HEGGIES

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North West Rail Link
Ground-borne Noise Study
Route Options Study

PREPARED FOR

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1 INTRODUCTION

As part of the proposed North West Rail Link (NWRL) concept plan, a direct tunnel connection is proposed between the existing underground station at Epping and the proposed underground station at Franklin Road at Cherrybrook (West Pennant Hills).

A number of alignment options between these stations have been identified by TIDC, the community and other stakeholders. These are referred to as the Green, Blue, Brown, Pink and Gold alignments.

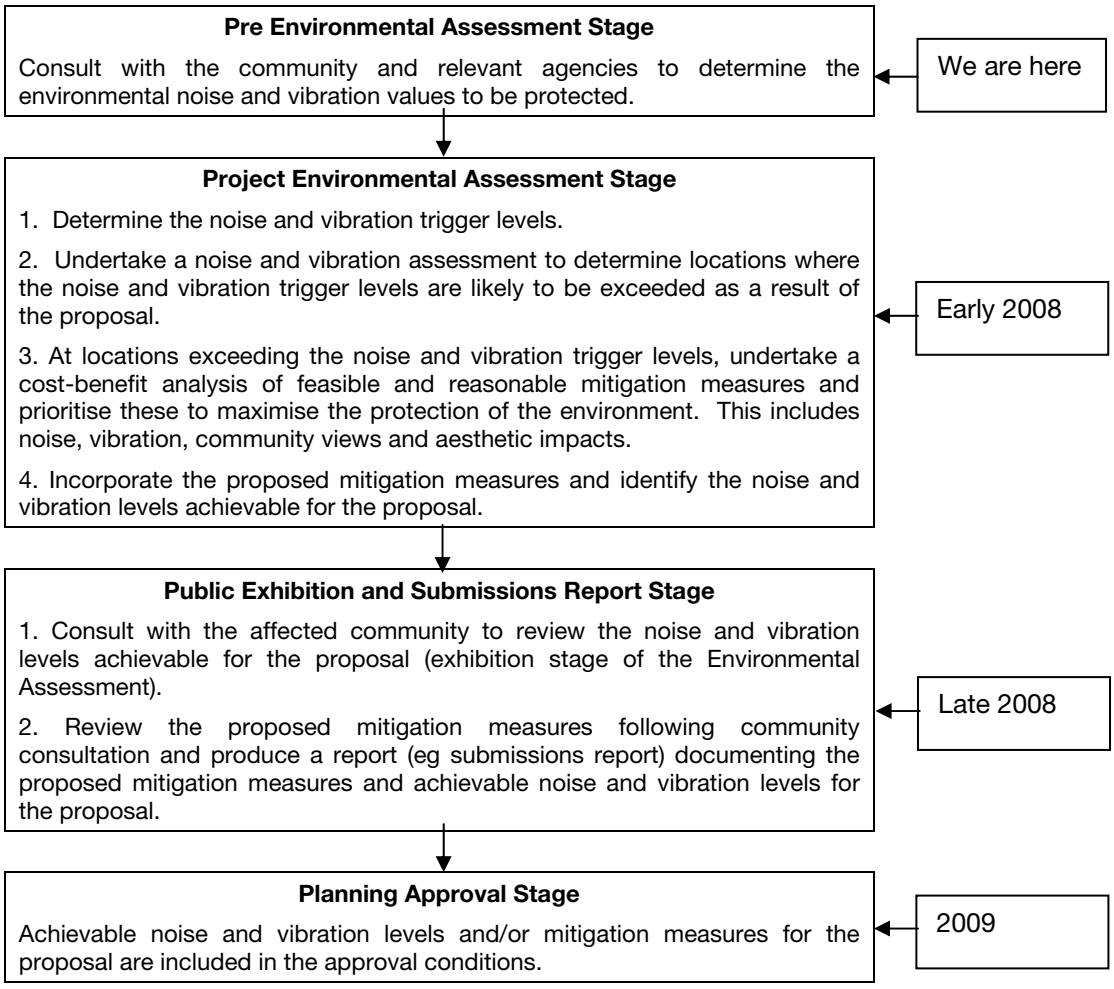
The purpose of this report is to determine whether the alignment options can comply with the ground-borne noise and vibration design targets that are likely to be applied to the project and assessed in detail as part of the next stage of environmental assessment of the NWRL project.

2 GROUND-BORNE NOISE AND VIBRATION TRIGGER LEVELS

Guidance in relation to the operational assessment process for rail projects is provided in the *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* (IGANRIP) (NSW Government – April 2007). The main purpose of the guideline is to assist the ongoing expansion of rail transport by ensuring that potential noise impacts associated with rail developments are assessed in a consistent and transparent manner. The guidelines have been endorsed by government and transport authorities, including DECC, DoP, RailCorp, RTA and TIDC.

For new and upgraded railway lines, the assessment process that is likely to be applied by the IGANRIP process following concept approval is illustrated in **Figure 1**.

Figure 1 Assessment Process (based on Figure 2 in IGANRIP)



For the proposed NWRL concept plan, the Environmental Assessment and the Preferred Project report identified environmental noise and vibration values to be protected. The Preferred Project report provided additional information in relation to proposed modifications to the concept plan (including some of the alignment options discussed in this report).

At this stage in the planning approvals process, a detailed investigation of the likely ground-borne noise and vibration levels has not been undertaken for the rail tunnel. This report identifies the ground-borne noise and vibration trigger levels that are likely to be applied during the project environment assessment stage. The report undertakes a preliminary investigation into locations where the trigger levels could potentially be exceeded and identifies mitigation measures that could be applied to minimise the potential impacts of the NWRL project between Epping and Franklin Road Stations.

Trigger Levels

For ground-borne noise created by the operation of trains in tunnels, noise trigger levels are provided for rail infrastructure projects including a "new railway line". The trigger levels identified in IGANRIP for residential and other noise sensitive receiver locations are provided in **Table 1**. IGANRIP provides guideline trigger levels only - it does not set specific, mandatory noise criteria. Appendix I of the IGANRIP notes that in NSW, the *"noise trigger levels are non mandatory targets that can be used to initiate an assessment of noise impacts and consideration of feasible and reasonable mitigation measures"*.

The ground-borne noise levels represent noise levels inside buildings and are measured/predicted and then assessed at the centre of the most affected habitable room.

Table 1 Ground-borne (Internal) Noise Trigger Levels

Receiver	Time of Day	Noise Trigger Levels (dBA)[1]
Residential	Day (7am to 10pm)	40 L_{Amax} (slow)
	Night (10pm to 7am)	35 L_{Amax} (slow)
Schools, Educational Institutions, Places of Worship	When in Use	40-45 L_{Amax} (slow)

Note 1: L_{Amax} refers to the maximum level not exceeded for 95% of rail pass-by events and is measured using the "slow" response setting on a sound level meter.

For new rail projects, the trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period into the future to represent the expected typical level of rail traffic usage (eg, ten years or similar period into the future).

The IGANRIP also provides commentary leading to the following observations in relation to ground-borne noise levels:

- It is reasonable to conclude that internal ground-borne noise levels from trains in tunnels at or below 30 dBA L_{Amax} will not result in adverse reactions, even where the source of noise is new and occurs in areas with low ambient noise levels (ie where outdoor background sound levels are in the order of 30 dBA or lower).
- International practice typically applies levels of 35-40 L_{Amax} for the design of underground rail systems. Such levels provide reasonable environmental outcomes for most urban residential situations, even in busy underground systems where there are large numbers of train "passby" noise events.
- In relation to potential sleep disturbance, ground-borne noise levels from trains not exceeding 45 dBA L_{Amax} (indoors) appear to be desirable.
- The guideline noise trigger levels in **Table 1** are aimed at providing a reasonable basis for triggering the assessment of impacts from ground-borne noise. As a result, 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 levels for assessing impacts may be suitable for urban areas where background noise levels are relatively high.

For the intermittent ground-borne vibration generated by train passbys, trigger levels are provided in the *Assessing Vibration - A technical guideline* (DEC 2006). For this project, the ground-borne noise trigger levels will be a more stringent design constraint than the ground-borne vibration trigger levels. Therefore, any relevant ground-borne vibration trigger levels would not be exceeded if noise trigger levels are not exceeded. For the sake of completeness, ground-borne vibration levels need to be addressed in later studies, but are not discussed further in this current report.

3 ASSESSMENT APPROACH

In 1995, the International Standards committee published for the first time, ISO 14837-1 1995 *Mechanical vibration - Ground-borne noise and vibration arising from rail systems - Part 1: General Guidance*. This standard provides some useful guidance in relation to the level of assessment that is normally required for new rail systems such as:

- **Scoping model** at the very earliest stages,
- **Environmental Assessment model** during planning process and preliminary design, and

- **Detailed design model** to finalise extent and form of mitigation for construction.

An extract from the standard is provided in **Appendix A**. This report adopted a hybrid scoping/environmental assessment model as the basis for a preliminary assessment of the ground-borne noise levels for each alignment option. The approach was as follows:

- For each alignment, identify the surface ground height at 20 m grid points between Epping and Franklin Road Stations (based on the latest available ground contour information).
- Review the alignment (vertical and horizontal) of the each option and determine the slant distance between the track and ground surface grid points.
- Predict the likely ground-borne noise levels for each alignment and generate surface ground-borne noise contours for the likely track configuration comprising Direct Fix and Floating Slab Track.
- On the basis of this assessment, determine whether the ground-borne noise trigger levels are likely to be exceeded with the likely track types for each alignment.

4 GROUND-BORNE NOISE MODELLING

Overview

As part of the Epping to Chatswood Railway Line (ECRL) project, TIDC requested Heggies to prepare a ground-borne noise model in order to verify the predictions undertaken by Wilkinson Murray Pty Ltd (WMPL). The Heggies and WMPL modelling results showed good correlation.

The Heggies spreadsheet noise model for ECRL was then used in this current study to calculate ground-borne noise levels for the proposed NWRL project (between Epping Station and Franklin Road Station). This is considered reasonable on the basis that the ground conditions are generally similar, the rolling stock will be the same, the maximum train speeds will be the same, the building types above the tunnel alignment are similar and the track design is likely to be similar.

The WMPL noise model is considered to represent a “best estimate” of the likely ground-borne noise levels within buildings above the proposed alignment.

Effect of Turnouts and Curves

For the purpose of this review, it has been assumed that there will be no turnouts in this section for the NWRL alignment options. At turnout locations, a potential increase of up to 10 dB in the ground-borne noise and vibration levels could occur at the nearest building locations, and therefore in the event that a turnout is required, appropriate noise mitigation would need to be considered. Where feasible, turnouts should be located away from sensitive receiver locations (e.g. under major roads such as the M2 Motorway).

A track defect known as corrugation has been observed on rail running surfaces at a number of locations throughout the Sydney Metropolitan Area and generally occurs (but not always) at locations where the curve radius is less than approximately 300 m. At some locations, the presence of corrugations on the rail running surface has resulted in ground-borne noise levels 20 dB higher than for track without corrugations.

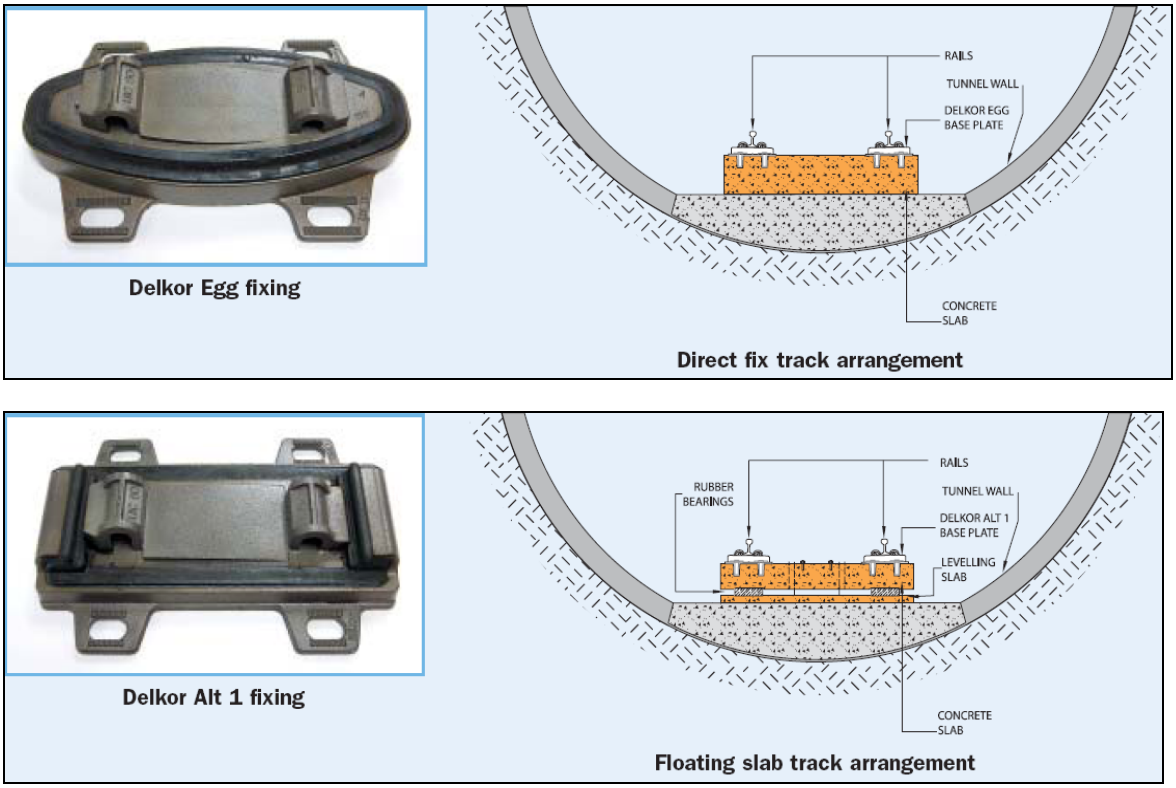
From a design perspective, the risk of corrugations forming is reduced by maximising the straight sections of track and ensuring that the curve radii are greater than approximately 300 m. Since all radii are 500 m or greater, the risk of corrugations forming on the curved sections is considered very low for all route options.

5 CALCULATED GROUND-BORNE NOISE RESULTS – NWRL

Based on previous experience with the Epping to Chatswood Rail Line, there is likely to be a mixture of direct fix track and floating slab track in the NWRL.

The direct fix track will have rubber isolation providing a high level of noise attenuation, but in areas where higher levels of attenuation is needed, a floating slab track will be used. **Figure 2** show typical details of the two types of track slab.

Figure 2 ECRL Direct Fix Track and Floating Slab Track (ECRL)



Source: www.tidc.nsw.gov.au, *Epping to Chatswood Rail Line Track Design Update,* June 2006

There is likely to be a four step process used for assessing the extent of different types of track. This is shown in **Figure 3**:

Figure 3 Process for Determining Extent of Direct Fix and Floating Slab Track

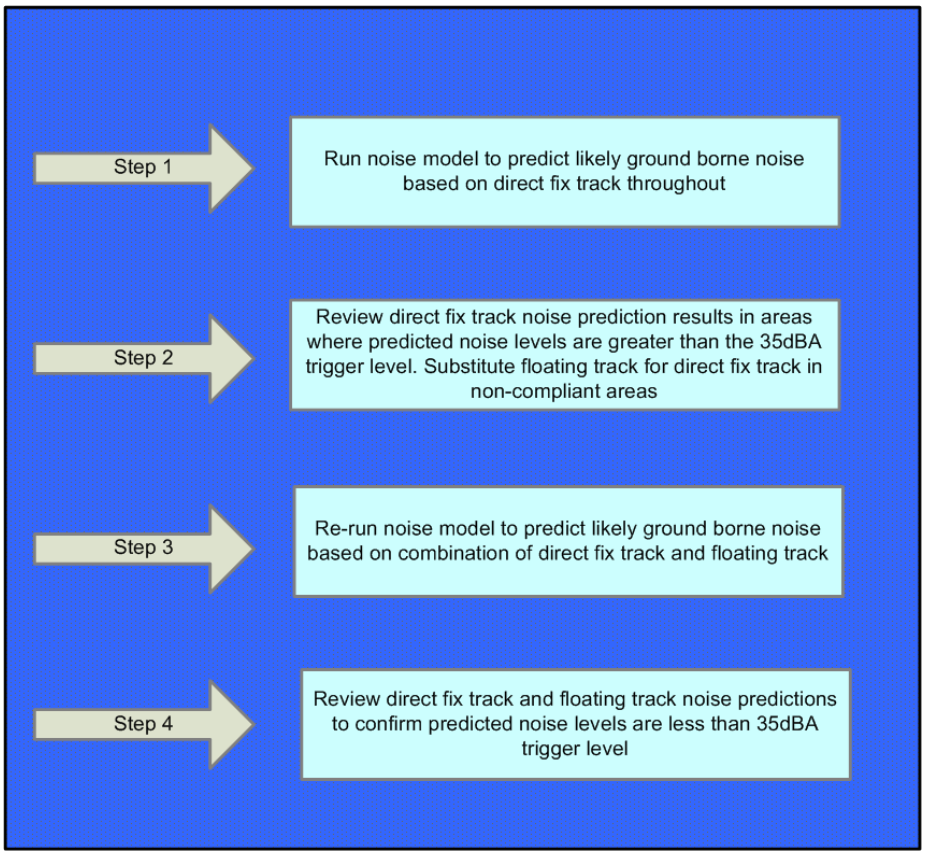
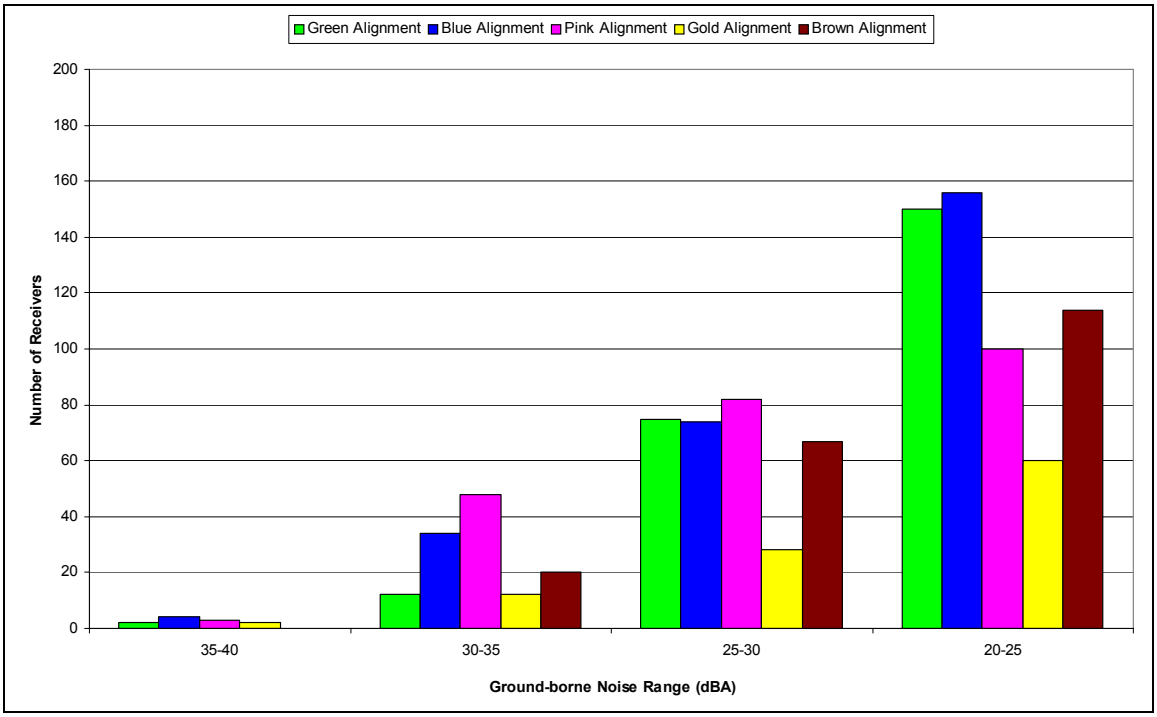


Table 2 provides a summary of the Step 1 results and indicates the number of properties within 5 dBA noise bands for each alignment and track type. The numbers are also summarised graphically in **Figure 4**. It is noted that there are no properties where the calculated likely ground-borne noise levels exceed 40 dBA (irrespective of the alignment option or track type).

Table 2 Step 1 - Ground-borne Noise Prediction Results for Direct Fix Track Throughout

Option	Number of Buildings			
	35-40	**30-35**	**25-30**	**20-25**
Green	2	12	75	150
Blue	4	34	74	156
Pink	3	48	82	100
Gold	2	12	28	60
Brown	0	20	67	114

Figure 4 Step 1 - Ground-borne Noise Prediction Results with Direct Fix Track Throughout – Graphical



The predicted ground-borne noise levels in **Table 2** represent a scenario of the "likely" outcomes for ground-borne noise from trains (as per IGANRIP recommendations) if direct fix track was used throughout. There remains a measure of conservatism in the calculations, as these adopted a maximum train speed of 80 km/h - and are based on the "worst case" building construction type for each building location (i.e. the building type with the highest conversion factor for ground vibration to internal noise levels).

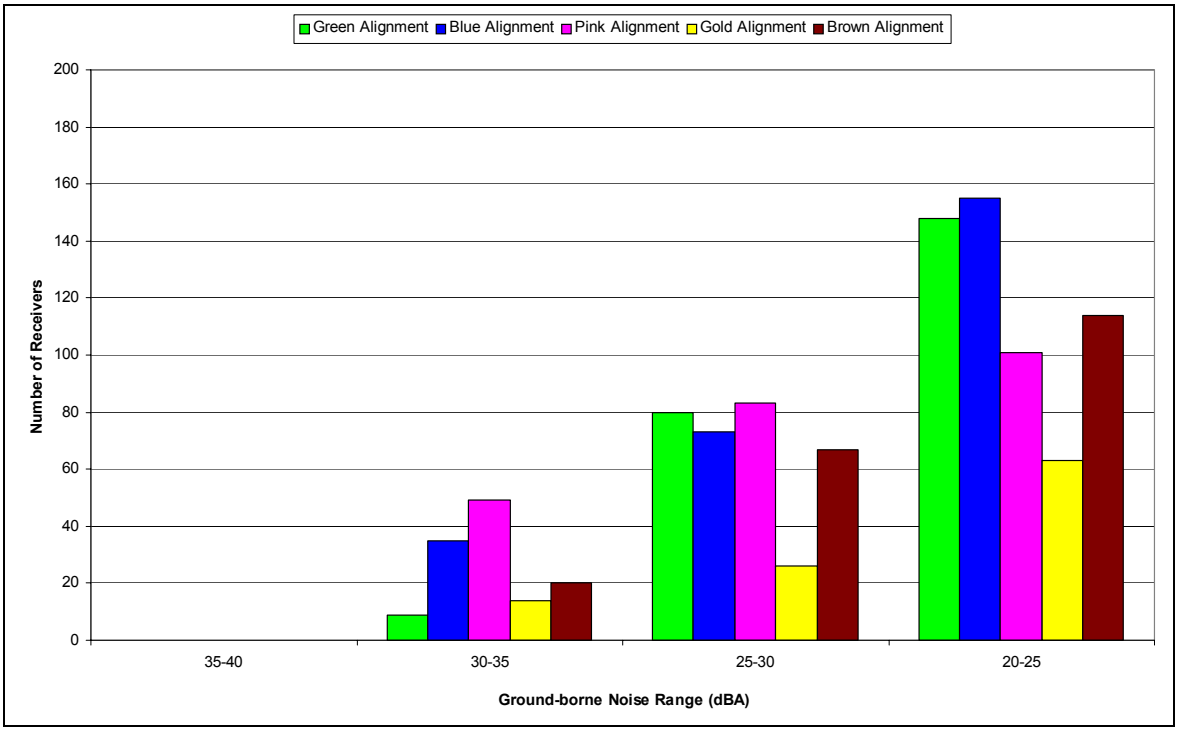
For areas where the predicted noise levels are greater than the 35 dBA trigger level, the model was re-run with the assumption that floating track slab would be provided in these sections (Step 2).

Table 3 provides a summary of the Step 3 results and indicates the number of properties within 5 dBA noise bands for each alignment and track type. The numbers are also summarised graphically in **Figure 5**. It is noted that there are no properties where the calculated likely ground-borne noise levels exceed 35 dBA (irrespective of the alignment option).

Table 3 Step 3 - Ground-borne Noise Prediction Results for Direct Fix and Floating Slab Track Configuration

Option	Number of Buildings			
	35-40	**30-35**	**25-30**	**20-25**
Green	0	9	80	148
Blue	0	35	73	155
Pink	0	49	83	101
Gold	0	14	26	63
Brown	0	20	67	114

Figure 5 Step 3 - Ground-borne Noise Prediction Results – Graphical



Calculated ground-borne noise contour plots for the different NWRL alignment options for the likely track configuration are provided in **Appendix B**. The tunnel centrelines within the 60 m rail corridor are used as an indicative location for the rail tunnels.

The ground-borne modelling results indicate that for all alignment options, the ground-borne noise trigger level of 35 dBA L_{Amax} (slow) would not be exceeded at any location based on the use of ECRL Direct Fix Track design and the ECRL Floating Track design in some locations.

Therefore, it is concluded that for all alignments with the use of an appropriate track form, ground-borne noise levels can be controlled to ensure they are below the non mandatory target (trigger) level of 35 dBA.

6 CONCLUSION

This report presents an assessment of the calculated likely ground-borne noise levels for five tunnel alignment options between Epping Station and Franklin Road Station for the proposed North West Rail Link (NWRL) project.

A ground-borne noise model was developed based on the noise modelling algorithms adopted for the Epping to Chatswood Railway Line (ECRL) assessment, assuming (conservatively) the maximum train speed of 80 km/h and worst case conversion of ground vibration into ground-borne noise inside buildings.

For each possible alignment, modelled ground-borne noise contours have been developed, which indicate the predicted ground-borne noise levels in 5 dBA bands. These are included in the attachments.

For the future environmental assessment of the NWRL project, the relevant noise trigger level within residential dwellings will be 35 dBA L_{Amax} (slow) in accordance with IGANRIP. The preliminary noise modelling indicates that the ground-borne noise trigger levels will not be exceeded for any of the alignment options with the application of a direct fix trackform and in some areas a floating slab trackform.

It is further noted that the ground-borne noise trigger levels are not intended to be applied as mandatory limits in statutory approvals or licences. Exceedances of the trigger level initiates a further assessment of the potential noise impacts and identification of feasible and reasonable mitigation measures.