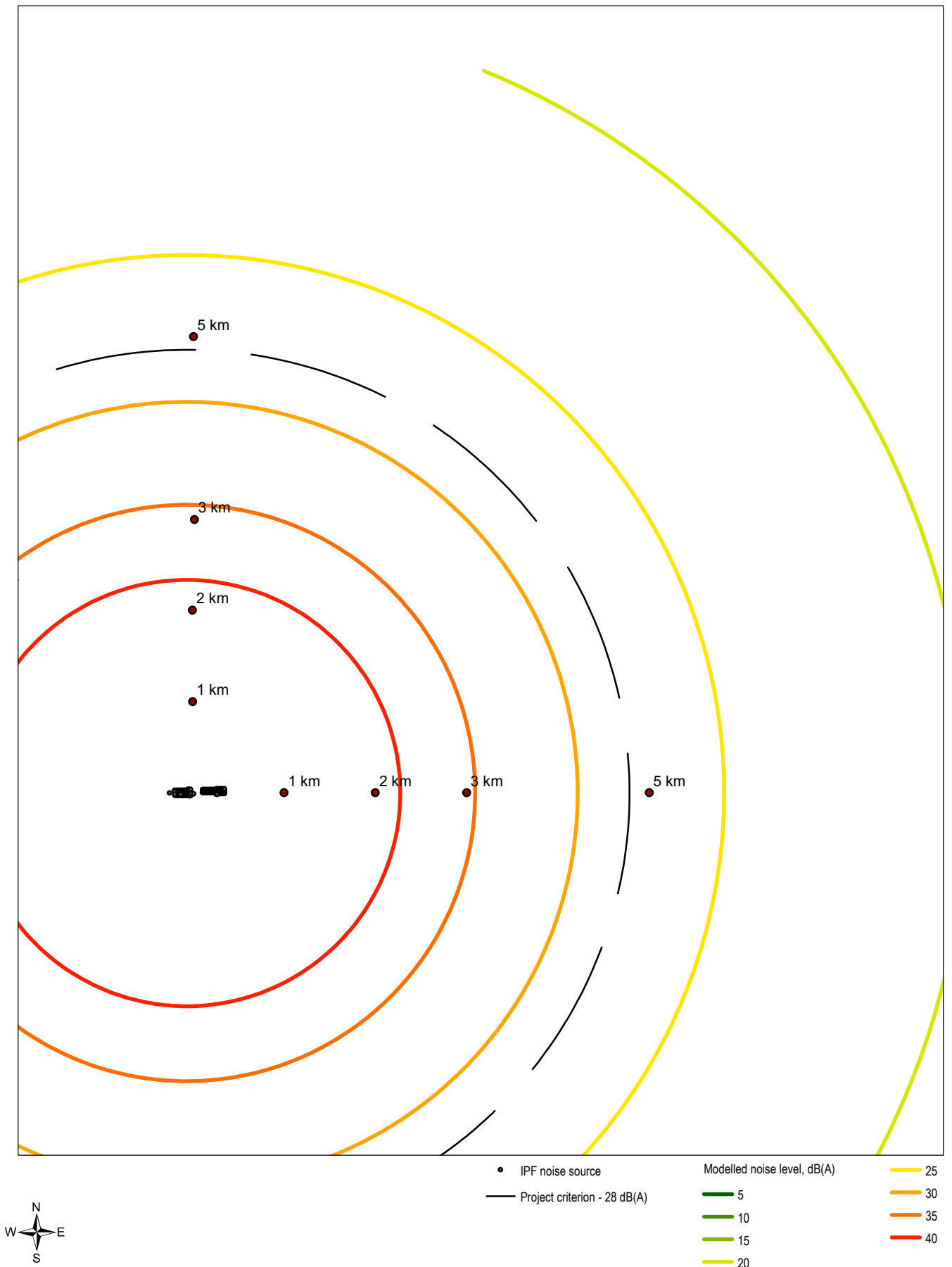
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Short-term noise sources (e.g. flaring noise) at the production facilities would not produce significant noise levels at distances greater than 2 km. Exceedances of up to 4 dB(A) are predicted at 1 km of setback distance from the production facilities.

For production wells and pipelines, the long-term Project noise criterion of 28 dB(A) would be achieved at distances beyond approximately 300 m, with no mitigation implemented.

Indicative noise contours for an IPF are provided in Figures 22–2 and 22–3 with and without mitigation.

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NOISE CONTOURS - WITHOUT ACOUSTIC TREATMENT



NOISE AND VIBRATION

Figure: **22-2**

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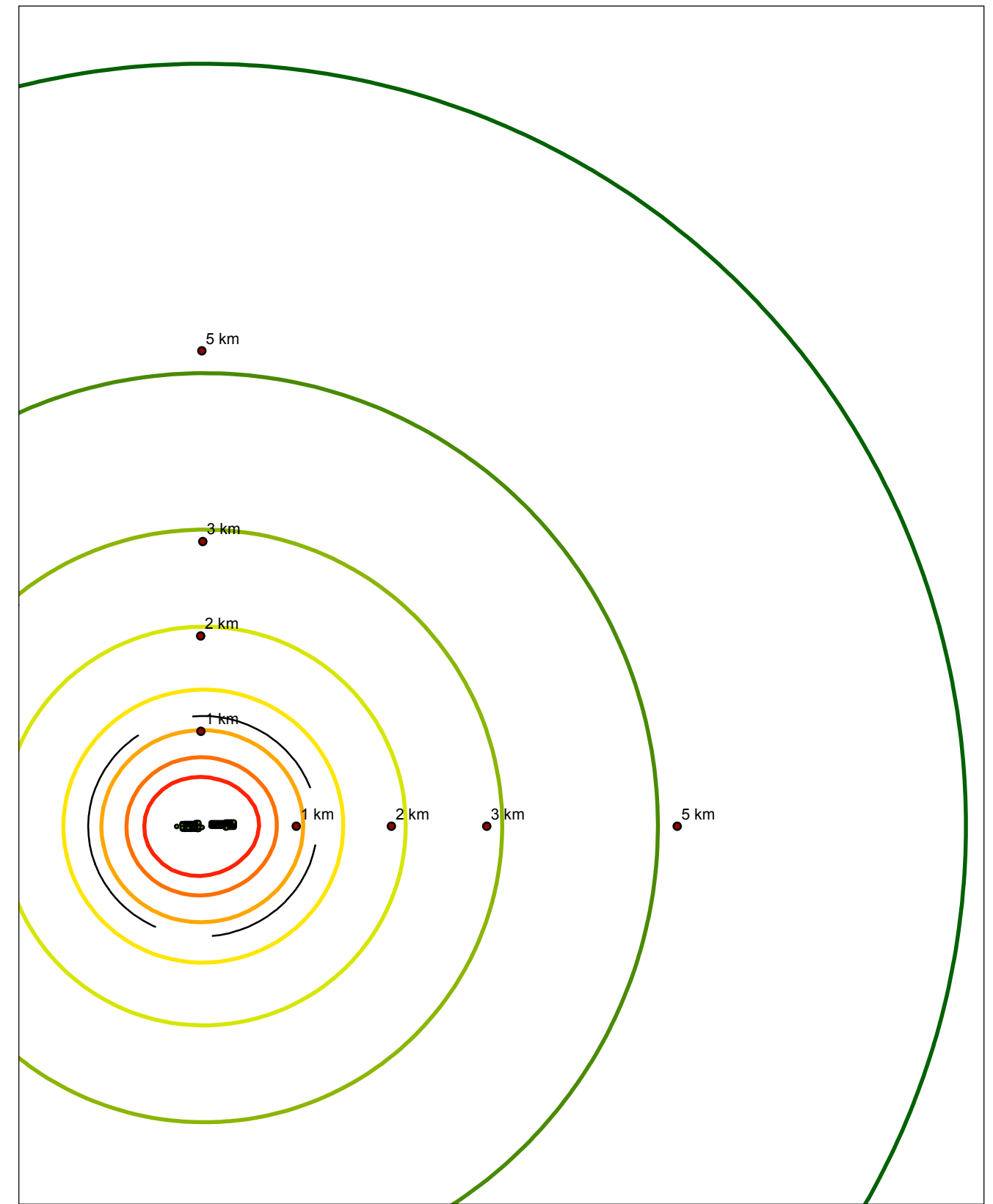
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BOWEN GAS PROJECT EIS

NOISE CONTOURS - WITH ACOUSTIC TREATMENT



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Figure: **22-3**



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Approved: DS

Date: 18-10-2012

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22.5.2 Construction Noise

Construction equipment noise data sourced from AS 2436-1981 and British Standard (BS) 5228-1 were used to predict noise levels at various setback distances from the site. The applicable noise criterion for daytime activities is 40 dB(A). Table 22–9 summarises the results for the different construction activities. Based on the predictions, construction noise will exceed the long-term criteria at receptors within 1 km of the activity for all periods of the day. Noise mitigation measures will be detailed in the following sections.

Table 22-9 Predicted Construction Noise from the Construction

Construction Stage	Modelled Noise Level (dB(A))							
	50 m	100 m	150 m	200 m	250 m	500 m	750 m	1000 m
Production Facilities								
Site preparation, clear and grade	79	74	71	68	66	59	54	51
Surface equipment installation	77	72	69	67	65	58	53	49
Commissioning and testing	45	41	38	37	33	24	18	14
Site rehabilitation	77	72	69	67	65	58	53	49
Production Wells								
Site preparation, clear and grade	79	74	71	68	66	59	54	51
Initial drilling	77	72	69	67	65	57	53	49
Completion and workover	68	64	61	58	56	50	45	42
Hydraulic fracturing	68	64	61	58	56	50	45	42
Surface equipment installation	77	72	69	67	65	58	53	49
Commissioning and testing	45	41	38	37	33	24	18	14
Site rehabilitation	77	72	69	67	65	58	53	49
Pipelines								
Site preparation, clear and grade	82	76	72	69	66	59	55	51
Trenching, stringing and lowering in	80	74	71	68	66	58	53	49
Pipe joining and welding	76	71	67	64	62	54	49	46
Pressure testing	74	69	65	62	60	53	48	45
Backfilling	81	75	71	68	66	58	53	49
Site rehabilitation	81	75	71	68	66	58	53	49
Abandonment of Production Wells								
Equipment disassembly and removal	80	75	71	68	66	59	53	49
Backfilling	81	75	71	68	66	58	53	49
Site rehabilitation	81	75	71	68	66	58	53	49

22.5.3 Off-Site Traffic Noise

Increase in vehicle movements on public roads due to the Project would produce a negligible increase in noise level and therefore no exceedance of the nominated CoP noise criterion is anticipated.

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22.5.4 Low-Frequency Noise

Predictions of low-frequency noise indicate that noise levels would be within the nominated internal noise criterion of 20 dB(A). The operational scenarios include the acoustics treatment packages mentioned in the operational noise assessment 'with mitigation'.

22.6 Framework for Noise Management

22.6.1 Noise Limits

Based on the criteria discussed in Section 22.4 of this report, appropriate noise limits for the different aspects of the Project are proposed below. The activities considered are summarised in Table 22–10 and the proposed noise limits are presented in Table 22–11.

Table 22-10 Activity Status

Noise Exposure	Activity / Event
Short term	Flaring.
Medium term	Drilling of production wells. Completion and workover activities. Hydraulic fracturing.
Long term	Site preparation and completion: Construction of the production facilities, production wells and pipelines (gas and water). Operation of the production facilities and production wells. Abandonment of production wells.

Table 22-11 Proposed Noise Limits at Sensitive Receptors

Time Period	Descriptor	Short Term Noise Event	Medium Term Noise Event	Long Term Noise Event
0700 – 1800h	$L_{Aeq, adj, 15 mins}$	45 dB(A)	43 dB(A)	40 dB(A)
1800 – 2200h	$L_{Aeq, adj, 15 mins}$	40 dB(A)	38 dB(A)	35 dB(A)
2200 – 0600h	$L_{Aeq, adj, 15 mins}$	28 dB(A)	28 dB(A)	28 dB(A)
	$max L_{p,A, 15 mins}$	55 dB(A)	55 dB(A)	55 dB(A)
0600 – 0700h	$L_{Aeq, adj, 15 mins}$	40 dB(A)	38 dB(A)	35 dB(A)

If the measured noise level is considered to have tonal or impulsive characteristics, the adjustments in Table 22–12 shall be made.

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Table 22-12 Character Adjustments to Noise Levels at Receptors

Noise Characteristic	Adjustment to Noise
Tonal characteristic is just audible	+2 dB(A)
Tonal characteristic is clearly audible	+5 dB(A)
Impulsive characteristic is just audible	+2 dB(A)
Impulsive characteristic is clearly audible	+5 dB(A)

Where a receptor is already subject to noise from any existing Arrow plant, no increase in noise level from industry should occur at these receptors. The level of noise from existing plant will be confirmed by measurements or predictions.

The assessment has indicated that there is no significant potential for adverse impacts from vibration, low-frequency noise, infrasound and blasting, therefore it is considered unnecessary to adopt these in conditions.

22.6.2 Site Selection and Detailed Design

Arrow will undertake the selection of locations for production facilities and wells on the basis of many criteria including environmental and engineering constraints, and the setback distances for noise described in Section 22.5 of this report will be one of them [B365]. This is consistent with the EPP (Noise) management hierarchy whereby avoidance must be considered first.

During the detailed design of the production facilities, the mitigation packages will be selected based on the attenuation required to achieve the Project criteria at the nearest receptor [B366]. Packages in this report have been identified based on fixed distances from the facilities.

The noise levels from the final design will be modelled to confirm that compliance with the Project criteria is still predicted [B367]. This modelling will include any terrain screening or local meteorological effects which would alter noise propagation. Detailed modelling will only serve to reduce the predicted level and the necessary mitigation, since additional noise attenuation would be gained from air absorption and topography screening.

22.6.3 Noise Monitoring

Noise monitoring may be required at a number of receptors during both, construction and operational periods; either in response to complaints, or to demonstrate that predicted noise levels are not being exceeded. More details of recommended noise monitoring would be set out in a Noise and Vibration section within an EM Plan.

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22.7 Impact Assessment

The potential direct and indirect impacts of the Project on environmental values have been assessed using one of three impact assessment methods: significance assessment, risk assessment and compliance assessment; this study has used compliance assessment. For further details see the Impact Assessment Method chapter (Section 6) of this EIS.

22.7.1 Operational Noise

All operational noise from production facilities is required to meet the noise limits in Section 22.6.1 of this report. As the majority of activities occur on a continuous basis, noise treatment will be designed to achieve the night-time criteria, which will result in noise levels in all other periods being significantly below the criteria.

In remote areas where the noise criteria are set based on the deemed background levels, noise from the Project will be greater than 5 dB(A) above the background environment. In these instances, noise will be audible outside of dwellings and may cause some disturbance.

In all instances, noise will comply with the objective environmental values.

22.7.2 Operational Vibration

During the operation of the facility, drilling is likely to produce the highest levels of vibration of the equipment to be used. Using a conservative assessment, human annoyance and building damage are not expected to occur at distances greater than 70 m from the sites. Notwithstanding this, Arrow has undertaken not to locate wells or other infrastructure within 200 m of sensitive receptors and therefore vibration impacts are not anticipated.

22.7.3 Construction Noise, Vibration, and Blasting

Noise from construction activities will at times exceed the long-term noise limit for receptors within 1 km of activities. Additional modelling may be warranted on a site specific basis to consider existing terrain screening at some locations. Where required, mitigation measures are proposed to reduce the impact of construction noise.

During the construction of the facilities, drilling is likely to produce the highest levels of vibration of the equipment to be used. Using a conservative assessment, human annoyance and building damage are not expected to occur at distances greater than 70 m from the sites. Drilling activities will be at distances greater than 200 m of any sensitive receptor, therefore no negative impacts are predicted from vibration.

As blasting is not intended, no predictions have been performed at this stage. If blasting were required at a later date, predictions would be performed to confirm compliance with the criteria.

22.7.4 Off-site Traffic Generation

Noise from heavy vehicles on public roads will have a negligible impact on the daily average noise level ($L_{A10,18h}$). Noise from individual vehicles may be audible at times.

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22.7.5 Livestock

In the absence of definitive criteria, the potential impact of noise and vibration on livestock located close to the Project infrastructure has been assessed by comparing predicted noise and vibration levels to those generated by common noise sources. With the implementation of mitigation to achieve the Project criteria at 2 km from a production facility, or adjacent to a production well, noise levels are likely to be in the order of 60 dB(A) at adjoining properties. This is of a similar scale to adjacent rail or roads, where livestock often graze with no obvious impact.