4.0 Noise and Vibration

4.1 Introduction

The construction and operation of a wind farm is likely to generate noise (such as aerodynamic noise from wind turbines or from associated sources such as construction traffic). It is therefore necessary to design a wind farm so that increases in ambient noise levels at nearby sensitive receptors are minimised or avoided.

A Noise and Vibration Impact Assessment (NVIA) has been carried out for the Project in order to appropriately positon the wind turbines to avoid or minimise the incidence of noise at nearby sensitive receptors.

Appendix F in Volume 3 provides the NVIA for the Project. This chapter provides a summary of that assessment.

4.2 Scope of assessment

The scope of the noise and vibration assessment is to:

- Conduct background noise monitoring at nearby sensitive receptors
- Undertake operational noise modelling and determine potential noise impacts generated by the Project
- Consider construction noise and vibration impacts
- Discuss potential mitigation and management measures.

The assessment methodology was undertaken in accordance with the Queensland Department of Infrastructure, Local Government and Planning Wind Farm State Code Planning Guideline (DILGP, 2016), in order to achieve compliance with the performance outcomes of the Code.

4.3 Legislation and policy

4.3.1 Queensland Wind Farm State Code and Planning Guideline

The Queensland Wind Farm State Code is contained in Module 20 Section 1 of the State Development Assessment Provisions (SDAP) (DILGP, 2016) and is intended to regulate the development of new wind farms, or the expansion of existing wind farms. The code aims to mitigate potential adverse impacts on the community and environment during the operation of a wind farm, and provides the assessment criteria performance outcomes that must be met.

The planning guideline that accompanies the code, also produced by DILGP, includes technical material that aims to assist proponents in preparing development applications for new or expanded wind farms and to provide assistance in responding to performance outcomes and acceptable outcomes of the code.

Sensitive receptors that are located on either host lots or non-host lots who have an agreed Deed of Release with AGL are referred to in this chapter as “participating landowners”. All other sensitive receptors on non-host lots, where landowners have not entered into a commercial agreement with AGL, are referred to in this chapter as “non-participating landowners”.

Appendix 4 of the planning guideline provides guidance material to assist in conducting a noise impact assessment for a wind farm, with the aim at meeting the performance outcomes for acoustic amenity. The Noise and Vibration Impact Assessment has been informed by this guideline and is included in Appendix F, Volume 3.

The Draft Queensland Wind Farm State Code (Draft QLD Code) has been referred to for assessment criteria for low frequency noise emissions, as the QLD Code does not cover low frequency noise emission criteria. A low frequency assessment was performed to address Information Requirement 10.5 of the Coopers Gap Wind Farm Project Terms of Reference for an Environmental Impact Statement, which states that impact predictions must address the potential impacts of any low frequency noise emissions below 200 Hz.

4.3.2 New South Wales Planning Guideline

The NSW Department of Planning & Infrastructure *Draft NSW Planning Guidelines – Wind Farms*, December 2011 (NSW Planning Guideline) has been referred to for low frequency noise limits, further to the Draft QLD Code. The Noise and Vibration Impact Assessment included in Appendix F, Volume 3 has been informed by this guideline.

4.3.3 Environmental Protection Act 1994

Division 3 – Default Noise Standards of the *Environmental Protection Act 1994* (EP Act), has been referred to for the determination of noise limits to specific noise sources, where applicable. The EP Act provides noise limits for noise sources of steady state nature, which can be applied to establish a noise criterion for steady-state noise emission of infrastructure related to the Project, other than the wind turbines.

4.4 Methodology

4.4.1 Construction noise

The Queensland Wind Farm State Code outlines a performance outcome for construction management, with guidelines to demonstrating compliance with this outcome for noise and vibration given in the associated planning guidelines (DILGP, 2016). There is no legislation in Queensland that specifically sets construction noise limits. For construction activity in Queensland, the EP Act states that:

"A person must not carry out building work in a way that makes an audible noise –

a. On a business day or Saturday, before 6:30am or after 6:30pm; or

b. On any other day, at any time."

Thus noise from construction activity is generally controlled through limiting the hours of operation, and through application of relevant industry management techniques.

4.4.2 Construction vibration

To assess perceptible vibration to humans, the vibration criteria from the Australian Standard (AS) 2670.2 - 1990 Evaluation of human exposure to whole-body vibration - Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz) is used. These criteria are summarised in Table 10 of Appendix F, Volume 3.

International standards exist for vibration-induced damage to structures and can provide guidance on acceptable limits. These documents are commonly used to assess structural response to vibration throughout Australia.

The German standard DIN 4150 Part 3, and British Standards (BS) 5228 Part 4 and BS 7385 Part 2 recommend vibration criteria relating to structural damage of buildings. These standards are considered to be best practice in Australia. The criteria from the standards are summarised in Table 11 and Table 12 of Appendix F, Volume 3.

Based on typical levels of vibration from construction activities, it is expected that both occupants and dwellings at distances of 200 m and greater from construction works will be unlikely to perceive construction vibration. Vibration impacts are not considered to present a significant impact to sensitive receptors and are therefore not considered further in this chapter.

4.4.3 Background noise measurements

The acoustic environment prior to construction of the Project was evaluated by undertaking a background noise monitoring program. Noise monitoring locations were selected to represent areas that are expected to have the greatest noise impact from the Project.

The monitoring was carried out in 2016 to measure background noise at 12 locations for a minimum period of 6 weeks. Both wind speed and noise data were collected as an average for each 10 minute measurement throughout the monitoring. In all cases, the microphone was located a minimum of 1.2 m above the ground and at least 5 m from any reflecting surface, including buildings or significant vegetation such as trees and away from existing significant noise sources where practicable, in order to get an indication of the typical acoustic environment at noise sensitive receptors.

Background noise measurements were undertaken following guidance from the DILGP 2016

4.4.4 Operational Noise Modelling

A three-dimensional computer noise model of the Project Site was created in SoundPLAN Version 7.4, acoustic modelling software. Environmental noise predictions were carried out using the algorithms from ISO 9613.2:1996 *Acoustics – Attenuation of Sound during propagation outdoors – Part 2: General method of calculation*, as implemented by the SoundPLAN software package and as required by the Queensland Wind Farm Planning Guideline. SoundPLAN is a modelling package that has been used in Queensland for numerous infrastructure developments.

The following data was used to create the computer model:

- Topographical ground contours for the Project Site and surrounding area
- Proposed turbine layout, developed in July 2016. The wind turbines were entered at hub height of 117 metres above ground level
- Receiver locations, determined from aerial photograph and cadastral data overlaid on the ground contours. Sensitive receptors were entered in the model at a height of four metres above ground level.

An aerial view of the Project showing the location of turbines and sensitive receptors (participating and non-participating landholders) is provided in Figure 4.1, Volume 2.

The following parameters were entered in the computer model, in accordance with the Queensland Wind Farm State Code and supporting Planning Guideline:

- Atmospheric conditions at 10°C and 70% temperature humidity
- Hard ground (0.1 ground factor)
- No penalty for tonality was applied (0.0 dB penalty)
- A sound power level (L_W) for a typical 3.6 MW turbine of 107 dB(A) has been assumed. Larger turbines may be considered where there is sufficient data to suggest that the sound power output and spectral content complies with the parameters in this assessment and the Queensland Wind Farm State Code and supporting Planning Guideline
- A relationship of $L_{Aeq} = L_{A90}$ was used to model the wind farm layout.

A noise-compliant wind turbine layout was generated using the acoustic modelling software, which is the basis of the current Project layout.

4.5 Potential impacts

4.5.1 Construction noise impacts

Specific details of the construction methodology and equipment are not known at this early stage of the Project. However, it is anticipated that the construction work may include excavation, rock hammering, drilling and bulldozing. Noise will be generated by mobile plant such as excavators, bulldozers, mobile cranes and semi-trailers delivering or removing material from construction sites.

It is expected that the following typical construction equipment will be used:

- Excavators
- Tracked bulldozers
- Semi-trailers
- Tractors
- Mobile cranes
- Concrete trucks.

Construction noise impacts for the majority of nearby sensitive receptors are likely to be below the existing typical daytime background level. Some nearby receptors may receive elevated construction noise levels during turbine foundation civil works. However, potential noise impacts would be localised and temporary and are unlikely to result in significant adverse impacts to sensitive receptors.

4.5.2 Operational noise impacts

Appendix F, Volume 3 presents the outdoor noise compliance assessment for the turbine layout during worst-case turbine noise emissions. The noise levels presented are $L_{Aeq,10min}$ noise levels at the receptors, assessed against the noise limits.

Figure 4.2, Volume 2 shows that the noise predictions comply with the Queensland Wind Farm State Code and supporting Planning Guideline noise limits at all sensitive receptors.

Appendix F, Volume 3 presents the low frequency noise compliance assessment for the turbine layout during worst-case turbine noise emissions. The noise levels presented are $L_{Ceq,10min}$ noise levels at the sensitive receptors, assessed against a 60 dB(C) night time limit, as per the NSW Code and Draft QLD Code. The Draft QLD Code has been referred to for assessment criteria for low frequency noise emissions, as the QLD Code does not cover low frequency noise emission criteria.

The noise contour maps are generated based on a grid of calculations which are interpolated to generate the contours. Single point calculations provided in Appendix F, Volume 3 should be referred to for specific levels at a receptor.

Figure 4.3 in Volume 2 shows that the noise predictions comply with the low frequency noise criteria at all but one receptor. The low frequency noise limit was exceeded by less than 1 dB(C) at receptor G. The conservative assumptions made when building the model mean that the measured noise levels would likely be lower than those predicted as part of this assessment. As such, noise compliance at receptor G with a 60 dB(C) noise limit is expected. The location of receptor G is shown in Figure 4.3, Volume 2.

The Project is seeking approval to install turbines up to a 4 MW power rating. The 4 MW upper limit is to allow for innovation in turbine design should there be a 4 MW turbine that has the same SPL as a 3.6 MW turbine prior to construction. Regardless of the size or output of the turbine. AGL will be required to build a wind farm that complies with the acoustic requirements of the Queensland Wind Farm State Code and supporting Planning Guideline.

In addition to the EIS noise assessment presented in Appendix F, Volume 3, AGL has conducted separate façade testing at the request of the community. This assessment determined that, with windows fully open, there was an 8 to 13 dB(A) reduction in noise levels between outdoors and indoors. The level of reduction was dependent on the construction material of the residence.

4.6 Mitigation measures

4.6.1 Construction noise mitigation measures

Construction noise will represent a short term impact and is anticipated to include a range of noise sources. To minimise the impacts of construction noise, the construction contractor will prepare a Construction Noise and Vibration Management Plan which outlines the proposed methodology and monitoring procedures to be put in place for the duration of the works. The Construction Noise and Vibration Management Plan will incorporate the following as a minimum:

- Community Noise Consultation
- Site Management
- Equipment management
- Noise Monitoring.

Further details of the plan are provided in Appendix F, Volume 3.

4.6.2 Operational mitigation measures

Operational noise would be limited to operational wind turbine noise and infrastructure noise. Once the wind farm is operational, compliance noise measurements will be undertaken at a number of sensitive receptors adjacent to the Project Site to demonstrate that compliance with the relevant criteria has been achieved.

A preliminary Compliance Management Plan has been developed to incorporate a compliance measurement methodology. It is noted that the Queensland Wind Farm Planning Guideline does not establish a methodology for conducting compliance noise measurements on wind farms, therefore, a compliance measurement methodology will be incorporated into a compliance management plan. This methodology is provided in Appendix F, Volume 3 and was developed following guidance from the following documents:

- NSW Department of Planning & Infrastructure *Draft NSW Planning Guidelines – Wind Farms*, December 2011
- Victoria Department of Planning and Community Development *Policy and Planning Guidelines for development of wind energy facilities in Victoria, July 2012*
- New Zealand Standard NZS6808:2010 *Acoustics – Wind farm noise.*

Compliance noise measurements will be conducted and processed following the principles for conducting background measurements outlined in the Queensland Wind Farm State Code and supporting Planning Guideline, with guidance from the above documents.

4.7 Residual impacts

4.7.1 Construction noise residual impacts

Construction noise is temporary and transient in nature and can be controlled through good site working practices, limiting construction hours and adopting noise control measures where necessary. The construction contractor will sign up to a Construction Environmental Management Plan (CEMP) which will include a Construction Noise and Vibration Management Plan that will ensure effective controls are put in place. For this reason, it is considered that residual noise impacts from the construction phase are unlikely to be significant.

4.7.2 Operational noise residual impacts

Based on the results of noise predictions, the noise limits proposed in Appendix F, Volume 3 are expected to be complied with during operation of the Project. On this basis, the current 'noise-compliant' wind turbine layout can be considered to protect the existing environmental values in the area from impacts by noise and vibration from the Project. Compliance measurements will ensure that residual impacts to nearby sensitive receptors will be minimised or avoided.

4.8 Cumulative impacts

No new or proposed developments have been identified within the Study Area that are likely to result in combined or successive noise impacts with the Project. Cumulative noise impacts to sensitive receptors are therefore considered to be unlikely.

4.9 Summary and conclusions

A noise impact assessment was conducted for the operation of the Project in general accordance with the requirements of the Queensland Wind Farm State Code and supporting Planning Guideline 2016. Operational noise limits were defined from the operational outcomes of the Queensland Wind Farm State Code and background noise levels measured on site prior to construction of the Project.

A noise model of the Project Site was created to predict noise levels at the nearest sensitive receptors to the Project. A noise-compliant wind turbine layout was generated and has formed the basis of the Project Site. The noise limits contained within the Queensland Wind Farm State Code are expected to be complied with during operation of the Project, based on the results of noise predictions. On this basis, the current 'noise-compliant' wind turbine layout can be considered to protect the existing environmental values in the area from impacts by noise and vibration from the Project.

Compliance measurements will be undertaken at a selected number of the potentially most affected sensitive receivers following the commissioning of the Project. In lieu of a compliance methodology within the Queensland Wind Farm State Code a basic methodology has been proposed in this assessment. A preliminary Compliance Management Plan has been developed to incorporate the compliance measurement methodology. This is provided in Appendix F, Volume 3. Testing will be undertaken once all noise sources associated with the Project are in operating mode, i.e. all turbines have been commissioned and are operating correctly.

4.10 References

Australian Standard AS 2670.2, 1990. *Evaluation of human exposure to whole-body vibration - Part 2: Continuous and shock induced vibration in buildings (1 to 80Hz)*

British Standards BS 5228 Part 4 Incorporating. Amendment No.1. Noise control on construction and open sites

British Standards BS 7385 Part 2 Vibration

German standard DIN 4150 Part 3 Structural vibration - Effects of vibration on structures

Commonwealth Government, 2010. *Draft National Wind Farm Development Guidelines*.

State of Queensland Department of Infrastructure, Local Governance and Planning (DILGP), 2016. *State Development Assessment Provisions.*

State of Queensland Department of Infrastructure, Local Governance and Planning (DILGP), 2016. *Queensland Wind Farm State Code and Planning Guideline.*

New Zealand Standard NZS6808:2010 *Acoustics – Wind farm noise.*

NSW Department of Planning & Infrastructure *Draft NSW Planning Guidelines – Wind Farms*, December 2011

Victoria Department of Planning and Community Development *Policy and Planning Guidelines for development of wind energy facilities in Victoria, July 2012*