34 POKENO ROAD

Acoustic Assessment of Setback Distance

Prepared for:

Fred Number 1 Ltd
34 Pokeno Road
Pokeno 2402

SLR Ref: 710.10566-R03
Version No: -v1.1
January 2021

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BASIS OF REPORT

This report has been prepared by SLR Consulting NZ Limited (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Fred Number 1 Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
710.10566-R03-v1.1	18 January 2021	Simon de Lisle	Peter Runcie	Peter Runcie
710.10566-R03-v1.0	14 September 2020	Simon de Lisle	Peter Runcie	Peter Runcie

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1 Introduction

Fred Number 1 Ltd (the **applicant**) proposes to establish a residential subdivision 34 Pokeno Road and 2 Helenslee Road in Pokeno. The applicant seeks to construct dwellings at a distance closer than 20 metres to State Highway 1, which is less than the setback distance specified by Rule 27A State Highway Yard.

SLR Consulting NZ Limited (SLR) has been commissioned to undertake an assessment of acoustic effects of the proposed building setbacks and, if necessary, to identify appropriate noise control measures in order to meet the acoustic criteria in Waikato District Plan – Franklin Section 27A.6.1.

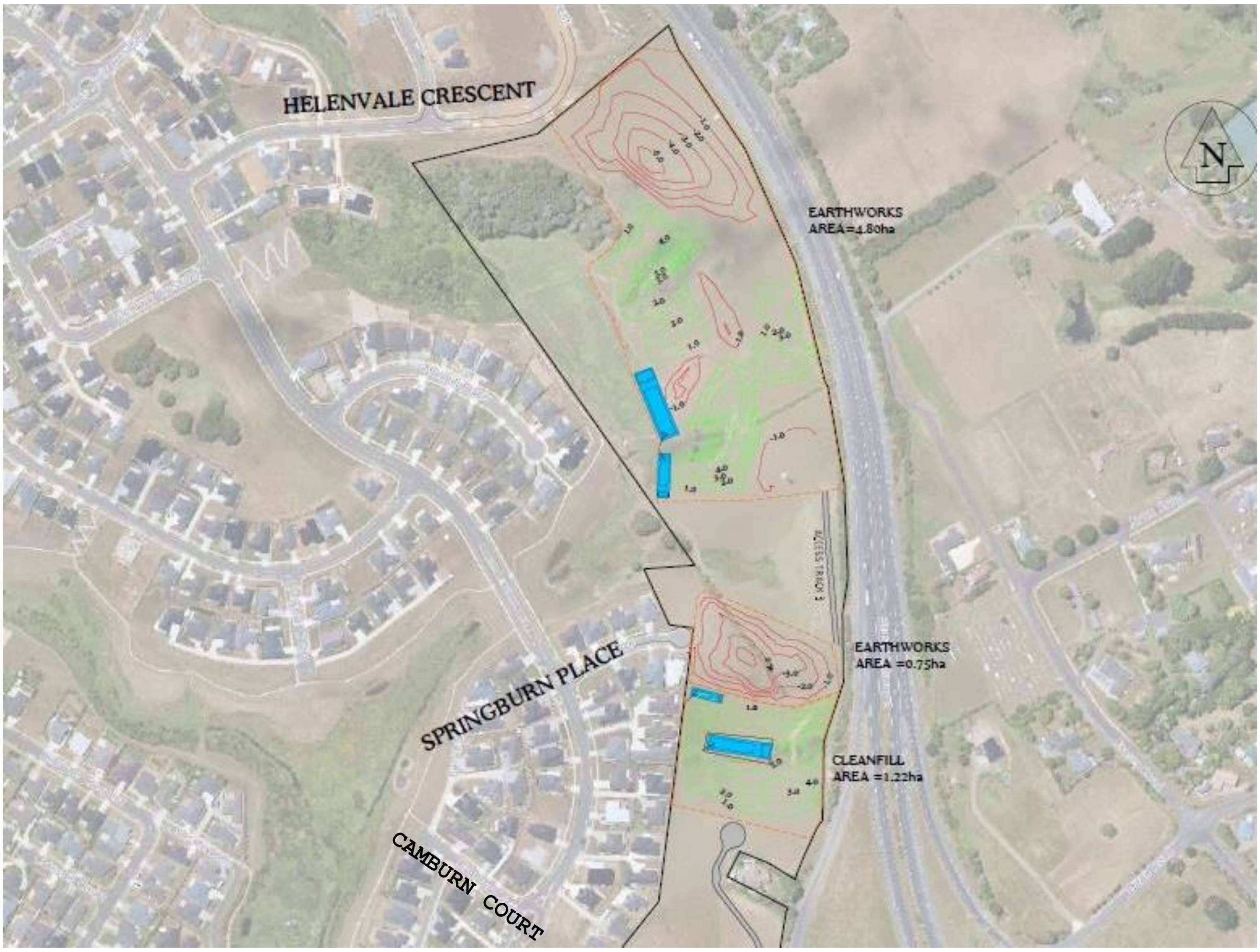
A description of acoustic terminology is provided in **Appendix A**.

2 Project Description and Site Location

The proposed development consists of single-storey dwellings located directly east of the State Highway 1 between Helenvale Crescent and Camburn Court in Pokeno. The site location is shown in **Figure 1** below.

It is proposed to construct dwellings at a setback distance of 10 metres from the boundary of State Highway 1.

Figure 1 Site location



3 Performance Requirements

3.1 Acoustic Requirements

The proposed development is located within a "high background noise area" as shown on the Waikato District Plan planning maps. Section 27A.6.1 of the *Waikato District Plan – Franklin Section* (the **Plan**) states the following acoustic criteria for noise from traffic:

> *2. Habitable rooms in a dwelling, house or residential building that is within the area shown on the planning maps as "Background Noise Area" and "High Background Noise Area" shall be designed and constructed such that:*
>
> *(a) The noise level resulting from traffic shall not exceed:*
>
> *•45dBALeq(24hour) in any habitable room; and*
>
> *•35dBALeq(9hour) from 10.00pm to 7.00am in any bedroom.*

The Plan also states that internal noise levels "shall be achieved with ventilation windows open and with any mechanical ventilation required to ventilate the rooms in accordance with the Building Code, switched on". SLR notes that through the use of the phrase 'ventilation windows' this rule provides for the situation where windows must be closed to achieve the required internal noise levels where the design does not incorporate ventilation windows but rather uses mechanical ventilation with windows closed. Therefore the rule can be met both in terms of the internal noise level requirements and those of ventilation related to the Building Code with windows closed.

The Plan requires the assessment to be based on "traffic flows predicted for the road 10 years after the construction of the building". No further guidance is given regarding appropriate assumptions for traffic flows 10 years in the future; please see **Section 4.1.4** regarding estimation of future traffic flows.

3.2 Set-back distance

Rule 27A.5.5.5 State Highway Yard specifies the following:

> *The minimum distance between any building and the legal boundary of a state highway to be 20 metres.*

4 Acoustic Assessment

4.1 Assessment Methodology

The traffic noise limits apply indoors (within bedrooms and habitable rooms), therefore the meeting these limits is dependent on the performance of the building envelope constructions and the external noise levels. Following a review of potential building constructions for dwellings of this nature, SLR has identified the acoustic performance of a typical building envelope which has been used for the assessment. It is noted that this acoustic performance is required for the worst-case buildings (i.e. the first row from the highway) and not the whole subdivision.

Based on the identified acoustic performance of the building envelope, external noise levels have been determined such that compliance with the Plan indoor noise limits would be achieved. This has been conducted in order to identify external noise mitigation measures, such as the height of the acoustic screening.

In order to determine the external traffic noise levels for the proposed dwellings, a noise survey was undertaken. Subsequently, a 3D acoustic model of the subject site, State Highway 1 and surrounding terrain was constructed. This acoustic model was calibrated using data from measurements conducted adjacent to the highway.

Acoustic mitigation measures, in the form of a noise barrier or bund located on the property boundary, were identified using the acoustic model, in order to meet the external noise targets (to achieve compliance with the indoor noise limits).

4.1.1 Building Constructions and External Noise Targets

For habitable rooms in the first row of dwellings, a traffic noise reduction of 26 dBA has been used for the assessment. This acoustic performance is achievable through typical constructions such as:

- Double glazing with a laboratory performance of Rw > 35 dB – e.g., 6/12/6 for windows and doors (with effective airtight perimeter seals);
- Non-glazed façade with a laboratory performance of Rw > 40 dB – e.g., lightweight exterior cladding, insulation in cavity with fibre cement rigid air barrier, fibrous insulation in main cavity and 13 mm plasterboard internal lining.
- Ceiling/roof construction with a laboratory performance of Rw > 40 dB – e.g., 0.6 mm steel roof, a minimum 200 mm deep ceiling cavity with fibrous insulation and 13 mm plasterboard ceiling.

Based on the above constructions, the external noise targets to achieve compliance with the noise limits are as follows:

- 71 dB $L_{Aeq(24hour)}$ –habitable rooms
- 61dB $L_{Aeq(9hour)}$ – bedrooms

4.1.2 Ventilation requirements

At dwellings where meeting the noise limits requires the windows to be closed, *Rule 27A.6.1.2 part c* states that the indoor noise level shall be measured with any mechanical ventilation required in accordance with the New Zealand Building Code to be switched on.

As per the results shown in **Section 4.2**, the modelling results show that mechanical ventilation is expected to be required for the worst-case dwellings considered in this assessment.

4.1.3 Traffic Noise Measurements

SLR conducted traffic noise measurements on the proposed site during July 2020. The measurements were undertaken using Svan 957 sound level meters (serial number 20673) in general accordance with the NZS 6802:2008 *Acoustics – Measurement of environmental sound*. The calibration of the sound level meter was checked before and after the measurements and were found to be within an acceptable margin of the reference signal.

The measurement location is shown in **Figure 2** below.

Figure 2 Measurement location

Unattended noise monitoring was conducted adjacent to State Highway 1, in order to determine the source noise level for the highway. These measurements were conducted from 3rd to 9th July 2020 at a free-field location on the site boundary without any significant reflecting surfaces present. The results of the unattended monitoring are summarised in **Table 1** below.

Table 1 Noise monitoring results

Date	Daytime measured noise level, dB $L_{Aeq(24\ hour)}$	Night-time measured noise level, dB $L_{Aeq(9\ hour)}$
3 July- Friday	-	68
4 July- Saturday	70	64
5 July- Sunday	70	67
6 July- Monday	72	68
7 July- Tuesday	72	68
8 July- Wednesday	72	69

Based on the results in **Table 1**, average State Highway 1 noise levels of 72 dB $L_{Aeq(24\ hour)}$ and 68 dB $L_{Aeq(9\ hour)}$ at the site boundary have been used for the assessment.

4.1.4 Noise Modelling

A 3D acoustic model of the subject site, State Highway 1 and surrounding terrain was constructed using SoundPLAN software. The SoundPLAN software is a recognised state-of-the-art predictive tool that utilises internationally approved algorithms for the calculation of noise propagation and attenuation through the built and natural environment, in this case *ISO 9613 Acoustics – Attenuation of Sound during Propagation Outdoors*. The model takes into account intervening/adjacent buildings and the land topography[1].

Topographical contours and the proposed subdivision plan were incorporated into the acoustic model to reflect the as proposed scenario. The road source was represented as a line source with a height of 0.5 metres above the terrain height. A grid spacing of 5 metres was used for the noise contours, which are calculated at a height of 1.5 metres above ground.

The model has been calibrated for local conditions based on the noise monitoring results as described in **Section 4.1.3**. To account for traffic growth over the next 10 years, a 3% non-compounding growth factor was applied to the source levels, as per the noted precedent for assessments undertaken by others for nearby similar developments. This resulted in an adjustment of +1.1 dB which was applied to the source level in the model.

4.2 Assessment Results and Proposed Mitigation

The modelling found the external noise targets of 71 dB $L_{Aeq(24\ hour)}$ and 61 dB $L_{Aeq(9\ hour)}$ are expected to be met with an acoustic screen built adjacent to the dwellings located within 20 metres of the legal boundary, as notionally shown in **Appendix B**. The acoustic screen shall be built to a height of 2 metres above the ground floor level of the adjacent dwelling; this height could be achieved by reducing the elevation of the dwellings (i.e. through use of earthworks to create a cutting) in combination with an acoustic screen of reduced height.

The results therefore indicate compliance with the Waikato District Plan internal noise limits can be achieved, based on the building envelope acoustic performance described in **Section 4.1.1** and the provision of acoustically effective screening on the boundary with SH1.

[1] Existing buildings and land topography (existing and proposed) GIS information are based on the Land Information New Zealand Data Service and information provided by the project planner, The Surveying Company, as of April 2019.

5 Summary and Recommendations

SLR Consulting NZ Limited (SLR) has been commissioned to undertake an assessment of acoustic effects of the proposed building setbacks and identify appropriate noise control measures in order to meet the acoustic criteria in Waikato District Plan – Franklin Section 27A.6.1.

Based on a 10 metre setback for the nearest dwellings from the boundary of State Highway 1 and the 2 metre high acoustic screen shown in **Appendix B**, the predicted noise levels at dwellings can be controlled such that the indoor noise limits of the Waikato District Plan can be met with typical building envelope constructions (with windows closed).

The following consent conditions are recommended for the development:

1. Internal traffic noise levels shall meet the requirements of Section 27A.6.1 of the *Waikato District Plan,* namely 35 dB $L_{Aeq(9\ hour)}$ from 10 pm to 7 am in bedrooms and 45 dB $L_{Aeq(24\ hour)}$ in habitable rooms. These noise levels shall be based on traffic volumes predicted for 10 years after the construction of the dwelling.
2. Mechanical ventilation is to be provided in dwellings where compliance with the noise limits in condition X requires the windows to be closed.
3. At dwellings where meeting the noise limits requires the windows to be closed, the indoor noise level shall be measured with any mechanical ventilation required in accordance with the New Zealand Building Code to be switched on.
4. An acoustically effective barrier with a height of 2 metres above the finished floor level of the dwellings shall be constructed along the boundary of State Highway 1, as per the report titled *34 Pokeno Road – Acoustic Assessment of Setback Distance* by SLR Consulting, dated September 2020. The acoustic barrier shall be free from gaps and holes and shall have a minimum surface mass of 10 kg/m^2.
5. Prior to the issue of building consent, an acoustic report shall be prepared by a suitably qualified acoustic consultant. This report shall demonstrate how the proposed building construction will result in compliance with the noise limits specified in condition 1. The report shall also provide an acoustic assessment of noise from any mechanical ventilation systems for dwellings where the windows are required to be closed in order to comply with the noise limits. The acoustic report may include adoption of the building constructions identified in the report titled *34 Pokeno Road – Acoustic Assessment of Setback Distance* by SLR Consulting, dated September 2020.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms ‘sound’ and ‘noise’ are almost interchangeable, except that ‘noise’ often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. ‘A’ Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an ‘A-weighting’ filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as ‘linear’, and the units are expressed as dB(lin) or dB.

3. Sound Power Level

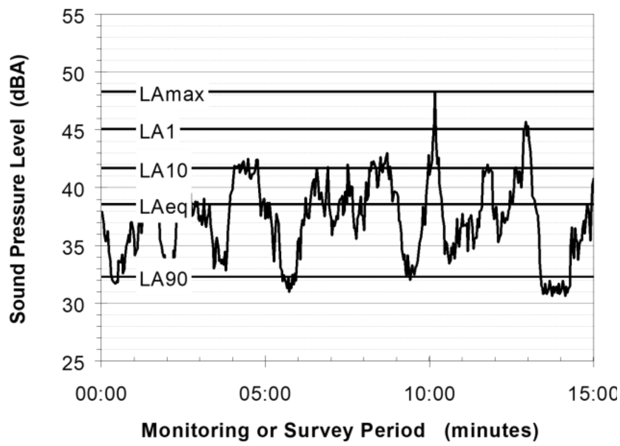
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

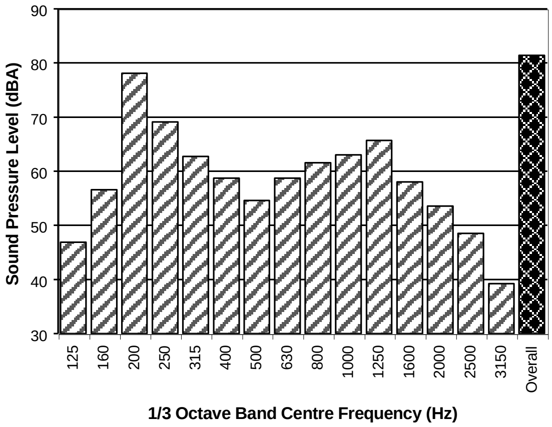
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (i.e. differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (i.e. vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

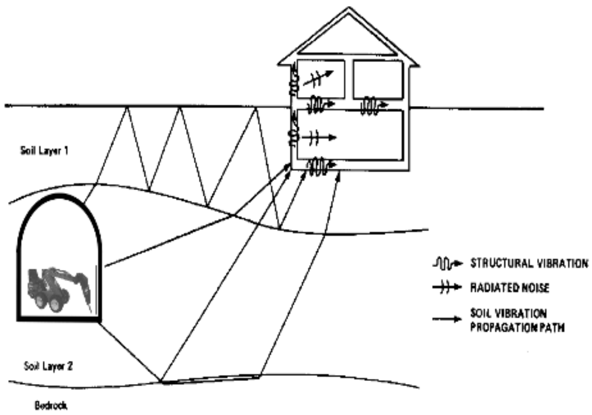
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience 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.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (e.g. rockbreakers), and building services plant (e.g. fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

APPENDIX B

Noise Contours

Noise contours for the subject site are shown in the figures below. These figures are considered an indicative graphical representation only, due to the interpolation of the results calculated at fixed grid points. The assessment has been based on noise levels calculated at the actual receiver locations.

Figure A1 Predicted free field future traffic noise levels, $L_{Aeq(24\ hour)}$

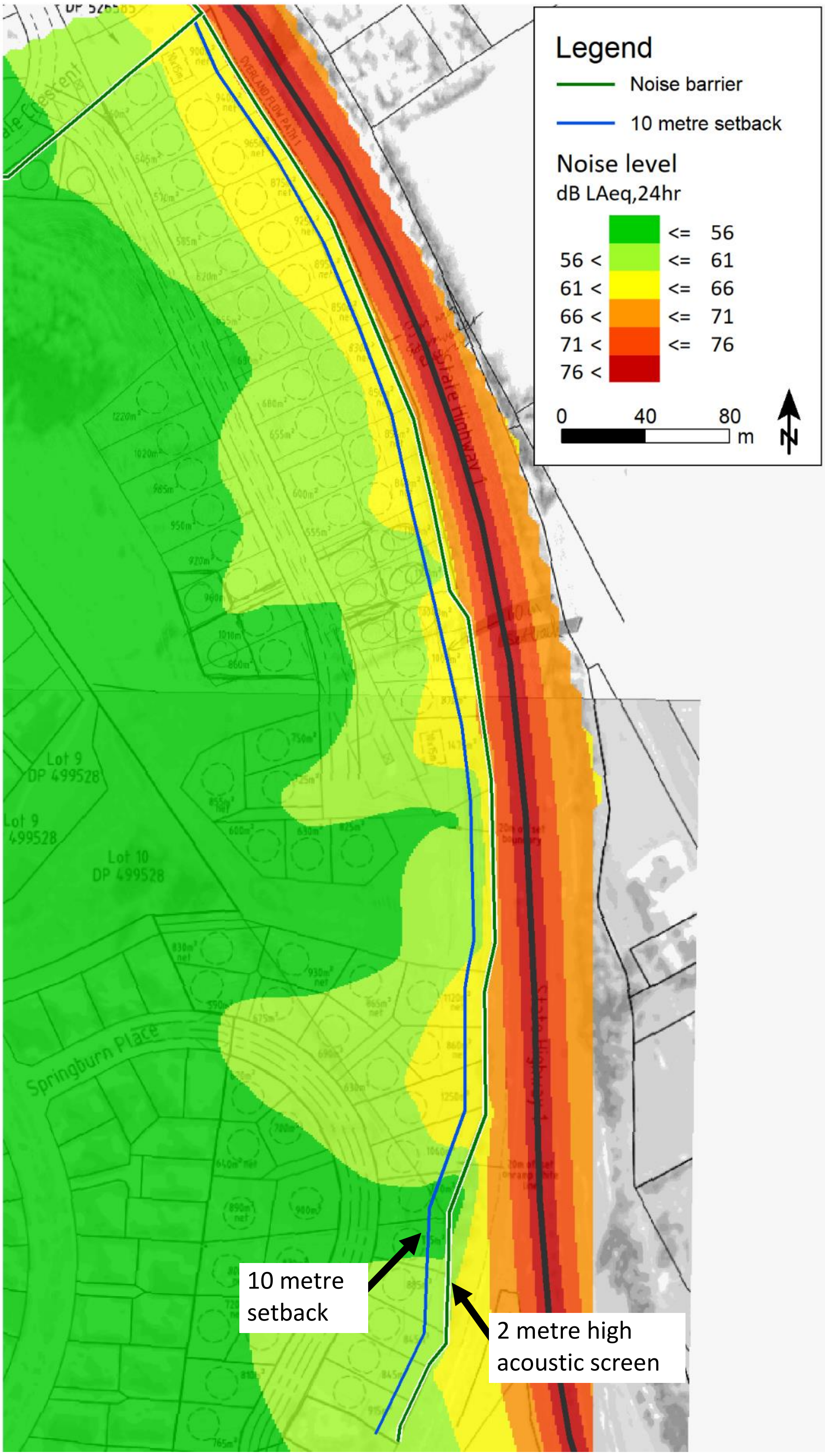
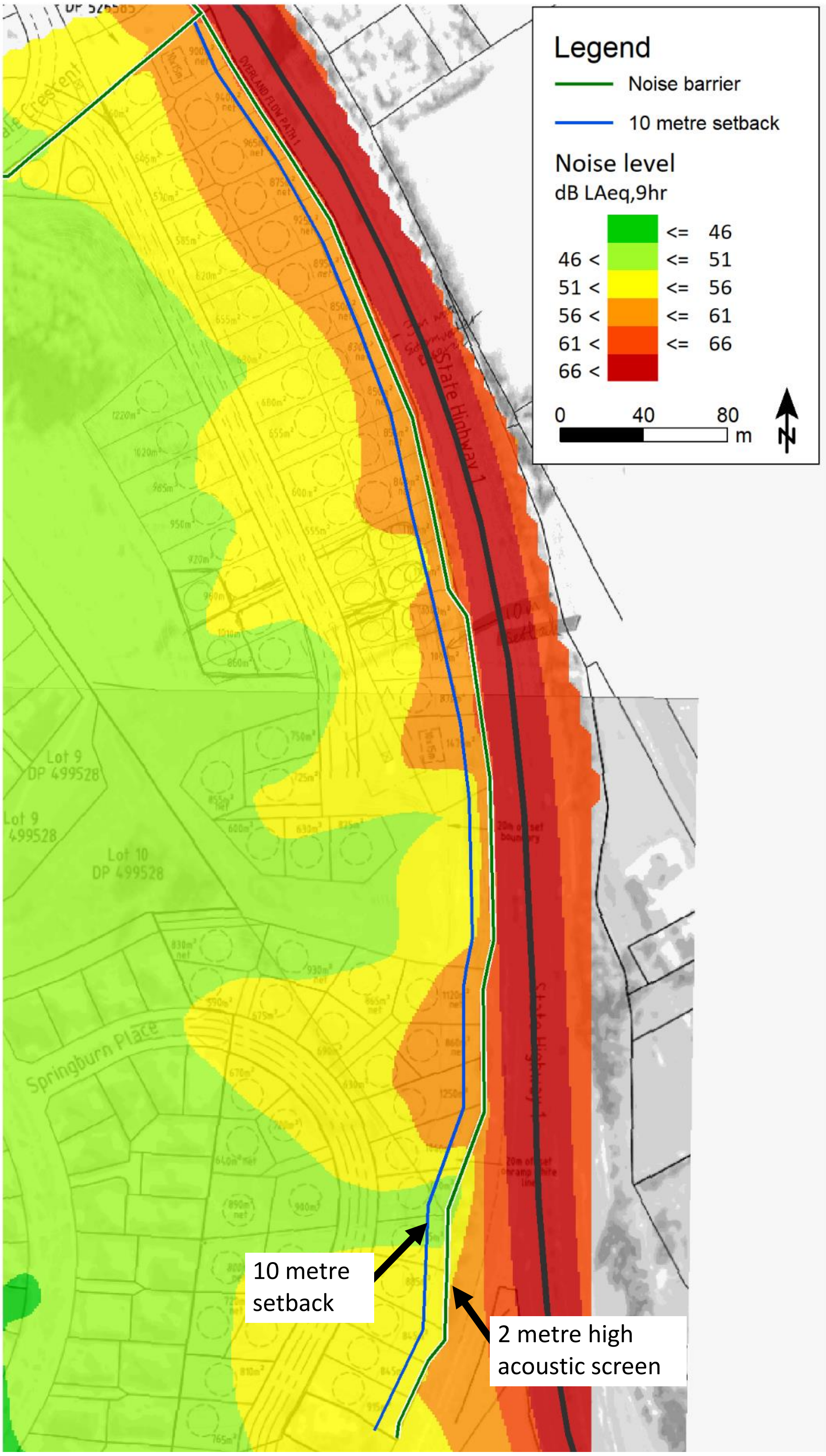


Figure A2 Predicted free field future traffic noise levels, $L_{Aeq(9\ hour)}$



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