Hexham
Wind Farm

Chapter 17

Noise and vibration

WIND PROSPECT

17.1 Overview

This chapter describes the potential noise and vibration impacts of the construction, operation and decommissioning of Hexham Wind Farm. This chapter is based on the findings of the ***Environmental Noise and Vibration Impact Assessment*** (provided in Appendix E1), prepared by Marshall Day Acoustics.

The results of the assessment demonstrate that the proposed wind turbines are predicted to achieve compliance with the applicable noise limits determined in accordance with NZS 6808:2010 for all receivers based on a candidate wind turbine model. The assessment also demonstrates that the operational noise levels from the on-site terminal station and battery energy storage system are predicted below the noise limits determined in accordance with the Noise Protocol.

Additionally, the assessment has considered the proposed on-site quarry and concrete batching plants, in accordance with the Noise Protocol. The results demonstrate that the predicted noise levels associated with operation of the on-site quarry and concrete batching plants during the construction period are below the noise limits determined in accordance with the Noise Protocol.

A detailed assessment of the noise from these construction activities, based on maximum overall sound power levels, was undertaken as part of the project's ***Construction Noise Assessment*** (attached to Appendix E1). Potential vibration impacts during construction were assessed to be below relevant standards, and vibration monitoring is not expected to be required.

The activities that have the potential to cause noise and vibration include works within the project site associated with wind turbine construction (including civil works, excavation, foundation construction and turbine erection), construction traffic, works associated with the on-site quarry and concrete batching plant operation, wind turbine operation, and the operation of the on-site substation and battery energy storage system. The assessment found that construction traffic is likely to result in clearly discernible increases in total road traffic noise levels for both the on-site and off-site material sourcing scenarios, with the increases expected to be most pronounced for the off-site sourcing due to the higher number of heavy vehicle movements.

With the implementation of identified management controls, the residual impacts associated with the project's construction, operation and decommissioning are anticipated to be low, with the exception of impacts related to off-site traffic noise, which were rated medium.

17.2 EES objectives and key issues

The EES scoping requirements specify the evaluation objective and key issues, outlined in Table 17.1, relevant to noise and vibration that have guided this assessment.

Table 17.1 EES evaluation objective and key issues

Evaluation objective	
Noise and vibration: *To minimise and manage adverse air quality and noise and vibration effects on residents and local communities as far as practicable during construction, operation and decommissioning having regard to applicable limits, targets or standards.*	
Key issues	Potential for adverse effects on noise and vibration amenity at sensitive receptors during construction, operation and decommissioning (including on-site quarry).

Matters relating to air quality are presented in Chapter 16 – ***Air quality and greenhouse gas*** and Appendix L – ***Air Quality Impact Assessment***.

17.3 Legislation, policy and guidelines

Key legislation, policies and guidelines relevant to the Noise and Vibration Impact Assessment (Appendix E1) are summarised in Table 17.2 below and would assist in achieving compliance with the general environmental duty.

Table 17.2 Relevant legislation and guidelines

Legislation, policy and guidelines	Description	Relevance to project
State		
Environment Protection Act 2017	The *Environment Protection Act 2017* provides the overarching legislated protection of the environment in Victoria and establishes mandatory requirements for the control of environmental noise.	The *Environment Protection Act 2017* requires the project to fulfil the general environmental duty to minimise the risk of harm so far as 'reasonably practicable'. The project must also not emit, or allow the emission of, noise that is prescribed as unreasonable or determined to be unreasonable according to the listed factors defined in this Act or prescribed as unreasonable by the Environment Protection Regulations 2021 (refer to Chapter 3 – ***Legislation and policy framework).***
Environment Protection Regulations 2021	The Environment Protection Regulations 2021 give effect to the *Environment Protection Act 2017* by establishing prescriptive requirements for a range of environmental considerations including noise. The noise requirements are defined according to the type of noise generating activity under consideration. The Environment Protection Regulations 2021 also define the types of noise sensitive areas where these requirements apply and the hours of different assessment time periods (i.e. day, evening and night).	The Environment Protection Regulations 2021 specify that the prediction, measurement, analysis and assessment of operational industry noise within a noise sensitive area must be conducted in accordance with EPA Publication 1826.5: Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues (Noise Protocol). Noise from industry is prescribed by the Environment Protection Regulations 2021 to be unreasonable for the purposes of the *Environment Protection Act 2017* if it exceeds the noise limit determined in accordance with the Noise Protocol. These noise limits were used to determine the criteria for the assessment of the project's on-site quarry. These Regulations define frequency spectrum as a prescribed factor for determining if the noise emitted from the premises is unreasonable. They also specify requirements for the assessment, verification and ongoing management of operational wind turbine noise, which have informed this assessment of the project. Regulation 131C refers to duties of operators of wind farms and provides that operators must ensure compliance with the noise limits in the relevant standard (for the project, this is NZS6808:2010). The 'note' under s131C stipulates that compliance with section 131C achieves compliance with section 25(1) of the *Environment Protection Act 2017*, being the general environmental duty.

Legislation, policy and guidelines	Description	Relevance to project
Environment Reference Standard	The Environment Reference Standard (ERS) was introduced under the *Environment Protection Act 2017* and sets out environmental and human health outcomes that are sought to be achieved and maintained in Victoria. The outcomes are described by the ERS in terms of environmental values, indicators and objectives. The ERS provides an environmental assessment reporting benchmark used to determine whether a proposal is consistent with the ERS.	The project has been assessed in accordance with the environmental values defined in the ERS.
Planning and Environment Act 1987	The Planning Policy Framework and Particular Provisions of the Moyne Shire Planning Scheme contains clauses relevant to noise and vibration.	A relevant Planning Policy Framework clause is 13.05-1S Noise abatement, with the objective being *"to assist the control of noise effects on sensitive land uses"*. Particular provision Clause 52.32 Wind Energy Facility states that noise impacts of wind farm proposals are to be assessed accordance with the New Zealand Standard NZS6808:2010, Acoustics - Wind Farm Noise. An application must be accompanied by a pre-construction (predictive) noise assessment report and a report that verifies that the assessment demonstrates the project can comply with the noise limits specified in the New Zealand Standard.
EPA Publication 1834.2: Civil construction, building and demolition guide	EPA Publication 1834.2 outlines controls for civil construction and earthworks to manage risks and obligations under the general environmental duty in relation to air, noise, land and water. This includes general information to assist with managing noise and vibration risks and obligations associated with scheduling works, community consultation, and controls for managing potential noise and vibration impacts.	The ***Construction Noise Assessment*** (attached to Appendix E1) was prepared in accordance with EPA Victorian Publication 1834.2.
EPA Publication 1826.5: Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues	EPA Publication 1826.5 (Noise Protocol) provides guidance in determining noise limits for new and existing commercial, industrial and trade premises in Victoria. The noise from wind energy projects is specifically excluded, with the exception of that associated with substations and transmission infrastructure. The Noise Protocol provides a method to determine noise limits for utilities and other commercial, industrial and trade premises in rural areas.	The assessment of noise from the project on-site substation, battery energy storage system, concrete batching plant, and on-site quarry was undertaken in accordance with the Noise Protocol. Applicable noise limits are outlined in Section 17.3.2.

Legislation, policy and guidelines	Description	Relevance to project
EPA Publication 1996: Noise guidelines: Assessing low frequency noise	EPA Publication 1996 provides guidance for determining the risk of "unreasonable noise" from low frequency noise emissions from commercial, industrial and trade premises. The Environment Protection Regulations 2021 specify that frequency spectrum is a prescribed factor for the purposes of determining whether the noise from commercial, industrial and trade premises is unreasonable under the *Environment Protection Act 2017*. EPA Publication 1996 may be used to objectively assess the frequency spectrum from 10 Hz to 160 Hz.	To manage the noise from the on-site substation, battery energy storage system, concrete batching plant, and on-site quarry, pre-construction noise assessments (required by management measures for the project, detailed in Section 17.7.3) will include evaluation against the low frequency noise thresholds specified in EPA Publication 1996.
Planning Guidelines for Development of Wind Energy Facilities (DTP, 2023a)	The Planning Guidelines for Development of Wind Energy Facilities (Planning Guidelines) provide a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project, and guidance as to how planning permit application requirements might be met. The Planning Guidelines specify the noise sources which require consideration and the assessment approach required to ensure nearby dwellings are protected.	Wind turbine operational noise has been assessed in accordance with the Planning Guidelines.
New Zealand Standard 6808:2010 Acoustics – Wind Farm Noise	New Zealand Standard 6808:2010 Acoustics – Wind Farm Noise (New Zealand Standard) provides methods for predicting, measuring and assessing noise from wind turbines. In accordance with the Planning Guidelines (DTP, 2023a) and Clause 52.32 of the Moyne Planning Scheme, a pre-construction (predictive) noise assessment is required in accordance with the New Zealand Standard.	Wind turbine operational noise has been assessed in accordance with the New Zealand Standard.
Construction Noise and Vibration Guideline (CNVG) (NSW Roads and Maritime Services, 2016)	The CNVG sets out indicative minimum working distances from sensitive receivers for typical items of vibration intensive plant. The indicative minimum working distances are quoted for effects relating to cosmetic damage and human comfort.	The indicative minimum working distances detailed in the CNVG have been used as the primary reference for assessing construction vibration related risks at the planning stage of the project.
Resources Victoria's online publication Guidelines for Ground Vibration and Airblast Limits for Blasting in Mines and Quarries	This Guideline describes the policy of the Department of Energy, Environment and Climate Action with respect to the limits on blasting impacts at residential premises and other sensitive sites.	This Guideline is relevant to any blasting associated with the quarries that are proposed to enable onsite sourcing of aggregate for construction of the project.

Noise assessment terminology

A-weighting: frequency adjustment representing the response of the human ear, devised to attempt to take into consideration that human response (or sensitivity) to sound is not consistent across all frequencies.

dB L_{A90} (A-frequency-weighted L_{90} centile level): used in the New Zealand Standard to assess noise generated by wind energy projects. It refers to a sound level measurement being the average decibel that was equalled or exceeded 90% of the time.

Effective noise level (ENL): The effective noise level from commercial, industrial or trade premises determined in accordance EPA Victoria Publication 1826.5: Noise limit and assessment protocol for the control of noise from commercial, industry and trade premises and entertainment venues. This is the L_{Aeq} noise level over a 30-minute period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.

L_{Aeq}: the A-weighted equivalent continuous noise level. It is the energy-average of noise levels of a continuous steady sound occurring over a measurement period.

Natural areas (ERS land use category V): Natural areas are a land-use category for which the ERS details desired outcomes in terms of noise level to be achieved or maintained in Victoria. The ERS defines natural areas as "*national parks, state parks, state forests, nature conservation reserves, wildlife reserves and environmentally significant areas and landscapes outside metropolitan Melbourne that are identified in a planning scheme*".

Noise criteria: refers to the noise values set to avoid potential noise impacts for most people, most of the time.

Noise limit: the maximum effective noise level permitted in a noise sensitive area, as determined in accordance with the EPA Victoria Noise Protocol. Effective noise level is determined (for noise from commercial, industrial and trade premises) as a 30-minute equivalent sound pressure level $L_{Aeq,30min}$ adjusted for duration, noise character and measurement position (where relevant).

Noise sensitive locations: defined by the New Zealand Standard as areas "*associated with a habitable space or education space in a building not on a wind farm site*". This includes:

- any part of land zoned predominantly for residential use
- residential uses including land uses listed in the accommodation group at Clause 73.04-1 of the Moyne Planning Scheme
- education and childcare uses listed in the education centre group at Clauses 73.04-4 of the Moyne Planning Scheme.

17.3.1 Working hours

Most project construction works would be restricted to normal working hours, as defined by EPA Publication 1834.2: Civil Construction, Building and Demolition Guide. This publication specifies normal working hours as:

- Monday to Friday, 7 am to 6 pm
- Saturday, 7 am to 1 pm.

Construction activities may also occur outside these hours, subject to the requirements for work 'outside normal working hours'. Work outside of normal working hours is required to be justified. For major infrastructure projects, such as energy projects, EPA Publication 1834.2: Civil Construction, Building and Demolition Guide defines 'outside normal working hours' as:

- Monday to Friday, 6 pm to 10 pm
- Saturday, 1 pm to 10 pm
- Sundays and public holidays, 7 am to 10 pm.

The following types of work may occur at these times, subject to specific requirements and approval from the relevant authority:

- low-noise impact works (quiet or unobtrusive works)
- managed-impact works (where the noise emissions are managed through actions specified in a noise and vibration management plan, and which do not have intrusive noise characteristics)
- unavoidable works (activities that need to occur outside of normal working hours due to risks to life or property, potential traffic hazards (e.g. oversized deliveries), or certain types of construction work that cannot be stopped midway through the process (concrete pours and tunnelling works are cited as examples).

Any justified 'low-noise impact works' or 'managed-impact works' must not exceed background noise at residential premises by 10 dB(A) or more for up to 18 months after project commencement, or 5 dB(A) or more after 18 months. This also applies to unavoidable works and works undertaken on weekend and evening periods. The noise associated with night period works must also be inaudible within a habitable room during the hours of 10 pm to 7am.

The blast firing times, to be specified in the quarry work plan, would typically be restricted to weekdays between 10 am and 4 pm (Attachment II – ***Preliminary draft Quarry Work Plan***).

17.3.2 Applicable noise limits

Construction

The requirements of the *Environment Protection Act 2017* are applicable to noise and vibration associated with construction activities. The following obligations therefore apply:

- construction activities must not cause unreasonable noise according to the listed factors set out in the *Environment Protection Act 2017*
- the risk of harm from construction noise and vibration must be minimised so far as reasonably practicable, in accordance with the general environmental duty under the *Environment Protection Act 2017*.

However, unlike project operation, there are no defined noise levels at which construction noise is prescribed to be unreasonable, and the Environment Protection Regulations 2021 do not specify mandatory assessment requirements.

The objectives defined in the Environmental Reference Standard (ERS) are relevant to on-site construction activities and construction traffic noise. While the ERS objectives do not represent limits or design targets, they provide a reporting benchmark and noise levels above the objectives are an indicator of risk. Based on the adjoining land use, the ERS objectives for receivers along the traffic routes and within the project site are 40 dB $L_{AEQ,16h}$ and 35 dB $L_{AEQ,8h}$ for the day and night, respectively.

There are no mandatory noise limits or guidelines in Victoria that are directly applicable to the noise of off-site construction traffic.

Quarry and concrete batching plants

The Noise Protocol defines a procedure for setting noise limits applicable to the operational stage of the project to assess whether a noise is prescribed to be unreasonable in accordance with the Environment Protection Regulations 2021 and *Environment Protection Act 2017.* Given the projected duration of operation of the proposed on-site quarry and concrete batching plants, these activities have been assessed against the noise limits specified in the Noise Protocol.

Sensitive receivers, the proposed on-site quarry and concrete batching plants are located within land designated as Farming Zone. Table 17.3 which outlines the applicable noise limites for this zoning.

Table 17.3 Applicable Noise Protocol noise limits (dB ENL) for the on-site quarry and concrete batching plants

Period	Day of week	Start time	End time	Noise limit (db)
Day	Monday – Saturday	7 am	6 pm	46
Evening	Monday – Saturday	6 pm	10 pm	41
	Sunday, Public holidays	7 am	10 pm	41
Night	Monday – Sunday	10 am	7 am	36

Operation

Wind turbines

In relation to the proposed Hexham Wind Farm, 'stakeholder receivers' refers to residential dwellings located on properties associated with the project. Regulation 131BA of the Environment Protection Regulations 2021 specifies noise limits for stakeholder receivers as:

- the noise limit specified in the agreement, where a noise agreement between the owner or operator of a wind energy facility and a landowner is made before 1 November 2021
- 45 dB L_{A90} or background noise (L_{A90}) + 5 dB, whichever is the greater, where a noise agreement between the owner or operator of a wind energy facility and a landowner is made on or after 1 November 2021.

Noise agreements are proposed between the landowners and the proponent at seven receivers outside the project site boundary and within five kilometres of a wind turbine. These receivers are assessed against the noise limits which would apply when an agreement is established after 1 November 2021.

The applicable noise limits are detailed in Table 17.4.

Table 17.4 Applicable noise limits, dB L_{A90}

Receiver status	Noise limit
Non-stakeholder	40 dB or background L_{A90} + 5 dB, whichever is greater
Stakeholder outside the project boundary where a noise agreement is proposed.	45 dB or background L_{A90} + 5 dB, whichever is the greater
Stakeholder within the project site boundary	Not applicable Reference level of 45 dB or background L_{A90} + 5 dB, whichever is greater

In accordance with NZS 6808, an assessment is required for all receivers located within the predicted 35 dB L_{A90} contour to determine whether a high amenity noise limit may be justified. EPA Publication 3011: Wind Energy Facility Turbine Noise – Technical Guideline states that the high amenity noise limit should apply to dwellings located in land use zones that are predominantly intended for residential development, and is not applicable to dwellings in the Farming Zone, As all receivers within the predicted 35 dB L_{A90} contour are located within areas identified as Farming Zone a high amenity noise limit it is not justified for this project.

The **high amenity noise limit** is a rule in the New Zealand Standard NZS 6808:2010, which is used in Victoria to regulate wind farm noise. It is designed to offer extra protection for people living in quiet, rural areas where the natural background noise is very low, particularly during the evening and night.

On-site terminal station and battery energy storage system

The on-site terminal station and battery energy storage system are located on land designated as Farming Zone. Given this land zoning, the noise limits applicable at the nearest receivers are summarised in Table 17.5.

Table 17.5 Noise Protocol time periods and noise limits, dB ENL

Period	Day of week	Start time	End time	Noise limit (DB)
Day	Monday – Saturday	7 am	6 pm	45
Evening	Monday – Saturday	6 pm	10 pm	39
	Sunday, Public holidays	7 am	10 pm	39
Night	Monday – Sunday	10 pm	7 am	34

17.4 Investigation area

The investigation area for the noise and vibration assessment extends to five kilometres from the proposed wind turbine locations and associated project infrastructure.

The investigation area is predominantly rural and includes the townships of Caramut to the north-west, Hexham to the north-east and Ellerslie to the south-east. To assess the potential noise of off-site traffic movements during construction, the assessment also extends to the township of Mortlake to the east of the project site. The investigation area includes noise sensitive receivers including residential dwellings (refer to Figure 17.1).

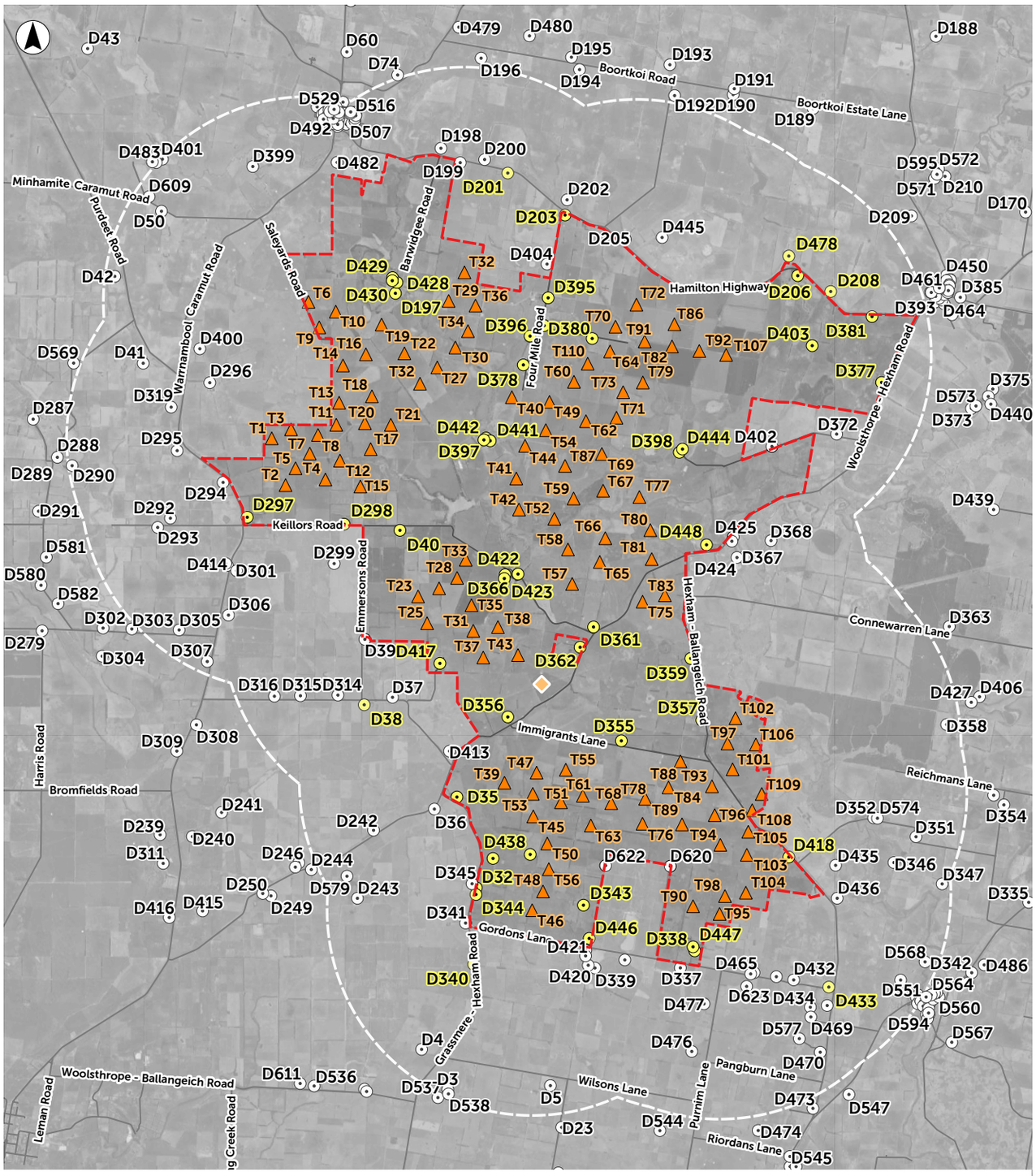

Figure 17.1 Site map of proposed wind turbines, on-site terminal station, battery energy storage system and receivers

17.5 Method

To determine potential adverse effects of noise and vibration at sensitive receivers near the project site, the noise and vibration assessment:

- reviewed existing noise conditions and identified noise sensitive receivers in the investigation area including natural areas in the vicinity of the project
- assessed background noise levels at key noise sensitive receivers around the project site
- predicted noise levels associated with the project construction and operation, and assessed the project's compliance with mandatory noise limits
- identified measures to avoid, minimise and mitigate noise impacts, and assessed the potential residual impact following the implementation of these measures.

17.5.1 Background noise monitoring

Background noise monitoring is undertaken to set noise limits for wind turbine noise. In accordance with NZS 6808, background noise monitoring was undertaken at seven receivers (six non-stakeholder dwellings and one stakeholder dwelling) from 5 June to 20 July 2023 near the project site. The noise monitoring locations are shown in Figure 17.2.These monitoring locations were selected on the basis that they represent noise levels in different directions from the project.

Background noise level information was collected to allow consideration of background noise levels and wind turbine noise levels for different wind conditions when establishing existing noise levels.

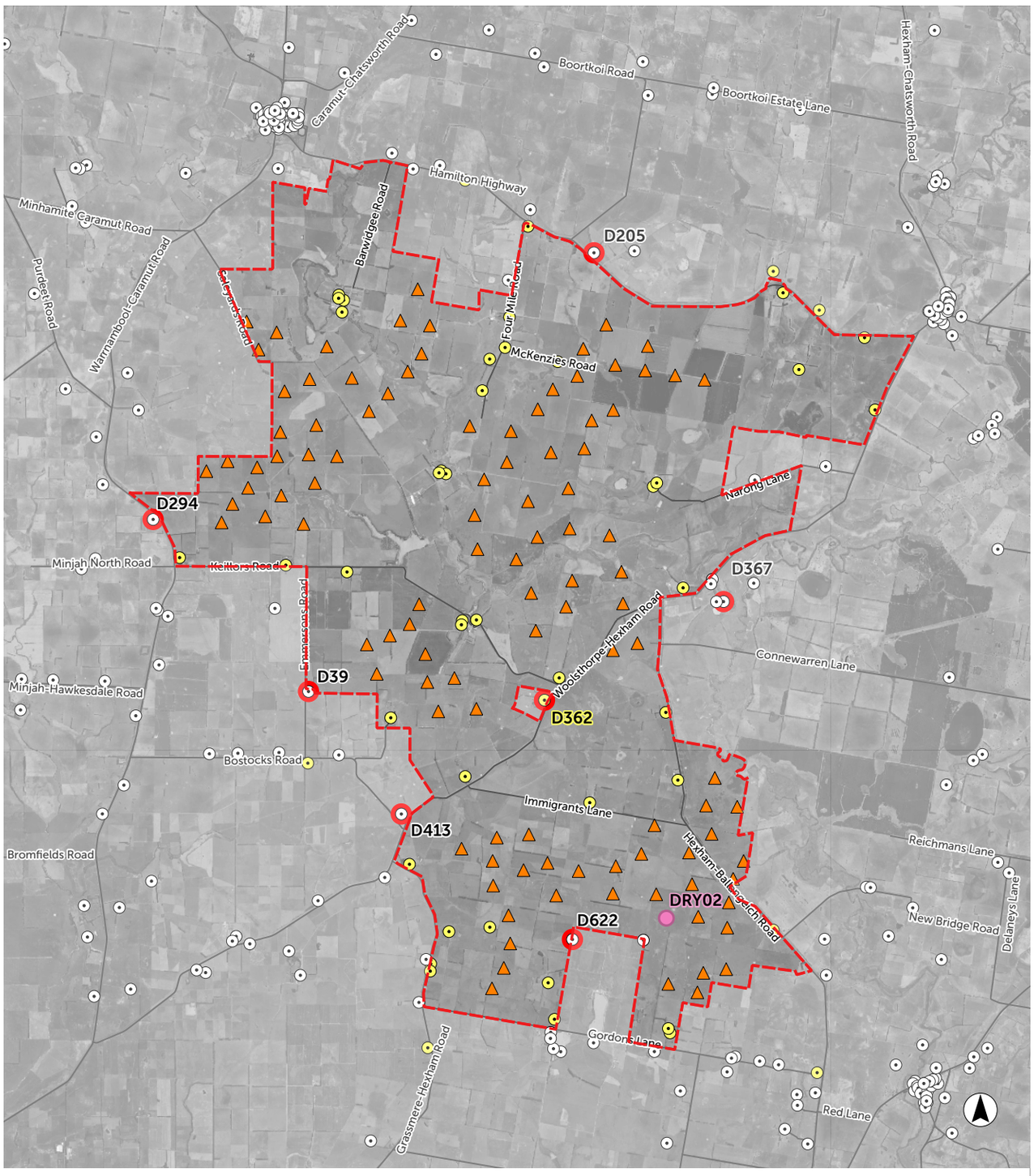

Figure 17.2 Sensitive receiver and background noise monitoring locations

17.5.2 Predicted noise levels

Construction noise and vibration

Predicted noise levels were calculated in accordance with the method detailed in AS 2436:2010 Guide to noise and vibration control on construction, demolition and maintenance sites (AS 2436). Key elements of the method used for predicting project construction noise are summarised in the ***Environmental Noise and Vibration Impact Assessment*** (Appendix E1).

Off-site traffic

The project includes a proposed on-site quarry for sourcing aggregate for construction material, reducing traffic on the surrounding road network. While this is the preferred option for the project, the on-site quarry is subject to a separate approvals process. As such, two potential scenarios were considered when assessing noise from off-site traffic:

- Scenario 1: 100% of all aggregate for the construction of internal access tracks and hardstand areas sourced from the on-site quarry (on-site material sourcing)
- Scenario 2: all construction material sourced off-site (off-site material sourcing).

Based on estimated average daily traffic movements (refer to Chapter 25 – ***Traffic and transport***), traffic noise levels were predicted using the Calculation of Road Traffic Noise prediction method.

Quarry and concrete batching plants

The on-site quarry and concrete batching plants were assessed against Victorian noise requirements for commercial, industrial and trade premises (industry premises).

The assessment considered that all plant would be continuously operating simultaneously within any given 30-minute assessment period. In practice, variations in the duration and intensity of operation of each item of plant are likely to result in lower noise levels. These variations in operating characteristics would need to be accounted for in the detailed design assessment report.

At this stage of the project, the assessment is primarily based on A-weighted noise levels. Low frequency noise would need to be addressed during the detailed design stage of the project, accounting for actual plant selections and detailed noise emission data.

Operation noise and vibration

Operational noise levels associated with the wind turbines, on-site terminal station, and battery energy storage system were predicted using noise emission data for the relevant equipment (e.g. wind turbines, transformers, inverters), a 3D digital model of the site and surrounding environment, and international standards used for the calculation of environmental sound propagation.

The assessment considered that the on-site terminal station and battery energy storage system are proposed to operate 24 hours a day, and 7 days a week.

Frequency spectrum is a prescribed factor in accordance with the Environment Protection Regulations 2021. As such, an objective assessment of low frequency noise may be applicable when determining whether noise emissions constitute 'unreasonable noise' under the *Environment Projection Act 2017.*

Low frequency noise emission data for this assessment is currently unavailable. Therefore, this assessment has not been included in this method and will be undertaken during the detailed design stage of the project (as required by management control NV07, detailed in Section 17.7.3).

17.5.3 Risk assessment

To evaluate the noise and vibration impacts associated with the project, EPA Publication 1695.1 Assessing and controlling risk: A guide for business was used to assess the risk of harm from noise and vibration to human health and/or the environment. The consequence and likelihood of noise and vibration-related risks are influenced by factors such as:

- type of noise or vibration source and its characteristics (e.g. a continuous or varying noise source and its frequency characteristics)
- nature of the noise or vibration source (e.g. an activity that can be readily modified or relocated versus an essential activity with limited opportunity to modify, relocate or reschedule)
- environment in which the noise or vibration is produced (e.g. the context and the background level of noise or vibration)
- time, duration and regularity of the noise or vibration
- environmental factors that may change the background noise environment and/or the noise level of the source (e.g. wind conditions)
- type and number of sensitive locations potentially affected by the noise or vibration
- type of assessment used to evaluate the risks (e.g. prediction or measurement-based assessments), and the level of information available for the assessment
- assessment framework for each noise and vibration source, and whether noise and vibration limits are clearly defined (e.g. legislation which defines prescriptive compliance requirements in quantitative terms or management-based guidance)
- options available to mitigate or manage the noise or vibration source.

17.6 Existing conditions

17.6.1 Receivers

A total of 188 sensitive receivers were identified within the investigation area, comprising:

- 139 non-stakeholder receivers on properties not associated with the project
- 49 stakeholder receivers on properties associated with the project including:
  - 42 receivers within the project site
  - seven receivers outside the project site where a noise agreement is proposed with the landowner.

17.6.2 Natural areas

Natural areas within 15 kilometres of the project site (shown in Figure 17.3) are:

- Hexham School Historic Reserve (approximately 4.4 kilometres to the north-east)
- Lake Connewarren (approximately 4.7 kilometres to the east)
- Mortlake Common Flora Reserve (approximately 10.2 kilometres to the east)
- Cobra Killuc Wildlife Reserve (approximately 10.6 kilometres to the east)
- Hopkins River, Framlingham Streamside Reserve (approximately 12 kilometres to the south).

The natural areas near the project provide a sound environment characterised by natural sounds and intermittent human-made noise sources including intermittent traffic, activities within Hexham township, and agricultural activity such as ongoing forestry operations.

For natural areas near townships, background noise levels would be elevated by road traffic noise and human-made noise. In natural areas where wind disturbance of vegetation is a key influence, the background noise would vary significantly according to factors such as ground elevation (in turn affecting exposure to the wind) and the type and density of vegetation in the surrounding area.