

Preliminary Noise Report

Overview of Noise Impacts

Caulfield to Dandenong

Report: P03-000-CTD-XEV-0101

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Executive Summary

This report has been prepared to provide an overview of noise considerations on the Level Crossing Removal Project: Caulfield to Dandenong. The proposed design centres on three elevated sections of modern separated rail viaduct. As part of the redevelopment of the rail corridor, rail noise emissions will be required to comply with the Victorian Passenger Rail Infrastructure Noise Policy, 2013 (PRINP). The policy has been developed to guide transport bodies and planning authorities in their consideration of the impacts of rail noise for improved or new passenger rail infrastructure and from changes to land use near existing and planned rail corridors.

The proposed design will alter how noise is generated and propagates throughout the rail corridor and surrounding community. A range of design features will reduce the level of noise being generated, and noise walls will be included within the proposed design to further minimise noise transmission to the surrounding community.

A summary of the potential noise impacts due to design features and the predicted change in noise is presented below:

| Design Feature | Predicted Change in Noise |
|------------------------------------|----------------------------------|
| New continuously welded rail track | 5dB reduction |
| Direct fix using resilient pads | 6dB reduction |
| New stations | 0-5dB reduction |
| Removal of level crossings | 6-8dB reduction |
| Reduction in horn soundings | 3-6dB reduction |
| Noise wall | 5-15dB reduction |
| Vibration isolation | 0-10dB reduction |
| Change in gradient | 4dB reduction to 1dB increase |
| Elevated structure | 0dB increase |

The above factors are assumed to act individually. When considered in combination the net increase or decrease will not be equal to the sum of each individual component.

Compared to existing conditions where relevant noise criteria are not applied, the proposed design will achieve full compliance with relevant noise criteria. The proposed design will result in an overall reduction in noise throughout the corridor and surrounding area through the use of considered design measures.

As the design progresses it is recommended that a comprehensive noise assessment is undertaken to understand noise impacts associated with the proposed design and the resulting change in noise emissions to the surrounding community. The assessment should also ensure the proposed design complies with all relevant noise criteria and project requirements.

Project Overview and Context

Introduction

This report has been prepared to provide an overview of noise considerations on the Level Crossing Removal Project: Caulfield to Dandenong. Noise within rail corridors is a complex interaction of a number of different sources of noise, the environment through which noise travels and the receiving location. While entire textbooks have been written on the subject of rail noise, this report presents a concise overview of the:

- key project objectives and proposed design
- key noise considerations associated with rail projects
- relevant noise criteria applicable to the project
- evaluation of potential noise impacts with the proposed design
- preliminary noise findings associated with the proposed design
- recommendations for future works as the project progresses.

This report describes the preliminary findings based on the proposed design that was presented to the community for consultation and feedback. Further design refinements and modelling will be undertaken to determine the final details of noise considerations for the project.

Project Objectives

The Level Crossing Removal Project: Caulfield to Dandenong was established to remove nine of Melbourne’s most congested level crossings along the Caulfield to Dandenong corridor and completely rebuild five stations on Melbourne’s busiest rail line by late 2018.



Figure 1 - Project Overview

The project allows for the lengthening of 30 existing platforms as well as new signalling and power systems to support new longer High Capacity Metro Trains (HCMT) affording a 42% capacity increase, equivalent to an extra 20,000 passengers a day.

Project objectives identified by the Level Crossing Removal Authority included:

- Maintain an acceptable level of service for road and rail users during delivery;
- Improve the reliability and efficiency of the transport network to improve productivity;
- Promote appropriate land utilisation around rail corridors to facilitate value capture development rights opportunities;
- Provide better connected, more vibrant activity centres and improved urban amenity for all users; and
- Create safer communities.

Proposed Solution

The proposed solution centres on three elevated sections of modern separated rail viaduct, providing key improvements to local communities including the creation of 225,000 square metres of community space for new shared user paths, parks, playground, sporting facilities, car parking and a range of other uses.

This modern design can be built over the existing rail line and will be significantly less disruptive to train services and local roads, meaning that the stations, rail line and local roads can stay open during construction. The majority of the work can be completed with trains and roads running normally.



Figure 2 - Proposed Elevated Design

The proposed solution integrates Urban Design, technical, construction and operational requirements which provide:

- Delivery certainty as elevating the railway reduces the potential for program delays as the majority of works are above ground and offline.
- Transport service improvement through less disruption to road users, train commuters and improved passenger experience.
- Positive stakeholder outcomes through an innovative design solution and new public spaces.
- Land value increase through integrated transport hubs and superior urban design outcomes.
- Enhanced safety through improved community connectivity.

Our Rail Noise Experts

The Level Crossing Removal Authority is working as part of the alliance to deliver the project. WSP | Parsons Brinckerhoff are a member of the alliance and have been selected to provide comprehensive noise and vibration services across the project. WSP | Parsons Brinckerhoff has one of the world's largest and most experienced noise and vibration teams with over 160 staff working globally on noise and vibration projects.

WSP | Parsons Brinckerhoff has extensive local, national and international experience in the assessment of rail noise and vibration, including designing engineering controls to minimise noise and vibration impacts on the community. Recent projects WSP | Parsons Brinckerhoff have been involved with include North West Rail Link in New South Wales (which includes 4km of elevated rail structure) and the Melbourne Noise Mapping project in which WSP | Parsons Brinckerhoff modelled noise from all existing rail lines in Melbourne.

The noise and vibration engineering team on the project is led by Adrian White who has extensive experience in the assessment of rail and environmental noise within Victoria and Australia. Adrian is a member of the Australian Acoustical Society (AAS) and a corporate representative to the Association of Australian Acoustical Consultants (AAAC).

Basic Rail Noise Concepts

Fundamentals of Noise

Although the terms sound and noise can be used interchangeably, noise is generally defined as unwanted sound which has the potential to impact on health and wellbeing. Sound from trains and rail infrastructure is often considered as having the potential to impact on the surrounding community, which is why we refer to it as rail noise.

Sound is due to small pressure fluctuations travelling through the air from the source to the receiver, usually the human ear. There are many ways in which noise can be generated, but typically the small pressure fluctuations are generated by the vibrating movement of a solid object (such as a speaker). As these small pressure fluctuations travel through the air they cause air particles to vibrate.

Key noise properties that relate to the information presented in this report are presented in Table 1.

Table 1 – Basic Noise Properties

| Noise Properties | Description |
|------------------|--|
| Amplitude | Amplitude is defined as the extent to which air particles are displaced when sound waves cause the air to vibrate. The amplitude of the displacement is experienced as the loudness of the sound. |
| Decibels | The human ear has a large dynamic range in what it can hear. At the threshold of pain the sound pressure is roughly 1 million times as large as the sound pressure at the threshold of hearing. Such large ranges can be conveniently expressed using a logarithmic scale. The decibel (dB) is a logarithmic ratio used to describe sound pressure levels. In general terms, changes in noise levels can be classified as: ±3dB – barely perceptible change in noise level ±5dB – clearly perceptible step change in noise level ±10dB – Perceived as a subjective doubling or halving of loudness in noise level |
| Frequency | Frequency is a measure of how many times the air particles vibrate back and forth in a single second. The unit of measurement used to describe frequency is Hertz (Hz). The frequency of a sound is the property that determines the pitch of the sound. Most sounds are made up of a mixture of frequencies with some sounds having more low frequencies (such as a truck engine) or high frequencies (such as a whistle). The human ear can hear frequencies between the range of 20Hz – 20,000 Hz. |
| A-Weighting | The sensitivity of the human ear to sounds is dependent on the frequency of the sound. The human ear is less sensitive to low frequency sounds than to mid-frequencies typically associated with speech. The a-weighting curve is applied to sound levels to account for the relative amplitude perceived by the human ear and is expressed as a-weighted decibels - dB(A). Effectively the a-weighting curve is an approximation of how the human ear perceives sound. |

Sources of Rail Noise

Rail noise is generated by a number of different sources throughout the rail corridor. Overall noise levels at residential locations due to the presence of a rail line is a complex interaction of different noise sources, the effect of the environment on noise transmission (such as noise shielding from buildings) and the receiving location.

While there are many sources of noise associated with rail, a description of some of the common noise sources is presented in Table 2.

Table 2 – Common Sources of Rail Noise

| Noise Source | Description |
|------------------------|--|
| Wheel/Rail Interaction | The interaction of the train wheel and the track is one of the major sources of noise in any rail corridor. As the wheel rolls along the track it produces noise based on a number of factors, including: train speed, track type (such as jointed or welded track), wheel and rail roughness and curves in the track. Wheel/rail noise is typically the predominant noise source for electric passenger trains. |
| Wheel Squeal | Wheel squeal is a phenomenon that can be highly annoying to the community, and occurs when rail wheels stick and slip laterally on the rail track head causing vibration. Wheel squeal is often more pronounced where tracks have tight curve radii and is caused by a complex interaction between the wheel and the track. |
| Train Engine | Train engine noise is a major noise source for freight and diesel trains. Diesel engine noise is the loudest source of freight noise when compared to wheel/rail noise and noise from carriages shunting. |
| Brakes | Noise from brakes can be generated when trains are slowing into stations or at level crossings. Excessive or hard braking can also cause wheel squeal in some instances. |
| Auxiliary Equipment | Noise from auxiliary equipment such as air-conditioning units can be a major source of noise when trains are either stationary or travelling at very low speeds. Typically wheel/rail noise is louder than auxiliary equipment noise when travelling at high speeds. |
| Horns | Horn noise is amongst the loudest noises within any rail corridor. Currently in Victoria all trains must sound horns when approaching a level crossing. Trains must also sound their horn when leaving a station. |
| Level Crossings | Noise from level crossings can be significantly higher than at other locations along the rail corridor. The use of warning bells can generate high noise levels, and the presence of the road causes the wheel/rail noise levels to increase at level crossings. |
| Stations | Stations can be a significant source of noise within the community due to noise associated with PA systems, mechanical plant (such as air-conditioners), and other fixed infrastructure. |
| Ground Vibration | Ground vibration generated by rail movements can cause regenerated noise in surrounding buildings. As vibration travels through the ground and into the surrounding buildings the vibration can cause walls and ceilings to vibrate and act as speakers, resulting in audible noise within the building. |

Environmental Noise Propagation

The propagation of noise throughout the environment is a complex interaction involving a range of factors. To accurately assess rail noise impacts on the community, environmental noise propagation is typically undertaken using industry standard noise modelling packages (such as SoundPLAN or CADNA) and implementing rail noise modelling algorithms.

Independent of the assessment method, environmental noise propagation adheres to a range of well understood physical principals. Common factors that affect environmental noise propagation are presented in Table 3.

Table 3 – Common Factors Affecting Environmental Noise Propagation

| Factor | Description |
|-----------------|---|
| Divergence | Noise levels naturally decrease due to distance. Technically called divergence, this attenuation with distance follows well understood and clearly defined mathematical principles. In general terms noise levels decrease in the following manner: Point source (such as a speaker) – Noise decreases 6dB per doubling of distance Line source (such as a train line) – Noise decreases 3dB per doubling of distance |
| Absorption | Noise propagation within the environment can be attenuated due to changes in ground coverings. Over large distances the effects of ground absorption are more pronounced. Soft ground coverings such as grass absorb some noise, while hard ground coverings such as car parks reflect noise. |
| Shielding | Objects in the environment such as buildings can provide effective shielding of noise to surrounding receiver locations. Shielding is most effective when it is located close to either the source of the noise or the receiver location. For example a noise wall provides shielding. |
| Weather Effects | Weather effects can have an impact on environmental noise propagation. Weather effects are typically more pronounced over large distances (several hundred metres to kilometres). Wind speed and direction, as well as temperature gradients are generally considered as part of any environmental noise modelling over large distances. |

In addition to airborne noise propagation, rail movements can also generate high levels of ground-borne noise. As rail movements generate vibration that travels through the ground and into the surrounding buildings, the vibration can result in walls and ceilings vibrating and acting like speakers, resulting in audible noise within the building.

Airborne and ground-borne noise transmission is illustrated in Figure 3.

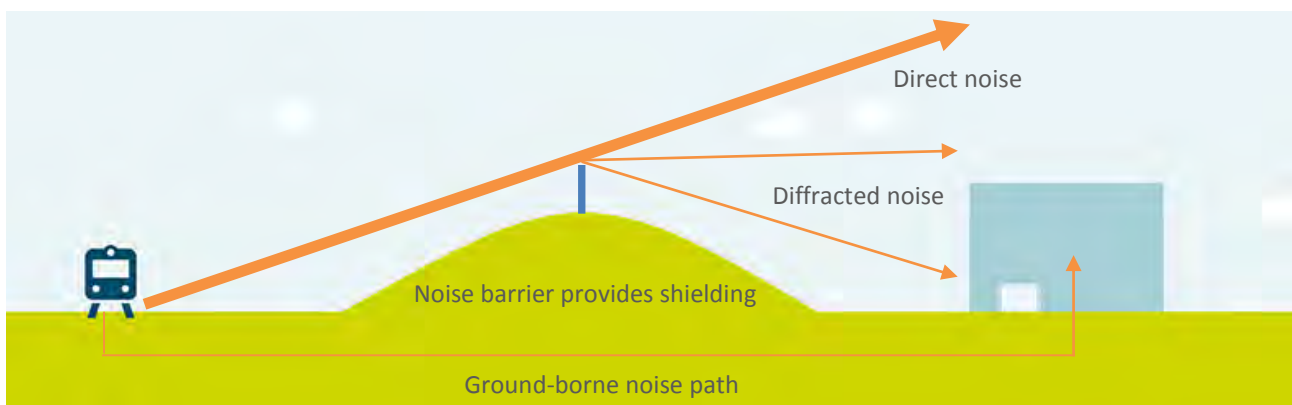


Figure 3 - Environmental Noise Propagation

Descriptors for Rail Noise

Various acoustic descriptors exist to assess differing impacts of noise sources on the environment. Rail noise is typically assessed against both average and maximum noise criteria to evaluate cumulative noise exposure due to intermittent rail movements and maximum noise exposure due to single movements.

An overview of typical rail noise descriptors are presented in Table 4.

Table 4 – Rail Noise Descriptors

| Noise Descriptor* | Description |
|---|---|
| Day Noise Level (6am-10pm), dBA L_{eq-16h} | <p>The A-weighted equivalent continuous sound level measured over the 16 hour (6am – 10pm) ‘day’ period.</p> <p>Equivalent continuous sound levels (L_{eq}) is the common assessment method to describe sound levels that vary over time, and is expressed as a single decibel value.</p> <p>The Day Noise Level descriptor is a measure of the cumulative noise exposure due to all rail movements throughout the corridor during the day period.</p> |
| Night Noise Level (10pm-6am), dBA L_{eq-8h} | <p>The A-weighted equivalent continuous sound level measured over the 8 hour (10pm – 6am) ‘night’ period.</p> <p>Equivalent continuous sound levels (L_{eq}) is the common assessment method to describe sound levels that vary over time, and is expressed as a single decibel value.</p> <p>The Night Noise Level descriptor is a measure of the cumulative noise exposure due to all rail movements throughout the corridor during the night period.</p> |
| Maximum Noise Level, dBA L_{max} | <p>The A-weighted maximum noise level measured during the assessment period (Day or Night).</p> <p>The maximum noise level (L_{max}) is a common assessment method to describe the loudest sound levels that have been measured during an assessment period, and is expressed as a single decibel value.</p> <p>The Maximum Noise Level descriptor is a measure of the loudest single noise level that occurs during the assessment period due to any rail movement.</p> |

Time periods used to classify noise descriptors are defined by the Victorian Passenger Rail Infrastructure Noise Policy, 2013.

Noise Criteria

Operational Noise Criteria

Rail noise within Victoria is assessed through the application of the Victorian Passenger Rail Infrastructure Noise Policy, 2013 (PRINP). The policy has been developed to guide transport bodies and planning authorities in their consideration of the impacts of rail noise for improved or new passenger rail infrastructure and from changes to land use near existing and planned rail corridors.

The policy prescribes a series of investigation thresholds to guide transport bodies and planning authorities when assessing the impacts of rail noise on nearby communities and exposure of people to passenger rail noise. The investigation thresholds are not a limit on allowable noise emissions.

The relevant investigation thresholds for the Level Crossing Removal Project: Caulfield to Dandenong project are presented in Table 5.

Table 5 - PRINP Investigation Thresholds

| Time | Type of Receiver | Investigation Threshold |
|----------------------------------|---|--|
| Day (6am-10pm) dBA External | Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks | 65 L_{Aeq} and change in L_{Aeq} of 3dBA or more |
| | Noise sensitive community buildings including schools, kindergartens, libraries | Or 85 L_{Amax}^* and change in L_{Amax} of 3dBA or more |
| Night (10pm-6am) dBA External | Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks | 60 L_{Aeq} and change in L_{Aeq} of 3dBA or more |
| | | Or 85 L_{Amax}^* and change in L_{Amax} of 3dBA or more |

*As defined in the PRINP - L_{Amax} means maximum A-weighted sound pressure level and is the 95 percentile of the highest value of the A-weighted sound pressure level reached within the day or night;

Fixed Infrastructure Noise Criteria

Noise emissions from fixed infrastructure, such as train stations, are required to comply with the Victorian State Environmental Policy (Control of Noise from, Commerce, Industry and Trade) No. N-1 (SEPP N-1).

SEPP N-1 prescribes procedures for determining the statutory environmental noise limits that apply to noise sensitive locations (such as residential areas) with regards to noise due to commercial, industrial and trade operations.

The noise limits prescribed by SEPP N-1 apply to the area of land on the noise sensitive property, which is within 10 metres of the noise sensitive building. The SEPP N-1 noise limits are based on:

- Zoning Levels – which are calculated based on the planning scheme zoning designations within 70 metre and 200mm radii of the noise sensitive area being assessed.
- The time of day – different noise limits apply for different periods of the day.
- The background (L_{A90}) noise level – the measured noise level in the noise sensitive area, in the absence of noise due to commercial, industrial or trade operations.

In accordance with SEPP N-1, noise from the source under consideration is measured to determine its impact over a continuous 30 minute period. Adjustments to the measured noise level are applied under SEPP N-1 to account for the effects of duration, tonality and impulsiveness.

SEPP N-1 noise limits will be established for all relevant noise sensitive locations as the project progresses and background noise survey work is undertaken.

Noise emissions associated with new stations and fixed infrastructure must be designed to fully comply with SEPP N-1 noise criteria.

Construction Noise Criteria

Noise emissions from construction activities are required to comply with permit and approvals conditions throughout Victoria. The Victorian Environment Protection Authority (EPA) provides guidelines and legislation to help manage construction noise.

Specific noise criteria applicable to construction activities will be dependent on a range of factors including the type of works, the time of works and the expected duration of works. As such, criteria will be determined on a case-by-case basis to ensure noise criteria appropriately protects the community from adverse impacts of construction noise.

This project will implement a best practice approach to managing construction noise, which may involve using tools such as predictive modelling of construction activities, and noise and vibration monitoring to ensure compliance with criteria.

Evaluation of Noise Impacts

This section summarises the predicted impact or change in airborne and ground-borne noise for the proposed design.

Track Type

The existing corridor is fitted with jointed track. Jointed track is made by using lengths of rail, typically about 20 metres long, bolted together using steel plates. The proposed design will use welded rail track to form one uniform piece of continuous track throughout the corridor.

The predicted reduction in noise emissions due to a change in track type is shown in Table 6.

Table 6 – Track Type Predicted Change in Noise

| Design Feature | Predicted Change in Noise | References |
|------------------------------------|---|--|
| New continuously welded rail track | Predicted 5dB reduction in noise from current levels, due to the removal of track joints and the installation of smooth new track | US FTA (2006) - 5dB change Swing and Pies (1973) - 4-8dB change |

Track Fixings

The existing corridor uses ballasted track fixings, where the rail track is fixed to concrete or timber sleepers sitting on rock ballast. The proposed design will use direct fix track mountings with anti-vibration resilient pads to directly attach the track to the structure, while minimising vibration transfer and the potential for structure borne noise.

The predicted reduction in noise emissions due to a change in track fixing is shown in Table 7.

Table 7 – Track Fixing Predicted Change in Noise

| Design Feature | Predicted Change in Noise | References |
|---------------------------------|--|--|
| Direct fix using resilient pads | Predicted 6dB reduction in noise when compared to using ballasted track on structure | Wang et al. (2000) – 6dB change (air-borne noise) Wilson (2004) – 6-8dB change (ground-borne noise) |

Station Design

The existing stations can generate high levels of noise through the use of mechanical plant (such as air-conditioners) and public address systems. Traditionally, public address systems have used fewer speakers generating higher levels of noise to achieve appropriate speech intelligibility. The proposed design will rebuild stations and allow for modern design features to be incorporated to achieve the required speech intelligibility at lower volumes. The station canopies will also provide shielding of noise to the surrounding environment.

The predicted reduction in noise emissions due to a change in station design is shown in Table 8.

Table 8 – Station Design Change in Noise

| Design Feature | Predicted Change in Noise | References |
|----------------|--|---|
| New stations | Predicted 0-5dB reduction in noise is feasible through considered design, placement, and orientation of noise generating equipment and speakers at stations. | Preliminary noise modelling based on location and orientation of speakers indicates 0-5dB change in noise is achievable through considered design. This finding is in agreement with our professional experience on other projects. |

Warning Bells/Level Crossings

The existing level crossings generate higher noise levels than other areas of the rail corridor. The increased noise at level crossings is due to a range of factors including, warning bell noise, track irregularities and train horn soundings. The proposed design will removal all level crossings resulting in a removal of all additional noise sources that currently exist at level crossings

The predicted reduction in noise emissions due to level crossing removal is shown in Table 9.

Table 9 – Level Crossings Predicted Change in Noise

| Design Feature | Predicted Change in Noise | Predicted Change in Noise |
|----------------------------|---|--------------------------------------|
| Removal of level crossings | Predicted 6-8dB reduction in noise from current situation | Swing and Pies (1973) – 6-8dB change |

Horn Soundings

The existing rail corridor requires that all trains sound horns when approaching a level crossing. The proposed design will removal all level crossings resulting in a reduction in horn noise throughout the rail corridor.

The predicted reduction in noise emissions due to reduced horn soundings is shown in Table 10.

Table 10 – Horn Soundings Predicted Change in Noise

| Design Feature | Predicted Change in Noise | Reference |
|-----------------------------|--|--|
| Reduction in horn soundings | Predicted 3-6dB reduction in noise from horns. | Preliminary noise modelling of noise levels based on a reduction in horn soundings of between 50%-75% throughout corridor. |

Noise Walls

The existing rail corridor contains no noise walls or noise reduction measures to reduce rail noise impacting on the surrounding community. The proposed design includes the provision for noise walls and visual screening at a number of locations. The proposed screens will vary in height between 600mm-2000mm. Noise barriers are most effective where they block line of sight between the receiver and the wheel/track interface.

The predicted reduction in noise emissions due to noise barriers is shown in Table 11.

Table 11 – Noise Wall Predicted Change in Noise

| Design Feature | Predicted Change in Noise | Reference |
|----------------|--|---|
| Noise wall | Predicted 5-15dB reduction in noise dependent on the location, height and extents of barriers installed. | US FTA (2006) - 5-15dB change in noise where barrier blocks line of sight Wilson (2004) – 6-9dB measured for different in situ barriers Preliminary modelling shows 0-15dB change in noise dependent on location, height and extents of barriers. |

Vibration Isolation

The existing rail corridor contains no vibration isolation measures to minimise ground-borne noise impacting on the surrounding community. The proposed design includes vibration isolation where the track is fixed to the elevated structure and where the elevated deck meets the structural piers. Both vibration isolation measures will result in lower levels of ground-borne noise being generated at surrounding areas.

The predicted reduction in noise emissions due to vibration isolation is shown in Table 12.

Table 12 – Vibration Isolation Predicted Change in Noise

| Design Feature | Predicted Change in Noise | Reference |
|---------------------|--|---|
| Vibration isolation | 0-10dB reduction in ground-borne noise transmission dependent on a range of factors such as train type, location, ground conditions and building footings. | US FTA (2006) – 10dB change for resilient rail ties |

Changes in Gradient

The existing rail corridor is generally flat and level with no major gradients. The proposed design will introduce gradients of between 0-2% at either end of the elevated structure as it transitions to ground level. The change in gradient will not impact on passenger electric noise levels, but will impact on diesel V-Line and freight noise emissions.

While an elevated design will result in changes to the acoustic environment due to changes in gradient, it is noted that any grade separation solution will required gradients (to either rail or road) that would impact on noise emissions throughout the corridor.

The predicted change in noise emissions due to changes in gradients is shown in Table 13.

Table 13 – Gradient Predicted Change in Noise

| Design Feature | Predicted Change in Noise | Reference |
|--------------------|---|-----------------------|
| Change in gradient | <p>0dB change for passenger electric trains.</p> <p>Up to 1dB increase in noise emissions for diesel V-Line and freight ascending compared to travelling along flat ground.</p> <p>Up to 4dB decrease in noise emissions for diesel V-Line and freight descending compared to travelling along flat ground.</p> | Swing and Pies (1973) |

Elevated Structures

The existing rail corridor is at-grade with no elevated sections. The proposed design will introduce elevated concrete structures which have the potential to generate structure-borne noise (noise due to the entire structure vibrating). Structure-borne noise is typically more pronounced in steel elevated structures than with concrete structures.

The predicted change in noise emissions due to an elevated structure is shown in Table 13.

Table 14 – Elevated Structure Change in Noise

| Design Feature | Predicted Change in Noise | Reference |
|---------------------|--|--|
| Elevated structures | 0dB increase in L_{max} noise levels due to pass-by events compared to existing situation. | Preliminary modelling indicates structure-borne noise 10dB below existing L_{max} levels. As such, no increase in noise level. |

Summary of Noise Impacts

The proposed design will significantly alter how noise is generated and propagates throughout the rail corridor and surrounding community. A range of design features will reduce the level of noise being generated, and noise walls will be designed to further minimise noise transmission to the surrounding community.

A summary of the noise impacts and the predicted change in noise is presented in Table 15.

Table 15 - Summary of Noise Impacts

| Design Feature | Predicted Change in Noise |
|------------------------------------|----------------------------------|
| New continuously welded rail track | 5dB reduction |
| Direct fix using resilient pads | 6dB reduction |
| New stations | 0-5dB reduction |
| Removal of level crossings | 6-8dB reduction |
| Reduction in horn soundings | 3-6dB reduction |
| Noise wall | 5-15dB reduction |
| Vibration isolation | 0-10dB reduction |
| Change in gradient | 4dB reduction to 1dB increase |
| Elevated structure | 0dB increase |

The above factors are assumed to act individually. When considered in combination the net increase or decrease will not be equal to the sum of each individual component.

Compared to existing conditions where relevant noise criteria are not applied, the proposed design will achieve full compliance with relevant noise criteria. The proposed design will result in an overall reduction in noise throughout the corridor and surrounding area through the use of considered design measures.

Preliminary Noise Modelling Results

Preliminary noise modelling has been undertaken to determine the effectiveness of potential noise control measures associated with the proposed design and to determine the potential change in airborne noise emissions to surrounding areas.

As the design progresses, a detailed assessment of all potential noise impacts associated with the proposed design will be undertaken to comprehensively assess noise emissions to surrounding areas.

Noise modelling calculations have been undertaken using acoustic noise modelling software, and have considered all noise modelling inputs that would impact on noise levels and propagation including:

- Ground topography
- Ground type (such as asphalt or grass)
- Building heights and locations
- The existing and proposed rail alignments
- For each of passenger electric, v-line diesel and diesel freight vehicles:
 - vehicle timetables and movements
 - vehicle lengths
 - vehicle speeds
 - vehicle source noise levels
- The existing and proposed track types and fixings
- Proposed elevated structure design
- Proposed noise wall design

Preliminary noise modelling has adopted a conservative approach of over-predicting the effect of modelling variables on the calculated noise emissions. As such, actual noise impacts associated with the proposed design are likely to be lower than those currently indicated.

Appendix A presents a summary of calculated potential noise exposure levels with regard to the established night period investigation threshold of 60L_{Aeq} dB. This night period investigation threshold has been ascertained as the controlling investigation threshold for the project.

The results of preliminary noise modelling indicated that the proposed design will achieve full compliance with relevant noise criteria and result in an overall reduction in noise throughout the corridor and surrounding area.

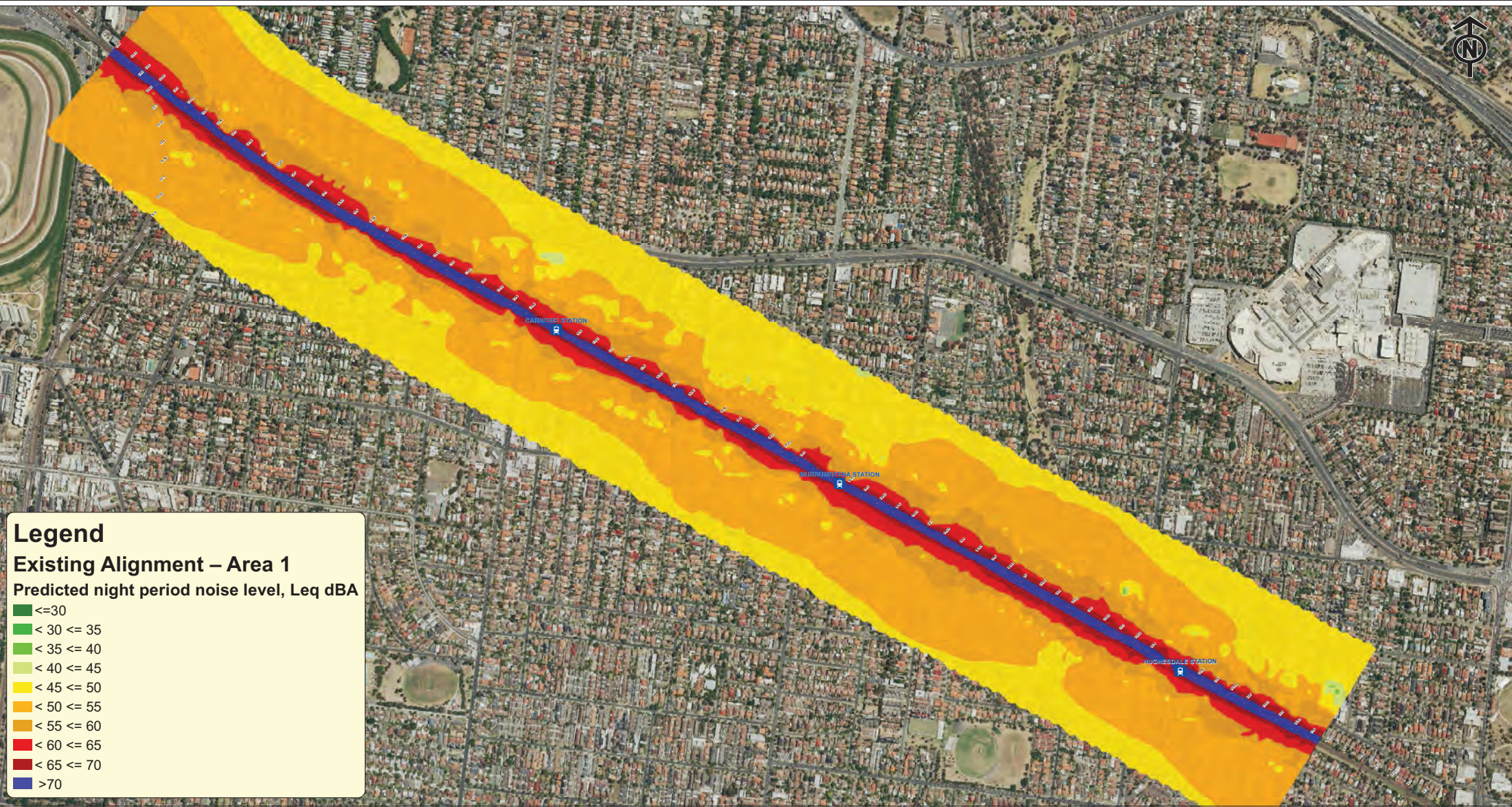
Recommended Future Works

As the design progresses it is recommended that a comprehensive noise assessment of the final design is undertaken to understand noise impacts associated with the proposed design and the resulting change in noise emissions to the surrounding community. The assessment should also ensure the proposed design complies with all relevant noise criteria and project requirements.

Future works should include:

- Additional site measurements for calibration and validation of modelling
- Detailed modelling assessment of proposed design
- Detailed design and optimization of barrier requirements
- Assessment of operational ground vibration levels
- Assessment of construction noise and vibration impacts
- Assessment of noise emissions from fixed infrastructure (such as station mechanical plant)
- Station platform acoustic and PA design to achieve speech intelligibility requirements
- Detailed assessment of structure borne noise level predictions
- Post construction validation of noise emissions

Appendix A – Preliminary Noise Modelling Results



Legend

Existing Alignment – Area 1

Predicted night period noise level, Leq dBA

- <=30
- < 30 <= 35
- < 35 <= 40
- < 40 <= 45
- < 45 <= 50
- < 50 <= 55
- < 55 <= 60
- < 60 <= 65
- < 65 <= 70
- >70

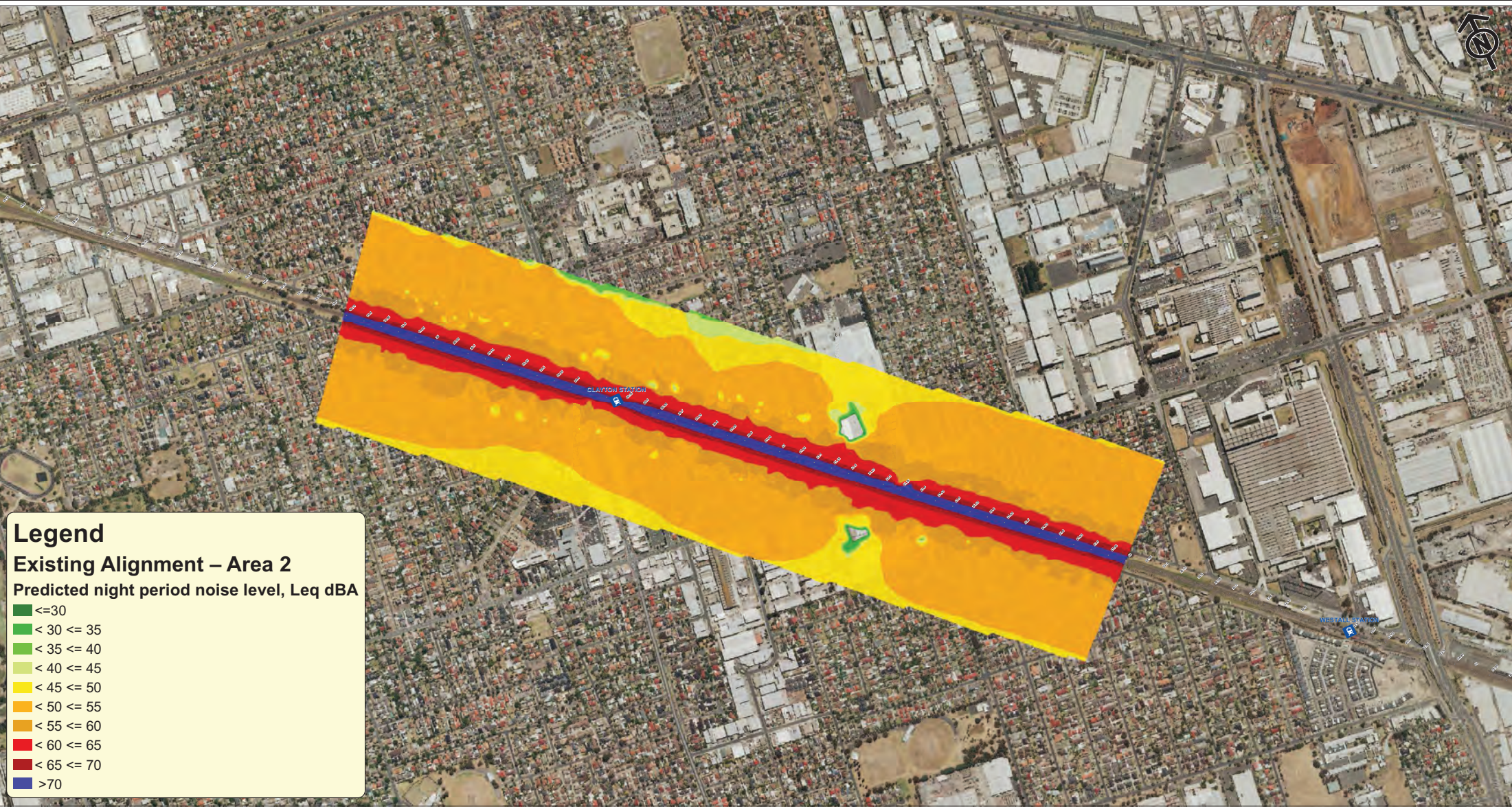


Legend

Proposed Alignment – Area 1

Predicted night period noise level, Leq dBA

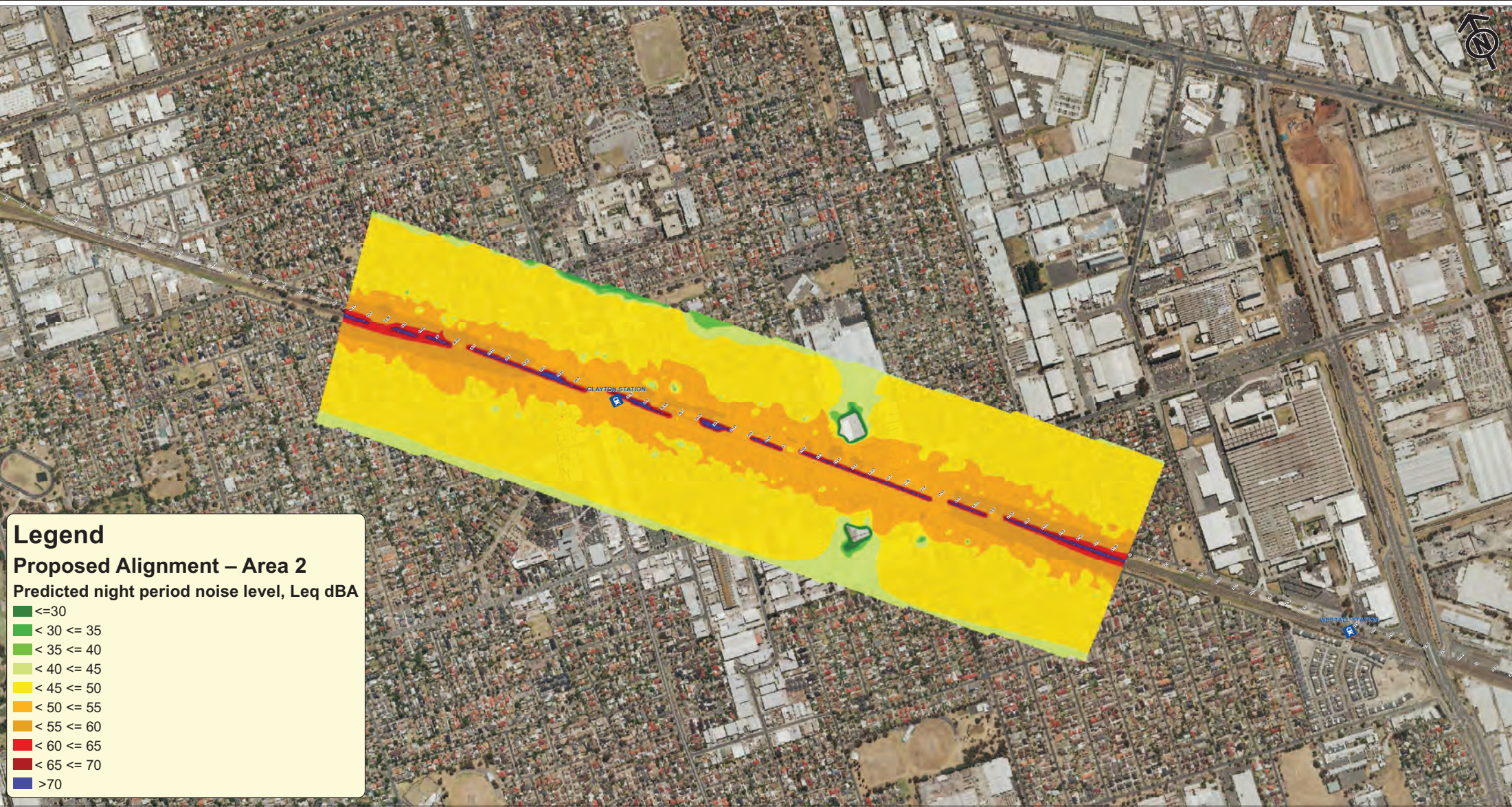
- <=30
- < 30 <= 35
- < 35 <= 40
- < 40 <= 45
- < 45 <= 50
- < 50 <= 55
- < 55 <= 60
- < 60 <= 65
- < 65 <= 70
- >70



Legend

Existing Alignment – Area 2
Predicted night period noise level, Leq dBA

- <=30
- < 30 <= 35
- < 35 <= 40
- < 40 <= 45
- < 45 <= 50
- < 50 <= 55
- < 55 <= 60
- < 60 <= 65
- < 65 <= 70
- >70



Legend
Proposed Alignment – Area 2
Predicted night period noise level, Leq dBA

| | |
|--------------|------------|
| Green | <=30 |
| Light Green | < 30 <= 35 |
| Medium Green | < 35 <= 40 |
| Yellow-Green | < 40 <= 45 |
| Yellow | < 45 <= 50 |
| Orange | < 50 <= 55 |
| Dark Orange | < 55 <= 60 |
| Red | < 60 <= 65 |
| Dark Red | < 65 <= 70 |
| Blue | >70 |



Legend
Existing Alignment – Area 3
Predicted night period noise level, Leq dBA

| | |
|--------------|------------|
| Green | <=30 |
| Light Green | < 30 <= 35 |
| Medium Green | < 35 <= 40 |
| Yellow-Green | < 40 <= 45 |
| Yellow | < 45 <= 50 |
| Orange | < 50 <= 55 |
| Red-Orange | < 55 <= 60 |
| Red | < 60 <= 65 |
| Dark Red | < 65 <= 70 |
| Blue | >70 |



Legend
Proposed Alignment – Area 3
Predicted night period noise level, Leq dBA

| | |
|--------------|------------|
| Green | <=30 |
| Light Green | < 30 <= 35 |
| Medium Green | < 35 <= 40 |
| Yellow-Green | < 40 <= 45 |
| Yellow | < 45 <= 50 |
| Orange | < 50 <= 55 |
| Dark Orange | < 55 <= 60 |
| Red | < 60 <= 65 |
| Dark Red | < 65 <= 70 |
| Blue | >70 |

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