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Loxford Project Management Pty Ltd

The Loxford – Precinct 1B

Railway Noise Assessment

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Rev. 00	Original issue	27 April 22	
Rev. 01	Minor updates including updated subdivision map and zoning maps	6 May 22	NL & FU
Rev. 02	Terrain data, rail noise data and subdivision layout updates.	13 July 2022	NL & FU
Rev. 03	Minor updates including freight rail speed scenarios.	25 July 2022	NL
Rev. 04	Noise model update to include 1.8m fencing to houses adjacent rail.	25 July 2022	NL
Rev. 05	Minor update with 1.8m fencing	28 July 2022	NL

Executive Summary

Vipac Engineers & Scientists (Vipac) was engaged to conduct a noise and vibration impact assessment, for the proposed residential subdivision known as 'The Loxford, Precinct 1B', to be located at 464 Cessnock Road, Gillieston Heights.

Potential rail noise impacts to 'The Loxford Precinct 1B' have been assessed. These include noise impacts from the freight train line located to the north west of the site, located along the South Maitland rail corridor. Although the freight rail line is currently not in use, it has been purchased by a nearby mining company and could be re-commissioned and redeveloped. Therefore, there is the potential for freight rail noise impacts to future residential lots within Precinct 1B.

The relevant noise and vibration criteria is set out in Section 3 of this report and include the following criteria and guidelines:

- NSW Environmental Protection Authority 'Rail Infrastructure Noise Guideline';
- AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors (AS2107);
- AS 3671 Acoustics – Road traffic noise intrusion – Building siting and construction (AS3671);
- NSW Government Department of Planning: Development near rail corridors and busy roads – interim guideline; and
- Department of Environment and Conservation NSW: Assessing Vibration: a technical guideline.

A 2 to 3 metre high noise barrier along the rail corridor was modelled, and results indicate that it would provide minimal noise mitigation, and has therefore not been included in this assessment report.

Modelling of the noise propagation over the site has identified potential freight rail noise impacts on a number of lots within stage 'Precinct 1B'. These lots have been identified as requiring architectural noise control treatments for new dwellings. Requirements have been set out in section 0 of this report and include the provision of alternative ventilation and upgraded glazing to specified areas.

The freight rail line may be utilised during the night time period between 2200 and 0700hrs. The potential for sleep disturbance has been assessed and integrated into the noise modelling calculation for the purpose of providing minimum architectural noise controls.

Table of Contents

1 Introduction

Vipac Engineers & Scientists (Vipac) was engaged to conduct a noise and vibration impact assessment, for the proposed residential subdivision known as 'Precinct 1B', to be located at 464 Cessnock Road, Gillieston Heights, located along the South Maitland rail corridor. The extent of the subject site is shown in Figure 2-1.

The 'Precinct 1B' site is currently undeveloped and rural in nature and is to be redeveloped with 224 lots for residential dwellings. The final number of dwellings is subject to design and assessment by the planning consent authority and will be finalised at a later date.

This report assesses noise and vibration impacts from the adjacent freight train railway corridor, that is not currently in operation. As such, this assessment is conducted based on certain assumptions, which have assisted in predicting the noise and vibration levels likely to be experienced at residential lots within the Precinct 1B subdivision development. Noise from the existing road known as Cessnock Road has not been considered in this assessment.

This assessment has been used to determine site specific external and internal project specific noise criteria to comply with relevant council and state requirements.

The noise study has taken into consideration the following:

- NSW Environmental Protection Authority 'Rail Infrastructure Noise Guideline';
- AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors (AS2107);
- AS 3671 Acoustics – Road traffic noise intrusion – Building siting and construction (AS3671);
- Site layout and land terrain contours provided by McCloy Group as presented in Appendix B and Appendix C;
- Vipac report: 'Noise Impact Assessment, Land Rezoning Development Masterplan for Hydro Aluminium Kurri Kurri, report ref 29N-14-0030-TRP-822335-2, dated 27th of March 2015';
- NSW Government Department of Planning: Development near rail corridors and busy roads – interim guideline; and
- Department of Environment and Conservation NSW: Assessing Vibration: a technical guideline
- Vipac letter: 'McCloy Group – Kurri Kurri Hydro – Aurizon Rail Noise & Vibration Measurements, letter ref 20E-21-0264-GCO-37098-0, dated 29th of June 2022'.

  Note: The letter summarised a series of attended site measurements conducted by Vipac at Aurizon's freight rail yard. Noise and vibration was measured for Aurizon freight rolling stock travelling at 30km/hr with varying amounts of carriages. The noise modelling in this report has been updated from that of Vipac's report dated 12th of May 202 as follows:

  - Freight train speed reduced from 80km/hr to 30km/hr.
  - Terrain data has been updated for the entire site based on a detailed site survey.
  - Existing fencing along the northern boundary has been included in the noise model.
  - The inclusion of acoustic fencing to several lots to along the west of the precinct.

2 Site Description

The subject site is located at 464 Cessnock Road, Gillieston Heights, and consists of the following information:

a) Precinct 1B is expected to contain 224 lots used for residential dwellings.
b) Is located in between Cessnock road and South Maitland rail corridor, border Cessnock LGA
c) Predominately zoned R1 General Residential, and includes land zoned RU2 Rural Landscape.

The extent of the proposed subject site is shown in Figure 2-1.

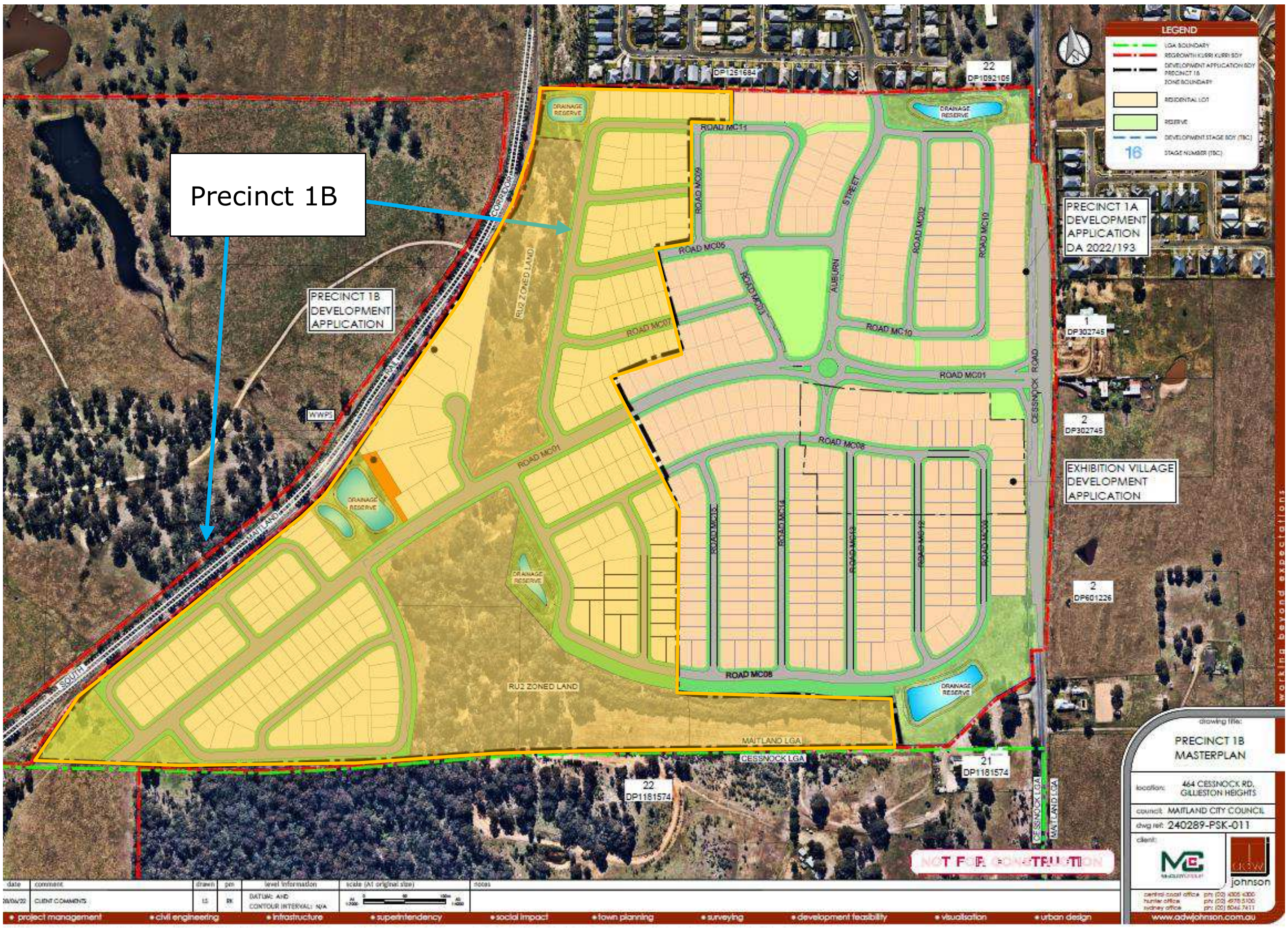


Figure 2-1: Site Location

3 Rail Traffic Noise & Vibration Criteria

The relevant rail noise criteria is outlined in the NSW EPA's 'Rail Infrastructure Noise Guideline', the relevant sections have been reproduced in this section of the report.

3.1 NSW EPA Rail Infrastructure Noise Guideline

3.1.1 Airborne

The NSW EPA's Rail Infrastructure Noise Guideline states the following regarding the redevelopment of heavy rail projects:

'1.4.1 Heavy rail projects

In NSW, heavy rail is considered to be rail infrastructure and its associated rolling stock which may be electrified or hauled by diesel locomotives that operates in dedicated rail corridors for either passenger and/or freight transportation. Heavy rail generally operates at higher speeds, has a higher carrying capacity than light rail and travels over longer distances. Passenger rail services currently provided by CityRail and CountryLink (operated by RailCorp) and freight operations are heavy rail. This guideline distinguishes between new or redeveloped rail lines as follows:

1.4.1.2 Redeveloped rail line

Redevelopment of a heavy rail line occurs where any rail infrastructure project is to be developed on land that:

- *is located within an existing and operational rail corridor where a rail line is or has been operational; or*
- *is immediately adjacent to an existing operational rail line which may result in widening of an existing rail corridor.*

Typically this will be where works on an existing rail line are proposed that will increase its capacity to carry rail traffic or alter the track alignment through design or engineering changes. In practice this often means duplicating track within an existing rail corridor.

A disused heavy rail line that is brought back into use should be assessed as a redevelopment under this guideline. This is because a line brought back into use will add to existing rail traffic noise where it is a feeder line rather than introduce a new noise source. However, if the corridor has been substantially realigned, then the realigned section should be assessed as a new rail line.

For example, a rail duplication project could require a section of track to be constructed outside the current corridor because constructing that section within the corridor would bring it too close to existing residences. The section to be constructed outside the existing corridor could allow for a noise barrier to be built which would not have been possible had the line not been moved onto the new path. This section would be considered a 'realigned' section of the project and should be designed to meet the more stringent 'new' noise trigger levels even though it is part of a redevelopment project.

1.4.3.3 Existing rail corridors

In the case of existing rail corridors, the Infrastructure SEPP refers to the Development near rail corridors and busy roads – interim guideline which must be taken into account where development is proposed in, or adjacent to, specific railway corridors. The guideline relates to SEPP rail clauses 85, 86 and 87. For certain development near rail corridors, the Infrastructure SEPP also requires agreement from the rail authority and identifies specific matters it must take into account before deciding whether to give approval.

2. Noise and vibration trigger levels

This guideline addresses rail noise and vibration, including:

- *airborne noise that is heard at or within noise-sensitive premises*
- *ground-borne noise generated inside a building by ground-borne vibration from a vehicle passing by on rail*
- *vibration in buildings that affects amenity.*

Airborne noise from rail pass-bys is generated by a combination of noise from the propulsion of the rolling stock (usually diesel or electric locomotives) and from its interaction with the track. This type of noise generally comes from the operation of a surface rail line and reaches a receiver primarily through the air.

Ground-borne noise or regenerated noise in buildings is typically noted at receiver locations where the level of ground-borne noise is likely to be greater than airborne noise (e.g. in buildings above rail tunnels where the airborne noise is masked by the tunnel).

Vibrations in buildings associated with movements on a rail network can cause disturbance and complaint in a similar fashion to noise. Assessment of vibration is dealt with by a separate guideline, as outlined in section 2.6 (of the Rail Infrastructure Guideline).

2.3 Airborne noise trigger levels for heavy rail

Trigger levels in this guideline that apply to heavy rail projects relate to:

- *the absolute level of rail noise associated with all rail transportation services, and*
- *the increase in the predicted rail noise due to the proposed rail infrastructure project in the case of redevelopments.*

If the noise impact assessment undertaken for the infrastructure proposal indicates that the trigger levels in this guideline are likely to be exceeded, a detailed study must be made to evaluate the predicted noise and vibration levels. The predicted levels should then be compared to the noise and vibration trigger levels identified in this guideline. It is then necessary to consider feasible and reasonable mitigation measures. If the triggers are not exceeded, mitigation considerations are not required under this guideline. However, assessment obligations under the EP&A Act remain unaffected.

For heavy rail projects, trigger levels are given for a new rail line development and for redevelopment of existing lines. In the case of a new railway, an assessment of noise impacts and mitigation measures must be considered where the predicted noise level is likely to exceed the trigger levels.

An assessment of noise impacts and mitigation measures for a redeveloped line must be considered when an increase in rail noise is predicted to occur (for either LAeq or LAmax) by the number of decibels specified in Table 3-1 *and when the predicted level exceeds the trigger values in* Table 3-1 *for residential receivers. The trigger levels for an increase in the LAeq and LAmax are set at levels where the increase in rail noise is likely to be perceptible.*

As mentioned (section 1.4), the trigger levels are more stringent for new heavy rail projects than for redevelopments. The reason is that it is possible to apply a greater range of noise prevention and mitigation options during the planning stages for new rail projects in greenfields or on land that has not previously had a rail line than for projects in existing rail *corridors. There is evidence to suggest that people's reactions to a newly introduced noise source are considerably greater than reactions to a source that has been present for some time (see Appendix 5.3).*

Separate triggers are provided for day and night periods, with a more stringent trigger applied for night. This reflects the need to protect the community from rail-noise related sleep disturbance at night and encourages a greater volume of rail movements to take place during daytime. The 15-hour daytime period is defined from 7 am to 10 pm and the 9-hour night-time period is from 10 pm to 7 am.

Table 3-1 – Airborne heavy rail noise trigger levels for residential land uses

Type of development	***Noise trigger levels dB(A) (External)***	
New rail line development	Day (7am – 10pm)	Night (10pm – 7am)
	60 or $L_{Aeq(15hr)}$ Or 80 L_{AFmax}	55 or $L_{Aeq(9hr)}$ Or 80 L_{AFmax}
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2dB or more, or existing L_{Amax} rail noise levels by 3 dB or more And Predicted rail noise levels exceed:	
	65 or $L_{Aeq(15hr)}$ Or 85 L_{AFmax}	60 or $L_{Aeq(9hr)}$ Or 85 L_{AFmax}

3.2 Ground-borne

Ground-borne noise is defined in ISO 14837 Mechanical vibration – ground-borne noise and vibration arising from rail systems as noise generated inside a building by ground-borne vibration generated from the pass-by of a vehicle on rail. It applies to both heavy and light rail. Ground-borne noise excludes direct airborne noise.

Ground-borne noise level values are relevant only where they are higher than the airborne noise from railways (such as in the case of an underground railway) and where the ground-borne noise levels are expected to be, or are, audible within habitable rooms.

Ground-borne noise differs from airborne noise because the actions available to reduce or avoid it are more limited. For example, airborne noise can often be reduced by actions such as closing windows, improving the acoustic insulation of the building façade or relocating noise-sensitive activities in the building to a location more remote from the noise source. These actions are likely to be relatively ineffective against ground-borne noise, because the noise is emitted by the building structure itself.

Retrospective measures to mitigate ground-borne noise generation can be more difficult and expensive than air-borne noise mitigation. This is because the ability to apply these measures can be restricted by the amount of head-room available in a tunnel or the ability of the track-bed to accommodate additional mitigation. It is therefore important to ensure that an adequate level of mitigation is applied during the design and construction of underground rail projects.

Limited research into the impacts of ground-borne noise is available, and information on practices applied overseas is also scarce. From a review of available material it appears the factors that can affect reaction to ground-borne noise include:

- *the level of the noise*
- *how often it occurs*
- *whether an area is already exposed to rail noise and*
- *whether the area affected has a low-density of development (e.g. low-density residential) with associated low levels of ambient noise.*

It appears reasonable to conclude that ground-borne noise at or below 30 dB LAmax will not result in adverse reactions, even where the source of noise is new and occurs in areas with low ambient noise levels. Levels of 35–40 dB LAmax are more typically applied and likely to be sufficient for most urban residential situations, even where there are large numbers of pass-by events.

When assessing the impact of ground-borne noise the noise trigger levels in Table 3-2 *and the associated measurement methodology described in section 3 should be referenced. They are necessarily set to the lower end of the range of possible* *trigger values so that potential impacts on quieter suburban locations are addressed. In practice, higher levels of ground-borne noise than the trigger level for assessing impacts may be appropriate for urban areas where background noise levels are relatively high.*

Table 3-2 – Ground-borne noise trigger levels for heavy or light rail projects

Sensitive land use	***Time of day***	***Internal noise trigger levels dB(A)***
Residential	Day (7am – 10pm)	*40 L_{ASmax}*
	Night (10pm – 7am)	*35 L_{ASmax}*

3.2.1 Vibration Criteria

Vibrations in buildings associated with rail network operations can cause disturbance and complaint in a similar manner to noise. It needs to be considered at the infrastructure planning stage as it is difficult to mitigate retrospectively.

A separate vibration guideline, Assessing vibration: a technical guideline (DEC 2006), covers continuous, impulsive and intermittent vibration from a variety of sources. Train movements on a rail network can cause vibration of an intermittent type. The vibration guideline contains information on 'preferred' and 'maximum' vibration values for assessing human responses to vibration. Consider the relevant 'preferred values' to be the triggers which initiate an assessment of feasible and reasonable mitigation measures under this guideline. See section 3 of the guideline for guidance in applying these trigger levels.

3.3 Internal Noise Criteria

The internal noise level criteria for residential dwellings is taken from the Development near rail corridors interim guideline, and are shown in Table 3-3.

Table 3-3 – Design Internal Noise Level Criteria

Type of occupancy/activity Residential Buildings	**Recommended design sound level, L_{Aeq} dB**	
	Satisfactory	**Applicable time period**
Other habitable areas	40	Anytime
Sleeping areas	35	Night period (10pm to 7am)

It is noted that a separate assessment is used within industry to assess the maximum noise level (L_{ASmax}) exposure inside an occupancy. Maximum noise level assessment can be used to assess sleep disturbance. The maximum noise level assessment is taken from recommended design levels in Australian Standard 2021, and are 50 dB(A) for sleeping areas, and 55 dB(A) for living/habitable areas.

4 Noise Impact Assessment

The predicted airborne noise impact of railway noise at the proposed development is provided in this section. Railway noise levels across the site have been predicted using SoundPLAN computer noise modelling software, and using the Kilde Rail Traffic noise prediction methodology. A noise model was generated of the proposed development, site surroundings and noise sources using ground terrain information received from McCloy Group on the 28th of March 2022 as provided in Appendix C.

4.1 Noise Modelling Parameters

The parameters in Table 4-1 have been used throughout the rail noise model.

Note: Vipac measured noise and vibration of Aurizon freight rail rolling stock on the 16th of June 2022 and have utilised the measured freight rail pass-by noise data for two (2) noise modelling scenarios:

- Noise modelling scenario: Freight trains passing by the site at 30km/hr

- Calibrated within the noise model to 80 L_{max} dB(A) at 40 metres.

Table 4-1: Noise Modelling Methodology Assumptions

Parameters	Assumptions
Height of receivers	1.5 metres above ground level for ground floor 4.5 metres above ground level for 1st floor
Type of rail surface	Unknown – Existing rail from hunter valley mining use
Number of rail tracks	1 track each way for all scenarios
Freight rail volumes	1 per day
Freight train speed	30km/hr
Freight train engine/exhaust height above ground level	4 metres
Length of train	500 metres
Freight train SPL	80 L_{max} dB(A) at 40 metres
Distances & ground heights	As provided by McCloy Group and terrain heights supplemented from google earth terrain heights as required
Number of engine wagons per train	1
Train direction	North and South along single track
External façade reflection	+2.5 dB(A)
Receiver heights	Ground = 1.5m above ground level 1st Floor = 4.5m above ground level

A +2.5 dB(A) factor has been applied to results to account for façade reflection. Note this means that on completion noise levels in a free field environment (i.e. backyard (away from the façade) will be 2.5 dB(A) lower than indicated on the contour plots.

4.2 Rail Noise Levels

Noise levels for the future freight rail operational scenario have been predicted to all lots within Precinct 1B. For the purpose of this assessment, Table 4-2 presents a summary of the predicted noise levels for the four (4) lots in each 'zone' that are most affected by noise. It is noted that the site plan should be referenced for each lot to determine which zone a dwelling may fall into. The predicted levels are to the most exposed façade facing the railway line. Ground floor results are 1.5 metres above ground, and 1st floor results are 4.5 metres above ground. It is noted that noise levels were predicted without a barrier. Barrier optimisation was conducted to determine an effective barrier height to reduce noise levels adequately. It was found that a barrier height of minimum 4.5 metres was required. Given this height requirement, it was not considered a valid option for assessment purposes.

A breakdown of Zones is as follows:

Zone 1: Above average architectural treatments required (detailed lot assessment recommended during design)

Zone 2: Average architectural treatments required (detailed lot assessment recommended during design)

Zone 3: Standard construction acceptable. No further acoustic consideration required

Table 4-2 – Predicted future freight train noise levels

Zone	Receiver Lot	Receiver Height	Freight train traveling at 30km/hr – Predicted Noise Level dB(A)	
			L_{Aeq}	L_{Amax}
Zone 1[1]	Lot 801 to Lot 805	Ground Floor	53	78
		1st Floor	54	80
Zone 2	Lot 401	Ground Floor	47	73
		1st Floor	50	76
	Lot 1322	Ground Floor	42	68
		1st Floor	44	70
	Lot 809	Ground Floor	44	70
		1st Floor	46	72
	Lot 349	Ground Floor	38	64
		1st Floor	43	69
Zone 3	Lot 1101	Ground Floor	37	63
		1st Floor	40	66
	Lot 1208	Ground Floor	36	62
		1st Floor	38	64
	Lot 1314	Ground Floor	39	65
		1st Floor	36	62
	Lot 305	Ground Floor	38	64
		1st Floor	39	65

Note[1]: The Client has advised Vipac that Lots 801 to 805 will only build single storey houses and therefore all comply with "Zone 2" requirements. However, if any 2 story houses are built on Lots 801 to 805, any upper levels must be built compliant with "Zone 1" architectural upgrades.

Furthermore, 1.8 metre acoustic fencing must be installed at the location marked in Figure 4-1.

Figure 4-1: Zones for minimum architectural upgrades for a freight train travelling at maximum 30km/hr

Based on the predicted airborne noise levels, the project trigger level has been exceeded for some lots within Precinct 1B. As such, further noise mitigation is required to ensure future rail noise impact is minimised. Section 5 provides the estimated building construction requirements for each noise affected lot (identified as zones within the precinct).

Note: Detailed noise contour maps showing the 3 zones for freight trains travelling at 30km/ are provided in Appendix D.

4.2.1 Acoustic Fence Details

The acoustic noise control barrier marked on the plans in Figure 4-1 must be a solid fence construction of close-boarded timber construction (minimum 20mm thick timber palings) with no gaps between the panels of the fence or between the ground and the bottom of the fence. Battens shall be used to cover gaps between palings, or palings can be overlapped. The acoustic fencing must have a minimum surface density of 25-30kg/m^2. Other approved fence constructions that are acoustically equivalent or greater may also be used.

5 Building Construction Requirements

Building construction requirements have been modelled as a worst-case free standing two-storey building. This is an assumption for modelling purposes only and housing heights and layouts will vary in practice. Unless otherwise stated the following dwelling construction in Table 5-1 is considered.

Table 5-1 – Building Construction Considered

Building Element	Construction
External walls	Double brick, brick veneer or lightweight system with minimum acoustic rating of R_w45
Roof	Either steel with anticon or tiled with sarking with minimum acoustic rating of R_w45
Ceiling insulation	R 3.0 batts
Ceiling	Flush 10mm plasterboard
Glazed Windows and Doors	Standard thickness glass 5mm, no special acoustic seals, acoustic rating R_w25

Calculation of internal noise levels are based on the following typical room properties shown in Table 5-2. The assumed room properties have been taken from the NSW Government Department of Planning document *'Development Near Rail Corridors and Busy Roads – Interim Guideline, Table B1: Assumed Room Volumes and Areas'* .

Table 5-2 – Assumed Internal Room Properties

Room	Volume m^3	Glazing area, m^2	Wall area, m^2	Roof / Ceiling area, m^2	Ceiling height, m	Internal Reverberation time, sec	Floor area, m^2
Bedroom	25	2	6	9	2.7	0.6	9
Living	95	6	12	36	2.7	1	36

5.1 Noise Modelling Results

Appendix C shows future freight rail noise contour maps at both ground level and at first floor receiver heights across the subdivision.

Noise contours for the following scenarios are provided:

- Future Day/Night L_{Amax} – Ground floor - 1.5m prediction height.
- Future Day/Night L_{Amax} – 1st floor - 4.5m prediction height.

The architectural upgrades have been divided into three (3) zones from worst to least affected by future freight rail noise, these are marked on the plans for reference. Figure 4-1.

5.2 Zone Specific Requirements

Where the internal noise criteria is exceeded by 5 dB with the windows open, the dwellings can comply with the internal criteria simply by closing the doors and windows. Construction for these lots is considered standard, and these lots are identified as being in zone 3. Where this is the case, alternative ventilation must also be provided to allow occupants the option of closing the windows while maintaining suitable fresh air flow.

Where the external LAeq criteria is predicted to exceed by a greater amount, and exceed the trigger noise levels, increased building construction is required, i.e. thicker glazing and external doors are required (in addition to alternative ventilation). A façade and roof system that has a higher acoustic rating from 'typical' construction is also required. These lots are identified as being in Zone 1 and 2.

The required alternate ventilation may involve acoustically treated vents etc., mechanical driven fresh air systems, air-conditioning (incorporating fresh air, or window opening in a non-noise affected facade) or some other design to provide fresh air to the space. This should be considered during the design of the dwelling. In accordance with Australia standards, the mechanical ventilation systems must be compliant with AS1668 and the Building Code of Australia. Any mechanical plant should be designed to comply with Council's internal and external limits for mechanical plant noise.

The estimated building construction requirements for each noise affected dwelling is presented in Table 5-3 and Table 5-4 where each façade is allocated a treatment type.

It is noted that the LAeq noise level has been used to determine the construction requirements given it is listed as the metric for consideration in relevant guidelines. It is also good practice to assess sleep disturbance for sleeping areas using LAmax levels. These have not been provided but can be completed at the detailed design stage of a lot assessment.

Detailed noise contour maps showing the 3 zones for freight trains travelling at 30km/hr are provided in Appendix D.

Table 5-3 – Summary Of Minimum Architectural Treatment Requirements – Freight Train Travelling at 30km/hr

Zone	Façade Orientation	Alternative Ventilation Requirement	Glazing Requirement		External Façade Construction	Roof/Ceiling	External Door Requirement
			Bed	Living			
Zone 1	North (Facing freight rail line)	Bedrooms & Living Areas	27	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Solid core doors with a minimum Rw30
	East	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Solid core doors with a minimum Rw30
	South	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Solid core doors with a minimum Rw30
	West	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Solid core doors with a minimum Rw30
Zone 2	North (Facing freight rail line)	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	East	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	South	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	West	Bedrooms & Living Areas	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
Zone 3	North (Facing freight rail line)	N/A	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	East	N/A	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	South	N/A	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors
	West	N/A	25	25	Standard lightweight construction Rw45	Standard tiles and insulation minimum Rw45	Standard solid core doors

The Rw acoustic performance of glazing systems will differ for each supplier, however for reference purposes the Rw requirements can be achieved with the glazing thicknesses shown in Table 5-4. Verification of acoustic performance is required.

Table 5-4 – Glazing Rw Thickness Summary

Glazing Rw	Approximate Glazing Thickness - mm
Rw 25	4mm
Rw 27	5mm
Rw 30	6.38mm
Rw 36	12.38mm laminated

Note[1]: The minimum Rw has been recommended, however it is important that acoustic seals and acoustic rated frames are installed for the entire window system to achieve the minimum Rw rating, and ensure leakage is not a concern.

In order to achieve the design internal noise levels, it is recommended that the proposed dwelling designs are submitted to a qualified acoustics consultant for review. At this early stage and with respect to rail noise the following recommendations are made to achieve design internal noise levels.

Where possible, from a design perspective, the following options can also be considered:

a) Dwellings in zone 1 are recommended not to have noise sensitive rooms (i.e. bedrooms) facing the rail corridor. The designs are recommended to utilise less noise sensitive spaces (e.g. non-habitable rooms) as a noise buffer between the noise source and noise sensitive rooms, however if a sensitive room is facing the rail corridor, then architectural treatments provided should be considered and assessed during the design phase.

b) Where possible, all dwelling designs in zone 1 should minimise the surface area of glazing and doors (which are sound insulation "weak points") facing towards freight rail corridor. Windows/glazing systems would require acoustic seals because standard seals offer negligible to nil sound insulation performance. All dwellings in zones 1 and 2 will require detailed lot specific acoustic reviews, and therefore concept drawings should be assessed by a suitably qualified acoustics consultant for review to ensure that design internal noise levels are satisfied and acoustic amenity is maintained.

6 Ground Borne Vibration Impact

6.1 Background & Criteria

Rail traffic generates vibration which propagates through ground and is transmitted into nearby buildings throughout their structure. Low frequency noise (rumble) is also radiated from the vibrating floors and wall. Vibration causes other phenomena to happen: rattle (windows, doors, furniture, kitchen utensils etc.), movement of objects (visual effects). In addition, rail traffic induces simultaneous airborne noise.

Vibration levels are dependent on a number of factors including the track design, train type, train speed, wheel condition and ground conditions. Distance is one of the most effective mitigation measures against noise and vibration, although geological make-up and terrain also have an effect. For example, some studies have shown that annoyance from railway vibrations is inversely proportional to distance from railway tracks, with a rapid decrease in vibration disturbance as the distance increases from 25 to 150 metres and a slower rate of reduction over 200 metres.

Usually there is no cosmetic or structural damage to a building due to train induced ground-borne vibration. The most important effect the vibration caused by train traffic is on the human occupants of buildings.

The NSW technical guideline contains reference to British Standard 6472. This guideline presents preferred and maximum vibration values for use in assessing human response to vibration.

The development near rail corridors and busy roads interim guideline states that for developments within 40 metres of a rail corridor, a full noise assessment should be undertaken (as shown in Figure 6-1). For developments within 25 metres of a rail corridor, a vibration assessment should be conducted. It is noted that the closest lots are estimated to be 20 to 25 metres from the rail corridor.

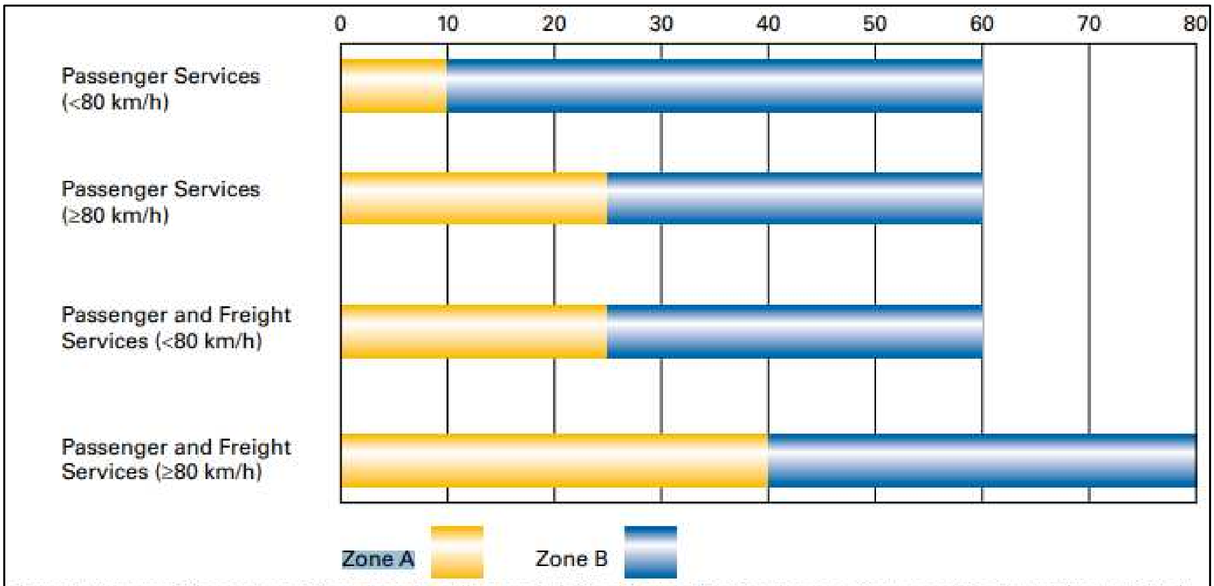


Figure 3.1: Acoustic Assessment Zones based on distance (m) of noise-sensitive development from operational track (not corridor)

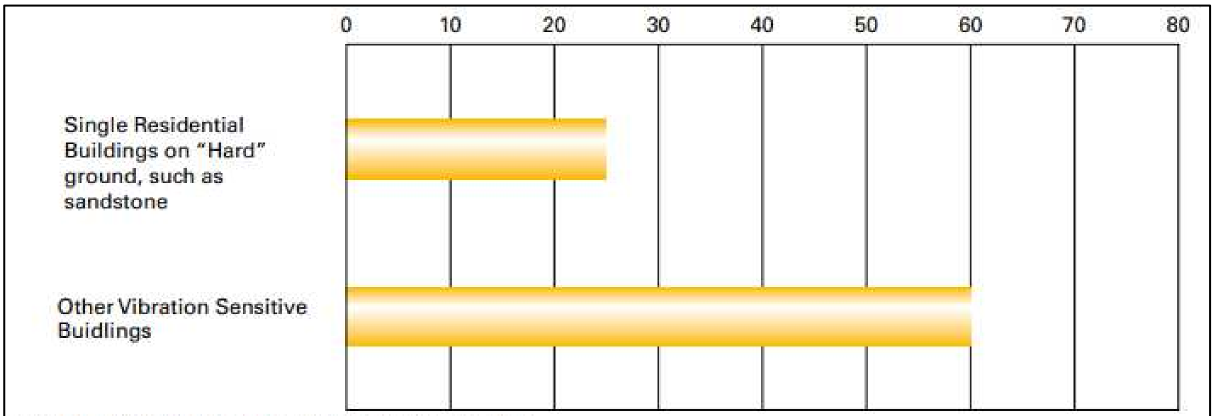


Figure 3.2: Distance from the nearest operational track (m)

Figure 6-1: Acoustic Assessment Zones based on Distance

For single dwelling residences in Zone B of Figure 6-1, standard mitigation measures consistent with Road Noise Control Treatment Category 2 from the guideline, will normally provide adequate mitigation to reduce internal noise levels to an acceptable level. If these measures are adopted as a minimum for single dwelling residences in Zone B, there should be no need for a specialist acoustic assessment. However the particular circumstances would also need to be considered.

Category of Noise Control Treatment	R_w of Building Elements (minimum assumed)				
	Windows/Sliding Doors	Frontage Facade	Roof	Entry Door	Floor
Category 1	24	38	40	28	29
Category 2	27	45	43	30	29
Category 3	32	52	48	33	50
Category 4	35	55	52	33	50
Category 5	43	55	55	40	50

It should be noted that the Zone B standard mitigation measures are based on having windows and external doors closed, therefore consideration of ventilation requirements for noise-exposed rooms will be required to meet the provisions of the Building Code of Australia and other relevant standards. To minimise sleep disturbance, air should be ducted into these rooms from a quiet area not exposed to rail noise or through the use of quiet, acoustically treated ventilators. In locations where noise levels are higher especially next to train stabling yards, freight lines and high speed operations, it may be advisable to seek specialist acoustic advice from an acoustic consultant to confirm that the measures will achieve the desired noise criteria.

Table 6-1 and Table 6-2 taken from the technical guideline provides preferred and maximum values for intermittent vibration. Intermittent vibration is used to assess rail impact using the vibration dose concept which relates vibration magnitude to exposure time. The criteria are non-mandatory: they are goals that should be sought to be achieved through the application of all feasible and reasonable mitigation measures. Where all feasible and reasonable measures have been applied and vibration values are still beyond the maximum value, the operator would need to negotiate directly with the affected community.

Table 6-1: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	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

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.
Source: BS 6472–1992

Table 6-2: Criteria for exposure to continuous and impulsive vibration

Place	Time	Assessment criteria					
		[1]rms acceleration (m/s^2) (& vib. accel. value) (dB re 10^{-6} m/s^2)		[2]rms velocity (mm/s) (& vib. velocity value) (dB re 10^{-6} mm/s)		[2]Peak velocity (mm/s)	
		Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day- or night-time	0.0050 (74 dB)	0.010 (80 dB)	0.10 (100 dB)	0.20 (106 dB)	0.14	0.28
Residences	Daytime[3]	0.010 (80 dB)	0.020 (86 dB)	0.20 (106 dB)	0.40 (112 dB)	0.28	0.56
	Night-time	0.0070 (77 dB)	0.014 (83 dB)	0.14 (103 dB)	0.28 (109 dB)	0.20	0.40
Offices	Day- or night-time	0.020 (86 dB)	0.040 (92 dB)	0.40 (112 dB)	0.80 (118 dB)	0.56	1.1
Workshops	Day- or night-time	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	1.1	2.2
Impulsive vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day- or night-time	0.0050 (74 dB)	0.010 (80 dB)	0.10 (100 dB)	0.20 (106 dB)	0.14	0.28
Residences	Daytime[3]	0.30 (110 dB)	0.60 (113 dB)	6.0 (136 dB)	12.0 (142 dB)	8.6	17.0
	Night-time	0.10 (100 dB)	0.20 (106 dB)	2.0 (126 dB)	4.0 (132 dB)	2.8	5.6
Offices	Day- or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)	18.0	36.0
Workshops	Day- or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)	18.0	36.0

1 Values derived from z-axis critical frequency range 4–8 Hz. Where required, a more detailed analysis can be conducted as per BS 6472–1992.
2 Values given for the most critical frequency range >8 Hz assuming sinusoidal motion. Where required, a more detailed analysis can be conducted as per AS 2670.2–1990. Sufficient justification should accompany the use of a peak velocity approach if used in an assessment.
3 Specific values depend on social and cultural factors, psychological attitudes and expected degree of intrusion.

The British Standard BS 6472-1 is also used for assessing vibration comfort in buildings in close proximity to vibration sources such as Major Roads, Railway tracks and Construction Sites. Vipac recommends that the acceptable level of vibration should be considered as the level that is equal to or lower than the vibration limits specified for "Low Probability of adverse Comment" in the standard. This is indicated in Table 13 below.

Table 6-3: Recommended Acceptable Level of Vibration in Building

Place and time	Low probability of adverse comment $m \cdot s^{-1.75}$ 1)	Adverse comment possible $m \cdot s^{-1.75}$	Adverse comment probable $m \cdot s^{-1.75}$ 2)
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

6.2 Rail Vibration Assessment

Attended vibration measurements were conducted at a section of rail adjacent to the Aurizon rail yard at 6 Junction Street, Telarah.

- Freight locomotives pulling up to 89 carriages, and passengers trains were measured.
- Noise and vibration measurements were conducted at 20 and 40 metres from the track
- Two noise loggers were located 100 metres apart at an equal distance from the track, the measurements from these locations were utilised to calculate the speed of the rail vehicles for each pass-by.
- 'Up track' refers to trains travelling towards Sydney
- 'Down track' refers to trains travelling away from Sydney.

The location of each measurement is marked in Figure 6-2.

Figure 6-2: Site Location & Measurement Point Locations N1, N2, N3, N4, V1 & V2

The vibration measurement results and compliance are provided in Table 6-4.

Table 6-4: Rail Pass-by Vibration Measurement Results

#	Train Type	Direction	Estimated Speed (km/hr)	Vertical PPV (mm/s)		Criteria Night Time (mm/s)		VPPV (mm/s)		Criteria Night Time (mm/s)	
				N1 20m	N2 40m	Preferred	Max	N1 20m	N2 40m	Preferred	Max
1	Passenger	Down	50	**0.10**	**0.08**	2	4	**0.14**	**0.11**	2.8	5.6
2	Passenger	Down	51	**0.23**	**0.08**	2	4	**0.32**	**0.12**	2.8	5.6
3	Freight Loco	Down	19	**0.81**	**0.20**	2	4	**1.08**	**0.27**	2.8	5.6
4	Freight with 89 full wagons	Up	36	**0.34**	**0.20**	2	4	**0.52**	**0.30**	2.8	5.6
5	Freight Loco	Down	60	**0.42**	**0.20**	2	4	**0.59**	**0.26**	2.8	5.6
6	Freight Loco	Up	10	**0.42**	**0.13**	2	4	**0.50**	**0.17**	2.8	5.6

Compliance of maximum peak and vector particle velocity at 20 metres and 40 metres are presented in Table 6-5 and Table 6-6.

Table 6-5: Maximum PPV and Vector Particle Velocity at 20 m (Freight Loco, Down Track Travelling at 19 km/hrr)

Direction	Maximum PPV (mm/s) at 20m	Criteria Night Time (mm/s)	
		Preferred	Maximum
Vertical	**0.81**	2	4
Radial (Longitude)	**0.56**	2	4
Transverse	**0.57**	2	4
Maximum VPPV (mm/s)	**1.08**	2.8	5.6

Table 6-6: Maximum PPV and Vector Particle Velocity at 40 m (Freight w/ 89 wagons , UP Track travelling 36 km/hrr)

Direction	Maximum PPV (mm/s) at 20m	Criteria Night Time (mm/s)	
		Preferred	Maximum
Vertical	**0.20**	2	4
Radial (Longitude)	**0.21**	2	4
Transverse	**0.18**	2	4
Maximum VPPV (mm/s)	**0.30**	2.8	5.6

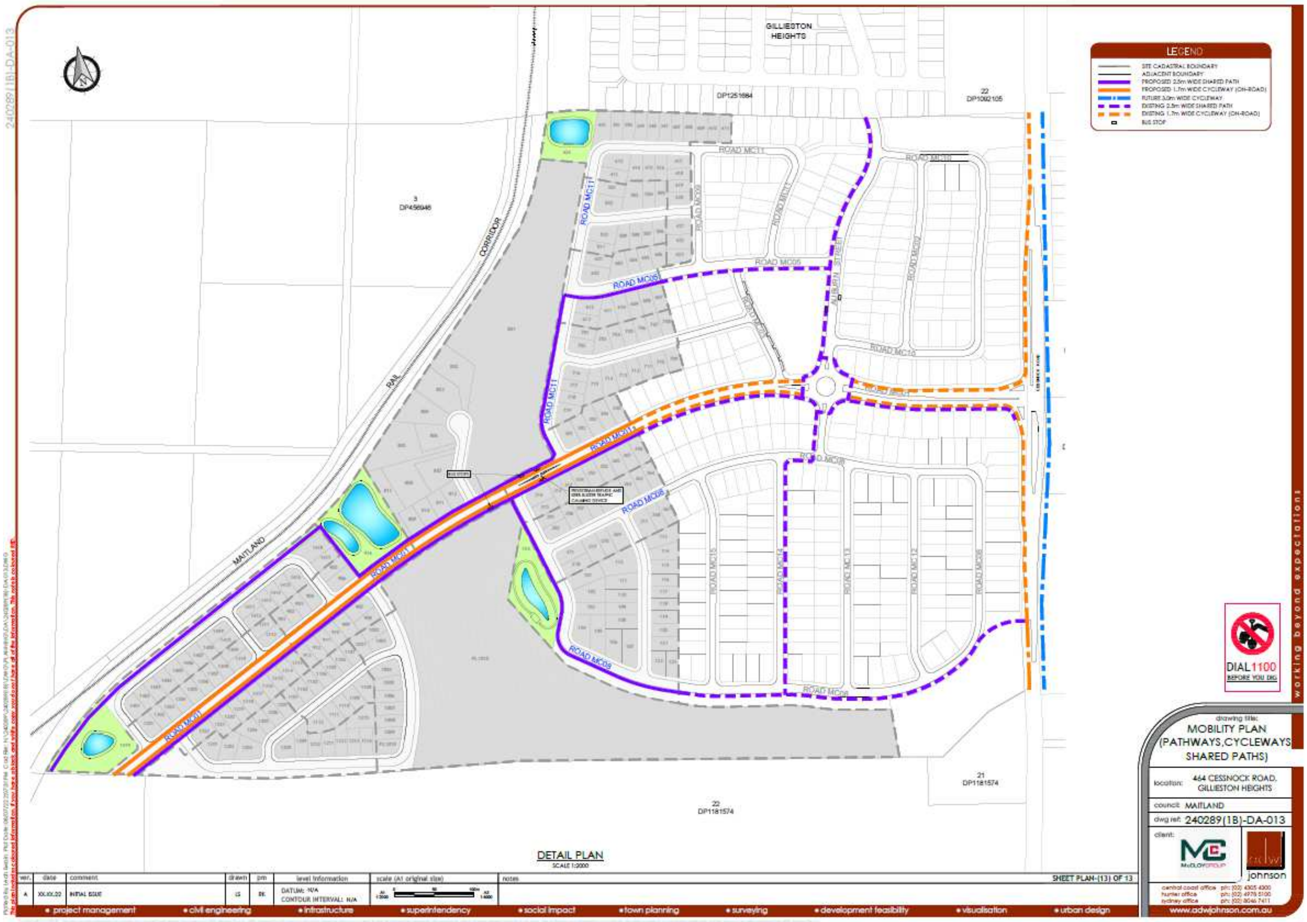
Based on references and measurements conducted, a single train pass-by event is expected to have a peak particle velocity between 0.1 to 0.81 mm/s and vector peak values between 0.14 to 1.08 mm/s for receivers located at worst case 20 metres setback. Results are expected to vary depending on conditions including ground conditions at site.

Vipac concludes that a single train pass-by event is expected to be compliant with the particle vibration velocity criteria at a worst case receiver distance of 20 metres. External noise levels due to ground borne noise at most exposed lots are predicted to be in the range of 37 to 53 dB(A). As such, internal noise levels are expected to be compliant with criteria. It is also noted that airborne noise contribution is predicted to be higher than ground borne noise contribution.

Appendix A Glossary of Terminology

SPL or L_P	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 µPa RMS) and expressed in decibels.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 µPa i.e. dB = 20 x log(P/Pr)
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
$L_{A90\ (t)}$	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L max	The maximum noise level over the measurement period for a given time weighting e.g. slow (s), fast (F) or impulse (I).
Percentile Level - L_{90}, L_{10}, etc:	A statistical measurement giving the sound pressure level which is exceeded for the given percentile of an observation period, e.g. L_{90} is the level which is exceeded for 90% of a measurement period. L_{90} is commonly referred to as the "background" sound level.
Rw	A new single number quantity for airborne sound insulation rating which replaces STC. STC has been traditionally used for the classification of partitions and to define acoustical requirements in the Building Code of Australia. For majority of partitions, the value for R_w will be similar to the value for STC. Partitions with particularly poor performance at 100Hz may have lower values for R_w than for STC. Conversely, partitions with poor performance at 4kHz may have higher values for R_w than for STC.
Rating Background Level - RBL	Method for determining the existing background noise level which involves calculating the tenth percentile from the L_{A90} measurements. This value gives the Assessment Background Noise Level (ABL). Rating Background Level is the median of the overall ABL.

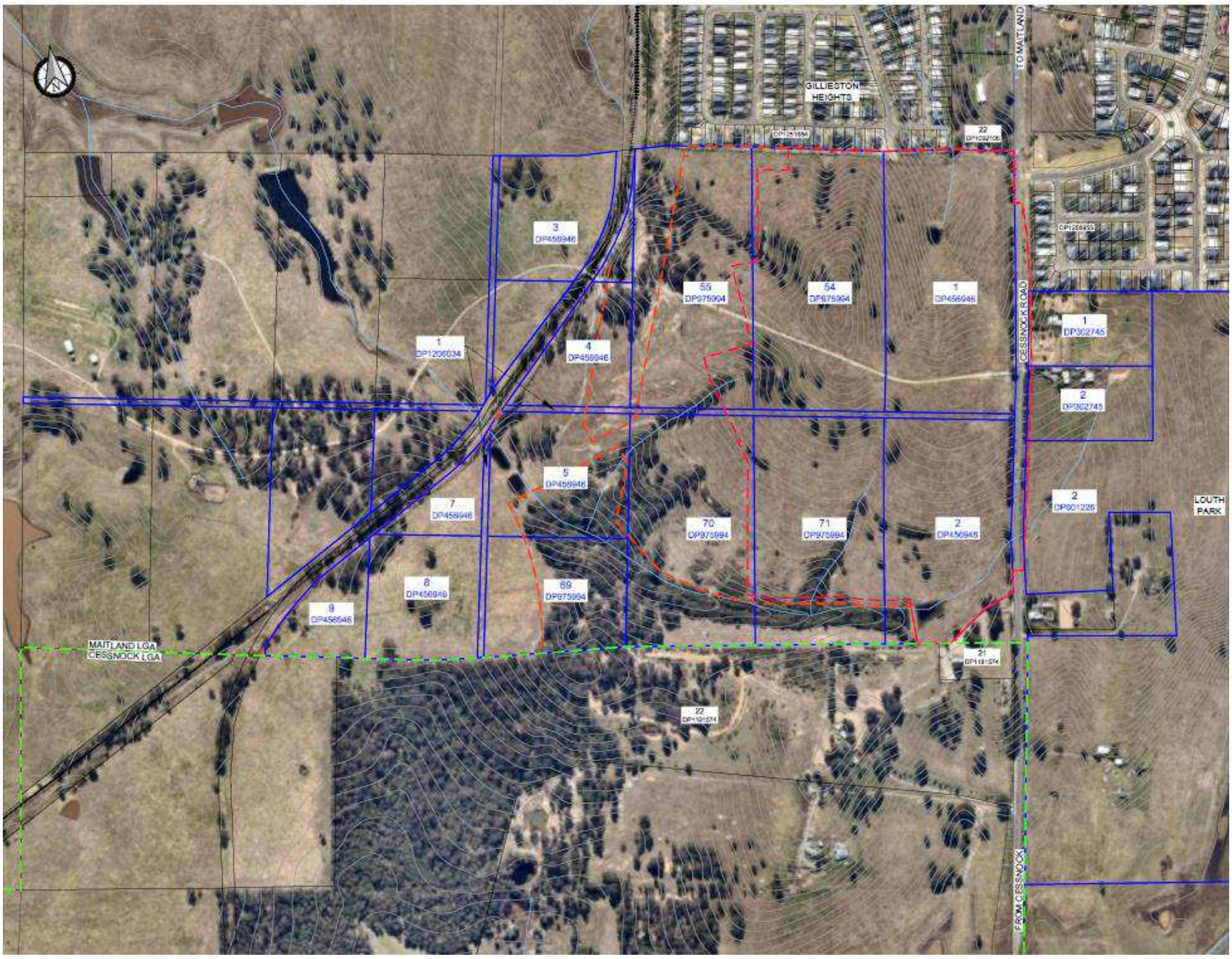
Appendix B Site Layout



Appendix C Terrain Contours

The aerial image below was provided by McCloy Group and shows the terrain contours utilised throughout the 3D noise modelling throughout this report.

Updated terrain data was provided by McCloy Group on the 3rd of June 2022.



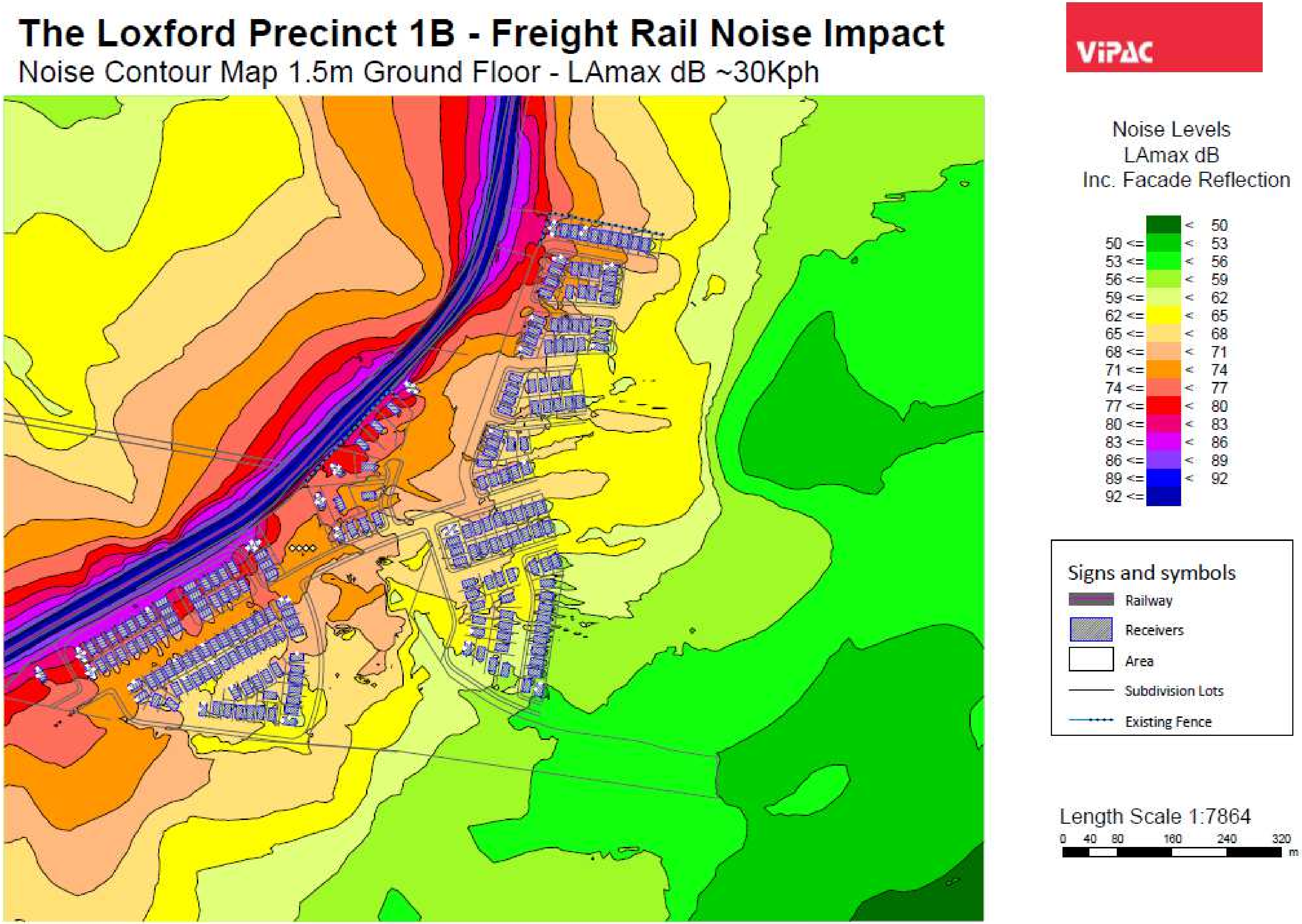
Appendix D Noise Contour Maps

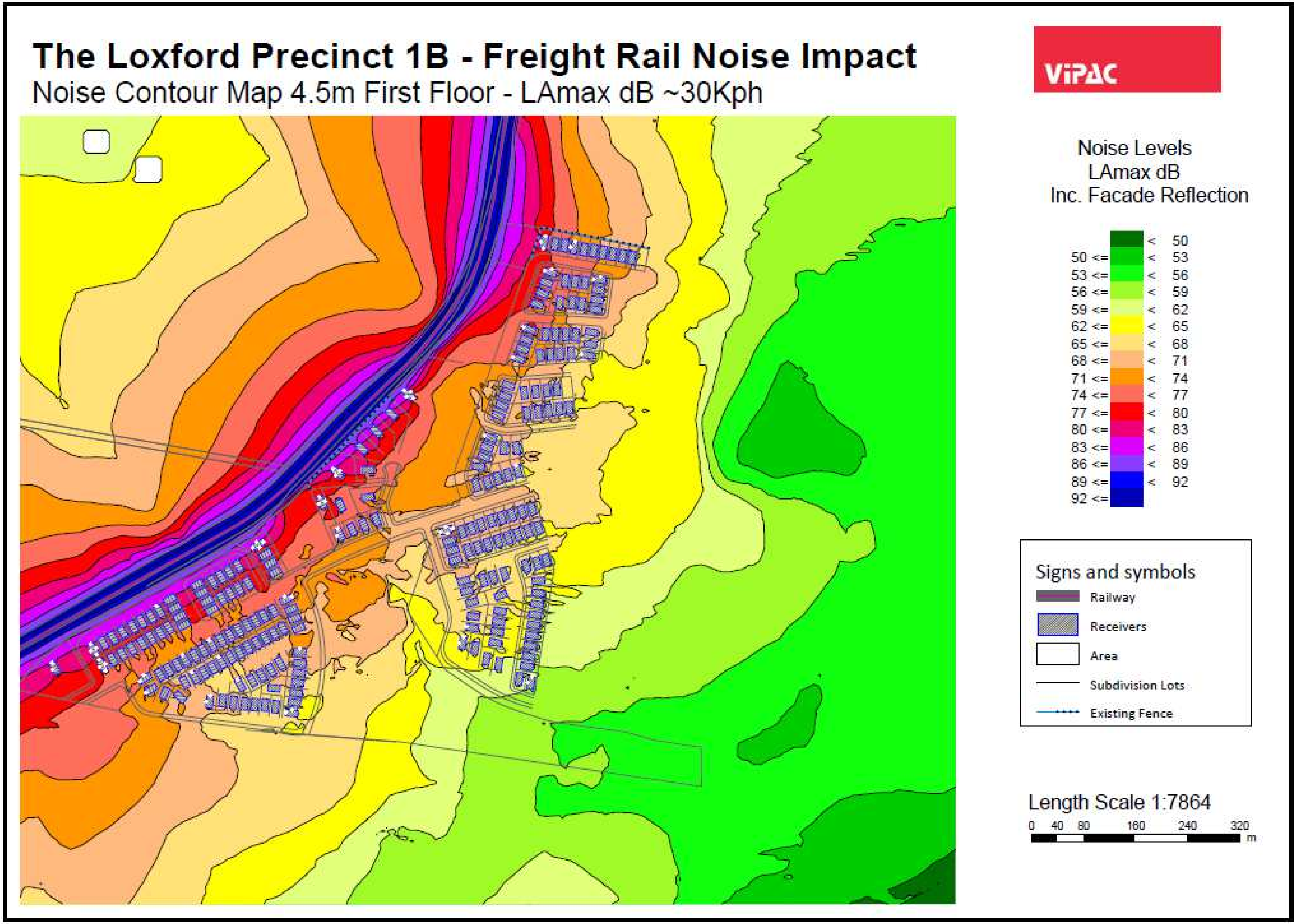
The future freight rail noise contour maps and noise zoned maps are provided in this section for freight trains travelling at 30km/hr:

D.1 Noise Contour Maps – Freight Train at 30km/hr

The Loxford Precinct 1B - Freight Rail Noise Impact

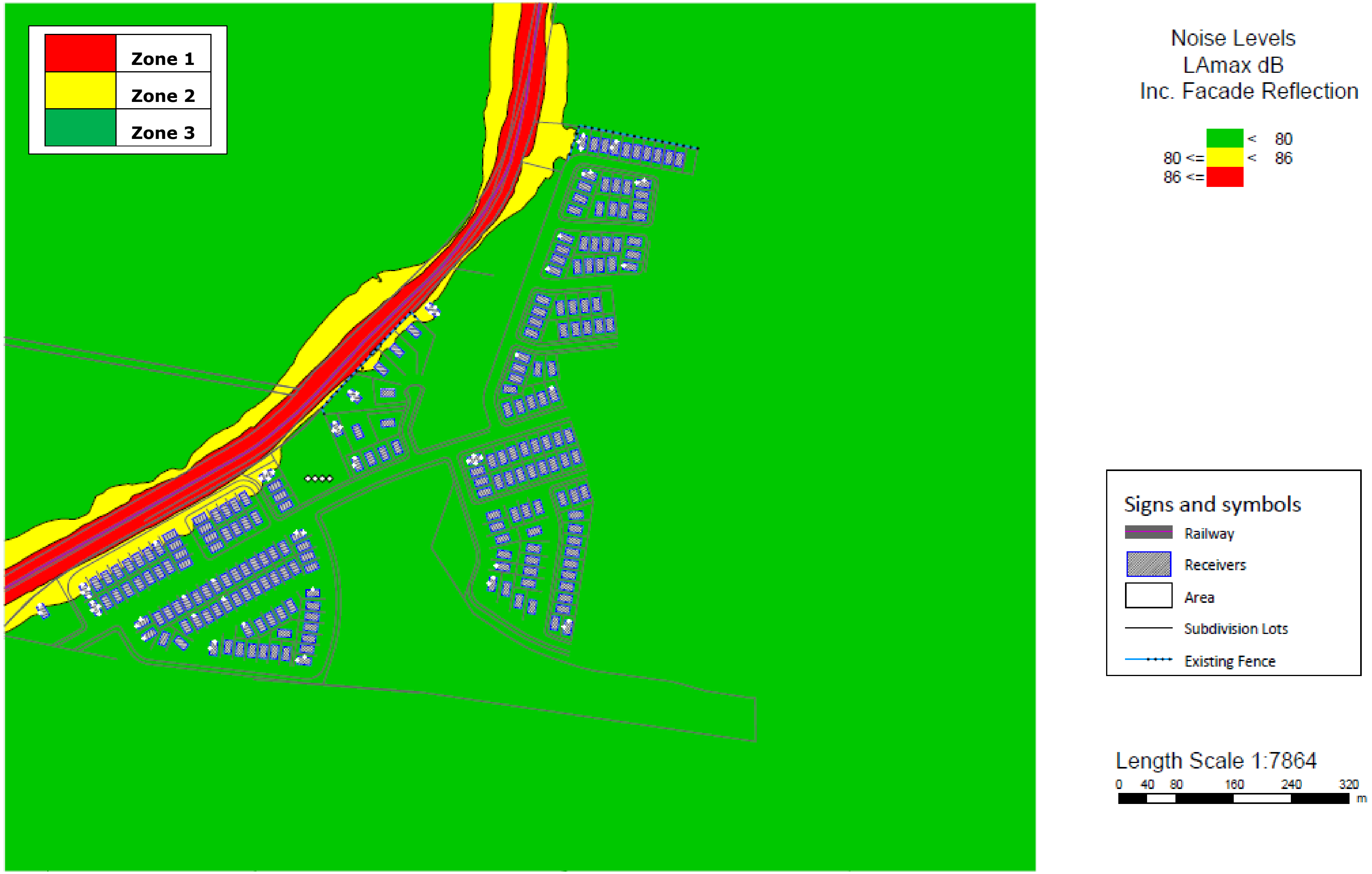
Noise Contour Map 1.5m Ground Floor - LAmax dB ~30Kph




The Loxford Precinct 1B - Freight Rail Noise Impact
Noise Contour Map 4.5m First Floor - LAmax dB ~30Kph
VIPAC
Noise Levels
LAmax dB
Inc. Facade Reflection
< 50
50 <= < 53
53 <= < 56
56 <= < 59
59 <= < 62
62 <= < 65
65 <= < 68
68 <= < 71
71 <= < 74
74 <= < 77
77 <= < 80
80 <= < 83
83 <= < 86
86 <= < 89
89 <= < 92
92 <=
Signs and symbols
Railway
Receivers
Area
Subdivision Lots
Existing Fence
Length Scale 1:7864
0 40 80 160 240 320
m

The Loxford Precinct 1B - Freight Rail Noise Impact

Noise Contour Map 1.5m Ground Floor - LAmax dB ~30Kph



The Loxford Precinct 1B - Freight Rail Noise Impact

Noise Contour Map 4.5m First Floor - LAmax dB ~30Kph