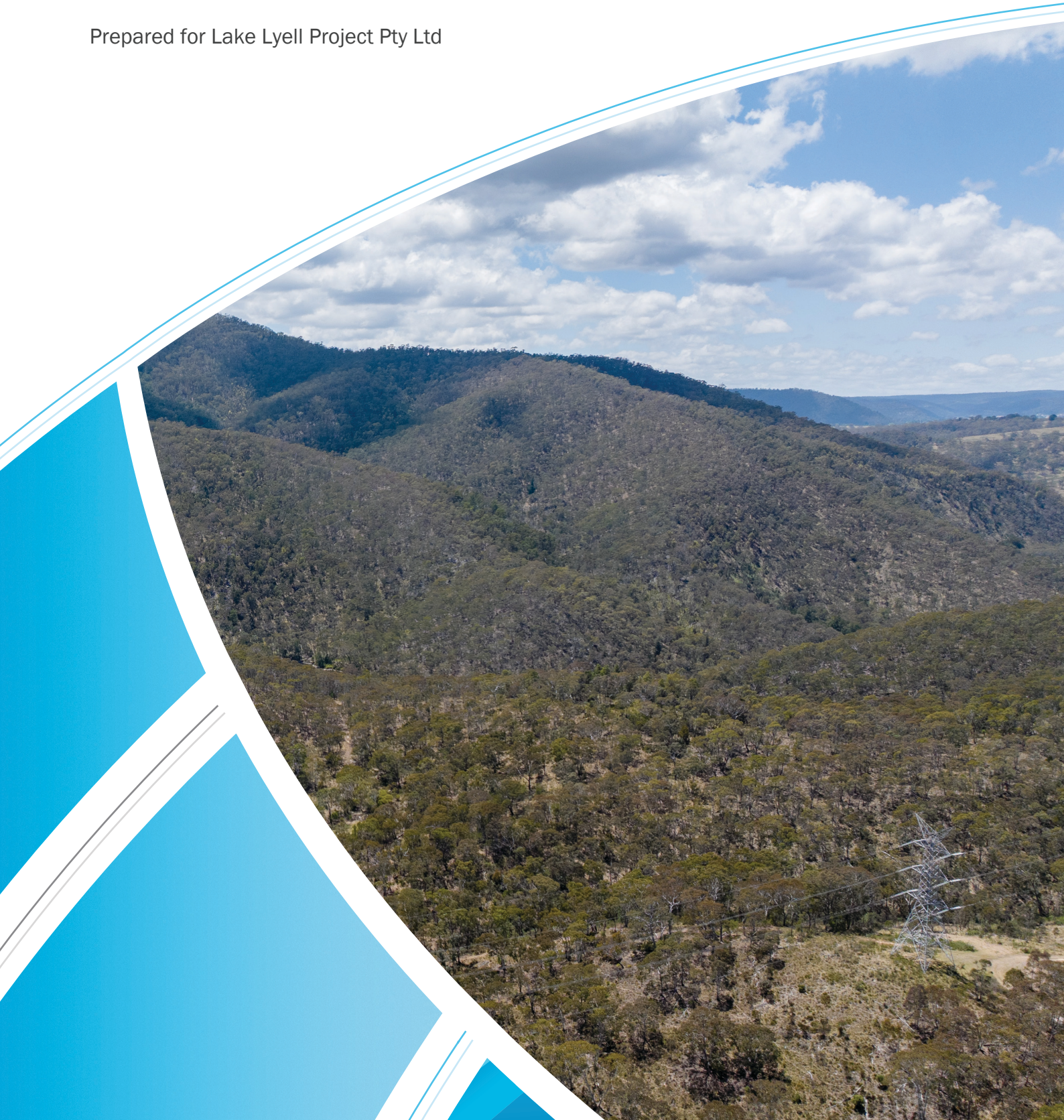


APPENDIX R – Environmental Impact Statement

Noise and vibration impact assessment

Prepared for Lake Lyell Project Pty Ltd



Lake Lyell Pumped Hydro Energy Storage

Noise and vibration impact assessment

Lake Lyell Project Pty Ltd

E221111 RP17

November 2025

Version	Date	Prepared by	Reviewed by	Comments
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2	22/08/2025	Lucas Adamson	Robert Kirwan	Second draft
3	22/09/2025	Lucas Adamson	Robert Kirwan	Final draft
4	21/11/2025	Lucas Adamson	Robert Kirwan	Final

Approved by



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ABN: 28 141 736 558

Executive Summary

This noise and vibration impact assessment (NVIA) has been prepared to support the environmental impact statement (EIS) for the Lake Lyell Pumped Hydro Energy Storage (PHES) Project (the project). It has documented the assessment methods, noise modelling results and the mitigation and management measures proposed to address any residual noise and vibration impacts not able to be avoided.

The construction schedule was reviewed to identify the worst-case periods for both the early works and main construction phases. These periods have been adopted on the basis that they are considered representative of the worst-case scenario for each phase.

Noise levels have been assessed against the relevant noise management levels (NMLs), determined in accordance with the methodology set out in the EPA's Interim Construction Noise Guideline (ICNG, 2009), which provides the criteria for evaluating construction noise impacts.

Noise levels from early works construction, under noise-enhancing weather conditions, are:

- not predicted to exceed the highly noise affected noise level of $L_{Aeq,15minute}$ 75 dB at any assessment location
- predicted to be above the relevant NMLs at 49 assessment locations during ICNG standard construction hours
- predicted to be above the relevant NMLs at 61 assessment locations during the day out of hours period
- predicted to be above the relevant NMLs at seven assessment locations during the evening period
- predicted to be above the relevant NMLs at eight assessment locations during the night-time period.

Noise levels from main construction, under noise-enhancing weather conditions, are:

- not predicted to exceed the highly noise affected noise level of $L_{Aeq,15minute}$ 75 dB at any assessment location
- predicted to be above the relevant NMLs at 12 assessment locations during ICNG standard construction hours
- predicted to be above the relevant NMLs at 27 assessment locations during the day out of hours period
- predicted to be above the relevant NMLs at seven assessment locations during the evening period
- predicted to be above the relevant NMLs at nine assessment locations during the night-time period
- predicted to be above the relevant NMLs at 75 assessment locations during the morning shoulder period.

Noise contours have also been provided for Lithgow (during early works and main construction phases of the alternative town accommodation camp) and South Bowenfels (during early works road upgrades) to show the extent of impact to the surrounding community under noise-enhancing weather conditions.

An out of hours works protocol will be developed for the project to ensure that appropriate measures are implemented to reduce potential impacts during these periods. The protocol will also ensure that high noise generating activities be limited during more sensitive periods.

The proponent will notify the affected residents of construction works and the potential noise impacts and discuss options for mitigating impacts. Noise monitoring should be undertaken during the initial stages of construction to determine if actual construction noise levels are above NMLs. If this initial testing identifies exceedance of the NMLs the contractor should identify feasible and reasonable mitigation measures that reduce construction noise levels to NMLs where practical.

This NVIA has identified potential for sleep disturbance as defined in the NSW Environment Protection Authority's *NSW Noise Policy for Industry* (NPfI) (EPA 2017) due to night-time activities associated with both the early works and main construction phases.

- Night-time maximum noise level events associated with early works construction, under noise-enhancing weather conditions, are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 15, 18 and 25 during the night-time period. These exceedances can be attributed to the proximity of the assessment locations to the south-eastern most geotechnical drilling pads.
- Night-time maximum noise level events associated with main construction, under noise-enhancing weather conditions, are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 15, 18 and 25 during the night-time period and assessment locations 6, 15, 18, 19, 21, 25 and 28 during the morning shoulder period. These exceedances can be attributed to the proximity of the assessment locations to the lower laydown area, concrete batching plant and southern access road.

A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in this NVIA. These measures, if integrated with project construction and operational environmental management plans and implemented as intended, would moderate the impact of the project on local receivers. A Neighbour Agreement Guide will also be implemented and provides a mechanism for specific landowner agreements to be negotiated based on their level of impact.

The potential for vibration impacts on residences and other vibration sensitive structures near construction activity has been assessed.

- The nearest residences surrounding the project area (including the lakeside accommodation camp) are located over 250 metres (m) from construction works. These distances exceed safe working limits for both human comfort response and cosmetic damage to structures, making vibration impacts unlikely. Notwithstanding, construction methodology should be reviewed if activity is proposed to occur in the vicinity of any sites with geological or heritage significance.
- The nearest residences surrounding the Town camp are dwellings on Silcock Street in the Pottery Estate. As the Pottery Estate is recognised as a Heritage Conservation Area within the Lithgow Local Environmental Plan, more stringent cosmetic damage criteria are also applicable. Vibration impacts may arise from some early works construction activities, given the small separation distances to residences. No vibration-generating activities are anticipated during the typical operation of the camp (throughout the main PHES construction phase). Given the possibility for vibration generating equipment to be operated within proximity to these residences, the guide values presented within should be followed in the first instance, with equipment and methods carefully selected, and mitigation measures implemented. If works are anticipated to occur within the safe working distances, real-time vibration monitoring with alarms should be considered.

A quantitative blast assessment has been undertaken to calculate blast ground vibration and overpressure offset distances required to achieve acceptable emissions at sensitive receiver locations. Residential receivers surrounding the project are located outside the relevant blast offset distances required to maintain acceptable noise and vibration emission levels from tunnelling and open cut blasting.

If blasting is required within these offset distances, a range of mitigation measures may be employed to ensure compliance to relevant blast criteria, including reduction of maximum instantaneous charge (MIC), the use of electronic detonators, optimised drill patterns and other factors to optimise blast design and reduce blasting impacts. Notwithstanding, a suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure compliance with the criteria provided in the ANZECC Blasting Guidelines (1990).

Whilst unlikely, blast practices associated with tunnelling during the night period will be reviewed and modified if higher air blast levels are generated and measured at a level that would cause adverse impacts on residents.

The project would result in additional road traffic movements during the construction period. Significant road traffic noise increases are predicted to occur on Sir Thomas Mitchell Drive and Magpie Hollow Road.

Road traffic movements associated with the town accommodation camp are anticipated to comply with the *Road Noise Policy* (RNP) 2 decibels (dB) relative increase criteria, as existing road traffic noise levels are predicted to be above the relevant RNP criteria for all roads on the proposed route and road traffic noise level increases are predicted to be less than 1 dB.

It is of note that the predicted road traffic noise levels are based on heavy vehicle movements during the peak construction scenario and hence the assessment of road traffic noise is conservative. Further, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

Project-related operational road traffic volumes are expected to be less than 2% of the total existing road traffic volumes on the abovementioned roads. As such, adverse impacts because of operational road traffic noise are considered unlikely.

The impacts of noise and ground vibration on fauna is expected to be low. The greatest emissions would occur during construction works, with emissions during the operation of the project anticipated to be significantly less than those experienced during construction works.

Assessment of operational noise associated with the project has predicted compliance with the NPfI requirements for all assessment locations.

A construction noise and vibration management plan (CNVMP) addressing relevant management and mitigation options for both noise and vibration (where required) will be prepared prior to commencement of construction activity associated with the project. The measures included in the CNVMP (where feasible and reasonable), together with negotiated mitigation measures to be implemented at specific residences, are expected to moderate the impact of the project on local receivers as far as reasonably practicable.

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1 Introduction

1.1 Background

EnergyAustralia Portfolio Holdings Pty Ltd (EnergyAustralia) in partnership with EDF power solutions Australia (EDFA), referred to as Lake Lyell Project Pty Ltd (LLP) as trustee, is developing the Lake Lyell Pumped Hydro Energy Storage (PHES) Project (the project). The project will have the capacity to store up to 3,080 megawatt hours (MWh) of energy and generate at 385 megawatts (MW) for 8 hours or generate up to around 440 MW for a shorter period. At a basic level, it will consist of upper and lower water reservoirs, a pipeline connecting them, and a hydro-electric power station connected to the national energy grid that is capable of generating or consuming electricity.

The project is located approximately 5 kilometres (km) west of Lithgow and 110 km west of the Sydney central business district, shown in Figure 1.1 and Figure 1.2. The project takes advantage of existing infrastructure (i.e. Lake Lyell) associated with Mt Piper power station which will be decommissioned in the coming decades and allows Lake Lyell to continue to serve a specific purpose in electricity generation (consistent with its existing use).

In June 2024, the Minister for Planning and Public Spaces declared the project to be critical State significant infrastructure (CSSI). Accordingly, approval for the project is required under Part 5, Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This requires the preparation of an environmental impact statement (EIS) for the project in accordance with Secretary's environmental assessment requirements (SEARs) and the approval of the Minister. EMM Consulting Pty Limited (EMM) has been engaged by LLP to prepare the EIS.

This noise and vibration impact assessment (NVIA) is an appendix to the project's EIS and should be read in conjunction with it. The NVIA addresses the SEARs issued for the project.

1.2 Assessment guidelines and requirements

This NVIA has been prepared with reference to relevant guidelines, policies and industry requirements, and following consultation with stakeholders, including relevant government agencies and the community. Guidelines and policies referenced are as follows:

- NSW Department of Environment Climate Change (DECC) 2009, *The Interim Construction Noise Guideline* (ICNG)
- NSW Environment Protection Authority (EPA) 2017, *NSW Noise Policy for Industry* (NPfI)
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP) and associated application notes
- Australian and New Zealand Environment Council 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*
- Department of Environment and Conservation (DEC) NSW 2006, *Assessing Vibration: a technical guideline*
- German Standard DIN4150.2:1975 *Structural noise vibration*
- Australian Standard AS2187.2:2006 *Explosives - Storage and Use - Use of Explosives*.

1.2.1 Secretary's environmental assessment requirements

This NVIA has been prepared in accordance with the requirements of the NSW Department of Planning, Housing and Infrastructure (DPHI) and relevant agencies, which are set out in the SEARs for the project, issued on 17 November 2025. The SEARs identify matters which must be addressed in the EIS. Individual requirements relevant to this NVIA and where they are addressed in this report are listed in Table 1.1.

Table 1.1 Noise and vibration related SEARs

Requirements	Section addressed
Amenity – including	
- an assessment of the: - construction, operational and road noise impacts of the Project - blasting impacts of the Project - visual impacts of the project, including lighting impacts and potential impacts on views of the Project from key vantage points and recreational areas surrounding Lake Lyell; and - amenity impacts on National Parks and Reserves (including Marrangaroo National Park).	Sections 6.1 to 6.3, 6.5 and 6.8 Section 6.4 Refer to Landscape and Visual Impact Assessment (EMM 2025) Section 6.9

1.2.2 Agency engagement

DPHI invited government agencies, including Lithgow City Council (Council), to recommend matters to be addressed in the EIS. These matters were considered by the Secretary for DPHI when preparing the SEARs. Comments made by agencies relating to the assessment of noise and vibration and where they are addressed in this report are listed in Table 1.2.

Table 1.2 Agency comments on SEARs

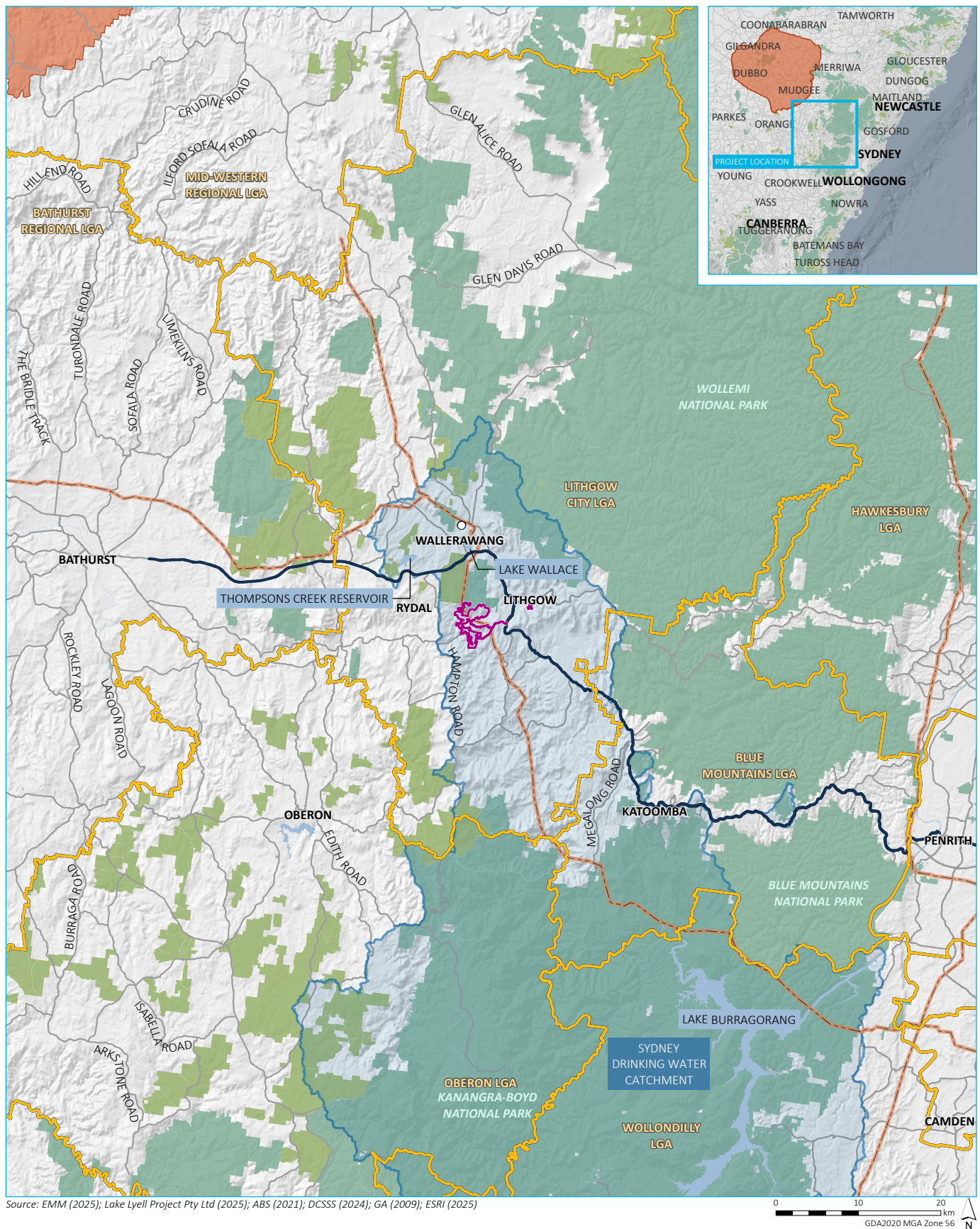
Agency	Comments	Section addressed
NPWS	"... potential impacts on park visitor amenity, with the noise assessment treating Marangaroo camping area as a 'sensitive receiver', equivalent to a residence."	Sections 6.1, 6.6 and 6.9
EPA	"Noise and vibration impacts associated with blasting (if applicable) and operational noise, particularly machinery, including cooling systems for the sheds and plant movements."	Sections 4.5, 6.4 and 6.6
Lithgow City Council	"Council is satisfied that a noise and vibration assessment, in accordance with the relevant policies and guidelines will be prepared and submitted with the EIS as well as a road traffic noise assessment, construction and operational noise impacts."	Sections 4, 5 and 6

These comments have been incorporated into the assessment where required.

1.2.3 Other relevant reports

This NVIA has been prepared with reference to other technical reports that were prepared as part of the project EIS. The other relevant reports referenced in this NVIA are as follows:

- Air quality impact assessment (EMM 2025)
- Historic heritage assessment (EMM 2025)
- Aboriginal cultural heritage assessment (EMM 2025)
- Traffic impact statement (EMM 2025)
- Landscape and visual impact assessment (EMM 2025).



KEY

- ▬ Project area
- ▬ Local government area
- ▬ Sydney Drinking Water Catchment
- ▬ Central West Orana Renewable Energy Zone
- Mt Piper Power Station
- Major road
- Great Western Highway
- 330 kV transmission line
- ▬ Named waterbody
- ▬ NPWS reserve
- ▬ State forest
- ▬ NPWS reserve
- ▬ State forest

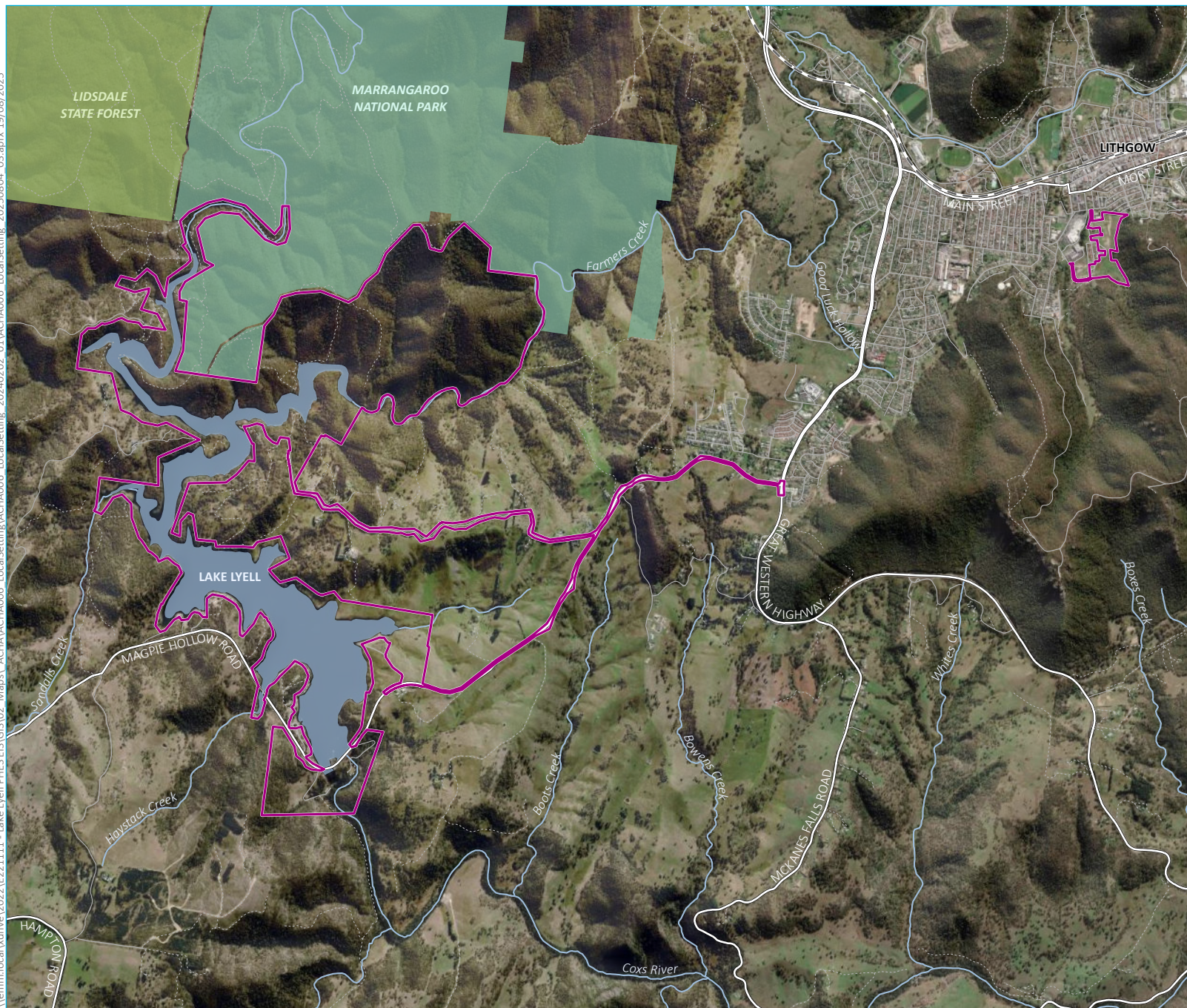
INSET KEY

- Major road
- ▬ NPWS reserve
- ▬ State forest
- ▬ Central West Orana Renewable Energy Zone

Regional context

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 1.1

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KEY

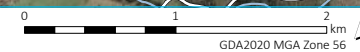
- Project area
- Existing environment
- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Local context

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 1.2



Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)



2 Description of the project

A detailed description of the project, including an overview of its design, construction and operation is provided in the project's EIS. The EIS (specifically Chapter 3 and Appendix B) should be read in conjunction with this report. A summary of the project's key elements is provided below.

The project design, as shown in Figure 2.1, can be broadly categorised into:

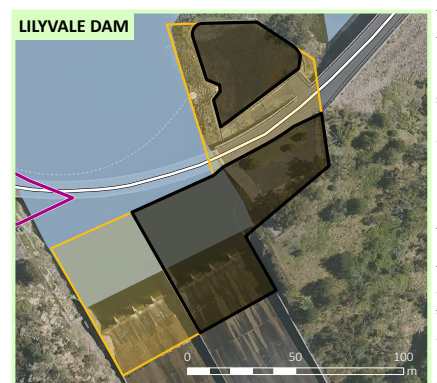
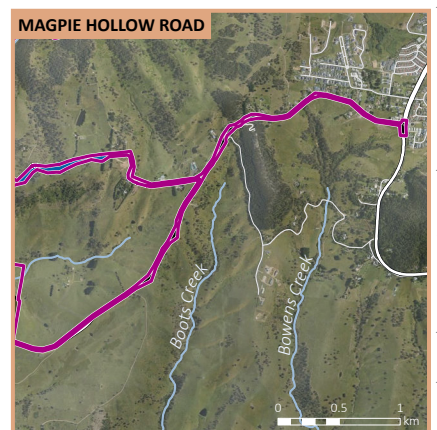
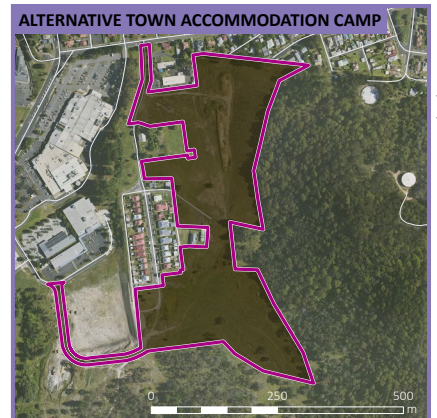
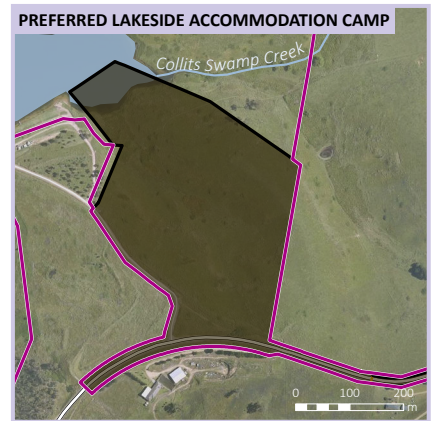
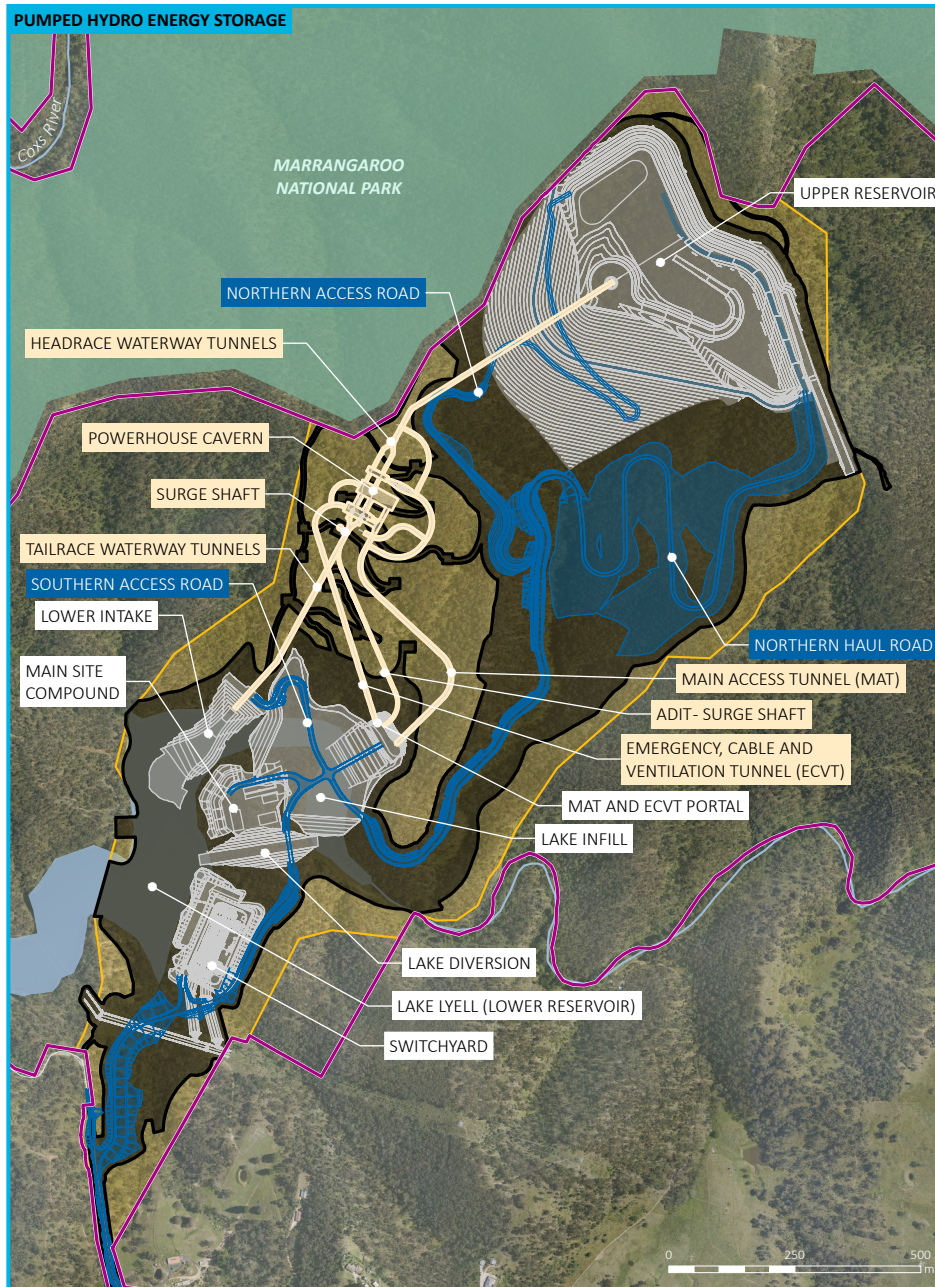
- pumped hydro generation components – including a 5.3 gigalitre GL upper reservoir to be constructed behind the southern ridge of Mount Walker, a 33.5 GL lower reservoir (existing Lake Lyell), inlet/outlet structures, and an underground powerhouse, surge shaft and waterway tunnels
- transmission connection components – including a new high voltage switchyard and connection to the existing 330 kilovolt (kV) transmission line that runs through the site
- site access and ancillary facilities – including upgrade of existing and construction of new access roads and bridges, a diversion and infill of a section of Lake Lyell, administration and utilities
- other construction components or works – including geotechnical investigations, temporary workforce accommodation, site work pads, laydown areas and facilities, and spoil management.

Construction will be completed in stages, including:

- pre-construction / enabling works – consisting of initial access works (internal and external roads), geotechnical investigations, site establishment and preparation of the worker's accommodation camp
- main works – consisting of all other construction activities needed to enable operation of the project.

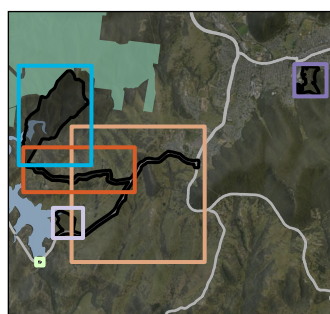
During operation, the project will act as an electrical energy storage system through the conversion of electrical to kinetic energy to gravitational energy and back via water as it is transferred from the elevated upper reservoir to a lower reservoir. The project will provide services to the wholesale 'spot' market on the National Electricity Market (NEM), and support ancillary services used to manage the power system reliably.

After the 80 to 100-year design life of the project, the asset may remain viable for a plant refurbishment and extension of life as has been seen for other older assets globally. Following the plants final refurbishment or once it has reached the end of its serviceable life then it is expected that the site would be returned to a more natural state and/or an alternative community beneficial use outcome.



Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); MetroMap (2025)

GDA2020 MGA Zone 56



KEY

- | | |
|--|--|
| Project area | Existing environment |
| Permanent road | Major road |
| Above ground design | Minor road |
| Underground design | Named watercourse |
| Construction envelope | Named waterbody |
| Disturbance footprint | NPWS reserve |

Project overview

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 2.1

3 Existing environment

3.1 Site description

The project area is located about 5 km west of Lithgow, within the City of Lithgow local government area (LGA). The project area includes parts of Mount Walker, Lake Lyell and adjacent land, and the road corridors needed for site access. Lithgow is located approximately 5 km to the east of the project and Bathurst is approximately 50 km to the west. Other nearby communities include South Bowenfels which is located approximately 4 km to the south-east, and Rydal located approximately 5 km to the west.

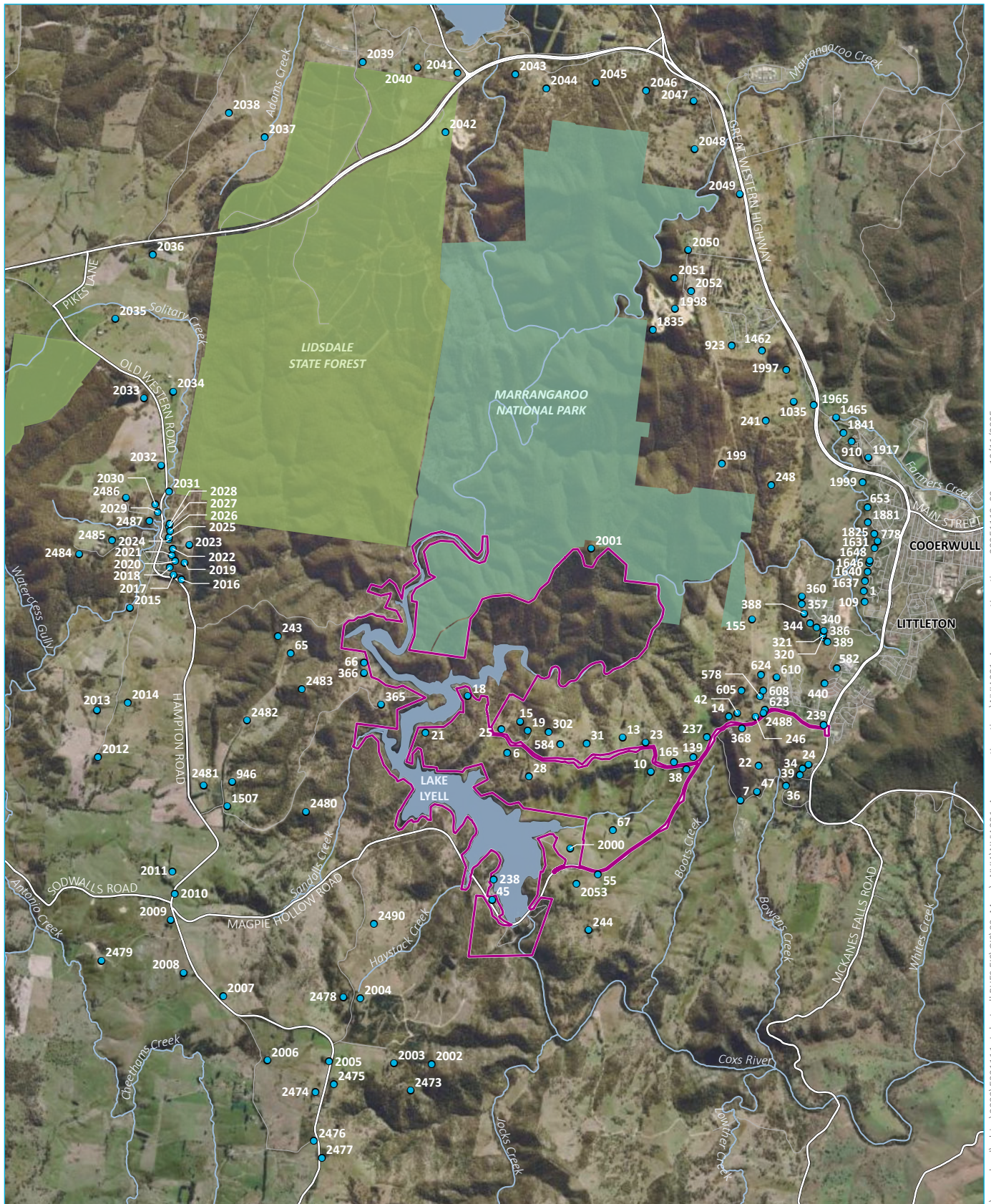
The project is off river, located on the Farmers Creek arm of Lake Lyell, a tributary of Cocks River. Lake Lyell borders the project area to the west, and the Marrangaroo National Park borders the project area to the north and east. These can be seen in Figure 1.1 and Figure 1.2 which show the regional and local contexts of the site, respectively.

3.2 Noise and vibration assessment locations

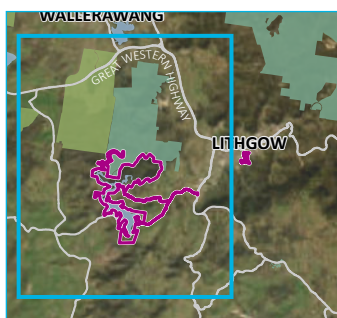
The nearest representative noise sensitive locations to the project have been identified for the purpose of assessing potential noise and vibration impacts. The project area and all assessment locations are presented in Figure 3.1. A full list of assessment locations has been included in Annexure A. Most sensitive receptors (assessment locations) identified in the region of the project are rural or suburban residential dwellings in the areas of South Bowenfels, Rydal and Lithgow. There are also passive recreation areas in the area surrounding the project such as the Mount Walker Trig Point (to the north-east), Marrangaroo Campground (to the north), Hampton River Road Campground (to the west) and Lake Lyell Recreational Park (to the south). These assessment locations are shown in Figure 3.1.

The nearest residential sensitive receivers are located to the southeast of the project in South Bowenfels. The closest residence is located approximately 250 metres (m) south-east of the southern access road.

The assessment locations most likely to be affected by road traffic noise are residences in the vicinity of Sir Thomas Mitchell Drive and Magpie Hollow Road, given that this is the main access and haulage route to the site. These assessment locations are also shown in Figure 3.1.



Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)



- KEY**
- ▬ Project area
 - Assessment location
 - Existing environment
 - ▬ Major road
 - ▬ Minor road
 - ▬ Named watercourse
 - ▬ Named waterbody
 - ▬ NPWS reserve
 - ▬ State forest

Project and assessment locations

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 3.1

3.3 Background noise survey

3.3.1 Ambient noise environment

i Project and surrounds (project area including Lakeside camp)

Given the nature of the project area and its surrounds, existing ambient noise levels at assessment locations are likely to be dominated by natural elements, with little to no road traffic noise. The rating background noise levels (RBLs) are expected to be relatively low and therefore the NPfI minimum RBLs of 35 decibels (dB) and 30 dB have been adopted for this assessment for the daytime and evening / night-time periods, respectively, in accordance with the NPfI (EPA 2017). This is a conventional assumption for such areas and leads to the most stringent noise targets available being applied. A summary of adopted background noise levels is given in Table 3.1.

Table 3.1 Summary of adopted rating background levels – Lake Lyell and surrounds

Monitoring location	Period ¹	RBL ² , dB(A)
All residential assessment locations surrounding the project area	Day	35
	Evening	30
	Night	30

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.
2. The RBL is an NPfI term and is used to represent the background noise level. In accordance with the NPfI, minimum thresholds were adopted given the rural nature of the locality.

ii Lithgow (Town camp)

Existing ambient noise levels have previously been measured and reported in Operational Noise Emission Assessment - Bunnings Lithgow prepared by Acoustic Dynamics dated 26 June 2022. The noise monitoring was conducted at 27 Silcock Street, Lithgow between Saturday 12 March 2022 and Friday 25 March 2022. Results of the ambient noise survey have been summarised in Table 3.2 based on data presented in the Acoustic Dynamics report. It is noted that the measured RBLs are considered conservative, given they were measured prior to, and therefore exclude, noise from the now-operational Bunnings development.

Table 3.2 Summary of measured rating background levels - Lithgow

Monitoring location	Period ¹	RBL ² , dB(A)	Ambient L _{Aeq,period} noise level, dB(A)
27 Silcock Street, Lithgow	Day	35	49
	Evening	37	52
	Night	32	47

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.
2. The RBL is an NPfI term and is used to represent the background noise level.

iii South Bowenfels (early works road upgrades)

Existing ambient noise levels have previously been measured and reported in Great Western Highway Upgrade – Little Hartley to Lithgow (West Section) Technical Paper: Noise and Vibration Impact Assessment (Reference: 610.30291-R01) prepared by SLR Consulting dated 18 October 2021. The noise monitoring was conducted at 15 Robinia Drive, South Bowenfels between March and May 2021. Results of the ambient noise survey have been summarised in Table 3.3 based on data presented in the SLR report.

Table 3.3 Summary of measured rating background levels – South Bowenfels

Monitoring location	Period ¹	RBL ² , dB(A)	Ambient L _{Aeq,period} noise level, dB(A)
15 Robinia Drive, South Bowenfels	Day	42	52
	Evening	33	47
	Night	30 ³	44

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.
2. The RBL is an NPfI term and is used to represent the background noise level.
3. The monitored level was adjusted to match the minimum background level in the Noise Policy for Industry.

3.4 Meteorology

3.4.1 NPfI requirements

The NPfI (EPA 2017) requires consideration of noise under standard and noise enhancing weather conditions. The NPfI defines these as follows:

- **Standard meteorological conditions:** defined by stability categories A through to D with wind speeds up to 0.5 metres per second (m/s) at 10 m above ground level (AGL) for day, evening and night periods.
- **Noise-enhancing meteorological condition:** defined by stability categories A through to D with light winds (up to 3 m/s at 10 m AGL) for the day and evening periods; and stability categories A through to D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL for the night-time period.

The NPfI specifies two options to consider meteorological effects:

1. adopt the noise-enhancing meteorological conditions (as outlined in the NPfI) for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night, or
2. determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in the NPfI. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

For the purposes of noise modelling, this assessment has adopted the noise-enhancing meteorological conditions as outlined in the NPfI. This approach provides a conservative assessment.

4 Assessment criteria

4.1 Construction noise

4.1.1 Interim Construction Noise Guideline (ICNG)

The ICNG (DECC 2009) has been jointly developed by NSW Government agencies including the EPA and DPHI. The objectives of the guideline relevant to the planning process are to promote a clear understanding of ways to identify and minimise noise from construction and to identify 'feasible' and 'reasonable' work practices. The guideline recommends standard construction hours where noise from construction activities is audible at residential premises (i.e. assessment locations):

- Monday to Friday 7:00 am to 6:00 pm
- Saturday 8:00 am to 1:00 pm
- no construction work is to take place on Sundays or public holidays.

The ICNG acknowledges that works outside standard hours may be necessary, however, a strong justification is required for construction works outside of standard construction hours. The project's proposed construction hours are outlined in Table 4.1.

Table 4.1 Construction hours

Work type	Hours of work
Normal construction	Monday to Saturday 6.00 am to 6.00 pm
	Sundays or public holidays 9:00 am to 5:00 pm (low noise work only)
Deliveries	Monday to Saturday 6.00 am to 10.00 pm
	No work on Sundays or public holidays
Blasting (at surface)	Monday to Saturday 9.00 am to 6.00 pm
	No work on Sundays or public holidays
Underground excavation and tunnelling (including blasting)	Monday to Saturday 24 hours
	Sundays or public holidays 24 hours
Camp operation	Monday to Saturday 24 hours
	Sundays or public holidays 24 hours

Utilising a 24/7 construction schedule will significantly reduce the duration of the construction program to ensure a 2031 operation target is met, thereby reducing the project's potential impacts to the local community and demands on local infrastructure. While the construction schedule will ultimately be determined by the lead contractors selected for the project, approval is being sought for this flexibility should it be required.

As noted in Chapter 2, a construction accommodation camp is required for the temporary workforce. An influx of a significant number of workers during the project's construction period has the potential to impact social characteristics within the local community such as accommodation, local infrastructure and local businesses, including community services and facilities. As noted in the social impact assessment (EMM, 2025), the construction accommodation camp would mitigate potential for adverse impacts to be experienced within the local community.

For a large proportion of the project's non-local construction workforce to be housed in the construction accommodation camp, the mobilised workforce would need to be utilised as efficiently as possible (i.e. over a seven-day working week). Without this flexibility, it is anticipated that the economic viability of the construction accommodation camp would be questionable given the higher up-front costs involved and the construction timeline would not be achievable.

As part of the preparation of the construction environmental management plan (CEMP), consideration will be given to the construction activities proposed to be undertaken during out of hours (OOH) periods.

The ICNG provides two methodologies to assess construction noise emissions. The first is a quantitative approach, which is suited to major construction projects with typical durations of more than three weeks. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG noise management levels.

The second is a qualitative approach, which is a simplified assessment process that relies more on noise management strategies. This method is suited to short-term infrastructure and maintenance projects of less than three weeks.

This assessment has adopted a quantitative approach. The qualitative aspects of the assessment include identification of assessment locations, description of works involved including predicted noise levels and proposed management measures that include a complaint's handling procedure developed as part of a construction environmental noise and vibration management plan.

4.1.2 Construction noise management levels

Table 4.2 provides ICNG noise management levels (NML) which apply to residential assessment locations.

Table 4.2 ICNG construction noise management levels at residences

Time of day	Management level $L_{Aeq,15minute}$	Application
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm, Saturday 8:00 am to 1:00 pm, no work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq,15minute}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise-affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	Management level $L_{Aeq,15\text{minute}}$	Application
Outside recommended standard hours	Noise-affected RBL + 5 dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise-affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Source: ICNG (EPA, 2009).

Table 4.3 summarises the ICNG NML for other land uses (non-residential).

Table 4.3 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15\text{minute}}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC, 2009).

The project construction NMLs for recommended standard and OOH periods are presented in Table 4.4 for all assessment locations. It is noted the sleep disturbance criteria in Section 4.2 will also be applied to residential assessment locations for any construction activity during the night-time period.

Table 4.4 Construction noise management levels

Assessment location	Period ¹	Adopted RBL ²	NML $L_{Aeq,15\text{minute}}$ dB
All residential assessment locations (Lake Lyell and surrounds)	Day (standard ICNG hours)	35	45
	Day (out of hours)	35	40
	Evening (out of hours)	30	35
	Night (out of hours)	30	35
All residential assessment locations (Lithgow)	Day (standard ICNG hours)	35	45
	Day (out of hours)	35	40
	Evening (out of hours)	35 ⁶	40
	Night (out of hours)	32	37

Assessment location	Period ¹	Adopted RBL ²	NML $L_{Aeq,15minute}$ dB
All residential assessment locations (South Bowenfels)	Day (standard ICNG hours)	42	52
	Day (out of hours)	42	47
Commercial premises	When in use	N/A	70
Accommodation ³	Day (standard ICNG hours)	N/A	50
	Day (out of hours)	N/A	45
	Evening (out of hours)	N/A	45
	Night (out of hours)	N/A	45
Industrial premises	When in use	N/A	75
Active recreation areas	When in use	N/A	65
Passive recreation areas ⁴	When in use	N/A	60
Hospital ⁵	When in use	N/A	55 (external)
			45 (internal)
Classroom ⁵	When in use	N/A	55 (external)
			45 (internal)

Notes:

1. Day (standard ICNG hours): 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day (out of hours): 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays; Morning shoulder: 6:00 am to 7:00 am Monday to Saturday; 6:00 am to 8:00 am Sundays and public holidays
2. The RBLs adopted from Table 3.1.
3. Accommodation assessed in accordance with AS/NZS 2107:2016, e.g. 35 dB(A) internal (night-time), becomes 45 dB(A) external accounting for windows open for ventilation.
4. The receptor type 'passive recreation' has been applied to campgrounds in the vicinity of the project in accordance with the Noise Policy for Industry. The 'passive recreation' receptor type is typically applied to places where people normally go to undertake quiet activities (e.g. picnics, bushwalks, etc.) and the noise goals applied at these locations are considerably less stringent than those applied at residential receptors. Any additional assessment should be carried out as per the NPfI and the ICNG, which would classify wilderness areas as 'passive recreation' areas.
5. External criteria equivalent to internal criteria plus 10 dB.
6. As per NPfI procedures, the project intrusiveness noise level for the evening period should be no greater than the project intrusiveness noise level for daytime period.

It is acknowledged that some assessment locations provide accommodation, for example assessment location 32. For the purposes of assessing noise, it is not a residence, but a temporary or transient accommodation facility. Under the definitions of the ICNG, commercial assessment locations include temporary accommodation (such as caravan parks and camping grounds) and leads to a target external NML of $L_{Aeq,15minute}$ 70 dB. For comparison purposes the ICNG recommends a target external NML of $L_{Aeq,15minute}$ 60 dB for passive recreation. A more conservative approach has been adopted to assess these locations as hotel-type receiver having internal noise targets as per the appropriate Australian Standard AS2107 *Recommended design sound levels and reverberation times for building interiors* category. This leads to an internal target noise level of $L_{Aeq,15minute}$ 35 dB and equivalent external noise level of $L_{Aeq,15minute}$ 45 dB. The daytime target noise level of $L_{Aeq,15minute}$ 50 dB has been derived based on the commonly accepted differential between day and night-time periods as recognised in EPA procedures.

4.2 Sleep disturbance

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where project related night-time noise levels at a residential location exceed:

- $L_{Aeq,15minute}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater)
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

Guidance regarding potential for sleep disturbance is also provided in the Road Noise Policy (RNP). The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- Maximum internal noise levels (L_{Amax}) below 50 to 55 dB are unlikely to awaken people from sleep.
- One or two noise events per night, with maximum internal noise levels (L_{Amax}) of 65 to 70 dB, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 dB calculated at the facade of a residence is unlikely to awaken people based on the findings presented in the RNP.

If noise levels over the screening criteria are identified, then additional analysis would consider factors such as:

- how often the events would occur
- the time the events would occur
- whether there are times of day when there is a clear change in the noise environment
- current scientific literature available regarding the impact of maximum noise level events at night.

Table 4.5 provides the noise level event screening criteria for the permanent residential assessment locations.

Table 4.5 Sleep disturbance screening criteria at residences¹

Assessment location	Adopted Night RBL, dB	Night-time maximum noise level event screening criteria, dB	
		$L_{Aeq,15minute}$	L_{Amax}
All residential assessment locations	30	40	52

Notes:

1. Does not apply to project-related accommodation, commercial or passive recreation assessment locations.

4.3 Road traffic noise

Construction traffic requires assessment for potential noise impact. The principal guidance to assess the impact of the road traffic noise on assessment locations is in the RNP. It is noted that the guidance provided in the RNP relate specifically to operational phases of developments and/or new roads rather than the construction phase, which typically generates a temporary change in road traffic volumes.

The road traffic noise assessment criteria at residential assessment locations is presented in Table 4.6, reproduced from Table 3 of the RNP for relevant road categories.

Table 4.6 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria (dB)	
		Day (7:00 am to 10:00 pm)	Night (10:00 pm to 7:00 am)
Freeway /arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeway / arterial / sub-arterial roads generated by land use developments.	$L_{Aeq,15hour}^{60}$ (external)	$L_{Aeq,9hour}^{55}$ (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,1hour}^{55}$ (external)	$L_{Aeq,1hour}^{50}$ (external)

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to +2 dB.

In addition to meeting the assessment criteria (refer to Table 4.6), any significant increase in total traffic noise at the relevant residential assessment locations must be considered. Residential assessment locations experiencing increases in total traffic noise levels above those presented in Table 4.7 should be considered for mitigation.

Table 4.7 Road traffic relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase (dB)	
		Day (7:00 am to 10:00 pm)	Night (10:00 pm to 7:00 am)
Freeway /arterial / sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq,15hour} + 12 \text{ dB}$ (external)	Existing traffic $L_{Aeq,9hour} + 12 \text{ dB}$ (external)

4.4 Construction vibration

4.4.1 Human perception of vibration

Humans can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not in itself be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN4150.2 *Structural vibration*. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in Table 4.8.

Table 4.8 Peak vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 to 80 Hz.

Table 4.8 suggests that people will just be able to feel floor vibration at levels of approximately 0.15 millimetres per second (mm/s) and that the motion becomes “noticeable” at a level of approximately 1 mm/s.

i Assessing vibration - a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC 2006) (the guideline) is based on British Standard BS647.2:2008 *Evaluation of human exposure to vibration in buildings (1-80Hz)*.

The guideline presents preferred and maximum vibration values for the use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended that the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. The guideline provides examples of the three vibration types and has been reproduced in Table 4.9.

Table 4.9 Examples of types of vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity.	Infrequent: activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles (HVs), forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Impulsive and intermittent vibration is most relevant to the project as discussed herein.

Intermittent vibration (as defined in section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of HV passbys and construction activities such as impact hammering, rolling or general excavation work.

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted root mean square (RMS) acceleration levels over the frequency range 1 to 80 hertz (Hz). To calculate VDV the following formula is used (refer to section 2.4.1 of the guideline):

$$VDV = \left[\int_0^T a^4(t) dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, $a(t)$ is the frequency-weighted rms of acceleration in m/s^2 and T is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV for intermittent vibration are reproduced in Table 4.10.

Table 4.10 **Acceptable vibration dose values for intermittent vibration**

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am.
2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline recommends that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

Impulsive vibration as defined in Table 4.9 can be caused by blasting which is discussed further in Section 4.5 and is otherwise not applicable to the other construction activities associated with the project.

4.4.2 Structural vibration

i Australian Standard AS2187.2:2006

In terms of the most recent relevant vibration damage criteria, AS2187.2:2006 *Explosives - Storage and Use - Use of Explosives* recommends that the frequency dependent guideline values and assessment methods given in British Standard BS7385.2-1993 *Evaluation and measurement for vibration in buildings* be used as they are “applicable to Australian conditions”.

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels provide a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during construction excavation), piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to manage minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4.11 and graphically in Figure 4.2.

Table 4.11 Transient vibration guide values - minimal risk of cosmetic damage

Line ¹	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type 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 and above

Notes: Refers to the “Line” in Figure 4.1.

The standard notes that the guide values in Table 4.11 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 4.11 may need to be reduced by up to 50%.

Some construction or tunnelling activities (for example) are considered to have the potential to cause dynamic loading in some structures and therefore transient values in Table 4.11 have been reduced by 50% for assessment purposes, with a vibration screening criterion set at 7.5 mm/s.

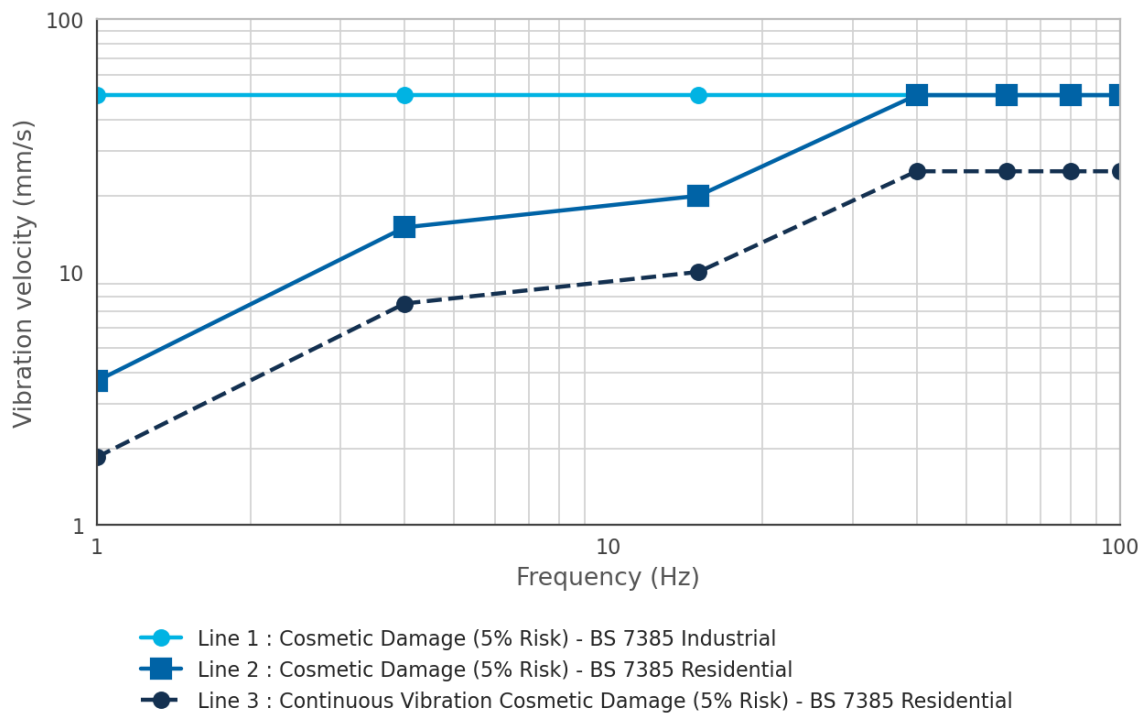


Figure 4.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz (as shown in Figure 4.1).

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 4.11 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 4.11.

It is noteworthy that in addition to the guide values nominated in Table 4.11, the standard states that:

Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.

ii German Standard DIN4150.3:2016

The German Standard DIN4150.3:2016 *Vibration in buildings – Effects on structures*, provides the strictest guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN4150.3 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 4.12 and shown graphically in Figure 4.2.

For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 to 30 Hz, and hence according to DIN4150, the safe vibration guide limit range for dwellings is 5 to 15 mm/s. For reinforced commercial type buildings, the limit is as low as 20 mm/s, while for heritage or sensitive structures the lower limit is 3 mm/s.

Table 4.12 Structural damage guideline values of vibration velocity – DIN4150

Line*	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	5 to 20	15

Line*	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Notes:

1. "Line*" refers to curves in Figure 1 of DIN4150.
2. For frequencies above 100 Hz the higher values in the 50 to 100 Hz column should be used.

These levels are "safe limits", for which damage due to vibration effects is unlikely to occur. "Damage" is defined in DIN4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the "safe limits" then it is likely to be attributable to other causes. DIN4150 also states that when vibration levels higher than the "safe limits" are present, it does not necessarily follow that damage will occur.

As indicated by the guide levels from DIN4150 in Table 4.12, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the "point source" nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

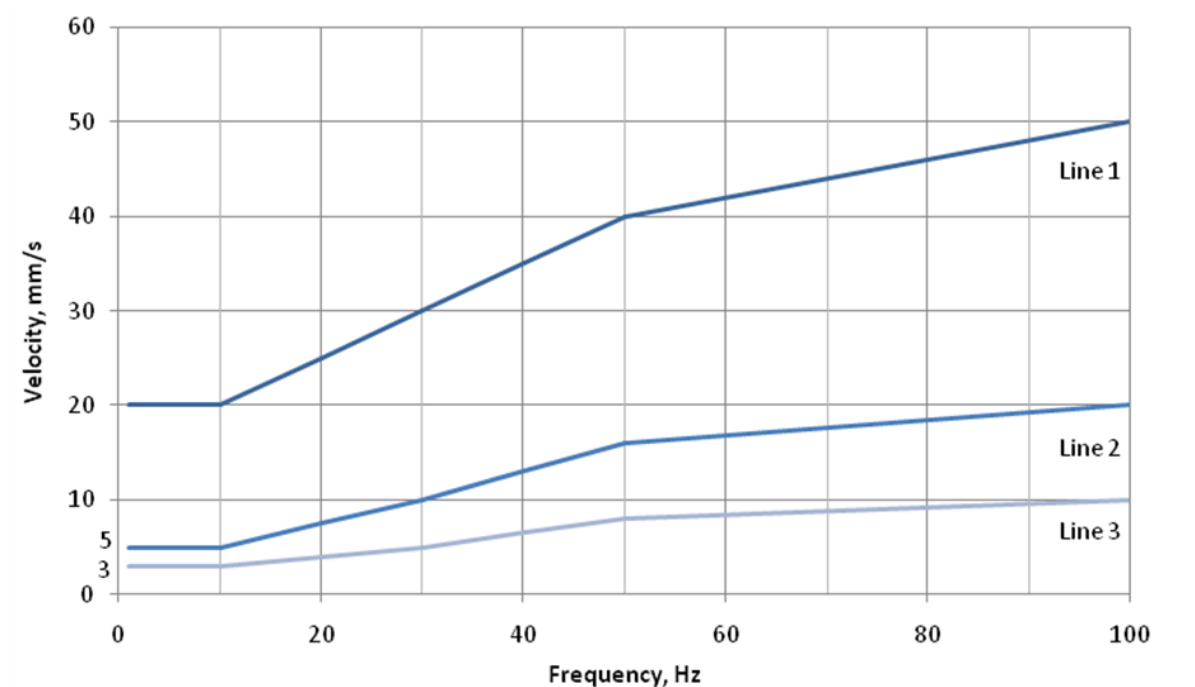


Figure 4.2 DIN4150 structural damage guideline values of vibration velocity

Vibration sensitive structures and places relevant to the project are shown in Figure 3.1.

The potential effect of vibration on structures can vary depending on many factors including their existing structural integrity and use. Criteria in the order of 20 to 100 mm/s are typically applied by regulatory authorities to other infrastructure items including tunnels, rock structures and transmission lines. DIN4150.3:2016 *Vibrations in buildings, Effects on structures* (refer to Section 5.2) provides guideline values for evaluating the effect of short-term vibration on structural components and underground structures. Based on the guideline values, the recommended short-term vibration assessment criteria to ensure minimal risk of damage are presented in Table 4.13.

Table 4.13 Guideline values for vibration - effects of short-term vibration on buried structures

Structure type	Short-term vibration PCPV ¹ criteria
Steel, welded	100 mm/s
Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s

Notes:

3. Vibration peak component particle velocity (PCPV) (mm/s).

4.4.3 Project specific vibration criteria

Assessment of human comfort/response to vibration generated by construction activities has adopted the criteria in accordance with *Environmental Noise Management – Assessing Vibration: a technical guideline* (DEC 2006) and British Standard BS6472.1:2008 *Guide to evaluation of human exposure to vibration in buildings*.

Assessment of potential for cosmetic / structural damage associated with construction activities on residential buildings, infrastructure items, rock structures and transmission lines has adopted the criteria established in British Standard BS7385.2-1993 *Evaluation and measurement for vibration in buildings*.

For the assessment of heritage items, in particular the buildings in the Pottery Estate, DIN4150.3 provides more conservative and detailed structural damage guideline values than BS7385.2. Further, if DIN4150.3 limits are satisfied, the limits in BS7385.2 will also be satisfied.

The heritage-specific criteria in DIN4150.3 are only applied where a suitably qualified structural engineer determines that a heritage building is structurally unsound. Where a building condition survey confirms the dwelling is structurally sound, the Line 2 values should be adopted as the vibration criteria. If the survey deems the building structurally unsound, the more stringent Line 3 values must be applied.

4.5 Construction blasting

4.5.1 Blasting guidelines

The limits typically adopted by regulators for blasting are provided in the Australian and New Zealand Environment and Conservation Council's (ANZECC) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZECC 1990). The criteria apply to residences only, with the aim to minimise annoyance and discomfort.

The blasting limits address two main effects of blasting:

- air blast noise overpressure
- ground vibration.

4.5.2 Air blast

The recommended maximum level for air blast is L_{Peak} 115 dB. This level may be exceeded on up to 5% of the total number of blasts over 12 months; however, should not exceed L_{Peak} 120 dB at any time.

4.5.3 Ground vibration

Ground vibration peak particle velocity (PPV) should not exceed 5 mm/s for more than 5% of the total number of blasts over 12 months. However, the maximum level should not exceed 10 mm/s at any time. A summary of blast limits is provided in Table 4.14.

Table 4.14 Air blast overpressure and ground vibration limits

Blasting	Criteria	Allowable exceedance
Air blast overpressure	115 dB (L_{Peak})	5% of the total number of blasts over 12 months
	120 dB (L_{Peak})	0%
Ground vibration	5 mm/s (PPV)	5% of the total number of blasts over 12 months
	10 mm/s (PPV)	0%

To assess the potential impact of damage to buildings and other structures from blasting vibration the criteria outlined in Section 4.4.3 would be utilised.

4.5.4 Times and frequency of blasting

The ANZECC guideline recommends blasting should generally only be permitted between 9:00 am to 5:00 pm Monday to Saturday and should be limited to one blast per day. Blasting should not take place on Sundays or public holidays.

Notwithstanding the above, the restrictions to times and frequency of blasting do not apply to premises where the effects of blasting are not perceived at noise sensitive sites.

4.6 Operational noise

4.6.1 Overview

Following the construction and commissioning of the project there is the potential for noise emissions from plant and equipment (transformers, pumps, HVAC, etc.) associated with the operation of the facilities.

Noise from industrial operations or processes in NSW is regulated by the local council, DPHI and/or the EPA, and generally have a licence and/or development consent conditions stipulating noise limits. These limits are typically derived from project specific trigger or operational noise levels predicted at assessment locations. They are based on EPA guidelines (i.e. NPfI) or noise levels that can be achieved by a specific site following the application of all reasonable and feasible noise mitigation.

The objectives of noise trigger levels for industry established in accordance with the NPfI are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance or impact at an assessment location.

To ensure these objectives are met, the EPA provides project specific noise trigger levels, namely intrusiveness and amenity.

4.6.2 Intrusiveness noise levels

The intrusiveness noise levels require that $L_{Aeq,15minute}$ noise levels from the site during the relevant operational periods do not exceed the RBL by more than 5 dB. It is noted that intrusiveness noise levels are only applicable at residential assessment locations.

Table 4.15 presents the intrusiveness noise levels determined based on the adopted RBLs.

Table 4.15 Project intrusiveness noise levels

Assessment location ¹	Assessment period ²	Adopted RBL, dB	Project intrusiveness noise level (RBL + 5 dB), $L_{Aeq,15minute}$, dB
All residential receivers	Day	35	40
	Evening	30	35
	Night	30	35

Notes:

1. Residential assessment locations only.
2. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.

4.6.3 Project amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail traffic noise. Where the measured existing industrial noise approaches recommended amenity noise levels, it needs to be demonstrated that noise levels from new industry will not contribute to existing industrial noise such that amenity noise levels are exceeded.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level for a new industrial development is the recommended amenity noise level (outlined in table 2.2 of the NPfI) minus 5 dB. It is noted that this approach is based on a receiver being impacted by three or four individual industrial sites (or noise sources). This approach has not been adopted for operational noise from the project as there are no existing or likely future industrial noise sources with the potential to result in cumulative noise.

There are no residential assessment locations in close proximity to sites likely to generate noise from operation of the project. Notwithstanding this, the amenity criteria for residential assessment locations has been included here for completeness. Receptors potentially exposed to operational noise are mainly residential dwellings and passive recreational land uses. The project amenity noise level for relevant assessment locations is presented in Table 4.16.

Table 4.16 **Project amenity noise levels**

Assessment location	Indicative area	Time period ¹	Project amenity noise level dB, L _{Aeq,period}
Residential	Rural	Day	50
		Evening	45
		Night	40
Accommodation	Rural	Day	55
		Evening	50
		Night	45
Commercial	When in use	When in use	65
Industrial	When in use	When in use	70
Active recreation area	All	When in use	55
Passive recreation area	All	When in use	50
Hospital	All	Noisiest 1-hour period	35 (internal) 50 (external)
Classroom ²	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)

Source: NPfl (EPA 2017).

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.
2. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to L_{Aeq,1hour} 40 dB.

4.6.4 Project noise trigger levels

The project noise trigger level (PNTL) is the lower of the calculated project intrusiveness or amenity noise levels. A summary of the PNTL for assessment of operational noise from the project is presented in Table 4.17. Note that project amenity $L_{Aeq,15minute}$ noise level is the recommended amenity noise level $L_{Aeq,period} + 3$ dB as per the NPfI.

Table 4.17 Project noise trigger levels

Assessment location	Assessment period ¹	Intrusiveness noise level, $L_{Aeq,15minute}$, dB	Amenity noise level ² , $L_{Aeq,15minute}$, dB	PNTL ³ , $L_{Aeq,15minute}$, dB
Residential	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Accommodation	Day	-	58	58
	Evening	-	53	53
	Night	-	48	48
Commercial	When in use	-	68	68
Industrial	When in use	-	73	73
Active recreation areas	When in use	-	58	58
Passive recreation areas	When in use	-	53	53
Hospital	Noisiest 1-hour period	-	35 (internal)	35 (internal)
			50 (external)	50 (external)
Classroom	Noisiest 1-hour period when in use	-	35 (internal)	35 (internal)
			45 (external)	45 (external)

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays; Morning shoulder: 6:00 am to 7:00 am Monday to Saturday.
2. Project amenity $L_{Aeq,15minute}$ noise level is the recommended amenity noise level $L_{Aeq,period} + 3$ dB as per the NPfI.
3. PNTL is the lower of the calculated intrusiveness or amenity noise levels.

In assessing amenity noise levels at passive recreation areas, the noise level is to be assessed at the most-affected point within the area that is reasonably expected to be used by people, for example, picnic areas or walking tracks.

5 Assessment methods

5.1 Construction noise

This chapter presents the methods and base parameters used to model construction noise emissions from the project.

Quantitative modelling of construction noise was done using RTA Technology's Environmental Noise Model (ENM), a computer based environmental noise model. ENM is approved by the DPHI and EPA as suitable for prediction of noise involving large propagation distances and is currently the industry standard for assessment of noise of this nature.

The model considers geometric spreading, atmospheric absorption, and barrier and ground attenuation. ENM Terrain Category 2, representing a rural land environment, was adopted for model input. Three-dimensional digitised ground contours of the project and surrounding land were incorporated into the noise model to account for topographic effects.

The proposed construction hours for the project are outlined in Section 4.1 (refer Table 4.1).

Noise modelling has been completed for the two major phases of construction: Early works construction and Main construction. The construction schedule was reviewed to identify the worst-case periods for both the early works and main construction phases. These periods have been adopted on the basis that they are considered representative of the worst-case scenario for each phase. Cumulative noise contributions from other periods during the construction works are anticipated to typically be of a lower level or of a much shorter duration.

The method for assessing blast noise (air blast overpressure) and vibration from construction is provided in Section 5.2.2.

5.1.1 Construction locations

The construction areas are predominantly centred around the generation components in the project area. The degree of construction related activities that are to be undertaken within each construction area varies, dependant on the infrastructure within each (refer Annexure B).

5.1.2 Equipment sound power levels

i Continuous

Equipment sound power levels have been adopted from the United Kingdom Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*, where available. Otherwise, data was sourced from an EMM database of similar equipment which is based on measurements at other construction sites as indicated.

Acoustically significant fixed and mobile equipment items were considered in the model for each construction camp/area and adopted typical worst-case scenarios and utilisation. A summary of the cumulative sound power level (L_w) for each component is presented in Table 5.1 acknowledging that multiple activities may occur simultaneously.

A schedule of construction plant and equipment for each construction area/activity is shown in Annexure B.

Table 5.1 **Equipment sound power levels**

Works area	Modelled activity	Sound power level, dB, L _{Aeq,15minute}			
		Day	Evening	Night	Morning shoulder
Early works					
Sir Thomas Mitchell Drive	Road upgrades	114	Nil	Nil	Nil
Magpie Hollow Road	Road upgrades	114	Nil	Nil	Nil
Access tracks and drilling sites	Limited earthworks (day only) Geotechnical drilling (all periods)	113	107	107	107
Accommodation camp	Camp / office / workshop construction	117	Nil	Nil	Nil
Main construction					
Reservoir	Bulk earthworks	121	Nil	Nil	121
Lower intake canal	Bulk earthworks	121	Nil	Nil	121
MAT/ECVT portals ²	Tunnel works (drill and blast – D&B)	109	109	109	109
Farmers Creek diversion	Bulk earthworks	121	Nil	Nil	121
Farmers Creek infill	Bulk earthworks	121	Nil	Nil	121
Lower laydown	Spoil emplacement	116	Nil	Nil	116
Laydown	Bulk earthworks (Day/Morning shoulder) Deliveries (Evening)	121	107	Nil	121
Accommodation camp	Camp operations	101	101	101	101
Switchyard area	Concrete batching plant	116	116	116	116
Southern access road (entrance to Laydown / Southern Intersection)	Haulage	107	106	105	107
Southern access road (Southern Intersection to Northern Intersection)	Haulage	113	Nil	Nil	113
Northern access road	Haulage	105	Nil	Nil	103
Western access road	Haulage	105	Nil	Nil	100
Northern haul road	Haulage	112	Nil	Nil	112

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night (including morning shoulder): 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays; Morning shoulder: 6:00 am to 7:00 am Monday to Saturday.
2. An acoustic enclosure is assumed to be constructed at the portals providing a nominal reduction of 10 dB (i.e. 119 dB to 10 dB = 109 dB).
3. All traffic on haul roads is assumed to be travelling at 40 km/h.
4. Southern, Northern and Western access/haul road sound power levels have been calculated for day and evening periods based on the assumptions that LV volumes were distributed 70% day (7:00 am to 6:00 pm) and 30% evening (6:00 pm to 10:00 pm) and HV volumes were distributed 85% day (7:00 am to 6:00 pm) and 15% evening (6:00 pm to 10:00 pm).

ii Night-time maximum noise level events and sleep disturbance

Construction activities will occur during the night-time hours of 10:00 pm to 7:00 am. Therefore, maximum noise events, such as loading/unloading of materials, equipment start-up alarms or other similar construction activity have been assessed against the sleep disturbance criteria at residential assessment locations.

Maximum (L_{Amax}) equipment sound power levels adopted to assess sleep disturbance from each activity are presented in Table 5.2. Equipment sound power levels have been taken from an EMM database of similar equipment which is based on measurements at other construction sites and consistent with the proposed project activity.

Table 5.2 Maximum noise from intermittent sources

Works area	Modelled activity	Equipment likely to generate maximum noise event	Adopted sound power level, dB L_{Amax}
Early works			
Drilling sites	Geotechnical drilling	Geotechnical drill	110
Main construction			
Reservoir	Bulk earthworks	Excavator	116
Lower intake canal	Bulk earthworks	Excavator	116
MAT, ECVT and ADIT portals	Tunnel works (Drill & Blast)	Drill	119
Farmers Creek diversion	Bulk earthworks	Excavator	116
Farmers Creek infill	Bulk earthworks	Excavator	116
Lower laydown	Spoil emplacement	Dozer	118
Laydown	Bulk earthworks	Excavator	116
Accommodation camps	Camp operations	Minibus	101
Switchyard area	Concrete batching plant	Concrete batching plant	116
Southern access road	Haulage	Heavy vehicle	113
Northern access road	Haulage	Heavy vehicle	113
Western access road	Haulage	Heavy vehicle	113
Northern haul road	Haulage	Heavy vehicle	113

5.1.3 Scenarios

Periods of potential worst-case construction noise levels were identified by reviewing the proposed construction schedule. The assessment has considered the identified plant and equipment operating simultaneously within the defined construction areas to predict the overall $L_{Aeq,15minute}$ noise contributions. Construction noise levels were predicted to all assessment locations identified in Figure 3.1 (refer Table A.1 of Annexure A).

Due to the complex nature of the project, extensive work force and staging at each construction camp/area the assessment has adopted an outer envelope approach, with all plant operating for each area simultaneously to identify the zone of affectation from construction works. This approach is conservative with the assumed level of activity unlikely to occur in practice.

5.1.4 Noise enhancing meteorology

A summary of weather conditions for which noise predictions have been provided are shown in Table 5.3. A conservative approach has been adopted, whereby worst-case noise enhancing meteorological conditions have been adopted for all time periods. It is of note that, as per the NPfI, both stability category D with winds up to 3 m/s and stability category F with winds up to 2 m/s were assessed for the night-time period, with the worst-case result reported.

Table 5.3 Meteorological parameters adopted for the noise modelling

Assessment period ¹	Stability category	Air temperature	Relative humidity	Wind speed	Wind direction
Day	D (-0.6°C/100 m)	20°C	70%	3 m/s	All
Evening	D (-0.6°C/100 m)	10°C	90%	3 m/s	All
Night / Morning shoulder	D (-0.6°C/100 m)	10°C	90%	3 m/s	All
	F (3.9°C/100 m)	10°C	90%	2 m/s	All

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night (including morning shoulder): 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays; Morning shoulder: 6:00 am to 7:00 am Monday to Saturday.

5.2 Construction vibration

5.2.1 Mobile plant and equipment

Table 5.4 provides an indication of potential offset distances required from sensitive receivers to comply with relevant vibration criteria outlined in Section 4.4.3. This information should be used by relevant personnel when planning their work to identify when other forms of construction methodology or vibration mitigation and/or management measures may need to be investigated or implemented. This data is based on publicly available data for large infrastructure projects in Sydney.

The safe working distances provided are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Table 5.4 Vibration levels and safe working distance guidance – transient vibration

Source	Estimated safe working distance			
	Human comfort	Commercial, Industrial or similar structures	Dwellings and similar structures	Heritage and other sensitive structures
Large vibratory roller (20 t)	100 m	5 m	33 m	50 m
Medium vibratory roller (10 t)	100 m	5 m	20 m	31 m
Compactor (7 t)	50 m	5 m	20 m	20 m
Hand operated whacka packer on backfill	10 m	5 m	5 m	5 m
Hand operated whacka packer on asphalt	10 m	5 m	5 m	5 m

Source	Estimated safe working distance			
	Human comfort	Commercial, Industrial or similar structures	Dwellings and similar structures	Heritage and other sensitive structures
Heavy hydraulic hammer (1,500 kg hammer on 30 t excavator)	73 m	5 m	22 m	44 m
Medium hydraulic hammer (900 kg hammer on 18 t excavator)	23 m	5 m	10 m	15 m
Light Hydraulic Hammer (300 kg on 5 t excavator)	10 m	5 m	5 m	5 m
Jack hammer	Avoid contact with structure	5 m	5 m	5 m
Air track drill	20 m	5 m	5 m	10 m
Small rock drill (estimate)	10 m	5 m	5 m	5 m
Down the hole hammer	10 m	5 m	5 m	5 m
Ripping (measured in Sydney sandstone)	10 m	5 m	5 m	5 m
Impact piling	30 m	5 m	10 m	20 m
Vibratory piling	30 m	5 m	26 m	100 m
Rock sawing	10 m	5 m	5 m	5 m
Bored piling	N/A	5 m	10 m	10 m

Notes:

1. Based on information provided in the NorthConnex Construction Noise and Vibration Management Sub Plan prepared by Lend Lease Bouygues Joint Venture dated 1 May 2017.

The safe working distances have been used to assess the potential for vibration impacts based on proposed construction activities.

5.2.2 Blasting

A review of information provided by LLP confirmed D&B construction method will be utilised for all tunnelling works and excavation of the underground caverns for the powerhouse, while open cut excavation and blasting will be required for the following locations:

- access roads where required, the upper reservoir access road
- main access tunnel
- switchyard
- upper reservoir
- lower inlet/outlet structure
- lake diversion.

Indicative vibration levels from blasting have been predicted using the guidance given in AS2187.2:2006 *Explosives – Storage and Use Part 2: Use of Explosives* and formulae provided in *Imperial Chemical Industries (ICI) Explosives Blasting Guide* (ICI Technical Services 1995). The ICI formula has been shown to be conservative in calculating overpressure and vibration.

The method considers charge mass delay (kg) or maximum instantaneous charge (MIC), constants relating to rock properties and distance to calculate ground vibration and over pressure levels.

All blasts MICs will be designed to meet the relevant ground vibration and overpressure requirements at the nearest sensitive receptors.

5.3 Road traffic noise

The nearest residential assessment locations potentially affected by an increase in road traffic as a result of the construction of the project are located on Sir Thomas Mitchell Drive, Magpie Hollow Road, Bent Street, Lithgow Street, Methven Street, Martini Parade and Bayonet Street.

For the purposes of this assessment Magpie Hollow Road, Bent Street, Lithgow Street and Methven Street have been classified as sub-arterial roads, while Sir Thomas Mitchell Drive, Martini Parade and Bayonet Street have been classified as local roads.

Transport of construction materials and equipment to the project area would use the transport route, which follows the Great Western Highway (from either the north or south) to South Bowenfels, turns on to Magpie Hollow Road, then turns right on to Sir Thomas Mitchell Drive and continues to the site entrance.

Transport of personnel to the project area would use one of two routes depending on the final location of the project accommodation camp. These are:

- Lakeside camp – north on Magpie Hollow Road and west on Sir Thomas Mitchell Drive
- Town camp – north on Silcock Street, west on Bent Street, south-west on Lithgow Street, west on Methven Street, south on Martini Parade, south on Bayonet Street, south on the Great Western Highway, south-west on Magpie Hollow Road and west on Sir Thomas Mitchell Drive.

It is of note that there are no residences located on Silcock Street between the Town camp entrance and Bent Street. As such, road traffic noise on Silcock Street has not been assessed.

The US Federal Highways Administration (FHWA) method has been utilised for the assessment of road traffic noise. Where traffic flows were low (<200 vehicles per hour) the assessment of construction traffic adopted the FHWA procedures since it is more sensitive to low traffic volumes than other prediction methodologies. The FHWA methodology was adopted for calculations for all roads, given the relatively low vehicle flows currently experienced on these roadways.

Two scenarios have been modelled for the purposes of assessing construction traffic noise from the project on Magpie Hollow Road and Sir Thomas Mitchell Drive:

- Peak heavy vehicle (Peak HV) – This scenario is representative of the three-month period (April to June 2027) where off -site spoil haulage is required as part of the Farmers Creek Diversion.
- Average – This scenario is representative of the typical traffic movements over the broader construction program and is based on forecast volumes between November 2027 and June 2030.

It is of note that for the roads on the route from the proposed Town camp to the Great Western Highway (Silcock Street, Bent Street, Lithgow Street, Methven Street, Martini Parade and Bayonet Street), the volumes for both the Peak HV and average scenarios are anticipated to be the same.

It is anticipated that road traffic movements generated during the operational phase of the project (i.e. maintenance and monitoring) would be significantly less than that generated by construction traffic movements. Hence, if it can be demonstrated that construction traffic movements comply with the relevant RNP noise criteria then it can be taken that noise from operational traffic will also comply.

The predicted daily traffic increases due to construction traffic associated with the project are shown in Table 5.5.

Table 5.5 Summary of daily traffic volumes and increases with construction traffic

Road	Vehicle type	Existing daily traffic	Additional daily traffic		Increase (%)	
			Peak HV	Average	Peak HV	Average
Magpie Hollow Road	Light	875	146 per day	619 per day	16.7	70.7
	Heavy	121	239 per day	84 per day	197	69.4
	All	996	385 per day	703 per day	38.7	70.6
Sir Thomas Mitchell Drive	Light	130	146 per day	619 per day	112	476
	Heavy	5	239 per day	84 per day	4780	1680
	All	135	385 per day	703 per day	285	521
Bent Street	Light	4147	Nil		Nil	
	Heavy	105	72 per day		68.6	
	All	4252	72 per day		1.7	
Lithgow Street	Light	9004	Nil		Nil	
	Heavy	242	72 per day		29.8	
	All	9246	72 per day		0.8	
Methven Street	Light	5968	Nil		Nil	
	Heavy	915	72 per day		7.9	
	All	6883	72 per day		1.0	
Martini Parade	Light	3927	Nil		Nil	
	Heavy	110	72 per day		65.5	
	All	4037	72 per day		1.8	
Bayonet Street	Light	4384	Nil		Nil	
	Heavy	182	72 per day		39.6	
	All	4565	72 per day		1.6	

Notes:

- Existing daily vehicle numbers have been sourced from the TIA (EMM 2025) and are the average of the two seven-day tube counts.

Most workers will be housed in the project accommodation camp, hence only a small number of light vehicle (LV) (or shuttle bus) trips would be generated during construction. These are anticipated to occur outside the commuter peak hours.

Traffic on the Great Western Highway has not been assessed, given proposed volumes are expected to be less than 2% of existing traffic volumes.

Road traffic movements associated with construction of the project have been referenced from the traffic impact assessment (EMM 2025) and adapted to suit RNP assessment requirements (refer to Section 4.3).

5.4 Operational plant and equipment

5.4.1 Design information

Detailed operational plant and equipment specifications were not available during the preparation of this NVIA. Preliminary design details and information was provided by LLP regarding the envisaged requirements for the operational components of the project. Preliminary selections for the various components are presented in Table 5.6.

Table 5.6 Operational plant and equipment

Site	Item	Description	No. of items	Sound power level (L_{AW}) per item, dB
Portal area (MAT / ECVT portals)	MAT ventilation fan ¹	250 kW	4	94
	MIV adit fan ¹	75 kW	4	98
	ECVT ventilation fan ¹	45 kW	2	98
	ECVT evacuation fan	8 kW	2	91
	Diesel generator	100 kVA	2	93
	Potable water pump	Small (0.7 l/s)	1	75
Switchyard	Dry type transformer	200 kVA	1	73

Notes:

1. The sound power levels provided for these items assume attenuation has been installed at both the fans (i.e. at the inlet and outlet).

6 Impact assessment

6.1 Construction noise

The construction schedule was reviewed to identify the worst-case periods for both the early works and main construction phases. These periods have been adopted on the basis that they are considered representative of the worst-case scenario for each phase. Cumulative noise contributions from other periods during the construction works are anticipated to typically be of a lower level or of a much shorter duration.

6.1.1 Project area (including Lakeside camp)

i Early works

In accordance with procedures outlined in Section 5.1.3, prediction of peak construction noise levels for the early works phase are provided in Figure 6.1, Figure 6.2 and Figure 6.3 for the day, evening and night-time periods, respectively. The levels presented represent the energy-average noise level (L_{Aeq}) over a 15-minute period and assumes all listed plant operating concurrently. Noise predictions for each individual assessment location have been included in Table C.1 of Annexure C.

During ICNG standard construction hours, early works construction noise levels under noise-enhancing weather conditions are predicted to be above the relevant NMLs at 49 locations. Noise levels are not predicted to exceed the highly noise affected noise level of $L_{Aeq,15minute}$ 75 dB at any assessment location. The worst-affected residential receiver (assessment location 2488), located on Magpie Hollow Road, are predicted to experience construction noise levels up to 70 dB during ICNG standard hours.

Outside of standard construction hours, early works construction noise levels under noise-enhancing weather conditions are predicted to be above the relevant NMLs at 60 locations during the day out of hours period, seven locations during the evening period and eight locations during the night-time period. The worst-affected residential receivers are predicted to experience construction noise levels up to 70 dB during the daytime out of hours period (assessment location 2488), 51 dB during the evening period and 53 dB during the night-time period (assessment location 18).

For further detail on early works noise levels at individual assessment locations, refer to Table C.1 in Annexure C.

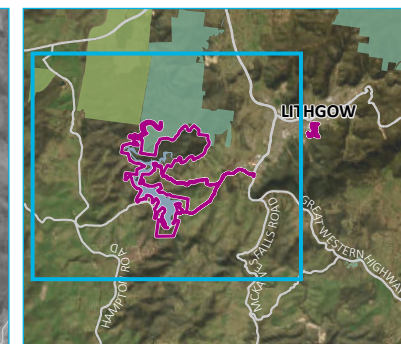
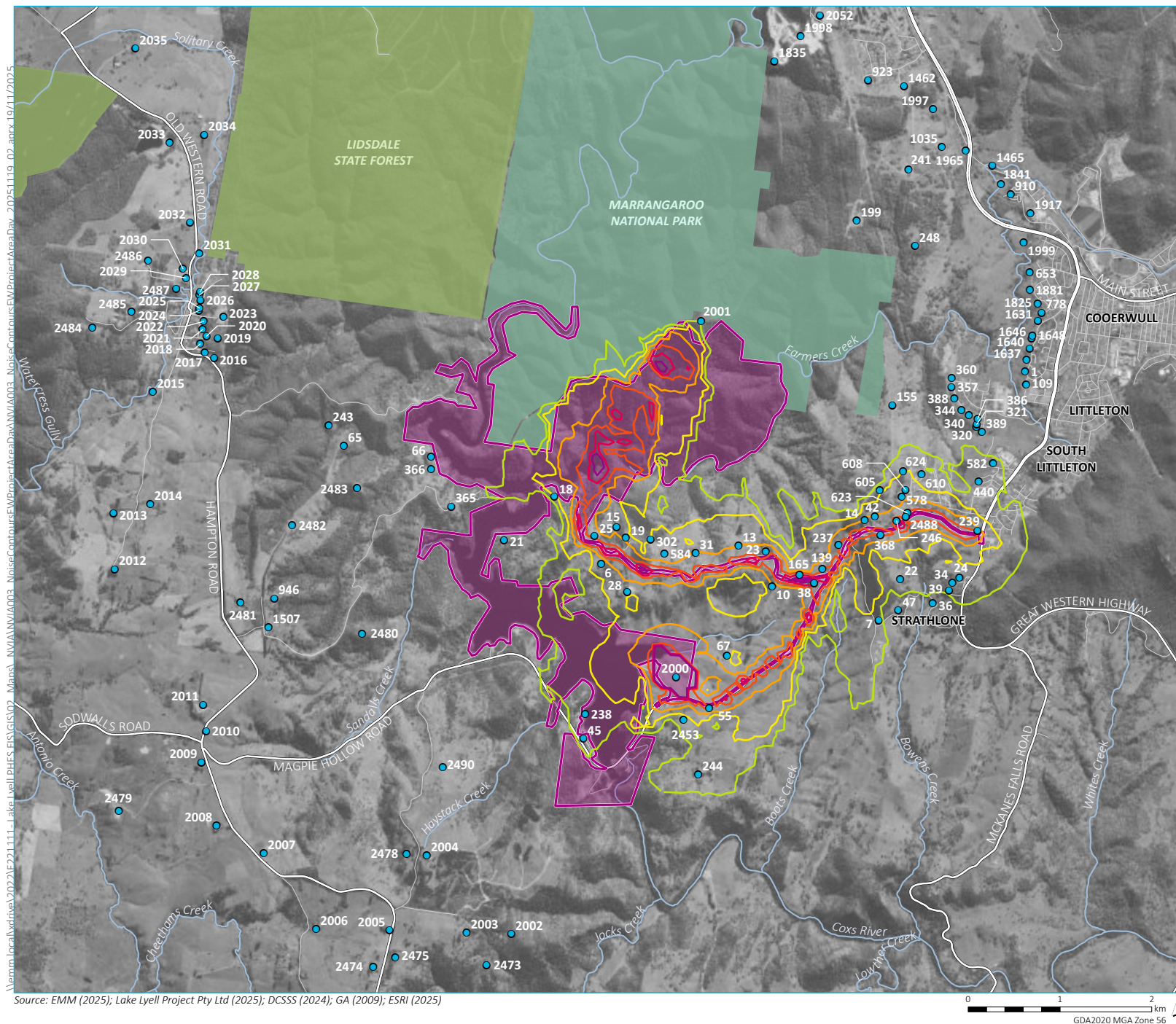
The magnitude of predicted early works construction noise impacts from the project area (including the Lakeside camp) has been summarised in Table 6.1.

Table 6.1 Magnitude of predicted construction noise impacts – project area (early works)

Period ¹	Noticeable (0–10 dB above RBL)	Clearly audible (10–20 dB above RBL)	Moderately intrusive (20–30 dB above RBL)	Highly intrusive (>30 dB above RBL)
Day & Day OOH	25	25 (6, 7, 10, 13, 15, 18, 19, 22, 24, 25, 28, 31, 34, 39, 67, 244, 302, 440, 578, 582, 584, 605, 608, 610, 624)	16 (14, 23, 38, 42, 55, 129, 139, 165, 200, 237, 246, 247, 368, 587, 588, 623)	10 (29, 108, 392, 393, 586, 594, 595, 606, 607, 2488)
Evening	12	4 (15, 19, 25, 302)	1 (18)	Nil
Night	14	4 (16, 19, 21, 302)	3 (15, 18, 25)	Nil

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day OOH: 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.

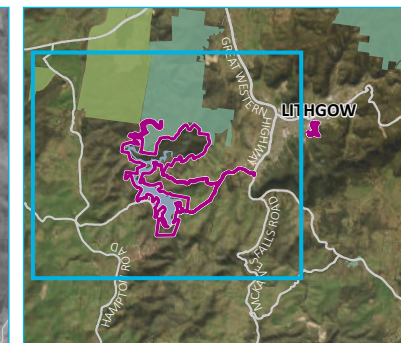
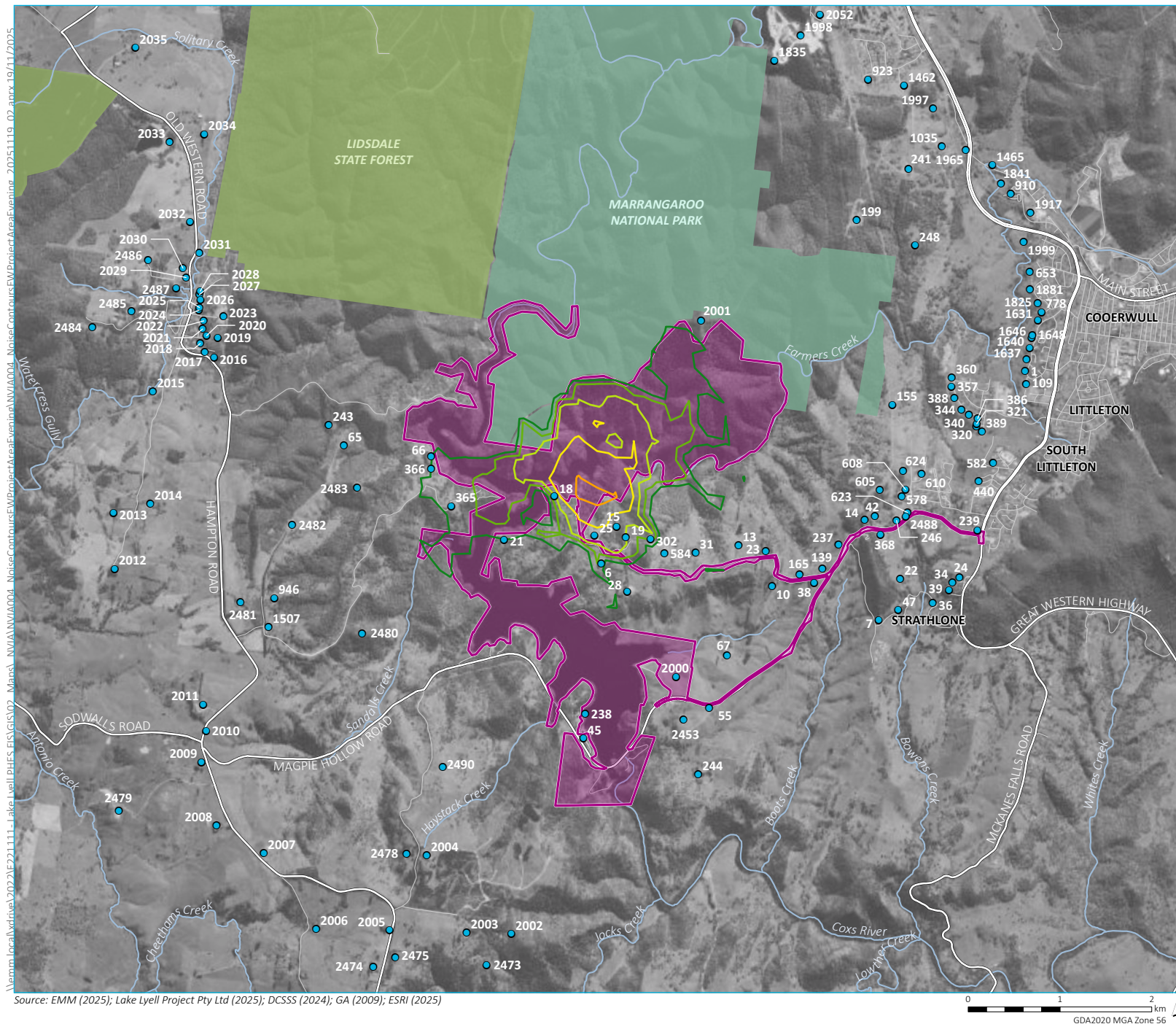


- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 45
 - 50
 - 55
 - 60
 - 65
 - 70
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Early Works
Project Area (Day)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.1



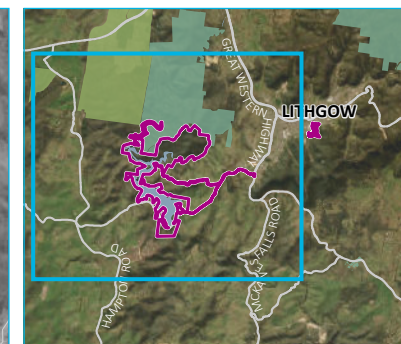
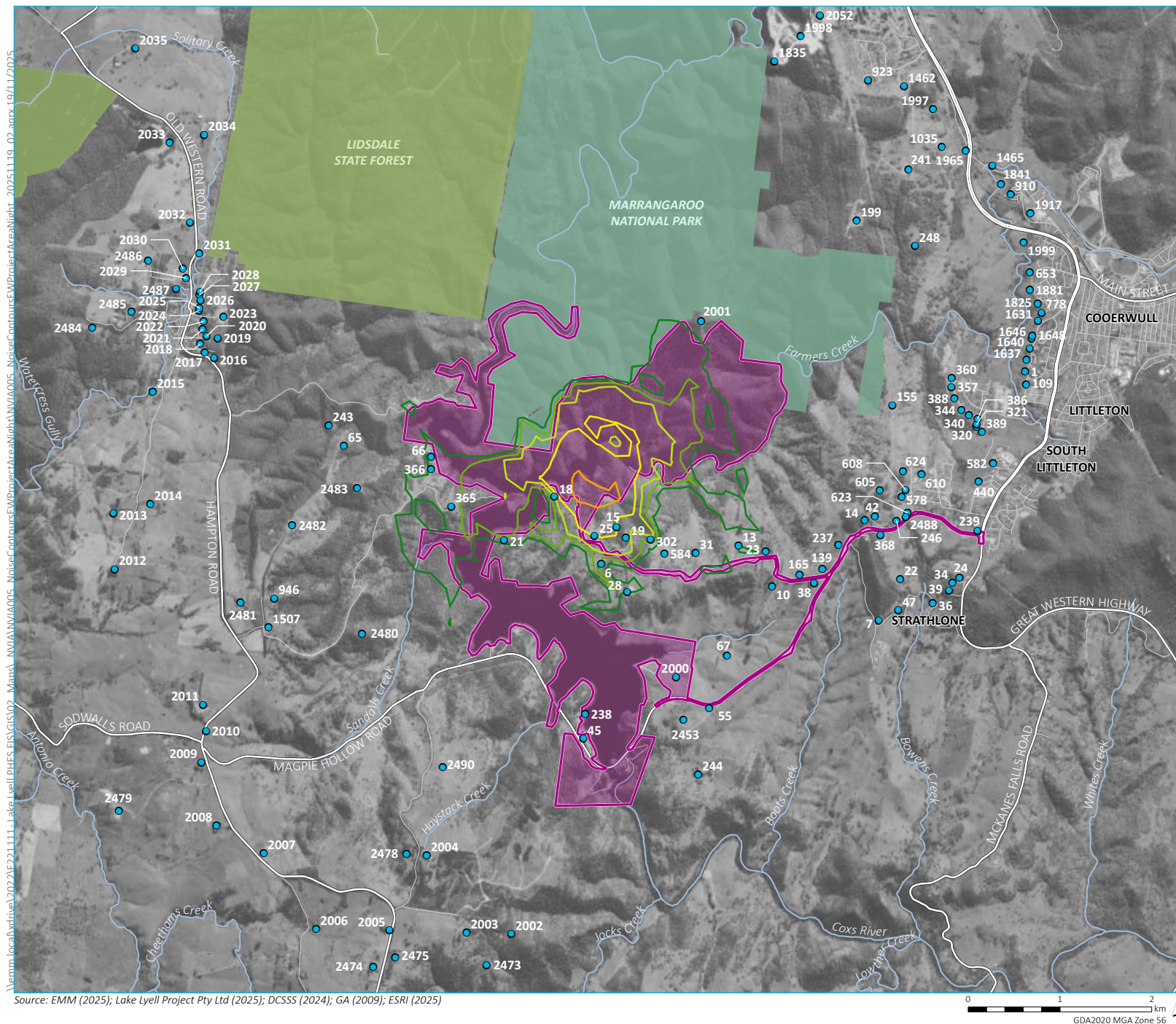


- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Early Works
Project Area (Evening)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.2





- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Early Works
Project Area (Night)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.3



ii Main construction

In accordance with procedures outlined in Section 5.1.3, prediction of peak construction noise levels for the main construction phase are provided in Figure 6.4, Figure 6.5, Figure 6.6 and Figure 6.7 for the day, evening, night-time and morning shoulder periods, respectively. The levels presented represent the energy-average noise level over a 15-minute period and assumes all listed plant operating concurrently. Noise predictions for each individual assessment location have been included in Table C.2 of Annexure C.

During ICNG standard construction hours, main construction noise levels under noise-enhancing weather conditions are predicted to be above the relevant NMLs at 12 locations (assessment locations 6, 13, 15, 18, 19, 21, 23, 25, 55, 67, 302, 365). Noise levels are not predicted to exceed the highly noise affected noise level of $L_{Aeq,15\text{minute}}$ 75 dB at any assessment location. The worst-affected residential receivers (assessment locations 15, 18 and 25), located on Sir Thomas Mitchell Drive, is predicted to experience construction noise levels up to 62 dB during ICNG standard hours.

Outside of standard construction hours, main construction noise levels under noise-enhancing weather conditions are predicted to be above the relevant NMLs at 26 locations during the day out of hours period, seven locations during the evening period, nine locations during the night-time period and 74 locations during the morning shoulder period. The worst-affected residential receivers, located on Sir Thomas Mitchell Drive, are predicted to experience construction noise levels up to 62 dB during the daytime out of hours period, 52 dB during the evening period, 54 dB during the night-time period and 65 dB during the morning shoulder period.

For further detail on main construction noise levels at individual assessment locations, refer to Table C.2 in Annexure C.

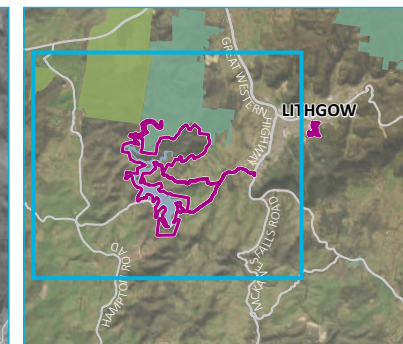
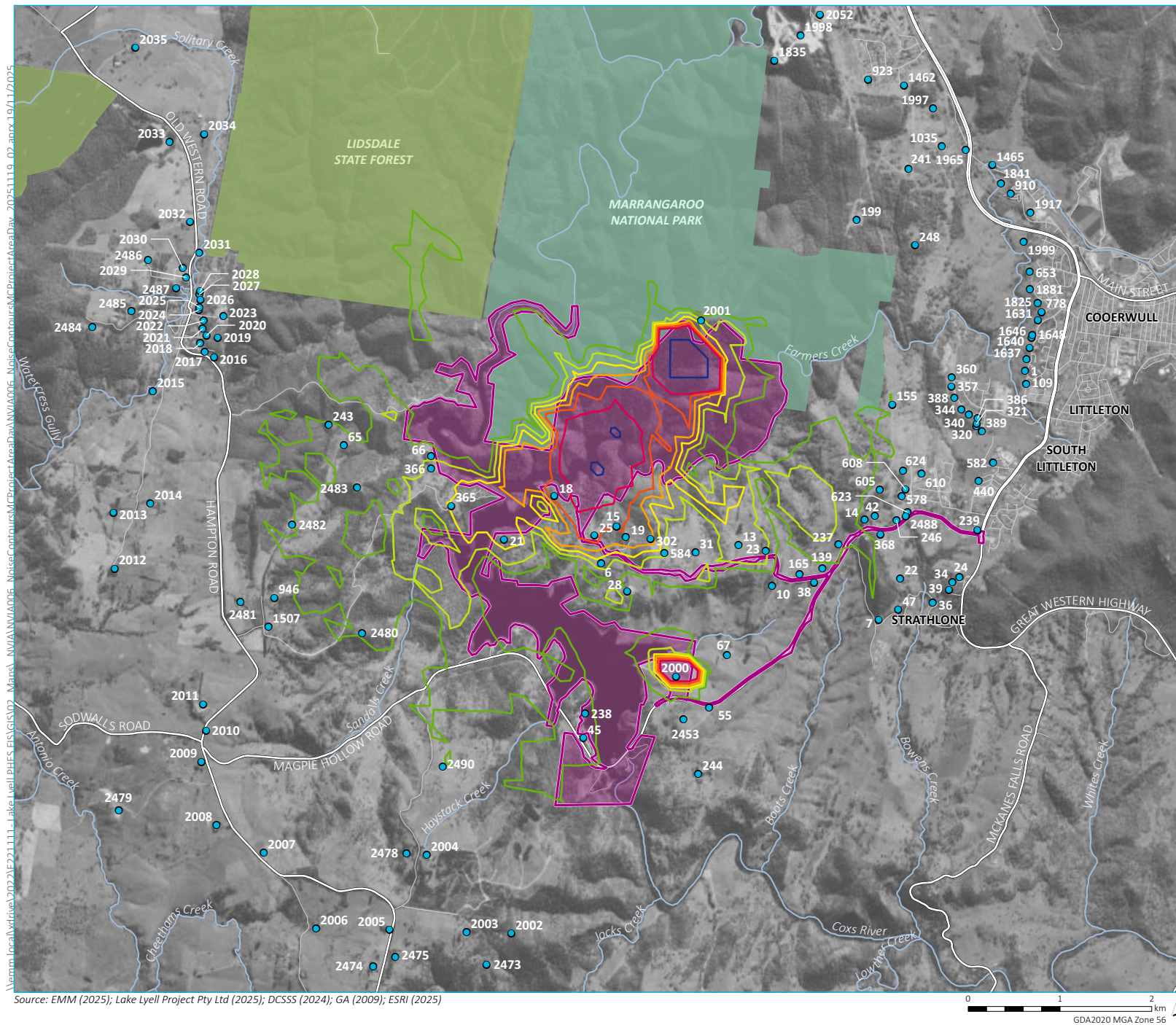
The magnitude of predicted main construction noise impacts from the project area (including the Lakeside camp) has been summarised in Table 6.2.

Table 6.2 Magnitude of predicted construction noise impacts – project area (main construction)

Period ¹	Noticeable (0–10 dB above RBL)	Clearly audible (10–20 dB above RBL)	Moderately intrusive (20–30 dB above RBL)	Highly intrusive (>30 dB above RBL)
Day & Day OOH	40	13 (6, 13, 19, 21, 23, 28, 45, 55, 66, 67, 238, 365, 366)	4 (15, 18, 25, 302)	Nil
Evening	15	4 (19, 21, 302, 365)	3 (15, 18, 25)	Nil
Night	15	5 (19, 21, 66, 365, 366)	4 (15, 18, 25, 302)	Nil
Morning shoulder	66	36 (28, 31, 38, 45, 55, 65, 108, 129, 139, 155, 165, 237, 238, 243, 244, 246, 584, 586, 587, 594, 595, 605, 606, 607, 623, 946, 1507, 2001, 2004, 2019, 2023, 2480, 2482, 2483, 2488, 2490)	8 (6, 13, 19, 21, 23, 66, 365, 366)	4 (15, 18, 25, 302)

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day OOH: 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays; Morning shoulder: 6:00 am to 7:00 am Monday to Saturday; 6:00 am to 8:00 am Sundays and public holidays.



KEY

- Project area
- Assessment location

Noise contour (dB)

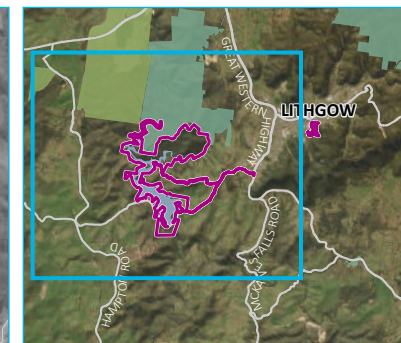
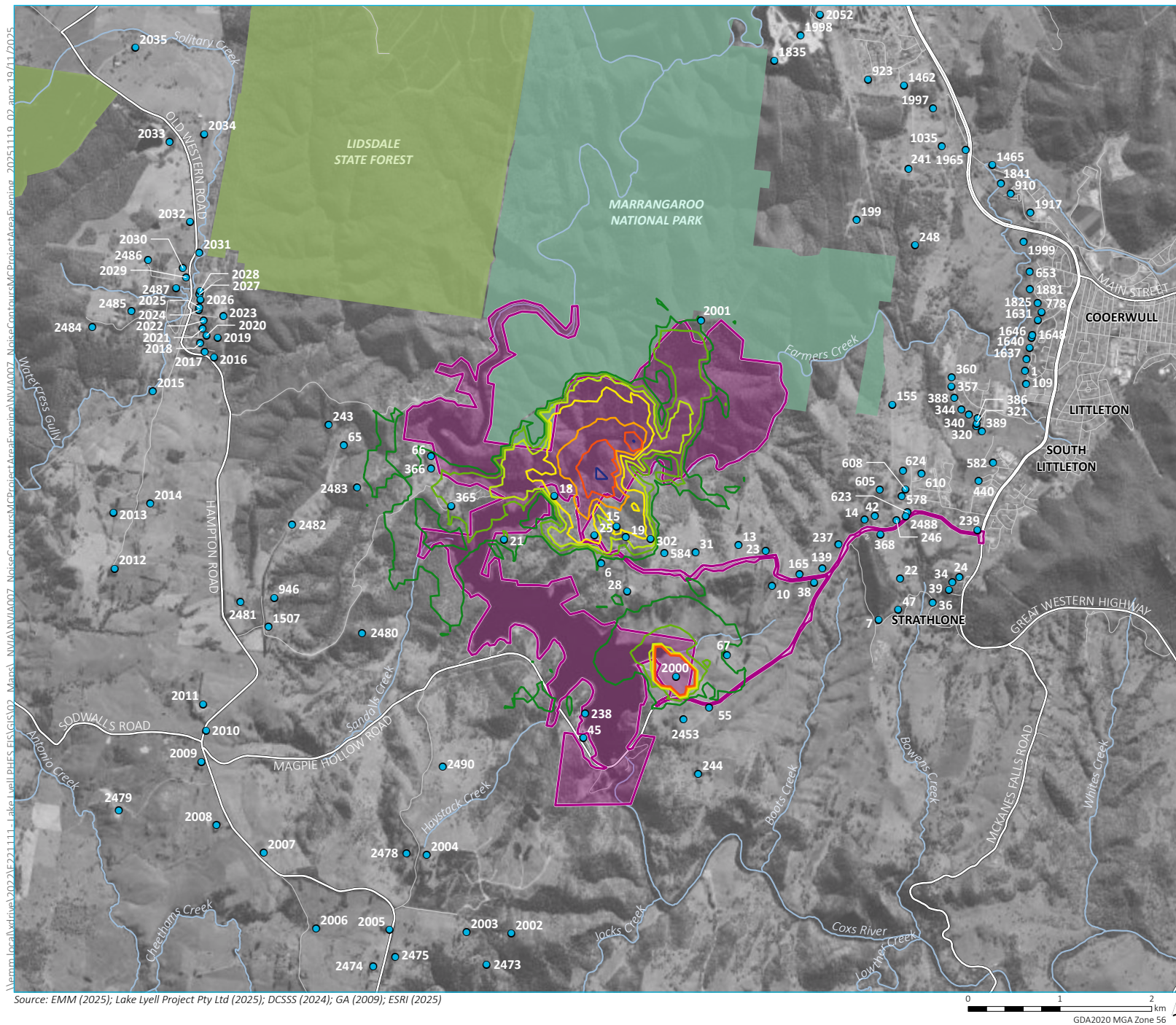
- 40
- 45
- 50
- 55
- 60
- 65
- 99

Existing environment

- Major road
- Minor road
- Named watercourse
- NPWS reserve
- State forest

Noise contours- Main Construction Project Area (Day)

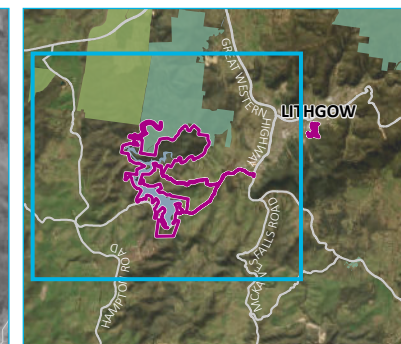
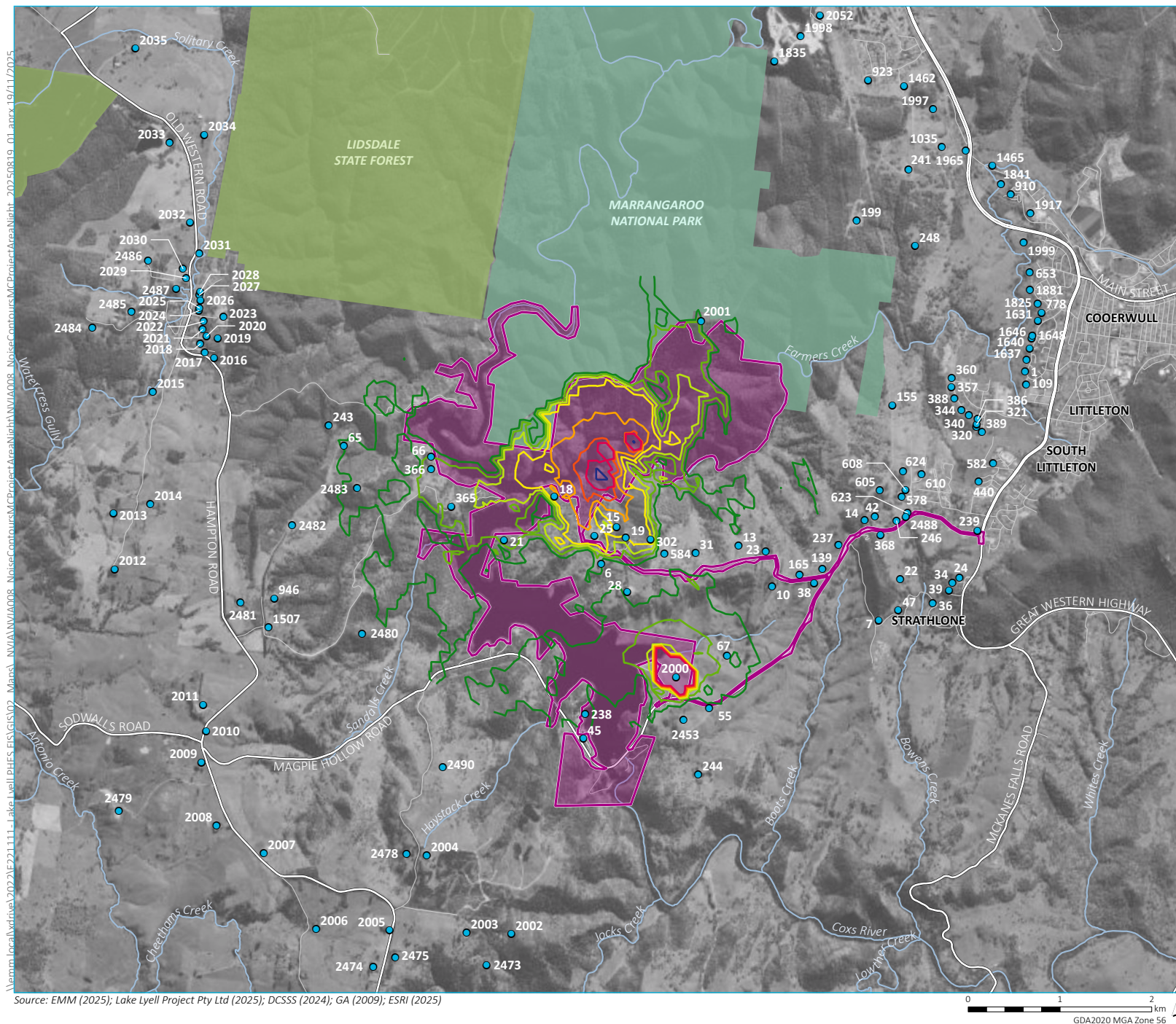
Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.4



- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
 - 60
 - 99
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Main Construction
Project Area (Evening)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.5

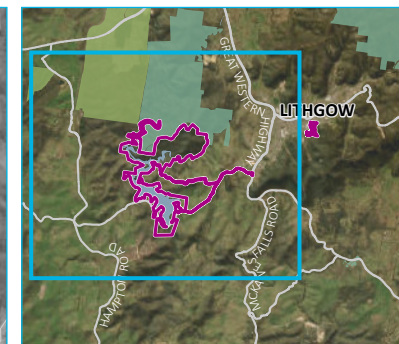
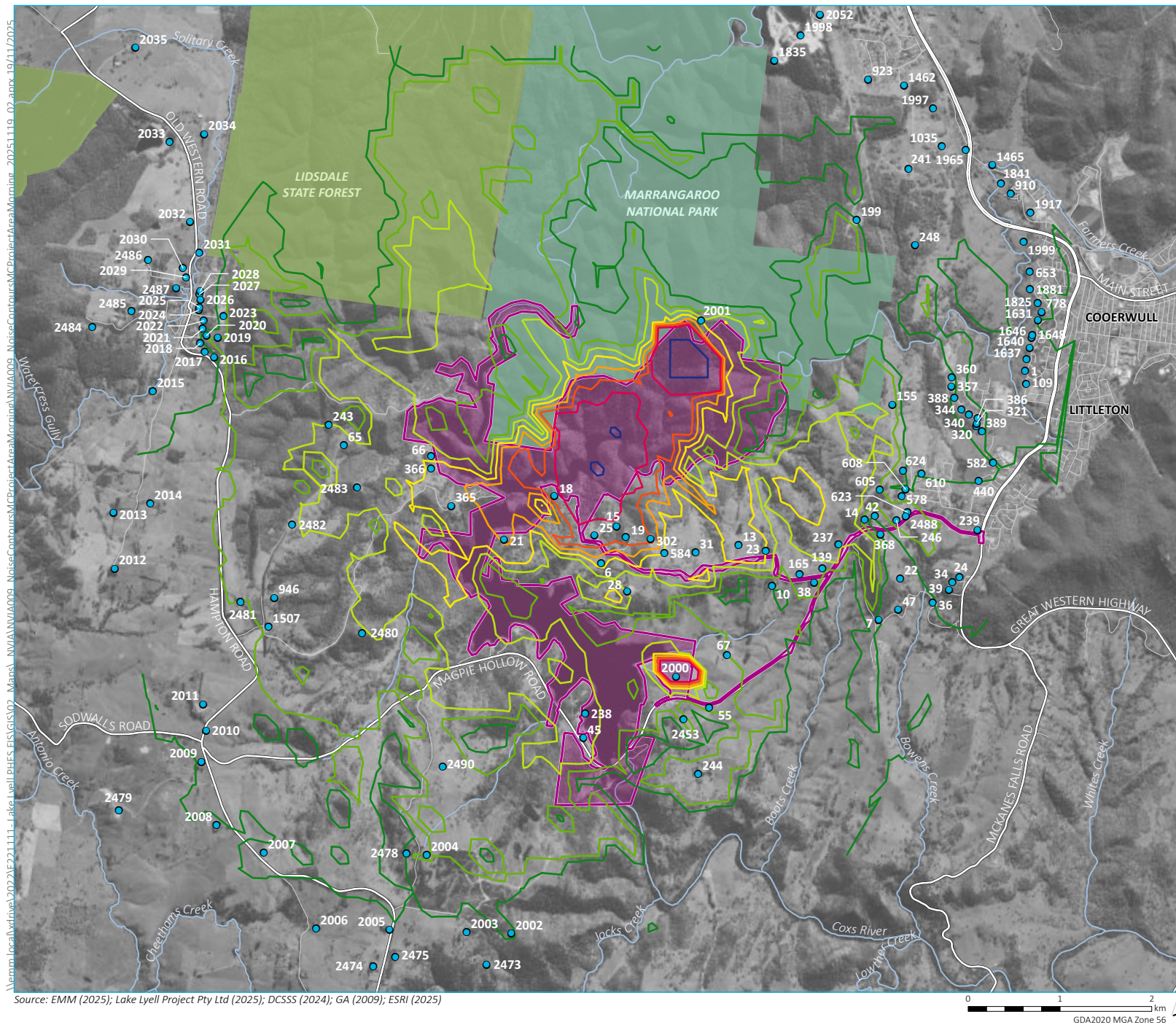


- KEY**
- █ Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
 - 60
 - 65
 - 99
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - █ NPWS reserve
 - █ State forest

Noise contours- Main Construction
Project Area (Night)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.6





- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
 - 60
 - 65
 - 99
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Main Construction
Project Area (Morning Shoulder)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.7

6.1.2 Town camp

Given the Town camp's alternative location within the township of Lithgow and its proximity to a substantial number of sensitive receivers, noise contours have been prepared to provide an indicative assessment of potential impacts on the surrounding community.

It should be noted that the noise contours have been prepared in accordance with the assessment methodology outlined in Section 5.1 and provides the same assessment outcomes to those of the project area assessment.

i Early works

In accordance with procedures outlined in Section 5.1.3, prediction of construction noise levels for the alternative Town camp during the early works construction period are provided in Figure 6.7 for the day period. The levels presented represent the energy-average noise level over a 15-minute period and assumes all listed plant operating concurrently.

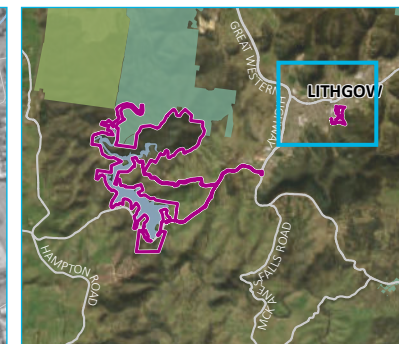
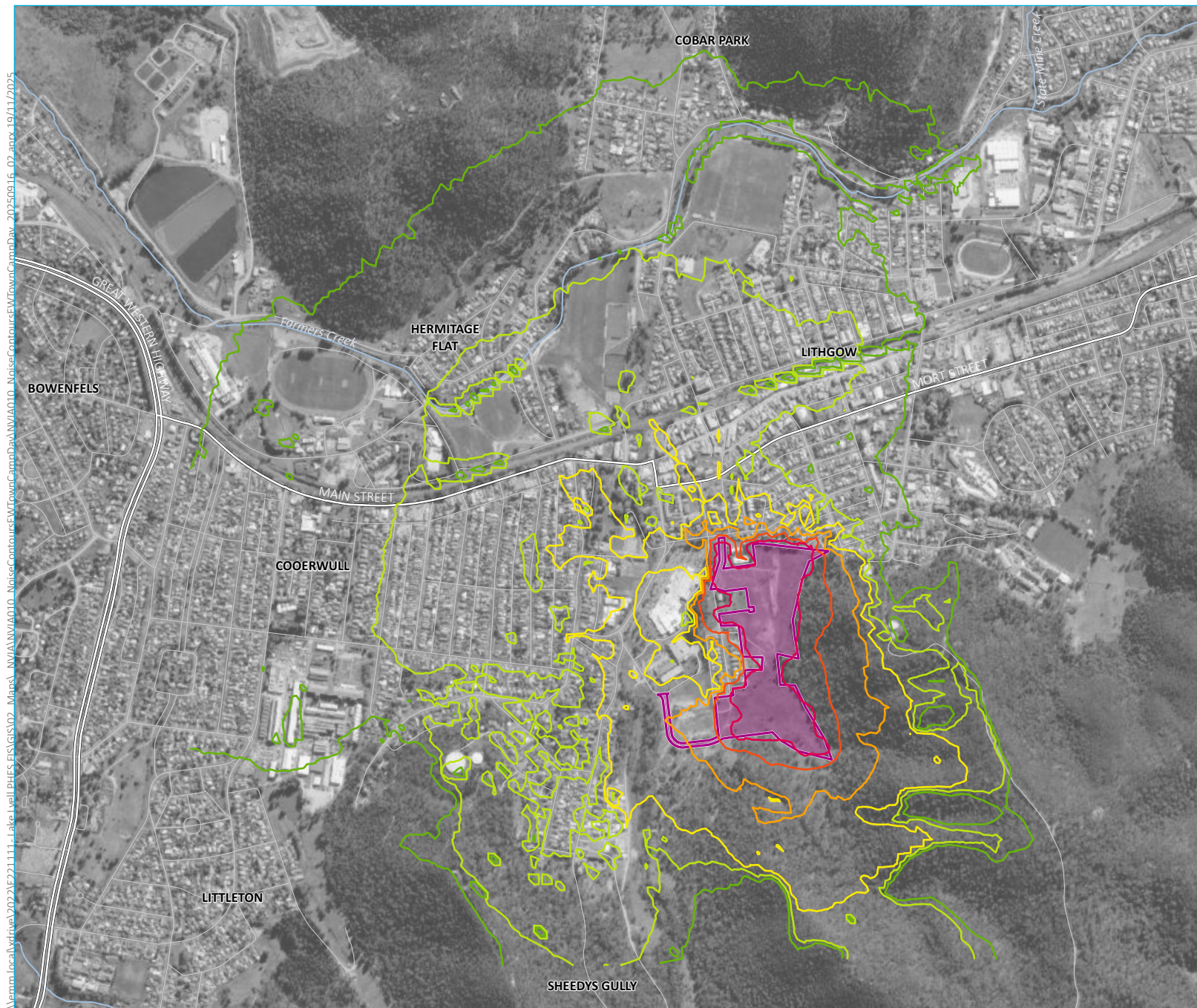
During the daytime period, the worst-affected residential receivers, located on Silcock Street, are predicted to experience construction noise levels up to 71 dB. Noise levels are not predicted to exceed the highly noise affected noise level of $L_{Aeq,15\text{minute}}$ 75 dB at any assessment location.

The magnitude of predicted early works construction noise impacts from the Town camp has been summarised in Table 6.3.

Table 6.3 Magnitude of predicted construction noise impacts – Town camp (early works)

Period ¹	Nominated RBL	Noticeable (0–10 dB above RBL)	Clearly audible (10–20 dB above RBL)	Moderately intrusive (20–30 dB above RBL)	Highly intrusive (>30 dB above RBL)
Day & Day OOH	35 dB	Receivers outside the 45 dB noise contour	Receivers within 45–55 dB noise contours	Receivers within 55–65 dB noise contours	Receivers inside of 65 dB noise contour

Notes: 1. Day: 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day OOH: 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.



KEY

Project area (town camp)

Noise contour (dB)

40

45

50

55

60

65

Existing environment

Major road

Minor road

Named watercourse

Noise contours- Early Works
Town Camp (Day & Day OOH)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.8

In accordance with procedures outlined in Section 5.1.3, prediction of construction noise levels for the alternative Town camp during the main construction period are provided in Figure 6.9, Figure 6.10 and Figure 6.11 for the day, evening and night-time periods, respectively. The levels presented represent the energy-average noise level over a 15-minute period and assumes concurrent operation of all plant and equipment required for the operation of the camp.

During the all periods, the worst-affected residential receivers, located on Silcock Street, are predicted to experience construction noise levels up to 55 dB. Noise levels are not predicted to exceed the highly noise affected noise level of $L_{Aeq,15\text{minute}}$ 75 dB at any assessment location.

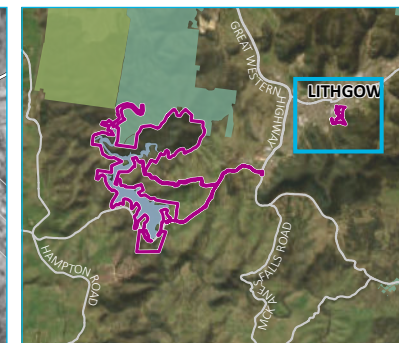
The magnitude of predicted main construction noise impacts from the Town camp has been summarised in Table 6.4.

Table 6.4 Magnitude of predicted construction noise impacts – Town camp (main construction)

Period ¹	Nominated RBL	Noticeable (0–10 dB above RBL)	Clearly audible (10–20 dB above RBL)	Moderately intrusive (20–30 dB above RBL)	Highly intrusive (>30 dB above RBL)
Day, Day OOH & Evening	35 dB	Receivers within 35–45 dB noise contours	Receivers within 45–55 dB noise contours	Receivers within 55–65 dB noise contours	Receivers inside of 65 dB noise contour
Night	32 dB	Receivers within 32–42 dB noise contours	Receivers within 42–52 dB noise contours	Receivers within 52–62 dB noise contours	Receivers inside of 62 dB noise contour

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day OOH: 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday; 10:00 pm to 8:00 am Sundays and public holidays.



KEY

Project area (town camp)

Noise contour (dB)

35

40

45

Existing environment

Major road

Minor road

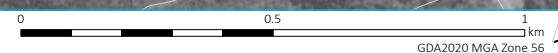
Named watercourse

Noise contours- Main Construction
Town Camp (Day & Day OOH)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.9



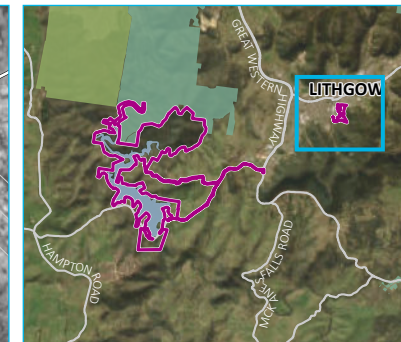
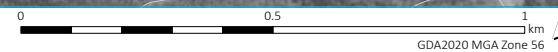
Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)





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Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)



KEY

Project area (town camp)

Noise contour (dB)

— 35

— 40

— 45

Existing environment

— Major road

— Minor road

— Named watercourse

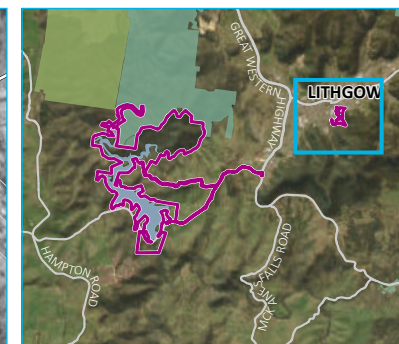
Noise contours- Main Construction
Town Camp (Evening)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.10

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Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)



KEY

Project area (town camp)

Noise contour (dB)

35

40

45

Existing environment

Major road

Minor road

Named watercourse

Noise contours- Main Construction
Town Camp (Night)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.11

6.1.3 South Bowenfels (early works road upgrades)

Given that early works road upgrades are proposed at the northeastern end of Magpie Hollow Road, which is in proximity to a substantial number of sensitive receivers in South Bowenfels, noise contours have been prepared to provide an indicative assessment of potential impacts on the surrounding community.

It should be noted that the noise contours have been prepared in accordance with the assessment methodology outlined in Section 5.1 and provides the same assessment outcomes to those of the project area assessment.

In accordance with procedures outlined in Section 5.1.3, prediction of construction noise levels for the road upgrades during the early works construction period are provided in Figure 6.12 for the day period. The levels presented represent the energy-average noise level over a 15-minute period and assumes all listed plant operating concurrently.

During the daytime period, the worst-affected residential receivers, located on Magpie Hollow Road, are predicted to experience construction noise levels up to 70 dB. Noise levels are not predicted to exceed the highly noise affected noise level of $L_{Aeq,15\text{minute}}$ 75 dB at any assessment location.

The magnitude of predicted early works construction noise impacts from the road upgrades has been summarised in Table 6.5.

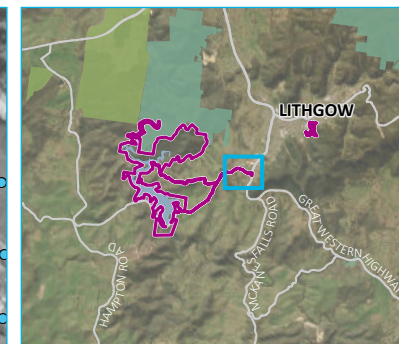
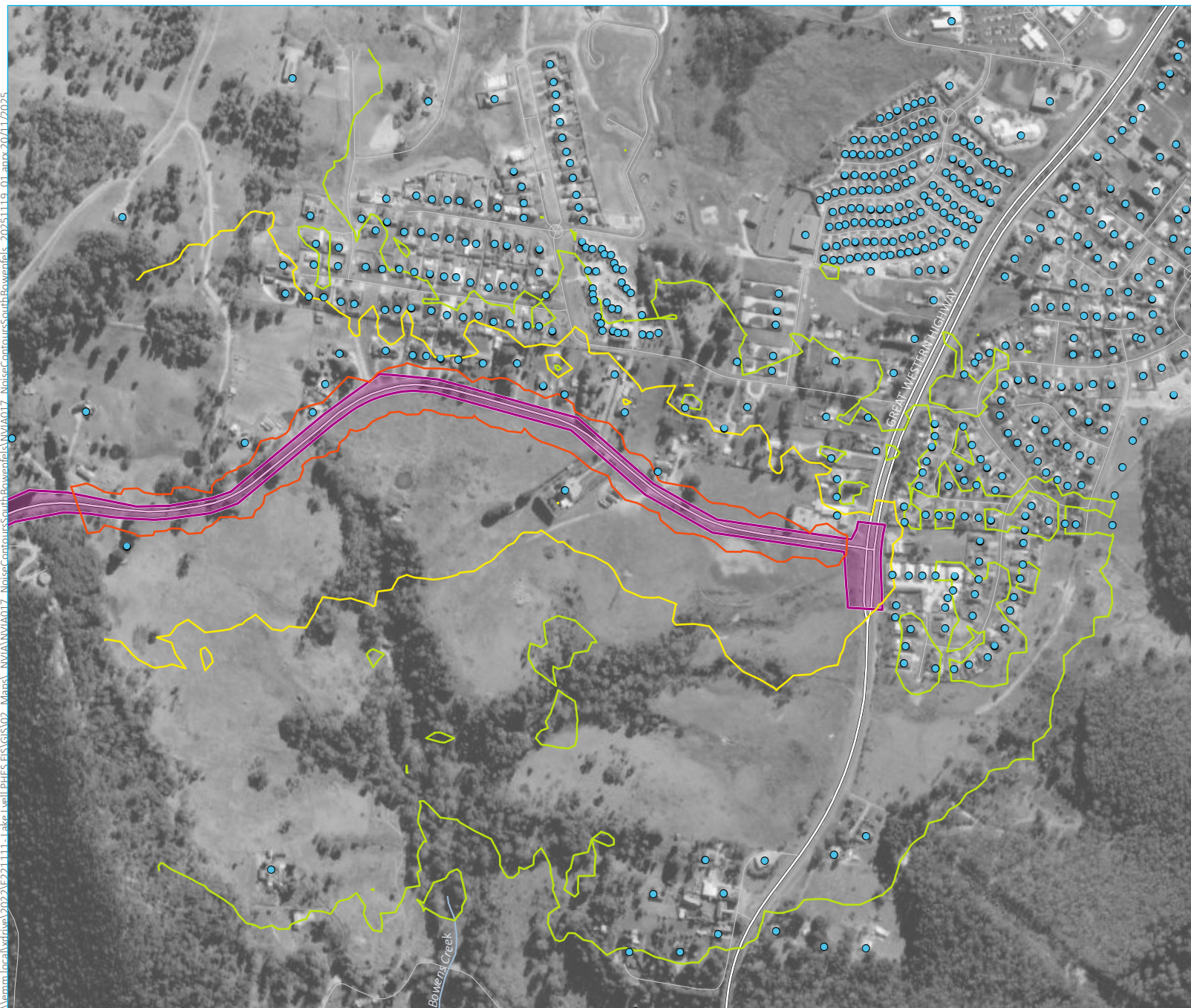
Table 6.5 **Magnitude of predicted construction noise impacts – South Bowenfels (early works road upgrades)**

Period ¹	Nominated RBL	Noticeable (0-10 dB above RBL)	Clearly audible (10-20 dB above RBL)	Moderately intrusive (20-30 dB above RBL)	Highly intrusive (>30 dB above RBL)
Day & Day OOH	42 dB	Receivers outside the 52 dB noise contour	Receivers within 52–62 dB noise contours	Receivers within 62–72 dB noise contours	Receivers inside of 72 dB noise contour

Notes:

1. Day: 7:00 am to 6:00 pm Monday to Friday, 7:00 am to 1:00 pm Saturday; Day OOH: 1:00 pm to 6:00 pm Saturday; 8:00 am to 6:00 pm Sundays and public holidays.

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- KEY
- Project area
 - Sensitive receiver
 - Noise contour (dB)
 - 47
 - 52
 - 62
 - Existing environment
 - Major road
 - Minor road
 - Named watercourse
 - NPWS reserve (refer to inset)
 - State forest (refer to inset)

Noise contours –
Early works road upgrades –
South Bowenfels (Day & Day OOH)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.12

6.1.4 Mitigation and management

The contractor will be required to manage construction noise levels where the potential for exceedances of NMLs has been identified. The construction noise management methods will be detailed in a construction noise and vibration management plan as discussed further in Chapter 7.

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of feasible and reasonable work practices to minimise noise
- inform potentially impacted residents of the nature and duration of the works to be carried out, expected noise levels and relevant contact details
- negotiation with impacted sensitive receivers where noise from work outside standard hours is found to exceed the relevant NML by more than 5 dB.

The contractor should review the construction schedule, stage activities (where possible) and identify reasonable and feasible work practices to minimise the possibility of unnecessary concurrent activities. The contractor should notify the owner / occupier of these assessment locations of the construction works and the potential noise impacts and discuss options for mitigating impacts. Noise monitoring should be undertaken during the initial stages of construction to determine if actual construction noise levels are above NMLs. If this initial testing identifies exceedances, the contractor should identify feasible and reasonable mitigation measures that reduce construction noise levels, as far as practicable, to NMLs.

It is also recommended that an out of hours works protocol be developed for the works. To reduce potential impacts during these periods, it is recommended that high noise generating activities be limited during more sensitive periods.

The response to construction noise emissions will be determined depending on the measured level of exceedance and the availability of feasible and reasonable noise mitigation and management measures. This is discussed further in Chapter 7.

6.2 Sleep disturbance

Predicted maximum noise levels from project construction at residential assessment locations during adverse weather are provided in Table C.3 and Table C.4 in Annexure C.

6.2.1 Project area (including the Lakeside camp)

i Early works

Under noise-enhancing weather conditions, night-time maximum noise level events associated with early works are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 15, 18 and 25.

Between 10:00 pm and 7:00 am, early works maximum noise levels are predicted to exceed the L_{Amax} sleep disturbance screening criteria by 2 dB at assessment location 15, 5 dB at assessment location 18 and 1 dB at assessment location 25. These exceedances can be attributed to the proximity of the assessment locations to the nearest on-site geotechnical drilling pad.

ii Main construction

Under noise-enhancing weather conditions, night-time maximum noise level events associated with main construction works are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 6, 15, 18, 19, 21, 25 and 302.

During the morning shoulder period (between 6:00 am and 7:00 am), main construction maximum noise levels are predicted to exceed the L_{Amax} sleep disturbance screening criteria by 2 dB, 13 dB, 13 dB, 7 dB, 4 dB, 13 dB and 9 dB at assessment locations 6, 15, 18, 19, 21, 25 and 302, respectively. These exceedances can be attributed to the proximity of the assessment locations to the lower laydown area and southern access road.

Between 10:00 pm and 6:00 am, main construction maximum noise levels are predicted to exceed the L_{Amax} sleep disturbance screening criteria by 2 dB at assessment location 15, 5 dB at assessment location 18 and 3 dB at assessment location 25. These exceedances can be attributed to the proximity of the assessment locations to the on-site concrete batching plant, which is proposed to support 24/7 tunnelling works.

The contractor should consult with the affected landowners / occupiers and appropriate feasible and reasonable mitigation measures be agreed and implemented to reduce / minimise maximum noise level events to below the relevant screening criteria or negotiate alternate solutions as described for construction noise in Chapter 7.

6.2.2 Town camp

i Early works

No night-time works are proposed as part of the Town camp in the early works construction period. Therefore, no assessment of sleep disturbance is required as per the NPfI.

ii Main construction

No maximum noise level events are anticipated from the Town camp during the night-time period of the main construction phase. Night-time noise at the Town camp is expected to originate primarily from mechanical services equipment (e.g. air conditioning units, fans, pumps), which produce consistent sound levels and are not expected to generate maximum noise level events. Accordingly, no sleep disturbance assessment has been undertaken in accordance with NPfI procedures.

6.3 Construction vibration

6.3.1 Human response

i Project area (including Lakeside camp)

The nearest residences to the proposed construction activities are assessment location 25 (approximately 250 m from the southern access road) and assessment location 55 (approximately 250 m from the Lakeside camp).

Based on the nature of the works, both locations are situated beyond the safe working distances for human comfort considerations. All other assessment locations surrounding the project area are located more than 100 m from the nearest construction activities and therefore exceed the safe working distances for human comfort considerations.

Accordingly, the potential for human comfort impacts at these locations is considered unlikely.

ii Town camp

The nearest residences to the early works construction are located on the eastern side of Silcock Street within the Pottery Estate, directly adjacent to the Town camp.

Early works construction activities with the highest potential to generate vibration impacts at these residences are expected to involve small compactors or vibratory rollers, which have human comfort safe working distances of approximately 50 to 100 m. No vibration-generating activities are anticipated during the main construction phase.

Given the possibility for vibration generating equipment to be operated within close proximity to these residences, the guide values presented in Table 5.4 should be followed in the first instance. Equipment specification and construction methodology should be carefully chosen to minimise potential vibration impacts on these dwellings. Appropriate vibration mitigation and management measures are detailed in Chapter 7.

6.3.2 Cosmetic damage

i Project area (including Lakeside camp)

As noted in Section 6.3.1, the nearest residences to the proposed construction activities are assessment location 25 (approximately 250 m from the southern access road) and assessment location 55 (approximately 250 m from the Lakeside camp).

Based on the nature of the works, both locations are situated beyond the safe working distances for cosmetic damage to structures. All other assessment locations surrounding the project area, including the Lakeside camp, are located more than 100 m from the nearest construction activities and therefore exceed the safe working distances for cosmetic damage.

Accordingly, the potential for cosmetic damage impacts at these locations is considered unlikely.

A number of specific areas of significance have been identified in the Aboriginal cultural heritage assessment (EMM 2025) and historic heritage assessment (EMM 2025); however, items of high significance or value are located well outside the nominated safe working distances and any items within these distances are not considered vibration-sensitive.

Notwithstanding, the construction methodology should be reviewed if any changes to the nature or location of activities are proposed, particularly where works may occur near sites of geological or heritage significance. This may include limiting the size of plant and equipment for excavation, compaction or removal of rock or re-assessing the significance and/or the sensitivity of these items to vibration prior to construction commencing in the area.

ii Town camp

As noted in Section 6.3.1, the nearest residences to the early works construction are located on the eastern side of Silcock Street within the Pottery Estate, directly adjacent to the Town camp.

As the Pottery Estate is recognised as a Heritage Conservation Area within the Lithgow Local Environmental Plan (LEP), more stringent vibration criteria are applied to these dwellings (refer Section 4.4.3).

Early works construction activities at the Town camp with the highest potential to generate vibration impacts at these heritage dwellings are expected to involve small compactors or vibratory rollers, which have a cosmetic damage safe working distance of approximately 20 m. No vibration-generating activities are anticipated during the main construction phase at the Town camp.

Given the possibility for vibration generating equipment to be operated within close proximity to these heritage residences, the guide values presented in Table 5.4 should be followed in the first instance. Equipment specification and construction methodology should be carefully chosen to minimise potential vibration impacts on these structures. Appropriate vibration mitigation and management measures are detailed in Chapter 7.

If construction activity is required to occur within the safe working distances, real time vibration monitoring with audible and visual alarms should be considered at vibration sensitive structures so actual vibration levels can be monitored and managed appropriately in real-time.

6.4 Blasting

A quantitative blast assessment has been undertaken to calculate blast ground vibration and overpressure based on conservative empirical prediction formula provided in the ICI guideline. A limiting MIC and associated offset distances were calculated for areas where blasting is anticipated to occur, based on a K factor of 1,140 (for average rock).

A summary of the offset distances required to satisfy blast vibration or air blast criteria for portals and tunnel excavation is provided in Table 6.6. It is noted that air blast criteria are only applicable at residential receivers.

Table 6.6 Minimum offset distances required to satisfy blast criteria

Activity	Area	Limiting MIC (kg)	Receiver type	Criteria		Offset distance required to satisfy criteria (m)	
				Ground vibration (PPV)	Air blast, L_{Peak} dB	Ground vibration	Air blast
Tunnel excavation	Underground tunnels	40 kg ¹	Residential	5 mm/s	115	190	370
			Other structures ³	20 mm/s	N/A	80	N/A
Open cut blasting ²	Switchyard	65 kg	Residential	5 mm/s	115	245	450
			Other structures ³	20 mm/s	N/A	105	N/A
	Farmers Creek diversion	160 kg	Residential	5 mm/s	115	375	600
			Other structures ³	20 mm/s	N/A	155	N/A
	Lower intake canal	175 kg	Residential	5 mm/s	115	395	620
			Other structures ³	20 mm/s	N/A	165	N/A
	Reservoir	2815 kg	Residential	5 mm/s	115	1,580	1,540
			Other structures ³	20 mm/s	N/A	660	N/A
	Portal area	585 kg	Residential	5 mm/s	115	720	920
			Other structures ³	20 mm/s	N/A	300	N/A

Notes:

1. Blasting for tunnel excavation is anticipated to occur at any time. Given these blasts are to occur underground and mitigated by portal enclosures, adopting a limiting MIC (as for the open cut blasting) is not appropriate. Therefore, a standard MIC value of 40 kg has been assumed for tunnel excavation. A suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure accordance with the ANZECC Blasting Guidelines (1990) to achieve the relevant blast criteria.
2. Open cut blasting is anticipated to occur during the day period only.
3. Rock structures/transmissions lines/heritage structures

6.4.1 Residential receivers

Provided that the MIC limits provided in Table 6.6 are adhered to, residential receivers surrounding the project are located outside the relevant blast offset distances required to maintain acceptable emission levels from tunnelling and open cut blasting.

If blasting is required within these offset distances, a range of mitigation measures may be employed to ensure compliance to relevant blast criteria, including reduction of MIC, the use of electronic detonators, optimised drill patterns and other factors to optimise blast design and reduce blasting impacts.

Notwithstanding, a suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure accordance with the ANZECC Blasting Guidelines (1990) to achieve the relevant blast criteria.

The ANZECC blasting guideline recommends that blasting be conducted during the day period (9:00 am to 5:00 pm Monday to Saturday) to avoid potential impacts during the more sensitive evening and night periods.

The proposed hours for construction blasting are 9:00 am to 6:00 pm Monday to Saturday, which do not strictly align with the hours recommended in the ANZECC Blasting Guideline. The proponent will discuss blasting hours with landowners as part of their engagement on potential impacts and notifications.

The ANZECC guideline goes on to state that restrictions on the time and frequency of blasting would not apply if the effects were not perceived at noise sensitive sites. Furthermore, ANZECC states that in some circumstances, blasts may not be able to comply with emission level, time and frequency requirements. In these instances, environmental authorities would apply appropriate controls based on individual project circumstances.

Although unlikely, blast practices associated with tunnelling during the night period will be reviewed and modified if higher air blast levels are generated that cause adverse impacts on residents.

6.4.2 Non-residential vibration sensitive receivers

i Potential impacts on heritage items

Table 6.6 presents the blast offset distances required to maintain acceptable vibration levels in relation to other structures (non-residential vibration sensitive receivers).

A few specific areas of significance have been identified in the Aboriginal cultural heritage assessment (EMM 2025); however, these mainly consist of areas of artefact scatter and are not considered to be vibration sensitive. The historic heritage assessment (EMM 2025) was also reviewed; however, no vibration sensitive areas / locations were identified. Any areas or items of high significance/value are located well outside of blast offset zones. However, if work methods and locations change, these areas should be reconsidered and reassessed to safeguard against adverse impacts. If additional vibration sensitive items are identified within the blast offset zone, blast practices should be managed accordingly when in the vicinity. This may include limiting the MIC or re-assessing the significance and/or the sensitivity of these items to vibration prior to construction commencing in the area.

Blasting activities would adopt the limits of Australian Standard AS2187.2:2006 *Explosives - Storage and Use - Use of Explosives* that recommends frequency dependent guideline values and assessment methods given in BS7385.2:1993 *Evaluation and measurement for vibration in buildings* be used as they are “applicable to Australian conditions”. Appropriate engineering investigations and advice will be part of the management process of safeguarding heritage areas. A review of BS7385 section 7.5.5 also notes that structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition.

Casaday and Lehmann, 1967¹ studied animal installations to observe animal behaviour when subjected to sonic booms. Animals observed included up to 10,000 beef cattle, 100 horses, 150 sheep and 320 dairy cattle. During the test period, sonic booms were scheduled at varying intervals during the morning, Monday to Friday of each week.

Study outcomes indicated that reactions of the sheep and horses exposed to sonic booms were minimal in terms of observed changes in behaviour. Similarly, dairy cattle were typically unaffected by sonic booms (125 to 136 dB). Less than 20% of sonic boom events produced even a mild reaction, as confirmed by a pause in eating, raising of heads, or mild startle effects. Production of milk was unaffected during the study, as evidenced by total and individual milk yield. The researchers summarised that the occasional abnormal behavioural changes observed were well within the range of activity variation to be expected of a group of animals. Changes were defined as horses jumping up and galloping, dairy cattle bellowing, and increased activity by beef cattle. The lowest air blast overpressure exposure adopted in the study was 125 dB and considered conservative in the assessment of livestock impacts.

Given the distances to the nearest areas with potential to accommodate livestock (approximately 1 km), the predicted noise levels from blasting that livestock may be exposed to are 120 dB or less. Given this, the impacts on livestock from the construction (or operation) of the project are considered unlikely.

6.5 Road traffic noise

6.5.1 Construction

Road traffic noise levels from the project have been assessed by calculating existing traffic and existing plus project traffic at representative residential assessment locations using the FHWA method as appropriate (i.e. FHWA method adopted for lower volumes as per industry accepted practice).

Traffic volumes were provided by LLP to represent the peak generation of light (LV) and HV associated with the construction of the project. LV volumes were distributed 70% day (7:00 am to 10:00 pm) and 30% night (10:00 pm to 7:00 am) and HV volumes were distributed 85% day (7:00 am to 10:00 pm) and 15% night (10:00 pm to 7:00 am) in accordance with expected activities.

Two scenarios have been modelled for the purposes of assessing construction traffic noise from the project on Magpie Hollow Road and Sir Thomas Mitchell Drive:

- Peak HV – This scenario is representative of the three-month period (April to June 2027) where off -site spoil haulage is required as part of the Farmers Creek Diversion.
- Average – This scenario is representative of the typical traffic movements over the broader construction program and is based on forecast volumes between November 2027 and June 2030.

It is of note that for the roads on the route from the proposed Town camp to the Great Western Highway (Silcock Street, Bent Street, Lithgow Street, Methven Street, Martini Parade and Bayonet Street), the volumes for both the Peak HV and average scenarios are anticipated to be the same.

¹ Responses of farm animals to sonic booms. Sonic Boom Experiment at Edwards Air Force Base. National Sonic Boom Evaluation Office Interim Report NS BE-1-67 of 28 July 1967. Annex H.

The following assumptions were adopted:

- The speed limits on road sections nearest to residences were (as sign posted):
 - 80 kilometres per hour (km/h) for Magpie Hollow Road
 - 60 km/h for Sir Thomas Mitchell Drive
 - 50 km/h for Bent Street
 - 50 km/h for Lithgow Street
 - 50 km/h for Methven Street
 - 50 km/h for Martini Parade
 - 50 km/h for Bayonet Street.
- There are no buildings or other intervening objects that will act like a noise barrier between the road and the noise assessment point.
- A façade reflection of +2.5 dB has been added to predicted noise levels.

The calculated existing and predicted future road traffic noise levels, inclusive of project-related construction traffic, are presented in Table 6.7. They are based on traffic volumes provided in Table 5.5.

Table 6.7 Predicted road traffic noise levels during construction

Receiver location	Location	Distance from road (m)	Period ²	RNP criteria	Road traffic noise level, dB	Predicted road traffic noise level, dB		Change, dB	
					Existing	Existing + construction (Peak HV)	Existing + construction (Average)	Peak HV	Avg.
Nearest residence to road	Magpie Hollow Road	16	Day	60 L _{Aeq,15hour}	61 L _{Aeq,15hour}	64 L _{Aeq,15hour}	63 L _{Aeq,15hour}	3.7	2.3
			Night	55 L _{Aeq,9hour}	57 L _{Aeq,9hour}	60 L _{Aeq,9hour}	59 L _{Aeq,9hour}	3.0	2.3
	Sir Thomas Mitchell Drive	33	Day	55 L _{Aeq,1hour}	43 L _{Aeq,1hour}	56 L _{Aeq,1hour}	53 L _{Aeq,1hour}	13.0	10.1
			Night	50 L _{Aeq,1hour}	41 L _{Aeq,1hour}	51 L _{Aeq,1hour}	50 L _{Aeq,1hour}	10.7	9.1
	Bent Street	7	Day	60 L _{Aeq,15hour}	62 L _{Aeq,15hour}	62 L _{Aeq,15hour}		0.8	
			Night	55 L _{Aeq,9hour}	59 L _{Aeq,9hour}	60 L _{Aeq,9hour}		0.4	
	Lithgow Street	7	Day	60 L _{Aeq,15hour}	65 L _{Aeq,15hour}	65 L _{Aeq,15hour}		0.4	
			Night	55 L _{Aeq,9hour}	62 L _{Aeq,9hour}	63 L _{Aeq,9hour}		0.2	
	Methven Street	8	Day	60 L _{Aeq,15hour}	67 L _{Aeq,15hour}	67 L _{Aeq,15hour}		0.2	
			Night	55 L _{Aeq,9hour}	63 L _{Aeq,9hour}	63 L _{Aeq,9hour}		0.2	
	Martini Parade	10	Day	55 L _{Aeq,1hour}	61 L _{Aeq,1hour}	61 L _{Aeq,1hour}		0.8	
			Night	50 L _{Aeq,1hour}	58 L _{Aeq,1hour}	58 L _{Aeq,1hour}		0.4	

Receiver location	Location	Distance from road (m)	Period ²	RNP criteria	Road traffic noise level, dB	Predicted road traffic noise level, dB		Change, dB	
					Existing	Existing + construction (Peak HV)	Existing + construction (Average)	Peak HV	Avg.
	Bayonet Street	8	Day	55 L _{Aeq,1hour}	63 L _{Aeq,1hour}	63 L _{Aeq,1hour}		0.7	
			Night	50 L _{Aeq,1hour}	59 L _{Aeq,1hour}	60 L _{Aeq,1hour}		0.4	

Notes:

1. Predicted noise level includes a 2.5 dB facade correction as required by the RNP.

Road traffic noise levels are predicted to increase from existing levels during the construction of the project on both Magpie Hollow Road and Sir Thomas Mitchell Drive.

Currently, existing road traffic noise levels on all roads are predicted to exceed the relevant RNP criteria for both the day and night-time periods, with the exception of Sir Thomas Mitchell Drive.

For construction traffic related to the town camp, road traffic noise levels on all associated roads (i.e. Bent Street, Lithgow Road, Methven Street, Martini Parade and Bayonet Street) are predicted to increase from existing levels by up to 1 dB. Given that these roads already exceed the relevant RNP criteria for both day and night-time periods, the RNP relative increase criteria of 2 dB is satisfied for these roads.

Construction traffic noise level predictions demonstrate a 2 to 4 dB increase in road traffic noise levels for the nearest residences on Magpie Hollow Road. During the day period, road traffic noise levels on Magpie Hollow Road are predicted to increase by up to 2 dB and 4 dB during average and peak HV construction traffic scenarios, respectively. During the night period, road traffic noise levels on Magpie Hollow Road are predicted to increase by up to 2 dB and 3 dB during average and peak HV construction traffic scenarios, respectively.

Construction traffic noise level predictions demonstrate a 9 to 13 dB increase in road traffic noise levels for the nearest residences on Sir Thomas Mitchell Drive. During the day period, road traffic noise levels on Sir Thomas Mitchell Drive are predicted to increase by up to 10 dB and 13 dB during average and peak HV construction traffic scenarios, respectively. During the night period, road traffic noise levels on Sir Thomas Mitchell Drive are predicted to increase by up to 9 dB and 11 dB during average and peak HV construction traffic scenarios, respectively.

Such changes result in levels above the RNP criteria and hence feasible and reasonable measures must be considered, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan and the construction noise and vibration management plan.

It is of note that the road traffic noise results for the peak HV construction traffic scenario are based on vehicle movements during offsite haulage associated with the Farmers Creek diversion, occurring over a short-term period (approximately three months). Hence, the assessment of road traffic noise during this peak HV construction traffic scenario is conservative. Further, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

6.5.2 Operations

Road traffic movements generated during the operational phase of the project (i.e. maintenance and monitoring) would be significantly less than that generated by construction traffic movements. Operational road traffic would consist of 1 to 2 LVs and a light truck, conducting routine maintenance around the site. These traffic volumes are expected to be less than 2% of the existing road traffic experienced on the abovementioned roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely and have not been assessed further.

6.6 Operational noise

6.6.1 Assessment procedure

Noise from operational plant and equipment associated with the project has been assessed considering:

- operating sound power level of plant calculated for number of items running simultaneously
- the characteristics of noise emissions from all plant and equipment including low frequency noise and tonality.

Noise from plant and equipment associated with operation of the project was considered and includes air conditioning condensers, exhaust and supply fans, transformers, pumps, natural ventilation openings for buildings and ventilation fans.

6.6.2 Operational noise modelling

Operational noise levels from the project were predicted using the same computer-generated model as that used for predicting construction noise levels.

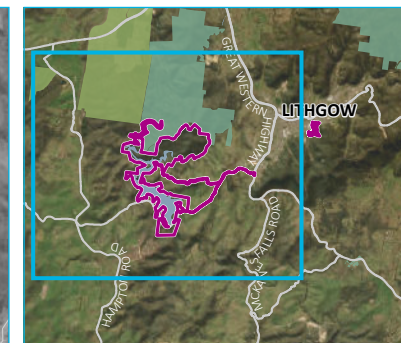
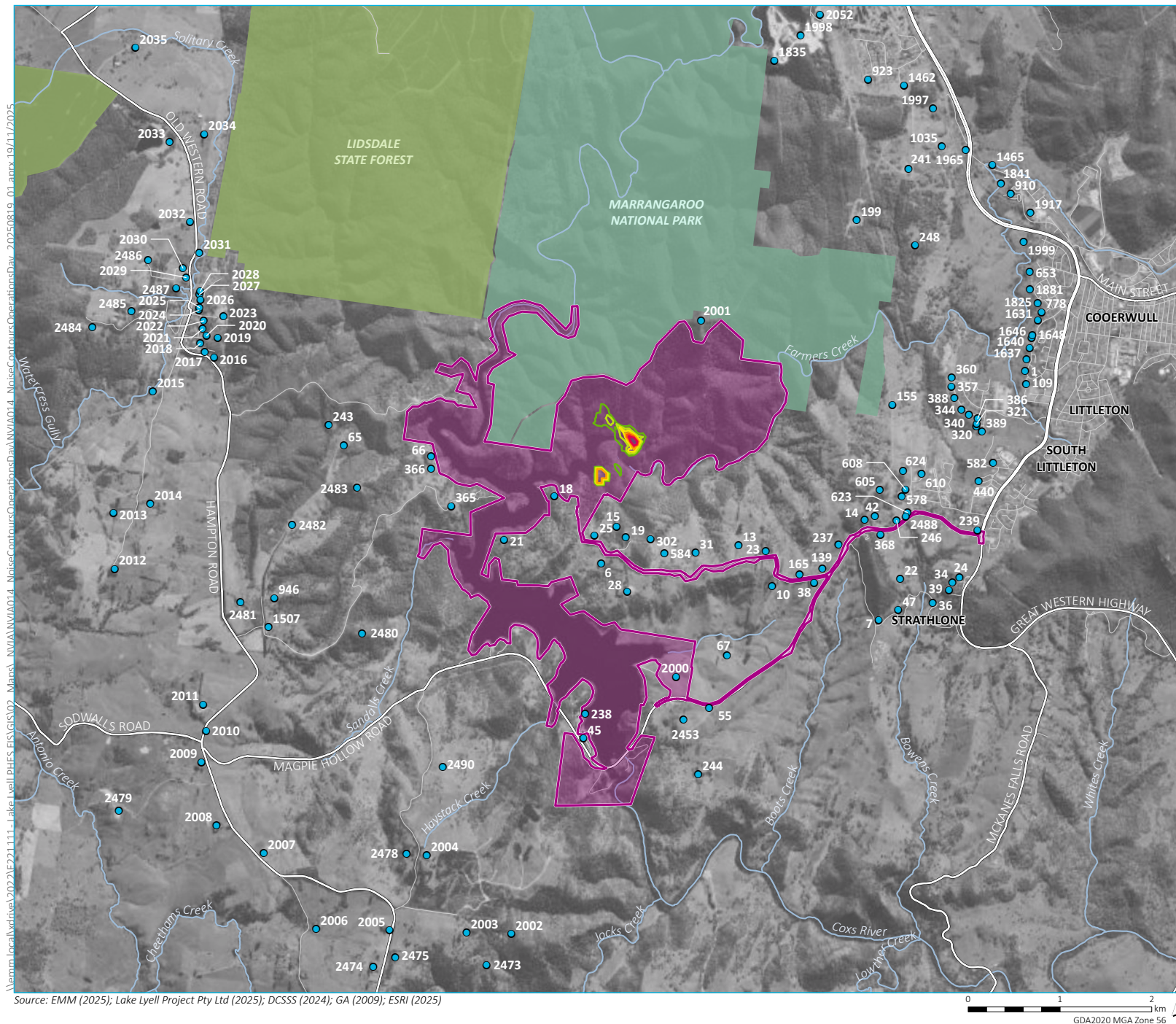
6.6.3 Predicted noise levels

Operational noise emission levels have been predicted for a peak operating scenario during noise enhancing meteorological conditions as relevant (refer to Table 3.3). As modelling was developed to represent noise levels during a peak operational scenario, noise level predictions are considered conservative for assessment purposes.

A screening test of single octave noise predictions was completed for the nearest receivers and concluded that it is unlikely that modifying factor corrections are applicable to any of the site's operational noise emissions given the quantity and nature of the proposed equipment and the large separation distances to the nearest receivers. Hence, modification factors have not been added to the operational noise predictions.

The modelling results for noise emissions from the projects' operations (refer to Table 5.6) are presented in Figure 6.13, Figure 6.14 and Figure 6.15 for day, evening and night periods, respectively, and have also been provided for individual assessment locations in Section C.5 of Annexure C. The operational noise levels are predicted to be below the relevant NPfI noise trigger levels at all assessment locations for noise enhancing meteorological conditions.

Emergency events have the potential to generate some short-term noise impacts. However, emergency events are anticipated to be extremely uncommon and, as such, they have not been assessed.

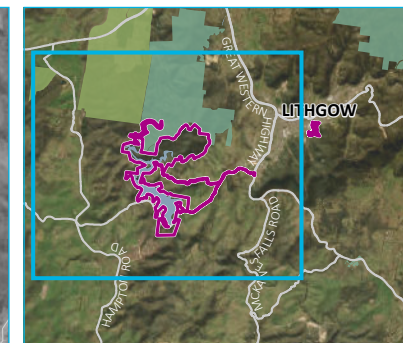
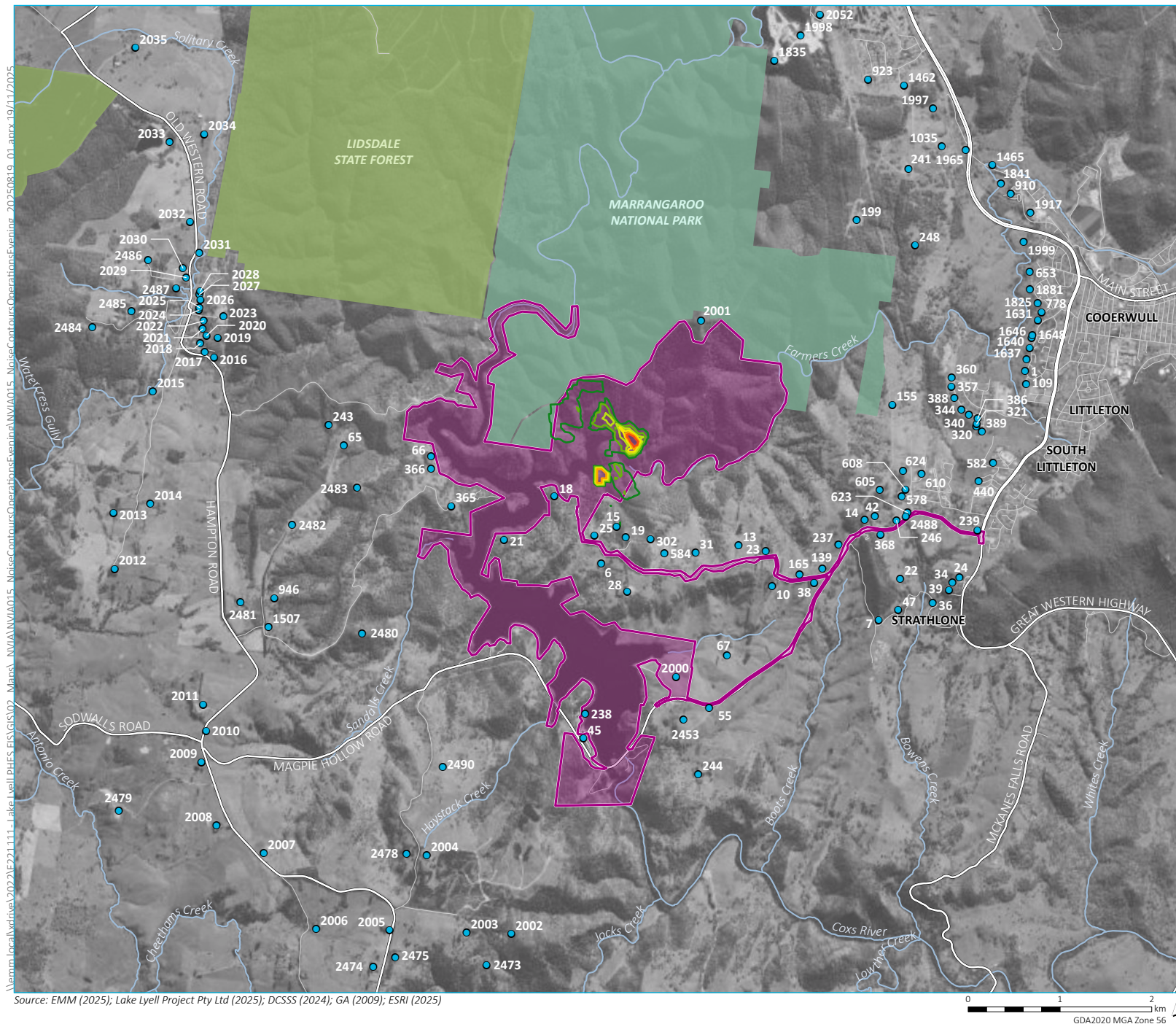


- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 40
 - 45
 - 50
 - 55
 - 60
 - 65
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Operations (Day)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.13

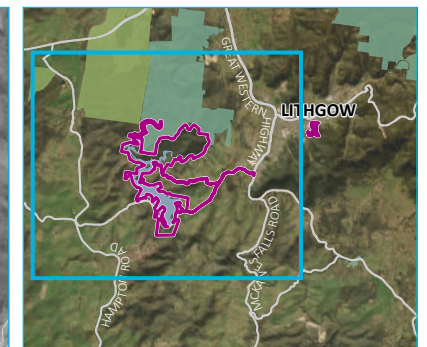
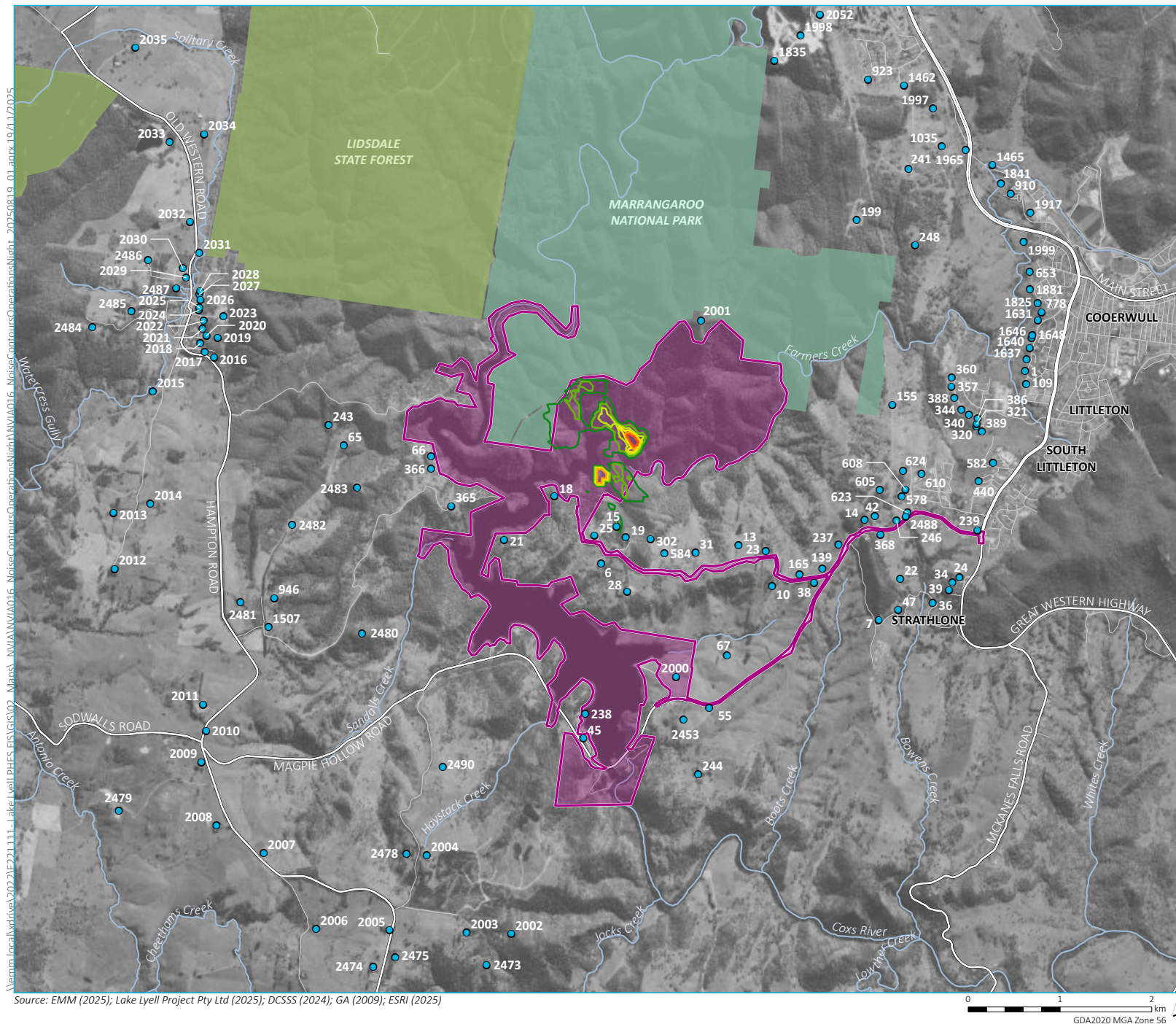




- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
 - 60
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours-
Operations (Evening)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.14



- KEY**
- Project area
 - Assessment location
- Noise contour (dB)**
- 35
 - 40
 - 45
 - 50
 - 55
 - 60
- Existing environment**
- Major road
 - Minor road
 - Named watercourse
 - NPWS reserve
 - State forest

Noise contours- Operations (Night)

Lake Lyell PHES
Noise and Vibration Impact Assessment
Figure 6.15

6.7 Operational vibration

Given that there are no significant vibration generating components included in the operational design of the project, and the significant distances between the infrastructure and the nearest residences (in the order of 500 m+), vibration impacts from operation of the project are considered unlikely.

6.8 Noise and vibration impact on fauna

The Australian Academy of Science has undertaken a review of research into noise impacts and the environment². The review included consideration of flying species, land species and marine species. The focus is largely on continuous noise from urban environments including roads and industrial sites, whilst consideration of marine species focuses on impacts of shipping and low frequency noise on the navigation of sea mammals. Indications confirm high noise levels can affect the calling of birds and communication, sometimes resulting in change in nesting areas, with noisy areas being repopulated by a more noise tolerant species of bird. However, the actual level of noise where this occurs is unclear. In terms of land species, studies have indicated high noise areas can affect the ability of frogs to communicate and breed.

There are no current government policies or guidelines that recommend noise thresholds or criteria in relation to fauna. High noise levels may lead some species avoiding noisy areas, potentially resulting in the fragmentation of species habitat. Radle³ (2007) states that typically terrestrial fauna will avoid any industrial plant or construction area where noise or vibration presents an annoyance to them. Additionally, many animals react to new noise initially as a potential threat, but quickly 'learn' that the noise is not associated with a threat (Radle, 2007).

In general, increased construction or operational activity levels are likely to result in reduced fauna activity around work areas and heavily trafficked road segments. Noise will be generated by the project through operation of machinery, plant, vehicles, and blasting. Construction and operational noise will be in areas largely untouched by direct human impacts and disturbance. Fauna species that occur in the vicinity of construction sites and main traffic routes are expected to leave the immediate area of noise impact. It would be anticipated that following completion of the construction period, fauna could return to the previous habitat.

Further details on this are available in the biodiversity development assessment report (EMM 2025) (EIS Appendix J) and Chapter 7 of the EIS.

6.9 Marrangaroo National Park

The Mount Walker Trig Point (assessment location 2001) has been identified as an assessment location in the noise assessment, and representative of potential impacts to Marrangaroo National Park. The receptor type 'passive recreation' has been applied to this location in accordance with the NPfI. The 'passive recreation' receptor type is typically applied to places where people normally go to undertake quiet activities (e.g. picnics, bushwalks, etc.).

It is anticipated that construction noise would be clearly audible (i.e. 10 to 20 dB above RBL) within the national park at times during the main construction period however would not exceed the adopted criteria for passive recreation.

² Noise pollution and the environment. Dr Kirsten Parris and Associate Professor Robert McCauley. Australian Academy of Science 2016.

³ The effect of noise on wildlife: A literature review. Autumn. Lyd Radle 2007.

7 Management of impacts

7.1 Avoidance and minimisation

Potential noise and vibration impacts have been considered during design of the project, where possible to avoid or reduce significant impacts. This includes:

- site selection of the Lakeside camp in an area with limited surrounding residential receptors
- limiting construction hours on Sundays to essential activities
- incorporating blast doors as part of the tunnel construction methodology.

7.2 Reasonable and feasible mitigation

The contractor will be required to manage construction noise levels where the potential for exceedances of NMLs has been identified. The response to construction noise emissions will be determined depending on the measured level of exceedance and the availability of feasible and reasonable noise mitigation and management measures.

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of feasible and reasonable work practices to minimise noise
- inform potentially impacted residents of the nature and duration of the works to be carried out, expected noise levels and relevant contact details
- negotiation with impacted sensitive receivers where noise from work outside standard hours is found to exceed the relevant NML by more than 5 dB.

Environmental management measures for noise and vibration are provided in Table 7.1.

Table 7.1 Environmental management measures for noise and vibration

Impact	Ref #	Environmental management measures
Construction Noise	N1	A construction noise and vibration management plan (CNVMP) that will address noise and vibration management and mitigation options (where required) will be prepared prior to commencement of construction activity associated with the project. With respect to noise impacts, the CNVMP will include as a minimum: • identification of nearby residences and sensitive land uses along with appropriate corresponding noise criteria • a description of approved hours of work and what works will be undertaken • a description of work practices to be applied to minimise and manage construction noise where it is predicted to be above relevant criteria. • a description of the out of hours works protocol • a description of the complaints handling process • a description of any noise monitoring that is required. The CNVMP will also outline a procedure to: • measure construction noise levels at early stages to validate the predicted construction noise levels

Impact	Ref #	Environmental management measures
		- re-evaluate the predicted construction noise levels at assessment locations, and where required review noise management and mitigation measures to reduce levels as close to NMLs as possible. This may include (but is not limited to): - limiting construction within a certain distance of assessment locations during the evening and night-time period - selecting quieter equipment or reduced equipment fleet - measuring construction noise levels at assessment locations, especially during the evening and night-time period, if relevant, and implementing further noise management and mitigation measures where an exceedance of NMLs is identified - entering into a negotiated agreement with affected landholders. Affected landholders will be consulted prior to and during construction where an exceedance of NMLs has been predicted and should be notified of proposed mitigation measures that will be used to manage construction noise levels to below ICNG NMLs where practicable.
Construction vibration	V1	A CNVMP that will address noise and vibration management and mitigation options (where required) will be prepared prior to commencement of construction activity associated with the project. With respect to vibration impacts, the CNVMP will include as a minimum: - identification of nearby residences and sensitive land uses along with appropriate corresponding vibration criteria - a description of approved hours of work and what works will be undertaken - a description of work practices to be applied to minimise and manage construction vibration where it is predicted to be above relevant criteria - a description of the complaints handling process - a description of monitoring that is required. If the safe working distances in Section 5.2.1 are encroached, vibration monitoring will be carried out at nearby sensitive structures. If required, the monitoring system will be fitted with an auditory and visual alarm that triggers when vibration levels reach the nominated criteria. This would indicate if or when alternate work practices should be adopted (such as a reduction in vibratory intensity, alternate equipment selection, etc.). Blast practices should be reviewed when blasting occurs in the vicinity of significant heritage items. This may include limiting the MIC or re-assessing the significance and/or the sensitivity of these items to vibration prior to construction commencing in the area. The potential for blast impacts on residents is considered unlikely given proposed mitigation measures, the topography and separation distance between construction and nearest residences. Notwithstanding, blast practices will be constantly reviewed and adapted if complaints are received from residents due to blasting. A survey of heritage items and other potential vibration sensitive receivers should be undertaken in the blast offset zones identified.
Operational noise	N2	All operational plant and equipment including ventilation, pumps, generators, transformers, variable speed drives (VSDs) or other plant associated with the operation of the project shall be subject to detailed acoustic review prior to final specification. Design shall be assessed against the requirements of the NPfI and consider the amenity criteria for all receiver types.

8 Conclusion

This NVIA has been prepared to support the EIS for the project. It has documented the assessment methods, noise modelling results and the mitigation and management measures proposed to address any residual noise and vibration impacts not able to be avoided.

The construction schedule was reviewed to identify the worst-case periods for both the early works and main construction phases. These periods have been adopted on the basis that they are considered representative of the worst-case scenario for each phase.

Noise levels from early works construction, under noise-enhancing weather conditions, are:

- not predicted to exceed the highly noise affected noise level of $L_{Aeq,15minute}$ 75 dB at any assessment location
- predicted to be above the relevant NMLs at 49 assessment locations during ICNG standard construction hours
- predicted to be above the relevant NMLs at 60 assessment locations during the day out of hours period
- predicted to be above the relevant NMLs at seven assessment locations during the evening period
- predicted to be above the relevant NMLs at eight assessment locations during the night-time period.

Noise levels from main construction, under noise-enhancing weather conditions, are:

- not predicted to exceed the highly noise affected noise level of $L_{Aeq,15minute}$ 75 dB at any assessment location
- predicted to be above the relevant NMLs at 12 assessment locations during ICNG standard construction hours
- predicted to be above the relevant NMLs at 26 assessment locations during the day out of hours period
- predicted to be above the relevant NMLs at seven assessment locations during the evening period
- predicted to be above the relevant NMLs at nine assessment locations during the night-time period
- predicted to be above the relevant NMLs at 74 assessment locations during the morning shoulder period.

Noise contours have also been provided for Lithgow (during early works and main construction phases of the alternative town accommodation camp) and South Bowenfels (during early works road upgrades) to show the extent of impact to the surrounding community under noise-enhancing weather conditions.

It is recommended that an out of hours works protocol be developed for the project. To reduce potential impacts during these periods, it is recommended that high noise generating activities be limited during more sensitive periods.

As part of the Neighbour Agreement Guide and in accordance with a community and social engagement plan (CSEP) to be prepared for the project, the proponent will notify the affected residents of construction works and the potential noise impacts and discuss options for mitigating impacts. Noise monitoring should be undertaken during the initial stages of construction to determine if actual construction noise levels are above NMLs. If this initial testing identifies exceedances, the contractor should identify additional feasible and reasonable mitigation measures that reduce construction noise levels to NMLs where practical.

The NVIA has identified potential for sleep disturbance as defined in the NPfI (EPA 2017) due to night-time activities associated with both the early works and main construction phases.

- Night-time maximum noise level events associated with early works construction, under noise-enhancing weather conditions, are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 15, 18 and 25 during the night-time period. These exceedances can be attributed to the proximity of the assessment locations to the south-eastern most geotechnical drilling pads.
- Night-time maximum noise level events associated with main construction, under noise-enhancing weather conditions, are predicted to satisfy the relevant sleep disturbance screening criteria at most residential assessment locations, except for assessment locations 15, 18 and 25 during the night-time period and assessment locations 6, 15, 18, 19, 21, 25 and 28 during the morning shoulder period. These exceedances can be attributed to the proximity of the assessment locations to the lower laydown area, concrete batching plant and southern access road.

A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in this NVIA. These measures, if integrated with project construction and operational environmental management plans and implemented as intended, would moderate the impact of the Project on local receivers.

The potential for vibration impacts on residences and other vibration sensitive structures near construction activity has been assessed.

- The nearest residences surrounding the project area (including the Lakeside camp) are located over 250 m from construction works. These distances exceed safe working limits for both human comfort response and cosmetic damage, making vibration impacts unlikely. Notwithstanding, construction methodology should be reviewed if activity is proposed to occur in the vicinity of any sites with geological or heritage significance.
- The nearest residences surrounding the Town camp are dwellings on Silcock Street in the Pottery Estate. As the Pottery Estate is recognised as a Heritage Conservation Area within the Lithgow LEP, more stringent cosmetic damage criteria are also applicable. Vibration impacts may arise from some early works construction activities, given the small separation distances to residences. No vibration-generating activities are anticipated during the main construction (camp operation) phase. Given the possibility for vibration generating equipment to be operated within proximity to these residences, the guide values presented within should be followed in the first instance, with equipment and methods carefully selected, and mitigation measures implemented. If works are anticipated to occur within the safe working distances, real-time vibration monitoring with alarms should be considered.

A quantitative blast assessment has been undertaken to calculate blast ground vibration and overpressure offset distances required to achieve acceptable emissions at sensitive receiver locations. Residential receivers surrounding the project are located outside the relevant blast offset distances required to maintain acceptable emission levels from tunnelling and open cut blasting.

If blasting is required within these offset distances, a range of mitigation measures may be employed to ensure compliance to relevant blast criteria, including reduction of MIC, the use of electronic detonators, optimised drill patterns and other factors to optimise blast design and reduce blasting impacts. Notwithstanding, a suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure compliance with the criteria provided in the ANZECC Blasting Guidelines (1990).

Although unlikely, blast practices associated with tunnelling during the night period will be reviewed and modified if higher air blast levels are generated and measured at a level that would cause adverse impacts on residents.

The project would result in additional road traffic movements during the construction period. Significant road traffic noise increases are predicted to occur on Sir Thomas Mitchell Drive and Magpie Hollow Road, as the primary haulage route for the project.

Road traffic movements associated with the Town camp are anticipated to comply with the RNP 2 dB relative increase criteria, as existing road traffic noise levels are predicted to be above the relevant RNP criteria for all roads on the proposed route and road traffic noise level increases are predicted to be less than 1 dB.

It is of note that the predicted road traffic noise levels are based on HV movements during the peak construction scenario and hence the assessment of road traffic noise is conservative. Further, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

Project-related operational road traffic volumes are expected to be less than 2% of the total existing road traffic volumes on the abovementioned roads. As such, adverse impacts because of operational road traffic noise are considered unlikely.

The impacts of noise and ground vibration on fauna is expected to be low, albeit based on limited literature on the topic. The greatest emissions would occur during construction works, with emissions during the operation of the project anticipated to be significantly less than those experienced during construction works.

Assessment of operational noise associated with the project has confirmed compliance with NPfI requirements for all assessment locations.

A CNVMP addressing relevant management and mitigation options for both noise and vibration (where required) will be prepared prior to commencement of construction activity associated with the project. The measures included in the CNVMP (where feasible and reasonable) are expected to moderate the impact of the project on local receivers as far as reasonably practicable. A Neighbour Agreement Guide will provide the process engagement with affected landowners and agreement for any site-specific mitigation measures.

References

- Aloui, Bleuzen Essefi and Abbed 2016, *Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia*.
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Glossary

Several technical terms are discussed in this report. These are explained in Table G.1.

Table G.1 **Project and technical terms**

Term	Meaning
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Amenity noise criteria	The amenity noise criteria relate to existing industrial noise. Where industrial noise approaches base amenity noise criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise. See Section 4.6.3 for more detail.
Day period	Monday-Saturday: 7:00 am to 6:00 pm; Sundays and public holidays: 8:00 am to 6:00 pm.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB C	Noise is measured in units called decibels (dB). There are several scales for describing noise, with the 'C-weighted' scale typically used to assess low frequency noise.
Evening period	Monday-Sunday and public holidays: 6.00 pm to 10.00 pm
Intrusive noise criteria	The intrusive noise criteria refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in Section 4.6.2.
L _{A1}	The noise level exceeded for 1% of the time.
L _{A10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L _{A90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L _{Aeq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The L _{Aeq,15minute} descriptor refers to a L _{Aeq} noise level measured over a 15-minute period.
L _{Peak}	The peak level of an event is normally measured using a microphone in the same manner as linear noise (i.e. unweighted), at frequencies both in and below the audible range.
L _{Amax}	The maximum sound pressure level received during a measuring interval.
Night period	Monday-Saturday: 10:00 pm to 7:00 am; Sundays and public holidays: 10:00 pm to 8:00 am.
Project area	The area required to access and build project infrastructure, including surface and tunnel components of the project
PNTL	The project-noise trigger level (PNTL) is criteria for a particular industrial noise source or industry. The PNTL is the lower of either the intrusive noise criteria or amenity noise criteria.
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
Sound power level (L _W)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

Term	Meaning
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

Common noise levels

It is useful to have an appreciation of the decibel (dB), the unit of noise measurement. Table G.2 gives an indication as to how an average person perceives changes in noise level in the environment. Examples of common noise levels are provided in Figure G.1.

Table G.2 **Perceived change in noise**

Change in noise level (dB)	Perceived changes in sound
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times as loud (or quarter) as loud

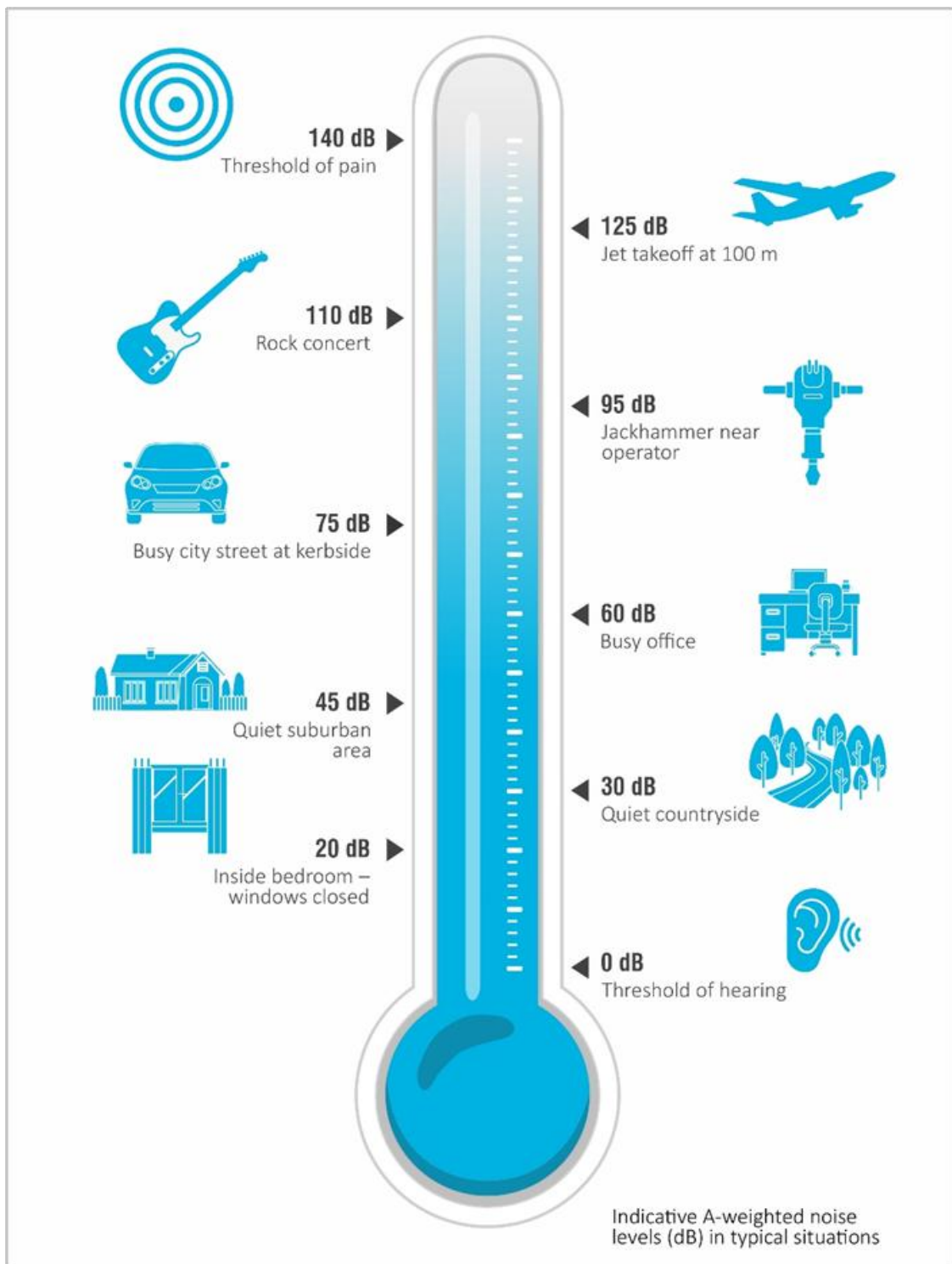


Figure G.1 Common noise levels

Abbreviations

Abbreviation	Term
AGL	above ground level
ANZECC	Australian and New Zealand Environment and Conservation Council
ABL	Assessment background level
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CoRTN	Calculation of Road Traffic Noise
DECC	Department of Environment and Climate Change
DEC	Department of Environment and Conservation
DEFRA	Department of Environment, Food and Rural Affairs
D&B	Drill and blast
DP&E	Department of Planning and Environment
EPA	Environmental Protection Authority
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
FHWA	US Federal Highway Administration
HV	Heavy vehicle
ICNG	Interim Construction Noise Guideline
LGAs	local government areas
LV	Light vehicle
MAT	Main Access Tunnel
MIC	Maximum Instantaneous Charge
MW	megawatts
NATA	National Association of Testing Authorities
NPfi	Noise Policy for Industry
NML	Noise management level
OOH	Out of hours
PPV	Peak particle velocity
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
PNTL	Project Noise Trigger Level
RBL	Rating Background Level
RNP	Road Noise Policy
RMS	Root mean square

Abbreviation	Term
SEARs	Secretary's environmental assessment requirements
VDV	Vibration dose value

Annexure A

Noise assessment locations

Table A.1 **Noise assessment locations**

ID	Receiver type	Description	Easting	Northing
1	Residential	100 Landa Street Bowenfels	233359	6290665
6	Residential	285 Sir Thomas Mitchell Drive South Bowenfels	228746	6288571
7	Residential	158 Old Bathurst Road South Bowenfels	231765	6287955
10	Residential	51 Sir Thomas Mitchell Drive South Bowenfels	230605	6288324
13	Residential	132 Sir Thomas Mitchell Drive South Bowenfels	230239	6288768
14	Residential	132 Magpie Hollow Road South Bowenfels	231613	6289045
15	Residential	282 Sir Thomas Mitchell Drive South Bowenfels	228912	6288971
18	Residential	409 Sir Thomas Mitchell Drive South Bowenfels	228234	6289305
19	Residential	274 Sir Thomas Mitchell Drive South Bowenfels	229012	6288856
21	Residential	407 Sir Thomas Mitchell Drive South Bowenfels	227687	6288827
22	Residential	100 Old Bathurst Road South Bowenfels	231998	6288403
23	Residential	84 Sir Thomas Mitchell Drive South Bowenfels	230536	6288703
24	Residential	8 Mudgee Street South Bowenfels	232644	6288418
25	Residential	310 Sir Thomas Mitchell Drive South Bowenfels	228670	6288876
28	Accommodation	259 Sir Thomas Mitchell Drive South Bowenfels	229028	6288265
29	Residential	32 Magpie Hollow Road South Bowenfels	232574	6288996
31	Residential	158 Sir Thomas Mitchell Drive South Bowenfels	229772	6288688
34	Residential	12 Mudgee Street South Bowenfels	232566	6288367
36	Residential	Old Bathurst Road South Bowenfels	232353	6288144
38	Residential	23 Sir Thomas Mitchell Drive South Bowenfels	231063	6288360
39	Residential	14 Quarry Place South Bowenfels	232531	6288281
42	Residential	122 Magpie Hollow Road South Bowenfels	231722	6289084
45	Commercial	Magpie Hollow Road South Bowenfels	228551	6286669
47	Residential	134 Old Bathurst Road South Bowenfels	231977	6288066
55	Residential	429 Magpie Hollow Road South Bowenfels	229918	6286998
65	Residential	11c Sandalls Drive Rydal	225944	6289855
66	Residential	272 Sandalls Drive Rydal	226893	6289735
67	Residential	340 Magpie Hollow Road South Bowenfels	230114	6287572
108	Residential	62 Magpie Hollow Road South Bowenfels	232313	6289158
109	Residential	10 Daruk Crescent Bowenfels	233370	6290521
129	Residential	58 Magpie Hollow Road South Bowenfels	232364	6289158
139	Residential	10 Sir Thomas Mitchell Drive South Bowenfels	231153	6288515

ID	Receiver type	Description	Easting	Northing
155	Residential	110 Sir Thomas Mitchell Drive South Bowenfels	231914	6290297
165	Residential	24 Sir Thomas Mitchell Drive South Bowenfels	230903	6288453
199	Residential	17c Great Western Highway Bowenfels	231524	6292308
200	Residential	44 Magpie Hollow Road South Bowenfels	232509	6289141
237	Residential	190 Magpie Hollow Road South Bowenfels	231328	6288776
238	Passive Recreation	Magpie Hollow Road South Bowenfels	228571	6286934
239	Commercial	888 Great Western Highway South Bowenfels	232840	6288932
241	Residential	17d Great Western Highway Bowenfels	232090	6292865
243	Residential	136 Bloody Cutting Road Rydal	225779	6290078
244	Residential	429 Magpie Hollow Road South Bowenfels	229799	6286279
246	Residential	96 Magpie Hollow Road South Bowenfels	231959	6289039
247	Residential	42 Magpie Hollow Road South Bowenfels	232525	6289085
248	Residential	Sir Thomas Mitchell Drive Bowenfels	232161	6292034
302	Residential	228 Sir Thomas Mitchell Drive South Bowenfels	229282	6288836
320	Residential	3 Fitzpatrick Place Bowenfels	232828	6290063
321	Residential	4 Fitzpatrick Place Bowenfels	232832	6290092
340	Residential	14 Hillcrest Avenue Bowenfels	232747	6290189
344	Residential	22 Hillcrest Avenue Bowenfels	232666	6290245
357	Residential	44 Hillcrest Avenue Bowenfels	232557	6290494
360	Residential	52 Hillcrest Avenue Bowenfels	232559	6290592
365	Accommodation	421 Sandalls Drive Rydal	227113	6289195
366	Accommodation	271 Sandalls Drive Rydal	226893	6289601
368	Residential	111 Magpie Hollow Road South Bowenfels	231783	6288884
386	Residential	6 Hillcrest Avenue Bowenfels	232843	6290149
388	Residential	34 Hillcrest Avenue Bowenfels	232587	6290371
389	Residential	22 Robertson Street Bowenfels	232889	6290005
392	Residential	50 Magpie Hollow Road South Bowenfels	232403	6289124
393	Residential	48 Magpie Hollow Road South Bowenfels	232435	6289111
440	Residential	27/9 Col Drewe Drive South Bowenfels	232852	6289468
578	Residential	29 Surveyors Way South Bowenfels	232016	6289302
582	Hospital / Classroom	Col Drewe Drive Bowenfels	233010	6289665
584	Residential	226 Sir Thomas Mitchell Drive South Bowenfels	229432	6288682
586	Residential	78 Magpie Hollow Road South Bowenfels	232169	6289176

ID	Receiver type	Description	Easting	Northing
587	Residential	80 Magpie Hollow Road South Bowenfels	232100	6289172
588	Residential	41 Magpie Hollow Road South Bowenfels	232436	6288968
594	Residential	72 Magpie Hollow Road South Bowenfels	232209	6289170
595	Residential	70 Magpie Hollow Road South Bowenfels	232229	6289169
605	Residential	7 Settlers Close South Bowenfels	231777	6289374
606	Residential	66 Magpie Hollow Road South Bowenfels	232277	6289163
607	Residential	68 Magpie Hollow Road South Bowenfels	232250	6289165
608	Residential	4 Settlers Close South Bowenfels	232056	6289376
610	Residential	3 Heritage Close South Bowenfels	232232	6289547
623	Residential	84 Magpie Hollow Road South Bowenfels	232078	6289125
624	Residential	11 Bowen Chase South Bowenfels	232030	6289580
653	Residential	54 Tweed Road Bowenfels	233408	6291743
778	Residential	6 Buttress Place Bowenfels	233537	6291304
910	Accommodation	58 Coerwull Road Bowenfels	233202	6292595
923	Residential	24 Girraween Drive Marrangaroo	231650	6293836
946	Residential	83 Sandalls Drive Rydal	225187	6288194
1035	Residential	Great Western Highway Bowenfels	232452	6293111
1462	Residential	10 Bundara Place Marrangaroo	232042	6293772
1465	Residential	81 Coerwull Road Bowenfels	233002	6292907
1507	Residential	111 Sandalls Drive Rydal	225124	6287879
1631	Residential	3 Ikara Street Bowenfels	233498	6291216
1637	Residential	3 Madle Street Bowenfels	233374	6290790
1640	Residential	126 Landa Street Bowenfels	233409	6290915
1646	Residential	138b Landa Street Bowenfels	233429	6291025
1648	Residential	140b Landa Street Bowenfels	233438	6291055
1825	Residential	4 Tangent Street Bowenfels	233496	6291404
1835	Industrial	Oakey Forest Road Marrangaroo	230630	6294043
1841	Accommodation	58 Coerwull Road Bowenfels	233096	6292706
1881	Residential	52 Tweed Road Bowenfels	233411	6291554
1917	Commercial	RMS Bowenfels District office - Coerwull Road Bowenfels	233417	6292388
1965	Residential	1c Great Western Highway Bowenfels	232712	6293070
1997	Residential	17b Great Western Highway Bowenfels	232357	6293522
1998	Industrial	122 Oakey Forest Road Marrangaroo	230915	6294316

ID	Receiver type	Description	Easting	Northing
1999	Residential	Coerwull House - 36 Andrew Street Bowenfels	233343	6292071
2000	Project related	Project Accommodation	229562	6287338
2001	Passive Recreation	Mount Walker Trig Point	229832	6291212
2002	Residential	269 Martins Road Rydal	227767	6284543
2003	Residential	Martins Road Rydal	227280	6284555
2004	Residential	209 Martins Road Rydal	226845	6285395
2005	Residential	1381 Hampton Road Rydal	226441	6284582
2006	Residential	61 Cheethams Flat Road Rydal	225643	6284594
2007	Residential	1570 Hampton Road Rydal	225072	6285420
2008	Residential	61 Cheethams Flat Road Rydal	224558	6285723
2009	Residential	Hampton Road Rydal	224393	6286410
2010	Residential	172 Sodwalls Road Rydal	224445	6286749
2011	Residential	1753 Hampton Road Rydal	224412	6287036
2012	Residential	1943 Hampton Road Rydal	223450	6288512
2013	Residential	1941 Hampton Road Rydal	223437	6289122
2014	Residential	183 Stacks Road Rydal	223837	6289219
2015	Residential	Railway Street Rydal	223864	6290443
2016	Residential	42 Sydney Road Rydal	224530	6290813
2017	Residential	Ford Street Rydal	224429	6290870
2018	Residential	7 Ford Street Rydal	224379	6290966
2019	Residential	New Street Rydal	224571	6291027
2020	Residential	1 High Street Rydal	224449	6291050
2021	Residential	7 Cartwright Street Rydal	224406	6291123
2022	Residential	11 Cartwright Street Rydal	224418	6291211
2023	Active Recreation	Rydal Showground, Market Street Rydal	224633	6291261
2024	Residential	Cartwright Street Rydal	224365	6291328
2025	Residential	1 Quarry Street Rydal	224371	6291358
2026	Residential	1 Cartwright Street Rydal	224384	6291439
2027	Residential	9 Cartwright Street Rydal	224371	6291497
2028	Residential	11 Cartwright Street Rydal	224380	6291534
2029	Residential	644 Old Western Road Rydal	224226	6291683
2030	Residential	1 Plain Street Rydal	224191	6291784
2031	Residential	615 Old Western Road Rydal	224369	6291950

ID	Receiver type	Description	Easting	Northing
2032	Residential	582 Old Western Road Rydal	224268	6292288
2033	Residential	492 Old Western Road Rydal	224047	6293156
2034	Residential	491 Old Western Road Rydal	224424	6293242
2035	Residential	373 Old Western Road Rydal	223675	6294184
2036	Residential	Great Western Highway Mount Lambie	224161	6295012
2037	Residential	217 Rydal Road Wallerawang	225608	6296534
2038	Residential	225 Rydal Road Mount Lambie	225144	6296850
2039	Residential	2 Forest Ridge Drive Wallerawang	226877	6297502
2040	Residential	2 Beacroft Place Wallerawang	227584	6297433
2041	Residential	4 Cypress Place Wallerawang	228103	6297365
2042	Industrial	963 Great Western Hwy Marrangaroo	227946	6296599
2043	Residential	161 Gemalong Close Marrangaroo	228852	6297345
2044	Residential	139a Gemalong Close Marrangaroo	229253	6297161
2045	Residential	93 Gemalong Close Marrangaroo	229893	6297241
2046	Residential	2d Hughes Lane Marrangaroo	230543	6297131
2047	Residential	4 Hughes Lane Marrangaroo	231157	6296998
2048	Residential	86 Hughes Lane Marrangaroo	231170	6296379
2049	Industrial	Marrangaroo RFS, 501 Great Western Highway Marrangaroo	231755	6295796
2050	Residential	88 Oakey Forest Road Marrangaroo	231087	6295073
2051	Residential	122 Oakey Forest Road Marrangaroo	230908	6294705
2052	Commercial	Lithgow City Raceway, 137 Oakey Forest Road Marrangaroo	231125	6294543
2478	Residential	208 Martins Road Rydal	226627	6285411
2480	Residential	270 Sandalls Drive Rydal	226143	6287808
2481	Residential	1920 Hampton Road Rydal	224819	6288149
2482	Residential	11A Sandalls Drive Rydal	225380	6288991
2483	Residential	11B Sandalls Drive Rydal	226088	6289398
2488	Residential	88 Magpie Hollow Road South Bowenfels	232060	6289085
2490	Residential	100 Martins Road Rydal	227017	6286353

Annexure B

Construction plant and equipment

Table B.1 **Plant and equipment schedule**

Period	Location (construction activity)	Item	Quantity	Sound power level, dB(A) per item	Sound power level, dB(A) per activity
Early works					
Day	Sir Thomas Mitchell Drive and Magpie Hollow Road (road upgrades)	Excavator (20 t)	1	110	114
		Bitumen / asphalt laying truck	1	112	
		Heavy vehicle	1	104	
Day	Access roads and drilling pads (limited earthworks)	Excavator (20 t)	1	110	113
		Dozer (25 t)	1	106	
		Roller	1	103	
		Articulated dump truck (40 t)	1	107	
Day	Accommodation area (camp / office / workshop construction)	Generator	2	102	117
		Concrete truck	2	108	
		Heavy vehicle	2	103	
		Watercart	2	109	
		EWP	2	94	
		Telehandler	1	107	
		Upright trench rammer	1	108	
		Light tower	2	93	
		Bobcat	1	95	
		Hand tools	4	101	
		Mobile crane (50 t)	1	104	
		Mobile crane (15 t)	1	98	
Day, Evening, Night & Morning shoulder	Drilling pads (geotechnical drilling)	Soilmec SM14 (drill)	1	105	107
		Generator	1	102	
Main Construction					
Day & Morning shoulder	Reservoir (bulk earthworks)	Excavator (20 t)	4	110	121
		Dozer (D10)	1	116	
		Roller	1	103	
		Articulated dump truck (40 t)	6	107	
		Heavy vehicle	2	103	

Period	Location (construction activity)	Item	Quantity	Sound power level, dB(A) per item	Sound power level, dB(A) per activity
Day & Morning shoulder	Lower Intake Canal (bulk earthworks)	Excavator (20 t)	4	110	121
		Dozer (D10)	1	116	
		Roller	1	103	
		Articulated dump truck (40 t)	6	107	
		Heavy vehicle	2	103	
Day, Evening, Night & Morning shoulder	Portals (D&B tunnel works)	Drill (jumbo 3 boom)	2	114	119 (unattenuated) 109 (assuming acoustic enclosures at portals)
		Concrete truck	1	108	
		Shotcrete robot / pump	2	106	
		Grout pump	1	106	
		Compressor	2	103	
		Generator	2	102	
Day & Morning shoulder	Farmers Creek Diversion (bulk earthworks)	Excavator (20 t)	4	110	121
		Dozer (D10)	1	116	
		Roller	1	103	
		Articulated dump truck (40 t)	6	107	
		Heavy vehicle	2	103	
Day & Morning shoulder	Farmers Creek Infill (bulk earthworks)	Excavator (20 t)	4	110	121
		Dozer (D10)	1	116	
		Roller	1	103	
		Articulated dump truck (40 t)	6	107	
		Heavy vehicle	2	103	
Day & Morning shoulder	Lower Laydown Area (spoil emplacement)	Dozer (D10)	1	116	116
		Heavy vehicles	2	103	
Day & Morning shoulder	Laydown Area (bulk earthworks)	Excavator (20 t)	4	110	121
		Dozer (D10)	1	116	
		Roller	1	103	
		Articulated dump truck (40 t)	6	107	
		Heavy vehicle	2	103	

Period	Location (construction activity)	Item	Quantity	Sound power level, dB(A) per item	Sound power level, dB(A) per activity
Evening	Laydown Area (accepting deliveries)	Telehandler	1	107	107
Day, Evening, Night & Morning shoulder	Accommodation area (camp operations)	Diesel generator	3	93	101
		Light tower	3	93	
		Minibus ³	2	94	
Day, Evening, Night & Morning shoulder	Switchyard Area (concrete batching plant)	Concrete batching plant	1	116	116
Day & Morning shoulder	Southern Access Road (site entrance to Southern Intersection) (haulage)	Heavy vehicle	1.2	103	107
		Light vehicle	7.2	96	
Day & Morning shoulder	Southern Access Road (Southern Intersection to Northern Intersection) (haulage)	Heavy vehicle	7.0	103	113
		Light vehicle	3.9	96	
Day & Morning shoulder	Northern Access Road (haulage)	Heavy vehicle	1.0	103	105
		Light vehicle	2.9	96	
Day & Morning shoulder	Western Access Road (haulage)	Heavy vehicle	1.0	103	105
		Light vehicle	1.4	96	
Day & Morning shoulder	Northern Haul Road (haulage)	Heavy vehicle	6.0	103	112
		Light vehicle	1.0	96	
Evening	Southern Access Road (site entrance to Southern Intersection) (haulage)	Heavy vehicle	1.0	103	106
		Light vehicle	5.2	96	
Night	Southern Access Road (CBP to Portals) (haulage)	Heavy vehicle	1.0	103	105
		Light vehicle	1.0	96	

Notes:

1. All traffic on haul roads is assumed to be travelling at 40 km/h.
2. Southern, Northern and Western access/haul road sound power levels have been calculated for morning shoulder/day and evening periods based on the assumptions that LV volumes were distributed 70% morning shoulder/day (6:00 am to 6:00 pm) and 30% evening (6:00 pm to 10:00 pm) and HV volumes were distributed 85% morning shoulder/day (6:00 am to 6:00 pm) and 15% evening (6:00 pm to 10:00 pm).
3. The minibuses used for employee transport are anticipated to travel on-site at the accommodation camp for approximately 2 minutes in any 15-minute period.

Annexure C

Results tables

C.1 Construction results – early works

Table C.1 Predicted construction noise levels – early works

Assessment location	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
1	37	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
6	52	37	42	45	40	35	75	7	12	2	7
7	48	<30	<30	45	40	35	75	3	8	Nil	Nil
10	53	<30	<30	45	40	35	75	8	13	Nil	Nil
13	54	31	33	45	40	35	75	9	14	Nil	Nil
14	56	<30	<30	45	40	35	75	11	16	Nil	Nil
15	51	50	51	45	40	35	75	6	11	15	16
18	50	51	53	45	40	35	75	5	10	16	18
19	51	41	44	45	40	35	75	6	11	6	9
21	42	38	42	45	40	35	75	Nil	2	3	7
22	49	<30	<30	45	40	35	75	4	9	Nil	Nil
23	56	33	35	45	40	35	75	11	16	Nil	Nil
24	50	<30	<30	45	40	35	75	5	10	Nil	Nil
25	54	49	50	45	40	35	75	9	14	14	15
28^	50	32	38	50	45	45	N/A	Nil	5	Nil	Nil
29	68	<30	<30	45	40	35	75	23	28	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
31	54	<30	<30	45	40	35	75	9	14	Nil	Nil
34	49	<30	<30	45	40	35	75	4	9	Nil	Nil
36	45	<30	<30	45	40	35	75	Nil	5	Nil	Nil
38	61	<30	<30	45	40	35	75	16	21	Nil	Nil
39	48	<30	<30	45	40	35	75	3	8	Nil	Nil
42	56	<30	<30	45	40	35	75	11	16	Nil	Nil
45	43	30	32	70	70	70	N/A	Nil	Nil	Nil	Nil
47	42	<30	<30	45	40	35	75	Nil	2	Nil	Nil
55	61	<30	<30	45	40	35	75	16	21	Nil	Nil
65	36	30	32	45	40	35	75	Nil	Nil	Nil	Nil
66	39	35	37	45	40	35	75	Nil	Nil	Nil	2
67	48	<30	<30	45	40	35	75	3	8	Nil	Nil
108	66	<30	<30	45	40	35	75	21	26	Nil	Nil
109	37	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
129	65	<30	<30	45	40	35	75	20	25	Nil	Nil
139	60	<30	<30	45	40	35	75	15	20	Nil	Nil
155	40	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
165	58	<30	<30	45	40	35	75	13	18	Nil	Nil
199	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
200	62	<30	<30	45	40	35	75	17	22	Nil	Nil
237	58	30	32	45	40	35	75	13	18	Nil	Nil
238	44	30	33	60	60	60	N/A	Nil	Nil	Nil	Nil
239	67	<30	<30	70	70	70	N/A	Nil	Nil	Nil	Nil
241	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
243	<35	<30	31	45	40	35	75	Nil	Nil	Nil	Nil
244	46	<30	<30	45	40	35	75	1	6	Nil	Nil
246	61	<30	<30	45	40	35	75	16	21	Nil	Nil
247	65	<30	<30	45	40	35	75	20	25	Nil	Nil
248	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
302	50	45	47	45	40	35	75	5	10	10	12
320	44	<30	<30	45	40	35	75	Nil	4	Nil	Nil
321	43	<30	<30	45	40	35	75	Nil	3	Nil	Nil
340	43	<30	<30	45	40	35	75	Nil	3	Nil	Nil
344	42	<30	<30	45	40	35	75	Nil	2	Nil	Nil
357	41	<30	<30	45	40	35	75	Nil	1	Nil	Nil
360	38	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
365^	41	37	39	50	45	45	N/A	Nil	Nil	Nil	Nil
366^	40	36	38	50	45	45	N/A	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
368	60	<30	<30	45	40	35	75	15	20	Nil	Nil
386	43	<30	<30	45	40	35	75	Nil	3	Nil	Nil
388	41	<30	<30	45	40	35	75	Nil	1	Nil	Nil
389	44	<30	<30	45	40	35	75	Nil	4	Nil	Nil
392	66	<30	<30	45	40	35	75	21	26	Nil	Nil
393	67	<30	<30	45	40	35	75	22	27	Nil	Nil
440	48	<30	<30	45	40	35	75	3	8	Nil	Nil
578	55	<30	<30	45	40	35	75	10	15	Nil	Nil
582	47	<30	<30	55	55	55	N/A	Nil	Nil	Nil	Nil
584	52	<30	<30	45	40	35	75	7	12	Nil	Nil
586	65	<30	<30	45	40	35	75	20	25	Nil	Nil
587	64	<30	<30	45	40	35	75	19	24	Nil	Nil
588	64	<30	<30	45	40	35	75	19	24	Nil	Nil
594	66	<30	<30	45	40	35	75	21	26	Nil	Nil
595	66	<30	<30	45	40	35	75	21	26	Nil	Nil
605	48	<30	<30	45	40	35	75	3	8	Nil	Nil
606	67	<30	<30	45	40	35	75	22	27	Nil	Nil
607	66	<30	<30	45	40	35	75	21	26	Nil	Nil
608	54	<30	<30	45	40	35	75	9	14	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
610	49	<30	<30	45	40	35	75	4	9	Nil	Nil
623	62	<30	<30	45	40	35	75	17	22	Nil	Nil
624	51	<30	<30	45	40	35	75	6	11	Nil	Nil
653	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
778	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
910^	<35	<30	<30	50	45	45	N/A	Nil	Nil	Nil	Nil
923	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
946	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1035	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1462	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1465	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1507	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1631	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1637	36	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1640	35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1646	35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1648	35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1825	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1835	<35	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
1841^	<35	<30	<30	50	45	45	N/A	Nil	Nil	Nil	Nil
1881	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1917	<35	<30	<30	70	70	70	N/A	Nil	Nil	Nil	Nil
1965	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1997	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
1998	<35	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil
1999	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2000	59	<30	<30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2001	39	<30	33	60	60	60	N/A	Nil	Nil	Nil	Nil
2002	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2003	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2004	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2005	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2006	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2007	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2008	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2009	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2010	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2011	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise	Exceedance, dB			
							affected NML, dB				
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
2012	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2013	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2014	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2015	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2016	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2017	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2018	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2019	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2020	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2021	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2022	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2023	<35	<30	<30	65	65	65	N/A	Nil	Nil	Nil	Nil
2024	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2025	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2026	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2027	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2028	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2029	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2030	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB		
	Day	Evening	Night	Day	Day OOH	Evening / Night	Day	Day	Day OOH	Evening	Night
2031	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2032	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2033	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2034	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2035	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2036	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2037	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2038	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2039	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2040	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2041	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2042	<35	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil
2043	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2044	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2045	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2046	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2047	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2048	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil
2049	<35	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Noise affected NML, dB			Highly noise	Exceedance, dB				
	Day	Evening	Night	Day	Day OOH	Evening / Night	affected NML, dB	Day	Day	Day OOH	Evening	Night
2050	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2051	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2052	<35	<30	<30	70	70	70	N/A	Nil	Nil	Nil	Nil	Nil
2478	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2480	<35	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2481	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2482	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2483	36	31	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2488	70	<30	<30	45	40	35	75	25	30	Nil	Nil	Nil
2490	<35	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil

Notes: ^ Commercial property assessed in accordance with AS/NZS 2107:2016, e.g. 35 dB(A) internal (night-time), becomes 45 dB(A) external accounting for windows open for ventilation.

C.2 Construction results – main construction

Table C.2 Predicted construction noise levels – main construction

Assessment location	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
1	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
6	48	34	37	53	45	40	35	75	3	8	Nil	2	18
7	40	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
10	44	<30	<30	40	45	40	35	75	Nil	4	Nil	Nil	5
13	47	<30	<30	51	45	40	35	75	2	7	Nil	Nil	16
14	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
15	62	52	54	64	45	40	35	75	17	22	17	19	29
18	62	52	54	65	45	40	35	75	17	22	17	19	30
19	54	44	47	58	45	40	35	75	9	14	9	12	23
21	52	41	43	55	45	40	35	75	7	12	6	8	20
22	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
23	48	31	33	52	45	40	35	75	3	8	Nil	Nil	17
24	35	<30	<30	39	45	40	35	75	Nil	Nil	Nil	Nil	4
25	62	52	54	64	45	40	35	75	17	22	17	19	29
28^	49	31	34	48	50	45	45	N/A	Nil	4	Nil	Nil	3

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB	Exceedance, dB				
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
29	36	<30	<30	39	45	40	35	75	Nil	Nil	Nil	Nil	4
31	42	<30	<30	46	45	40	35	75	Nil	2	Nil	Nil	11
34	35	<30	<30	39	45	40	35	75	Nil	Nil	Nil	Nil	4
36	<35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
38	43	<30	<30	42	45	40	35	75	Nil	3	Nil	Nil	7
39	35	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
42	<35	<30	<30	34	45	40	35	75	Nil	Nil	Nil	Nil	Nil
45	48	34	36	47	70	70	70	N/A	Nil	Nil	Nil	Nil	Nil
47	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
55	47	<30	32	42	45	40	35	75	2	7	Nil	Nil	7
65	44	34	35	48	45	40	35	75	Nil	4	Nil	Nil	13
66	45	37	40	51	45	40	35	75	Nil	5	2	5	16
67	52	33	35	39	45	40	35	75	7	12	Nil	Nil	4
108	37	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
109	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
129	37	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
139	42	<30	<30	44	45	40	35	75	Nil	2	Nil	Nil	9
155	40	<30	<30	44	45	40	35	75	Nil	Nil	Nil	Nil	9

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
165	39	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
199	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
200	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
237	45	<30	32	47	45	40	35	75	Nil	5	Nil	Nil	12
238	48	32	36	47	60	60	60	N/A	Nil	Nil	Nil	Nil	Nil
241	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
243	42	32	33	45	45	40	35	75	Nil	2	Nil	Nil	10
244	41	<30	<30	43	45	40	35	75	Nil	1	Nil	Nil	8
246	<35	<30	<30	42	45	40	35	75	Nil	Nil	Nil	Nil	7
247	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
248	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
302	58	49	51	61	45	40	35	75	13	18	14	16	26
320	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
321	<35	<30	<30	35	45	40	35	75	Nil	Nil	Nil	Nil	Nil
340	<35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
344	<35	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
357	<35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
360	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
365^	51	41	43	54	50	45	45	N/A	1	6	Nil	Nil	9
366^	48	39	41	52	50	45	45	N/A	Nil	3	Nil	Nil	7
368	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
386	<35	<30	<30	35	45	40	35	75	Nil	Nil	Nil	Nil	Nil
388	<35	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
389	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
392	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
393	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
440	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
578	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
582	<35	<30	<30	35	55	55	55	N/A	Nil	Nil	Nil	Nil	Nil
584	42	<30	<30	45	45	40	35	75	Nil	2	Nil	Nil	10
586	<35	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
587	<35	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
588	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
594	35	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
595	36	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
605	39	<30	<30	43	45	40	35	75	Nil	Nil	Nil	Nil	8

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB	Exceedance, dB				
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
606	37	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
607	37	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
608	<35	<30	<30	34	45	40	35	75	Nil	Nil	Nil	Nil	Nil
610	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
623	<35	<30	<30	42	45	40	35	75	Nil	Nil	Nil	Nil	7
624	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
653	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
778	<35	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
910^	<35	<30	<30	<30	50	45	45	N/A	Nil	Nil	Nil	Nil	Nil
923	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
946	40	<30	30	43	45	40	35	75	Nil	Nil	Nil	Nil	8
1035	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1462	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1465	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1507	39	<30	30	42	45	40	35	75	Nil	Nil	Nil	Nil	7
1631	<35	<30	<30	35	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1637	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1640	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
1646	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1648	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1825	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1835	<35	<30	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil	Nil
1841^	<35	<30	<30	<30	50	45	45	N/A	Nil	Nil	Nil	Nil	Nil
1881	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1917	<35	<30	<30	<30	70	70	70	N/A	Nil	Nil	Nil	Nil	Nil
1965	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1997	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
1998	<35	<30	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil	Nil
1999	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2000	51	51	52	52	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2001	42	31	35	47	60	60	60	N/A	Nil	Nil	Nil	Nil	Nil
2002	37	<30	<30	38	45	40	35	75	Nil	Nil	Nil	Nil	3
2003	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2004	39	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
2005	35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
2006	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
2007	35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
2008	<35	<30	<30	35	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2009	<35	<30	<30	35	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2010	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
2011	<35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
2012	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
2013	<35	<30	<30	36	45	40	35	75	Nil	Nil	Nil	Nil	1
2014	<35	<30	<30	37	45	40	35	75	Nil	Nil	Nil	Nil	2
2015	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2016	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2017	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2018	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2019	38	<30	<30	41	45	40	35	75	Nil	Nil	Nil	Nil	6
2020	<35	<30	<30	31	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2021	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2022	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2023	38	<30	<30	41	65	65	65	N/A	Nil	Nil	Nil	Nil	Nil
2024	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
2025	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2026	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2027	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2028	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2029	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2030	<35	<30	<30	30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2031	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2032	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2033	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2034	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2035	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2036	<35	<30	<30	33	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2037	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2038	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2039	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2040	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2041	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2042	<35	<30	<30	33	75	75	75	N/A	Nil	Nil	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB				Noise affected NML, dB			Highly noise affected NML, dB		Exceedance, dB			
	Day	Evening	Night	Morning shoulder	Day	Day OOH	Evening / Night / Morning shoulder	Day	Day	Day OOH	Evening	Night	Morning shoulder
2043	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2044	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2045	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2046	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2047	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2048	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2049	<35	<30	<30	<30	75	75	75	N/A	Nil	Nil	Nil	Nil	Nil
2050	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2051	<35	<30	<30	<30	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2052	<35	<30	<30	<30	70	70	70	N/A	Nil	Nil	Nil	Nil	Nil
2478	<35	<30	<30	32	45	40	35	75	Nil	Nil	Nil	Nil	Nil
2480	42	32	34	45	45	40	35	75	Nil	2	Nil	Nil	10
2481	36	<30	<30	40	45	40	35	75	Nil	Nil	Nil	Nil	5
2482	41	31	33	45	45	40	35	75	Nil	1	Nil	Nil	10
2483	44	34	36	49	45	40	35	75	Nil	4	Nil	1	14
2488	35	<30	<30	42	45	40	35	75	Nil	Nil	Nil	Nil	7
2490	40	30	32	44	45	40	35	75	Nil	Nil	Nil	Nil	9

Notes: ^ Commercial property assessed in accordance with AS/NZS 2107:2016, e.g. 35 dB(A) internal (night-time), becomes 45 dB(A) external accounting for windows open for ventilation.

C.3 Sleep disturbance results – early works

Table C.3 Predicted maximum noise levels – early works

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB		Sleep disturbance screening criteria, dB		Exceedance, dB	
	Night		Night		Night	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
1	<30	<30	40	52	Nil	Nil
6	42	47	40	52	2	Nil
7	<30	31	40	52	Nil	Nil
10	<30	33	40	52	Nil	Nil
13	33	38	40	52	Nil	Nil
14	<30	<30	40	52	Nil	Nil
15	51	54	40	52	11	2
18	53	57	40	52	13	5
19	44	47	40	52	4	Nil
21	42	46	40	52	2	Nil
22	<30	<30	40	52	Nil	Nil
23	35	38	40	52	Nil	Nil
24	<30	<30	40	52	Nil	Nil
25	50	53	40	52	10	1
31	<30	37	40	52	Nil	Nil
34	<30	<30	40	52	Nil	Nil
36	<30	<30	40	52	Nil	Nil
38	<30	34	40	52	Nil	Nil
39	<30	<30	40	52	Nil	Nil
42	<30	<30	40	52	Nil	Nil
47	<30	<30	40	52	Nil	Nil
55	<30	33	40	52	Nil	Nil
65	32	34	40	52	Nil	Nil
66	37	40	40	52	Nil	Nil
67	<30	30	40	52	Nil	Nil
109	<30	<30	40	52	Nil	Nil
139	<30	34	40	52	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB		Sleep disturbance screening criteria, dB		Exceedance, dB	
	Night		Night		Night	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
155	<30	35	40	52	Nil	Nil
165	<30	35	40	52	Nil	Nil
199	<30	30	40	52	Nil	Nil
237	32	36	40	52	Nil	Nil
241	<30	<30	40	52	Nil	Nil
243	31	33	40	52	Nil	Nil
244	<30	31	40	52	Nil	Nil
246	<30	32	40	52	Nil	Nil
248	<30	30	40	52	Nil	Nil
302	47	51	40	52	7	Nil
320	<30	30	40	52	Nil	Nil
321	<30	30	40	52	Nil	Nil
340	<30	30	40	52	Nil	Nil
344	<30	31	40	52	Nil	Nil
357	<30	32	40	52	Nil	Nil
360	<30	31	40	52	Nil	Nil
368	<30	32	40	52	Nil	Nil
386	<30	30	40	52	Nil	Nil
388	<30	31	40	52	Nil	Nil
389	<30	30	40	52	Nil	Nil
440	<30	<30	40	52	Nil	Nil
578	<30	<30	40	52	Nil	Nil
584	<30	36	40	52	Nil	Nil
605	<30	34	40	52	Nil	Nil
608	<30	32	40	52	Nil	Nil
610	<30	<30	40	52	Nil	Nil
623	<30	32	40	52	Nil	Nil
624	<30	<30	40	52	Nil	Nil
653	<30	<30	40	52	Nil	Nil
778	<30	<30	40	52	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB		Sleep disturbance screening criteria, dB		Exceedance, dB	
	Night		Night		Night	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
923	<30	<30	40	52	Nil	Nil
946	<30	30	40	52	Nil	Nil
1035	<30	<30	40	52	Nil	Nil
1462	<30	<30	40	52	Nil	Nil
1465	<30	<30	40	52	Nil	Nil
1507	<30	<30	40	52	Nil	Nil
1631	<30	<30	40	52	Nil	Nil
1637	<30	<30	40	52	Nil	Nil
1640	<30	<30	40	52	Nil	Nil
1646	<30	<30	40	52	Nil	Nil
1648	<30	<30	40	52	Nil	Nil
1825	<30	<30	40	52	Nil	Nil
1881	<30	<30	40	52	Nil	Nil
1965	<30	<30	40	52	Nil	Nil
1997	<30	<30	40	52	Nil	Nil
1999	<30	<30	40	52	Nil	Nil
2002	<30	<30	40	52	Nil	Nil
2003	<30	<30	40	52	Nil	Nil
2004	<30	<30	40	52	Nil	Nil
2005	<30	<30	40	52	Nil	Nil
2006	<30	<30	40	52	Nil	Nil
2007	<30	<30	40	52	Nil	Nil
2008	<30	<30	40	52	Nil	Nil
2009	<30	<30	40	52	Nil	Nil
2010	<30	<30	40	52	Nil	Nil
2011	<30	<30	40	52	Nil	Nil
2012	<30	<30	40	52	Nil	Nil
2013	<30	<30	40	52	Nil	Nil
2014	<30	<30	40	52	Nil	Nil
2015	<30	<30	40	52	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB		Sleep disturbance screening criteria, dB		Exceedance, dB	
	Night		Night		Night	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
2016	<30	<30	40	52	Nil	Nil
2017	<30	<30	40	52	Nil	Nil
2018	<30	<30	40	52	Nil	Nil
2019	<30	<30	40	52	Nil	Nil
2020	<30	<30	40	52	Nil	Nil
2021	<30	<30	40	52	Nil	Nil
2022	<30	<30	40	52	Nil	Nil
2024	<30	<30	40	52	Nil	Nil
2025	<30	<30	40	52	Nil	Nil
2026	<30	<30	40	52	Nil	Nil
2027	<30	<30	40	52	Nil	Nil
2028	<30	<30	40	52	Nil	Nil
2029	<30	<30	40	52	Nil	Nil
2030	<30	<30	40	52	Nil	Nil
2031	<30	<30	40	52	Nil	Nil
2032	<30	<30	40	52	Nil	Nil
2033	<30	<30	40	52	Nil	Nil
2034	<30	<30	40	52	Nil	Nil
2035	<30	<30	40	52	Nil	Nil
2036	<30	<30	40	52	Nil	Nil
2037	<30	<30	40	52	Nil	Nil
2038	<30	<30	40	52	Nil	Nil
2039	<30	<30	40	52	Nil	Nil
2040	<30	<30	40	52	Nil	Nil
2041	<30	<30	40	52	Nil	Nil
2043	<30	<30	40	52	Nil	Nil
2044	<30	<30	40	52	Nil	Nil
2045	<30	<30	40	52	Nil	Nil
2046	<30	<30	40	52	Nil	Nil
2047	<30	<30	40	52	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB		Sleep disturbance screening criteria, dB		Exceedance, dB	
	Night		Night		Night	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
2048	<30	<30	40	52	Nil	Nil
2050	<30	<30	40	52	Nil	Nil
2051	<30	<30	40	52	Nil	Nil
29	<30	30	40	52	Nil	Nil
108	<30	31	40	52	Nil	Nil
129	<30	31	40	52	Nil	Nil
200	<30	30	40	52	Nil	Nil
247	<30	30	40	52	Nil	Nil
392	<30	30	40	52	Nil	Nil
393	<30	31	40	52	Nil	Nil
586	<30	31	40	52	Nil	Nil
587	<30	33	40	52	Nil	Nil
588	<30	30	40	52	Nil	Nil
594	<30	31	40	52	Nil	Nil
595	<30	31	40	52	Nil	Nil
606	<30	32	40	52	Nil	Nil
607	<30	31	40	52	Nil	Nil
2478	<30	<30	40	52	Nil	Nil
2480	31	34	40	52	Nil	Nil
2481	<30	<30	40	52	Nil	Nil
2482	<30	32	40	52	Nil	Nil
2483	33	35	40	52	Nil	Nil
2488	<30	32	40	52	Nil	Nil
2490	<30	31	40	52	Nil	Nil

Notes: 1. The maximum noise level event assessment is applied at residential assessment locations only.

C.4 Sleep disturbance results – main construction

Table C.4 Predicted maximum noise levels – main construction

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
1	<30	<30	32	35	40	52	Nil	Nil	Nil	Nil
6	37	38	53	54	40	52	Nil	Nil	13	2
7	<30	<30	38	40	40	52	Nil	Nil	Nil	Nil
10	<30	32	40	42	40	52	Nil	Nil	Nil	Nil
13	<30	41	51	52	40	52	Nil	Nil	11	Nil
14	<30	<30	31	36	40	52	Nil	Nil	Nil	Nil
15	54	54	64	65	40	52	14	2	24	13
18	54	57	65	65	40	52	14	5	25	13
19	47	48	58	59	40	52	7	Nil	18	7
21	43	45	55	56	40	52	3	Nil	15	4
22	<30	<30	31	37	40	52	Nil	Nil	Nil	Nil
23	33	40	52	52	40	52	Nil	Nil	12	Nil
24	<30	<30	39	40	40	52	Nil	Nil	Nil	Nil
25	54	55	64	65	40	52	14	3	24	13
29	<30	30	39	40	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}			L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
31	<30	<30	46	47	40	52	Nil	Nil	6	Nil
34	<30	<30	39	40	40	52	Nil	Nil	Nil	Nil
36	<30	<30	37	39	40	52	Nil	Nil	Nil	Nil
38	<30	31	42	43	40	52	Nil	Nil	2	Nil
39	<30	<30	38	40	40	52	Nil	Nil	Nil	Nil
42	<30	<30	34	39	40	52	Nil	Nil	Nil	Nil
47	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
55	32	34	42	43	40	52	Nil	Nil	2	Nil
65	35	38	48	48	40	52	Nil	Nil	8	Nil
66	40	43	51	52	40	52	Nil	Nil	11	Nil
67	35	38	39	41	40	52	Nil	Nil	Nil	Nil
108	<30	31	41	42	40	52	Nil	Nil	1	Nil
109	<30	<30	32	37	40	52	Nil	Nil	Nil	Nil
129	<30	31	40	42	40	52	Nil	Nil	Nil	Nil
139	<30	36	44	46	40	52	Nil	Nil	4	Nil
155	<30	33	44	46	40	52	Nil	Nil	4	Nil
165	<30	<30	41	43	40	52	Nil	Nil	1	Nil
199	<30	<30	30	40	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
200	<30	30	40	41	40	52	Nil	Nil	Nil	Nil
237	32	37	47	48	40	52	Nil	Nil	7	Nil
241	<30	<30	<30	37	40	52	Nil	Nil	Nil	Nil
243	33	36	45	46	40	52	Nil	Nil	5	Nil
244	<30	32	43	43	40	52	Nil	Nil	3	Nil
246	<30	33	42	43	40	52	Nil	Nil	2	Nil
247	<30	30	40	41	40	52	Nil	Nil	Nil	Nil
248	<30	<30	30	38	40	52	Nil	Nil	Nil	Nil
302	51	51	61	61	40	52	11	Nil	21	9
320	<30	<30	36	38	40	52	Nil	Nil	Nil	Nil
321	<30	<30	35	38	40	52	Nil	Nil	Nil	Nil
340	<30	<30	37	40	40	52	Nil	Nil	Nil	Nil
344	<30	<30	38	41	40	52	Nil	Nil	Nil	Nil
357	<30	<30	37	41	40	52	Nil	Nil	Nil	Nil
360	<30	<30	36	40	40	52	Nil	Nil	Nil	Nil
368	<30	<30	33	40	40	52	Nil	Nil	Nil	Nil
386	<30	<30	35	38	40	52	Nil	Nil	Nil	Nil
388	<30	<30	38	41	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}			L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
389	<30	<30	36	39	40	52	Nil	Nil	Nil	Nil
392	<30	31	40	41	40	52	Nil	Nil	Nil	Nil
393	<30	30	40	42	40	52	Nil	Nil	Nil	Nil
440	<30	<30	36	39	40	52	Nil	Nil	Nil	Nil
578	<30	<30	33	39	40	52	Nil	Nil	Nil	Nil
584	<30	<30	45	47	40	52	Nil	Nil	5	Nil
586	<30	32	41	43	40	52	Nil	Nil	1	Nil
587	<30	32	41	43	40	52	Nil	Nil	1	Nil
588	<30	31	40	42	40	52	Nil	Nil	Nil	Nil
594	<30	31	41	42	40	52	Nil	Nil	1	Nil
595	<30	31	41	42	40	52	Nil	Nil	1	Nil
605	<30	33	43	45	40	52	Nil	Nil	3	Nil
606	<30	32	41	42	40	52	Nil	Nil	1	Nil
607	<30	32	41	42	40	52	Nil	Nil	1	Nil
608	<30	<30	34	41	40	52	Nil	Nil	Nil	Nil
610	<30	<30	32	38	40	52	Nil	Nil	Nil	Nil
623	<30	32	42	43	40	52	Nil	Nil	2	Nil
624	<30	<30	33	39	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}			L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
653	<30	<30	<30	34	40	52	Nil	Nil	Nil	Nil
778	<30	<30	38	39	40	52	Nil	Nil	Nil	Nil
923	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
946	30	32	43	43	40	52	Nil	Nil	3	Nil
1035	<30	<30	<30	33	40	52	Nil	Nil	Nil	Nil
1462	<30	<30	<30	32	40	52	Nil	Nil	Nil	Nil
1465	<30	<30	<30	33	40	52	Nil	Nil	Nil	Nil
1507	30	32	42	42	40	52	Nil	Nil	2	Nil
1631	<30	<30	35	37	40	52	Nil	Nil	Nil	Nil
1637	<30	<30	31	35	40	52	Nil	Nil	Nil	Nil
1640	<30	<30	32	36	40	52	Nil	Nil	Nil	Nil
1646	<30	<30	31	36	40	52	Nil	Nil	Nil	Nil
1648	<30	<30	33	36	40	52	Nil	Nil	Nil	Nil
1825	<30	<30	30	35	40	52	Nil	Nil	Nil	Nil
1881	<30	<30	32	36	40	52	Nil	Nil	Nil	Nil
1965	<30	<30	<30	34	40	52	Nil	Nil	Nil	Nil
1997	<30	<30	<30	33	40	52	Nil	Nil	Nil	Nil
1999	<30	<30	<30	34	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}			L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
2002	<30	<30	38	39	40	52	Nil	Nil	Nil	Nil
2003	<30	<30	<30	32	40	52	Nil	Nil	Nil	Nil
2004	<30	31	40	40	40	52	Nil	Nil	Nil	Nil
2005	<30	<30	37	37	40	52	Nil	Nil	Nil	Nil
2006	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2007	<30	<30	37	37	40	52	Nil	Nil	Nil	Nil
2008	<30	<30	35	35	40	52	Nil	Nil	Nil	Nil
2009	<30	<30	35	36	40	52	Nil	Nil	Nil	Nil
2010	<30	<30	36	37	40	52	Nil	Nil	Nil	Nil
2011	<30	<30	37	37	40	52	Nil	Nil	Nil	Nil
2012	<30	<30	36	37	40	52	Nil	Nil	Nil	Nil
2013	<30	<30	36	37	40	52	Nil	Nil	Nil	Nil
2014	<30	<30	37	38	40	52	Nil	Nil	Nil	Nil
2015	<30	<30	31	32	40	52	Nil	Nil	Nil	Nil
2016	<30	<30	32	33	40	52	Nil	Nil	Nil	Nil
2017	<30	<30	31	33	40	52	Nil	Nil	Nil	Nil
2018	<30	<30	33	34	40	52	Nil	Nil	Nil	Nil
2019	<30	30	41	42	40	52	Nil	Nil	1	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
2020	<30	<30	31	32	40	52	Nil	Nil	Nil	Nil
2021	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2022	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2024	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2025	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2026	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2027	<30	<30	30	32	40	52	Nil	Nil	Nil	Nil
2028	<30	<30	30	31	40	52	Nil	Nil	Nil	Nil
2029	<30	<30	<30	31	40	52	Nil	Nil	Nil	Nil
2030	<30	<30	30	31	40	52	Nil	Nil	Nil	Nil
2031	<30	<30	<30	31	40	52	Nil	Nil	Nil	Nil
2032	<30	<30	<30	31	40	52	Nil	Nil	Nil	Nil
2033	<30	<30	<30	30	40	52	Nil	Nil	Nil	Nil
2034	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2035	<30	<30	33	33	40	52	Nil	Nil	Nil	Nil
2036	<30	<30	33	34	40	52	Nil	Nil	Nil	Nil
2037	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2038	<30	<30	<30	30	40	52	Nil	Nil	Nil	Nil

Assessment location	Predicted maximum construction noise level, noise-enhancing weather, dB				Sleep disturbance screening criteria, dB		Exceedance, dB			
	Night		Morning shoulder				Night		Morning shoulder	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}			L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
2039	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2040	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2041	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2043	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2044	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2045	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2046	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2047	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2048	<30	<30	<30	30	40	52	Nil	Nil	Nil	Nil
2050	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2051	<30	<30	<30	<30	40	52	Nil	Nil	Nil	Nil
2478	<30	<30	32	33	40	52	Nil	Nil	Nil	Nil
2480	34	36	45	46	40	52	Nil	Nil	5	Nil
2481	<30	30	40	40	40	52	Nil	Nil	Nil	Nil
2482	33	35	45	45	40	52	Nil	Nil	5	Nil
2483	36	38	49	49	40	52	Nil	Nil	9	Nil
2488	<30	32	42	43	40	52	Nil	Nil	2	Nil
2490	32	34	44	44	40	52	Nil	Nil	4	Nil

Notes: 1. The maximum noise level event assessment is applied at residential assessment locations only.

C.5 Operational results

Table C.5 Predicted operational noise levels

Assessment location	Predicted noise level, $L_{Aeq,15minute}$, dB			Project Noise Trigger Level (PNTL), $L_{Aeq,15minute}$, dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	<35	<30	<30	40	35	35	Nil	Nil	Nil
6	<35	<30	<30	40	35	35	Nil	Nil	Nil
7	<35	<30	<30	40	35	35	Nil	Nil	Nil
10	<35	<30	<30	40	35	35	Nil	Nil	Nil
13	<35	<30	<30	40	35	35	Nil	Nil	Nil
14	<35	<30	<30	40	35	35	Nil	Nil	Nil
15	<35	<30	<30	40	35	35	Nil	Nil	Nil
18	<35	30	33	40	35	35	Nil	Nil	Nil
19	<35	<30	<30	40	35	35	Nil	Nil	Nil
21	<35	<30	<30	40	35	35	Nil	Nil	Nil
22	<35	<30	<30	40	35	35	Nil	Nil	Nil
23	<35	<30	<30	40	35	35	Nil	Nil	Nil
24	<35	<30	<30	40	35	35	Nil	Nil	Nil
25	<35	<30	30	40	35	35	Nil	Nil	Nil
28	<35	<30	<30	58	53	48	Nil	Nil	Nil
29	<35	<30	<30	40	35	35	Nil	Nil	Nil
31	<35	<30	<30	40	35	35	Nil	Nil	Nil
34	<35	<30	<30	40	35	35	Nil	Nil	Nil
36	<35	<30	<30	40	35	35	Nil	Nil	Nil
38	<35	<30	<30	40	35	35	Nil	Nil	Nil
39	<35	<30	<30	40	35	35	Nil	Nil	Nil
42	<35	<30	<30	40	35	35	Nil	Nil	Nil
45	<35	<30	<30	68	68	68	Nil	Nil	Nil
47	<35	<30	<30	40	35	35	Nil	Nil	Nil
55	<35	<30	<30	40	35	35	Nil	Nil	Nil
65	<35	<30	<30	40	35	35	Nil	Nil	Nil
66	<35	<30	<30	40	35	35	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Project Noise Trigger Level (PNTL), L _{Aeq,15minute} , dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
67	<35	<30	<30	40	35	35	Nil	Nil	Nil
108	<35	<30	<30	40	35	35	Nil	Nil	Nil
109	<35	<30	<30	40	35	35	Nil	Nil	Nil
129	<35	<30	<30	40	35	35	Nil	Nil	Nil
139	<35	<30	<30	40	35	35	Nil	Nil	Nil
155	<35	<30	<30	40	35	35	Nil	Nil	Nil
165	<35	<30	<30	40	35	35	Nil	Nil	Nil
199	<35	<30	<30	40	35	35	Nil	Nil	Nil
200	<35	<30	<30	40	35	35	Nil	Nil	Nil
237	<35	<30	<30	40	35	35	Nil	Nil	Nil
238	<35	<30	<30	53	53	53	Nil	Nil	Nil
241	<35	<30	<30	40	35	35	Nil	Nil	Nil
243	<35	<30	<30	40	35	35	Nil	Nil	Nil
244	<35	<30	<30	40	35	35	Nil	Nil	Nil
246	<35	<30	<30	40	35	35	Nil	Nil	Nil
247	<35	<30	<30	40	35	35	Nil	Nil	Nil
248	<35	<30	<30	40	35	35	Nil	Nil	Nil
302	<35	<30	<30	40	35	35	Nil	Nil	Nil
320	<35	<30	<30	40	35	35	Nil	Nil	Nil
321	<35	<30	<30	40	35	35	Nil	Nil	Nil
340	<35	<30	<30	40	35	35	Nil	Nil	Nil
344	<35	<30	<30	40	35	35	Nil	Nil	Nil
357	<35	<30	<30	40	35	35	Nil	Nil	Nil
360	<35	<30	<30	40	35	35	Nil	Nil	Nil
365	<35	<30	<30	58	53	48	Nil	Nil	Nil
366	<35	<30	<30	58	53	48	Nil	Nil	Nil
368	<35	<30	<30	40	35	35	Nil	Nil	Nil
386	<35	<30	<30	40	35	35	Nil	Nil	Nil
388	<35	<30	<30	40	35	35	Nil	Nil	Nil
389	<35	<30	<30	40	35	35	Nil	Nil	Nil

Assessment location	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB			Project Noise Trigger Level (PNTL), $L_{Aeq,15\text{minute}}$, dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
392	<35	<30	<30	40	35	35	Nil	Nil	Nil
393	<35	<30	<30	40	35	35	Nil	Nil	Nil
440	<35	<30	<30	40	35	35	Nil	Nil	Nil
578	<35	<30	<30	40	35	35	Nil	Nil	Nil
582	<35	<30	<30	45	45	45	Nil	Nil	Nil
584	<35	<30	<30	40	35	35	Nil	Nil	Nil
586	<35	<30	<30	40	35	35	Nil	Nil	Nil
587	<35	<30	<30	40	35	35	Nil	Nil	Nil
588	<35	<30	<30	40	35	35	Nil	Nil	Nil
594	<35	<30	<30	40	35	35	Nil	Nil	Nil
595	<35	<30	<30	40	35	35	Nil	Nil	Nil
605	<35	<30	<30	40	35	35	Nil	Nil	Nil
606	<35	<30	<30	40	35	35	Nil	Nil	Nil
607	<35	<30	<30	40	35	35	Nil	Nil	Nil
608	<35	<30	<30	40	35	35	Nil	Nil	Nil
610	<35	<30	<30	40	35	35	Nil	Nil	Nil
623	<35	<30	<30	40	35	35	Nil	Nil	Nil
624	<35	<30	<30	40	35	35	Nil	Nil	Nil
653	<35	<30	<30	40	35	35	Nil	Nil	Nil
778	<35	<30	<30	40	35	35	Nil	Nil	Nil
910	<35	<30	<30	58	53	48	Nil	Nil	Nil
923	<35	<30	<30	40	35	35	Nil	Nil	Nil
946	<35	<30	<30	40	35	35	Nil	Nil	Nil
1035	<35	<30	<30	40	35	35	Nil	Nil	Nil
1462	<35	<30	<30	40	35	35	Nil	Nil	Nil
1465	<35	<30	<30	40	35	35	Nil	Nil	Nil
1507	<35	<30	<30	40	35	35	Nil	Nil	Nil
1631	<35	<30	<30	40	35	35	Nil	Nil	Nil
1637	<35	<30	<30	40	35	35	Nil	Nil	Nil
1640	<35	<30	<30	40	35	35	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Project Noise Trigger Level (PNTL), L _{Aeq,15minute} , dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1646	<35	<30	<30	40	35	35	Nil	Nil	Nil
1648	<35	<30	<30	40	35	35	Nil	Nil	Nil
1825	<35	<30	<30	40	35	35	Nil	Nil	Nil
1835	<35	<30	<30	73	73	73	Nil	Nil	Nil
1841	<35	<30	<30	58	53	48	Nil	Nil	Nil
1881	<35	<30	<30	40	35	35	Nil	Nil	Nil
1917	<35	<30	<30	68	68	68	Nil	Nil	Nil
1965	<35	<30	<30	40	35	35	Nil	Nil	Nil
1997	<35	<30	<30	40	35	35	Nil	Nil	Nil
1998	<35	<30	<30	73	73	73	Nil	Nil	Nil
1999	<35	<30	<30	40	35	35	Nil	Nil	Nil
2001	<35	<30	<30	53	53	53	Nil	Nil	Nil
2002	<35	<30	<30	40	35	35	Nil	Nil	Nil
2003	<35	<30	<30	40	35	35	Nil	Nil	Nil
2004	<35	<30	<30	40	35	35	Nil	Nil	Nil
2005	<35	<30	<30	40	35	35	Nil	Nil	Nil
2006	<35	<30	<30	40	35	35	Nil	Nil	Nil
2007	<35	<30	<30	40	35	35	Nil	Nil	Nil
2008	<35	<30	<30	40	35	35	Nil	Nil	Nil
2009	<35	<30	<30	40	35	35	Nil	Nil	Nil
2010	<35	<30	<30	40	35	35	Nil	Nil	Nil
2011	<35	<30	<30	40	35	35	Nil	Nil	Nil
2012	<35	<30	<30	40	35	35	Nil	Nil	Nil
2013	<35	<30	<30	40	35	35	Nil	Nil	Nil
2014	<35	<30	<30	40	35	35	Nil	Nil	Nil
2015	<35	<30	<30	40	35	35	Nil	Nil	Nil
2016	<35	<30	<30	40	35	35	Nil	Nil	Nil
2017	<35	<30	<30	40	35	35	Nil	Nil	Nil
2018	<35	<30	<30	40	35	35	Nil	Nil	Nil
2019	<35	<30	<30	40	35	35	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Project Noise Trigger Level (PNTL), L _{Aeq,15minute} , dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
2020	<35	<30	<30	40	35	35	Nil	Nil	Nil
2021	<35	<30	<30	40	35	35	Nil	Nil	Nil
2022	<35	<30	<30	40	35	35	Nil	Nil	Nil
2023	<35	<30	<30	58	58	58	Nil	Nil	Nil
2024	<35	<30	<30	40	35	35	Nil	Nil	Nil
2025	<35	<30	<30	40	35	35	Nil	Nil	Nil
2026	<35	<30	<30	40	35	35	Nil	Nil	Nil
2027	<35	<30	<30	40	35	35	Nil	Nil	Nil
2028	<35	<30	<30	40	35	35	Nil	Nil	Nil
2029	<35	<30	<30	40	35	35	Nil	Nil	Nil
2030	<35	<30	<30	40	35	35	Nil	Nil	Nil
2031	<35	<30	<30	40	35	35	Nil	Nil	Nil
2032	<35	<30	<30	40	35	35	Nil	Nil	Nil
2033	<35	<30	<30	40	35	35	Nil	Nil	Nil
2034	<35	<30	<30	40	35	35	Nil	Nil	Nil
2035	<35	<30	<30	40	35	35	Nil	Nil	Nil
2036	<35	<30	<30	40	35	35	Nil	Nil	Nil
2037	<35	<30	<30	40	35	35	Nil	Nil	Nil
2038	<35	<30	<30	40	35	35	Nil	Nil	Nil
2039	<35	<30	<30	40	35	35	Nil	Nil	Nil
2040	<35	<30	<30	40	35	35	Nil	Nil	Nil
2041	<35	<30	<30	40	35	35	Nil	Nil	Nil
2042	<35	<30	<30	73	73	73	Nil	Nil	Nil
2043	<35	<30	<30	40	35	35	Nil	Nil	Nil
2044	<35	<30	<30	40	35	35	Nil	Nil	Nil
2045	<35	<30	<30	40	35	35	Nil	Nil	Nil
2046	<35	<30	<30	40	35	35	Nil	Nil	Nil
2047	<35	<30	<30	40	35	35	Nil	Nil	Nil
2048	<35	<30	<30	40	35	35	Nil	Nil	Nil
2049	<35	<30	<30	73	73	73	Nil	Nil	Nil

Assessment location	Predicted noise level, L _{Aeq,15minute} , dB			Project Noise Trigger Level (PNTL), L _{Aeq,15minute} , dB			Exceedance, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
2050	<35	<30	<30	40	35	35	Nil	Nil	Nil
2051	<35	<30	<30	40	35	35	Nil	Nil	Nil
2052	<35	<30	<30	68	68	68	Nil	Nil	Nil
2478	<35	<30	<30	40	35	35	Nil	Nil	Nil
2480	<35	<30	<30	40	35	35	Nil	Nil	Nil
2481	<35	<30	<30	40	35	35	Nil	Nil	Nil
2482	<35	<30	<30	40	35	35	Nil	Nil	Nil
2483	<35	<30	<30	40	35	35	Nil	Nil	Nil
2488	<35	<30	<30	40	35	35	Nil	Nil	Nil
2490	<35	<30	<30	40	35	35	Nil	Nil	Nil

