

Environment
Effects Statement

Chapter 12

Tunnel vibration



Chapter 12

Tunnel vibration and regenerated noise

This chapter provides an assessment of the potential vibration and regenerated noise impacts associated with the construction of the North East Link tunnels. It is based on the impact assessment presented in Technical report D – Tunnel vibration.

Construction of North East Link would include activities and equipment that could generate noise and vibration at levels greater than the existing background environment. In particular, construction of the trench, tunnels, portals and cross passages has the potential to cause ground-borne vibration and regenerated noise that could impact amenity, buildings or utility assets, or affect the operation of sensitive equipment.

The EES scoping requirements include the following evaluation objective:

- To minimise adverse air quality, noise and vibration effects on the health and amenity of nearby residents, local communities and road users during both construction and operation of the project.

To assess the potential effects of vibration and regenerated noise caused by tunnel construction, a tunnel vibration and regenerated noise impact assessment was undertaken. The assessment included use of a vibration and regenerated noise model to predict impacts, informed by baseline monitoring of existing vibration levels. Project-specific vibration and regenerated noise guideline targets were developed to minimise adverse impacts as far as practicable.

What is tunnelling vibration and regenerated noise?

The vibration and regenerated noise caused by construction of the North East Link tunnels, portals and cross passages would be 'ground-borne'.

Ground-borne vibration is vibration propagated through the ground and into buildings, structures and underground services. If sufficiently high, this can cause rattling and movement of building contents, such as small objects on hard surfaces or loosely-hung pictures.

Vibration may be either continuous or semi-continuous, as typical for tunnelling equipment, or impulsive, as in the case of blasting.

Ground-borne noise (also called **regenerated noise**) is the noise heard within a building or structure when vibration is propagated through the ground and into a structure. It is generally heard indoors as a 'rumble' in addition to existing background noise levels.

No tunnel vibration or regenerated noise impacts would occur during operation of North East Link, as tunnelling activities would already be completed.

Other aspects covered in the above evaluation objective are air quality, and surface noise and vibration. These are addressed in the following EES chapters and technical reports:

- Chapter 10 – Air quality and Technical report B – Air quality
- Chapter 11 – Surface noise and Technical report C – Surface noise and vibration.

12.1 Method

Informed by the risk assessment described in Chapter 4 – EES assessment framework, the tunnelling vibration and regenerated noise assessment involved the following key tasks:

- Review of relevant legislation and policy at a national, state and local level.
- Establishment of a study area for assessing tunnel vibration and regenerated noise, shown in Figure 12-1. This comprised the trench section north of Blamey Road extending to near Elder Street, and the full tunnel length, between and including both the northern and southern tunnels portals. The area within approximately 200 metres each side of the carriageway was assessed. Based on the reference project, there would be no impacts from vibration or regenerated noise beyond this study area.
- Desktop assessment and baseline data review, including review of methods used in other tunnelling projects for predicting and analysing vibration and regenerated noise effects.
- Site assessment to identify key sensitive receptors (including meeting with the Heide Museum of Modern Art).
- Monitoring existing vibration levels at residential properties.
- Development of guideline targets for vibration and regenerated noise.
- Assessment of the potential for vibration and regenerated noise impacts during construction of the trench, tunnels, portals and cross passages, including modelling of the predicted vibration and regenerated noise levels based on:
 - the type of equipment expected to be used to construct the trench, tunnels, portal structures and cross passages
 - the location of sensitive receptors
 - the geological conditions
 - depth of tunnelling.

What are the risk categories?

Risk levels were categorised as very low, low, medium, high or very high. The results of the initial risk assessment were used to prioritise the focus of the impact assessments.

- Development of Environmental Performance Requirements (EPRs) in response to impact assessment. The residual risk ratings and the assessment of impacts presented in this chapter assume implementation of the EPRs. Refer to Chapter 27 – Environmental management framework for the full list of EPRs.

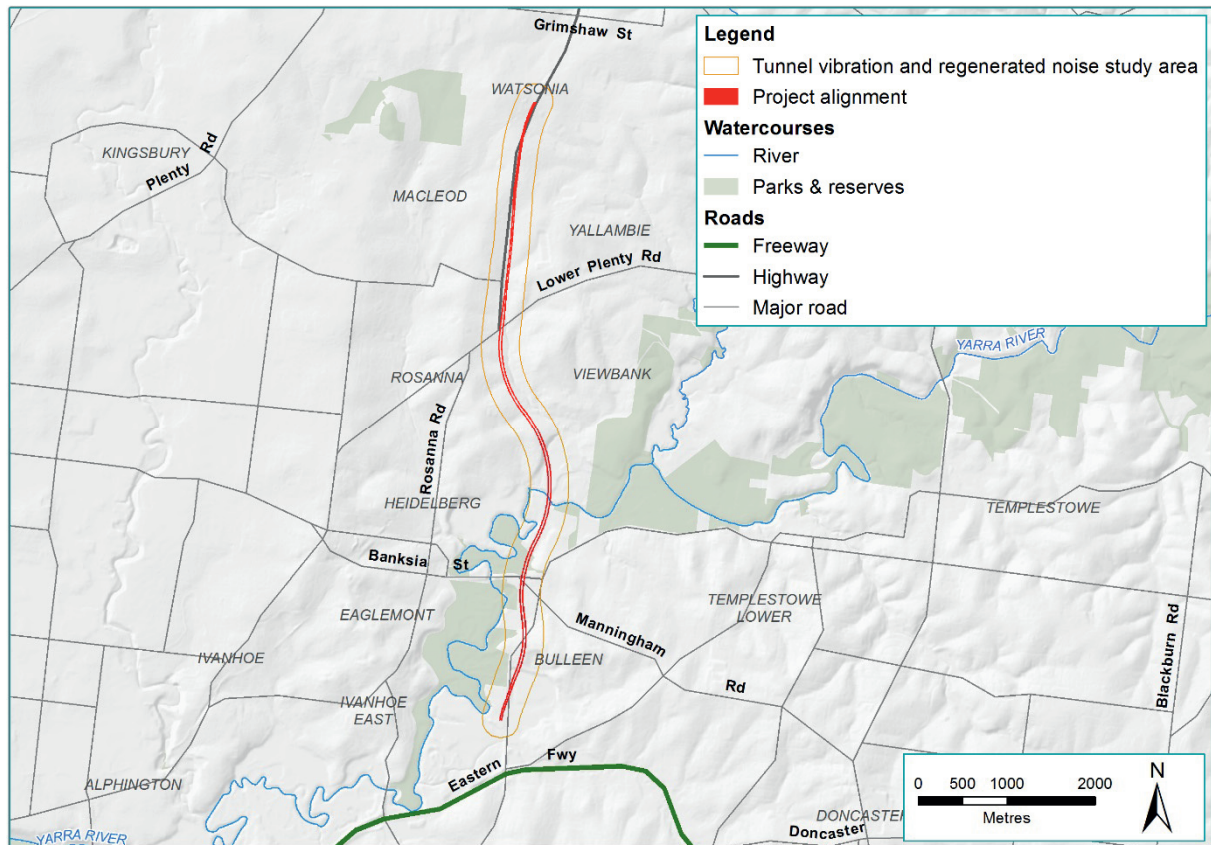


Figure 12-1 Study area for tunnel vibration and regenerated noise assessment

12.2 Existing conditions

This section outlines the existing conditions within the study area that relate to tunnel vibration and regenerated noise.

12.2.1 Geological conditions

Geological conditions are a key consideration for the transmission of vibration below ground. Geology influences the type of equipment that can be used for tunnelling, development of the tunnel cross passages and the excavation of the tunnel portals.

Geotechnical investigations were undertaken along the alignment to understand the ground conditions and inform the design and proposed construction methods. The geology underlying the alignment varies, with areas of silt/gravel/clay material (alluvium), softer rock (weathered siltstone) and harder rock (fresh siltstone) all present.

Excavating hard rock material would require equipment with a higher energy than equipment used for excavating softer material. Generally, as the energy level of the excavation equipment increases the level of vibration increases.

The following geology is predicted along the tunnel alignments:

- At the northern end of the tunnel alignments, there is slightly weathered to fresh siltstone overlain by approximately 10 metres of extremely weathered to highly weathered siltstone. Intersecting the surface at Lower Plenty Road is a possible highly faulted zone with frequent shear zones and soil-like geotechnical properties.
- From around Lower Plenty Road to Banyule Flats and Warringal Parklands, 20 to 30 metres of extremely weathered to highly weathered siltstone (bordering on alluvium) overlays slightly weathered to fresh siltstone. The top of the tunnels would vary in their depth beneath the interface of the alluvium and the slightly weathered to fresh siltstone, up to 10 metres. The tunnels would pass through an altered fault zone of 10 metres in the area around the Heide Museum of Modern Art.
- Near Banksia Park, the tunnels would rise in grade through slightly weathered to fresh siltstone into overlying moderately weathered siltstone. There are small sections (less than 5 metres depth) of the older alluvium and fill above the moderately weathered siltstone.
- The geology approaching the Manningham Road interchange is complex. It consists of bands of slightly weathered to fresh siltstone, moderately weathered, extremely weathered, older alluvium and possible landslide material (progressing from the location proposed for the floor of the tunnels to the surface).
- Toward the southern end of the tunnel alignments near the Trinity Grammar School Sporting Complex, the geology consists of layers of sand alluvium, clays, sand and fill clay.

12.2.2 Existing vibration environment

It is important to assess the existing vibration environment to understand how this may change as a result of construction of the project. Understanding the existing vibration environment is also an important part of defining guideline target levels for vibration (see Section 12.3).

Background vibration monitoring was undertaken in the vicinity of the proposed tunnel alignment to quantify the existing vibration environment. Vibration sensors were positioned at 19 residential locations shown in Figure 12-2. The monitoring undertaken for two to 12 days at each location provided information on how often vibration levels are higher than the constant background level.

The monitoring results confirmed that existing vibration conditions in the vicinity of the proposed North East Link tunnels are typical of quiet residential areas, with minimal sources of vibration. The average level of vibration measured at all the monitoring locations was below levels at which continuous vibration would typically be considered noticeable (around 0.3-0.5mm/s). Where instances of elevated vibration were recorded, they were infrequent and most likely due to activities occurring near the monitor (such as people walking, gardening, or from animals).



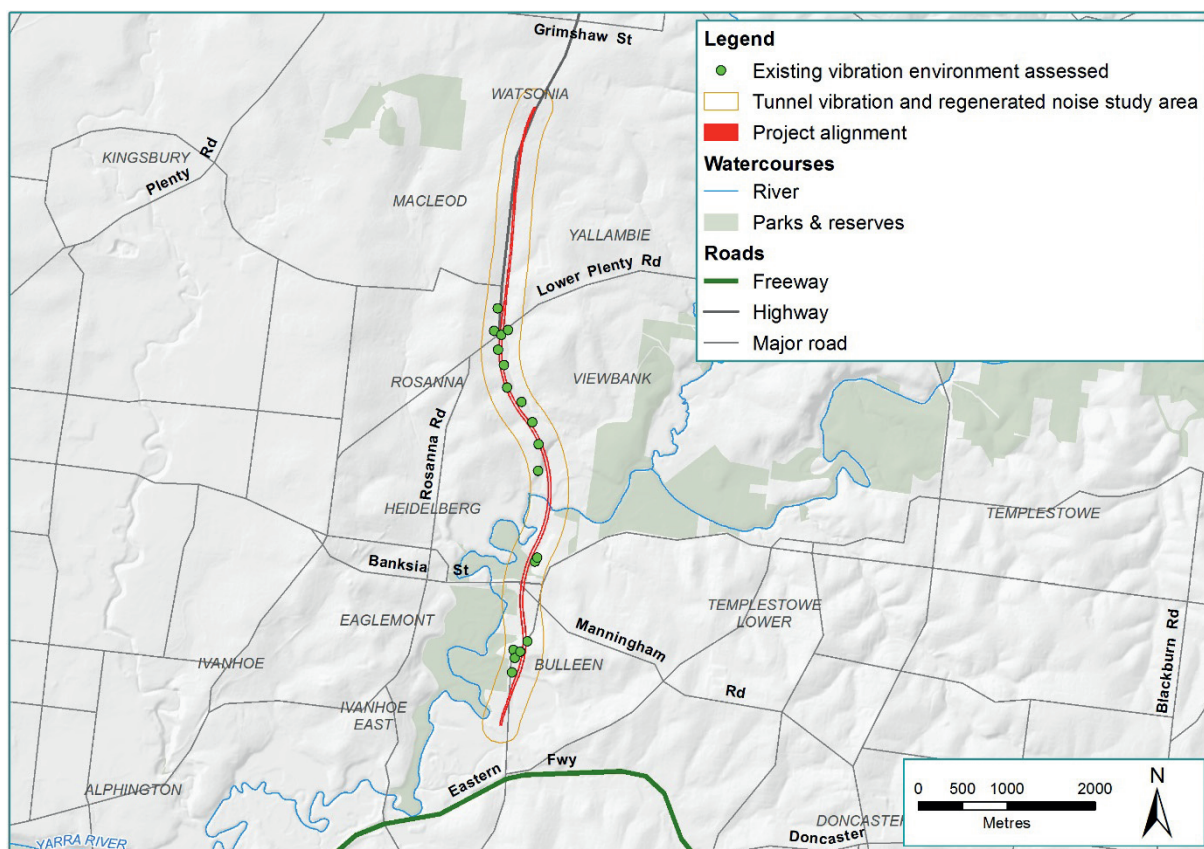


Figure 12-2 Background vibration monitoring locations

12.2.3 Sensitive receptors

People, buildings and structures that could be sensitive to tunnelling vibration and regenerated noise effects are called ‘sensitive receptors’.

All people and buildings within the study area are considered to be sensitive receptors. People may feel vibration in a building structure or it may produce audible regenerated noise in a building. Vibration generally reduces as it passes from the ground into the foundations of a building. It also reduces in magnitude as it travels up a building from floor to floor.

Regenerated noise is caused by vibration in floor and wall elements that radiates into a room. Regenerated noise is more difficult to predict than noise transmitted through the air; its transmission depends on ground conditions and the structure and internal acoustic characteristics of a building.

Some buildings and structures the tunnels would pass beneath or near may be particularly sensitive to vibration and regenerated noise effects. These include:

- **Residential buildings.** The tunnels would pass beneath residential areas south of Lower Plenty Road in Rosanna and Heidelberg, and south of Manningham Road in Bulleen.

- **Buildings with sensitive uses.** Within the study area, this includes:
 - Greensborough Road Early Learning Centre
 - St. Martins of Tours Catholic Primary School
 - Goodstart Early Learning Centre in Rosanna
 - Buildings at Simpson Barracks, a Commonwealth Defence facility adjacent to Greensborough Road in Yallambie.
- **Heritage buildings.** There are three heritage buildings within the vicinity of the tunnel alignment (refer also to Chapter 19 – Historical heritage):
 - Banyule Homestead – A residence listed on the Victorian Heritage Register (VHR), located on the escarpment above the Banyule Flats parkland, approximately 40 metres from the tunnel alignment
 - Heide Museum of Modern Art – A state-owned public museum and gallery set within 6.5 hectares of gardens and including a sculpture park. The museum is located in Bulleen, approximately 70 metres from the tunnel alignment. An early timber farmhouse known as Heide I and a newer Mt. Gambier limestone art gallery known as Heide II are both VHR-listed
 - Clarendon Eyre – A large Italianate residence in Bulleen approximately 180 metres from the tunnel alignment which is within a Manningham Planning Scheme Heritage Overlay (HO147)
- **Utility assets.** There are telecommunications, gas, electricity, water, drainage and sewer services along the tunnel alignment.

Tunnelling vibration and regenerated noise can also affect the operation of sensitive equipment. The site assessment did not identify any buildings within close proximity to the tunnel alignment that are likely to contain sensitive equipment (such as hospitals, laboratories, or research institutions). The presence of sensitive equipment would be further investigated before construction started.

12.3 Vibration and regenerated noise guideline target levels

This section outlines the development of vibration and regenerated noise guideline target levels that are used to inform impact assessment and the implementation of management actions.

It is inevitable that some vibration and regenerated noise would occur during construction of the North East Link tunnels, portals and cross passages. It is therefore important to develop vibration and regenerated noise guideline target levels to protect amenity, buildings and utility asset integrity.

The guideline target levels form the basis for several EPRs relevant to managing tunnel vibration and regenerated noise. The EPRs are listed in Chapter 27 – Environmental management framework.

These guideline target levels are precautionary – they are goals that should be sought to be achieved through the application of practical mitigation measures. Higher levels of vibration than the target levels does not necessarily mean the vibration or regenerated noise effects would be unacceptable; the extent of exceedance above the target would inform management actions to mitigate the effects. Management actions are discussed in Section 12.5.

Relevant legislation, policy and guidelines

The vibration and regenerated noise guideline target levels are based on the relevant standards and guidelines identified below.

Vibration and regenerated noise guideline target levels – standards and guidelines

EPR ID	Description	Basis for guideline target levels
NV5	Utility asset protection	Guideline target levels for vibration would be established in consultation with infrastructure and utility asset owners or applied in accordance with German Standard DIN 4150-3 <i>Structural Vibration Part 3: Effects of vibration on structures</i>
NV8	Construction vibration targets (amenity)	British Standard BS6472-1:2008 <i>Guide to evaluation of human exposure to vibration in buildings, vibration sources other than blasting</i>
NV9	Construction vibration targets (structures)	German Standard DIN4150-3 <i>Structural Vibration Part 3: Effects of vibration on structures</i>
NV10	Ground-borne (internal) noise targets)	New South Wales Interim Construction Noise Guideline
NV11	Amenity – blast vibration	Australian Standard AS2187.2-2006, <i>Explosives – Storage and use, Part 2: Use of explosives</i>
NV12	Amenity – blast overpressure	

The guideline target levels for vibration and regenerated noise are based on:

- Relevant legislation, policy and guidelines: There is no specific legislation in Victoria that regulates ground-borne vibration and regenerated noise. The guideline target levels were informed by a review of Australian and international legislation, policy and guidelines, which were applied as relevant.
- Consideration of the existing vibration environment: Establishing the existing vibration environment was necessary to determine whether the guideline target levels are applicable. For example, it would not be appropriate to specify a guideline target level of vibration for tunnelling activities if this level of vibration was already being exceeded before construction of North East Link.
- Understanding key sensitive receptors:
 - People perceive vibration at levels well below those where structural damage occurs to buildings. The guideline target levels for the protection of amenity and human comfort include requirements for lower levels of vibration in residential areas, and for lower levels of vibration and regenerated noise at night. The guideline targets represent levels of vibration and regenerated noise that are acceptable to the majority of persons, rather than levels that are imperceptible or inaudible.
 - Guideline target levels for the protection of building and utility assets reflect vibration levels below which damage has not been credibly observed, rather than reflecting the level at which there would be onset of infrastructure damage. An external site assessment indicated that vibration guideline target levels that are commonly applied to protect buildings and structures from damage during similar construction projects would also be suitable for buildings within the vicinity of the North East Link tunnel alignment. Guideline target levels for the protection of utility assets from vibration would be determined in consultation with asset owners.

12.4 Vibration and regenerated noise modelling

This section describes the development and application of a model to predict the levels of vibration and regenerated noise that would be expected to occur during construction of the North East Link tunnels, portals and cross passages.

A digital model was developed for the North East Link tunnels to predict the levels of vibration and regenerated noise at key sensitive receptors from construction activities.

Relationships between distance and vibration level for the tunnel construction methods and equipment were estimated based on a review of other construction projects completed in similar geology. The modelling was verified by using these vibration relationships to manually predict vibration levels and comparing these predicted levels to those measured from similar equipment used in the construction of other projects.

The level of regenerated noise was modelled based upon the modelled level of vibration and an assumed set of building characteristics.

The modelling is conservative. Modelled vibration levels are expected to comply with 95 per cent of all actual measurements of vibration during tunnel construction, and it is anticipated that lower vibration values would also be recorded. The actual construction equipment and methods used, the geological conditions encountered and the transmission characteristics of different building types (and their internal furnishings) could all influence the measured levels of vibration and regenerated noise during construction.

Tunnel construction methods and equipment

The tunnelling construction methods and equipment are described in detail in Chapter 8 Project Description. Tunnel construction activities would occur 24 hours per day, seven days per week.

The geological conditions along the tunnel alignment indicate that trenching and tunnelling could be undertaken using the following methods:

- Support of the trench or cut and cover tunnel by the installation of **diaphragm walls** and **bored piles** and shotcrete infill.
- Excavation of the tunnel portals, cut and cover sections and open trench with **excavators**, or **excavators with a hydraulic hammer** for the harder, more competent rock material.
- The construction of the mainline twin tunnels for approximately 3 kilometres between Lower Plenty Road and Bridge Street with **Tunnel Boring Machines (TBMs)**. TBMs could be configured to safely excavate through a variety of soil and rock strata. The TBMs would progress at an estimated average rate of approximately 60 metres per week. It is expected that TBM operation could total around 18 months to two years, allowing for launch and retrieval, maintenance, holidays and construction industry calendars.
- Mining a 400-metre section of the tunnels south of Manningham Road interchange from Avon Street to Rocklea Road with a **road header**. Construction of the mined tunnel sections would progress at an estimated average rate of approximately 10 metres per week.
- Development of cross passages with a smaller **excavator with a hydraulic hammer**. Cross passages would connect the tunnels at a spacing of approximately 120 metre intervals, allowing access to and from the tunnels for maintenance work and during emergencies.

The overall duration for construction of the mined tunnel section and the cut and cover sections would be dependent on the sequencing of works applied by the contractors. It is possible that the cut and cover works could last for the duration of project construction.

It is possible that drilling and blasting could be undertaken by the contractors as an alternative to excavation using mechanical equipment. This construction method may be used in sections where the rock is very hard and would take a long time to excavate, or if drilling and blasting is expected to reduce the impact on amenity to sensitive receptors.

Modelled vibration and regenerated noise levels were plotted as a series of contours across the tunnel alignment (included as relevant in the construction impact assessment in Section 12.5.1).

The contours show:

- Vibration levels in millimetres per second (mm/s), between 0.5 mm/s and 2.5 mm/s in 0.5 mm/s increments
- Regenerated noise levels in A-weighted decibels (dBA), between 35 dBA and 55 dBA in 5 dBA increments.

Vibration and regenerated noise envelopes were also developed for 70 representative properties above the tunnels to show how these effects would be likely to change over time. The location of these properties is shown in Figure 12-3.

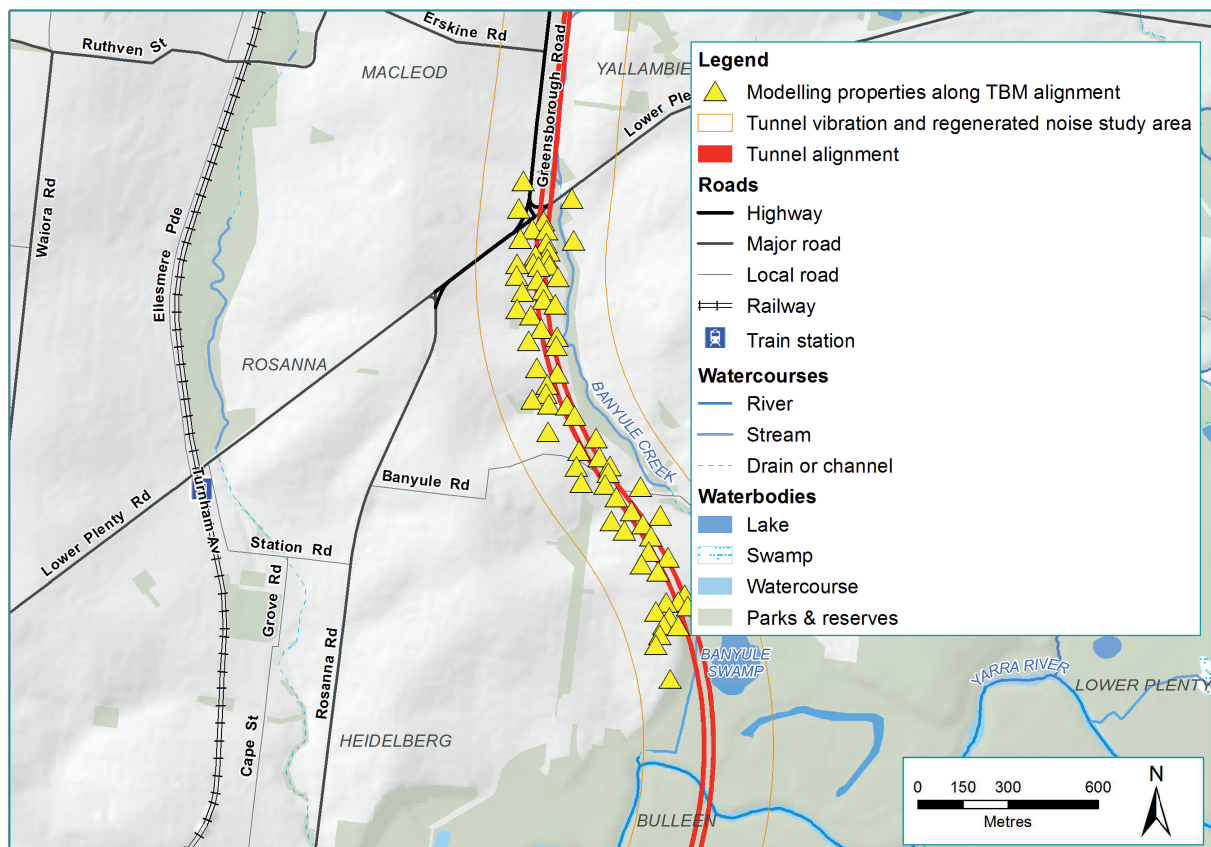


Figure 12-3 Location of representative modelling properties along the tunnel alignment

The reference project is based on two TBMs operating concurrently to excavate the northbound and southbound tunnels. Construction would be planned so these TBMs would not be operating side by side in the same area at the same time. This approach would minimise vibration and regenerated noise effects occurring at any one time, but would mean that receptors would potentially experience effects during construction of the northbound tunnel, and again during construction of the southbound tunnel.

The TBMs may be launched from the northern or southern end of the tunnel. The direction of travel of the TBM is not anticipated to impact upon the predicted levels of vibration or regenerated noise.

The duration of the vibration and regenerated noise effects during TBM operation would depend upon how quickly the TBM is moving. This is illustrated in Figure 12.4, which shows an example of a predicted vibration envelope for the southbound tunnel that is typical of some residences around Homewood Court in Rosanna. A similar range and duration of vibration levels could be expected during the construction of the northbound tunnel at this location. For context, this figure also shows the typical background level of vibration and the limit of perception in a residential environment. The time where the TBM is at the nearest point to the property is referred to as Day 0. A TBM tunnelling rate of 10 metres per day was adopted in the modelling. A faster TBM tunnelling rate would reduce the duration of the effect at individual locations, as illustrated in Figure 12-4.

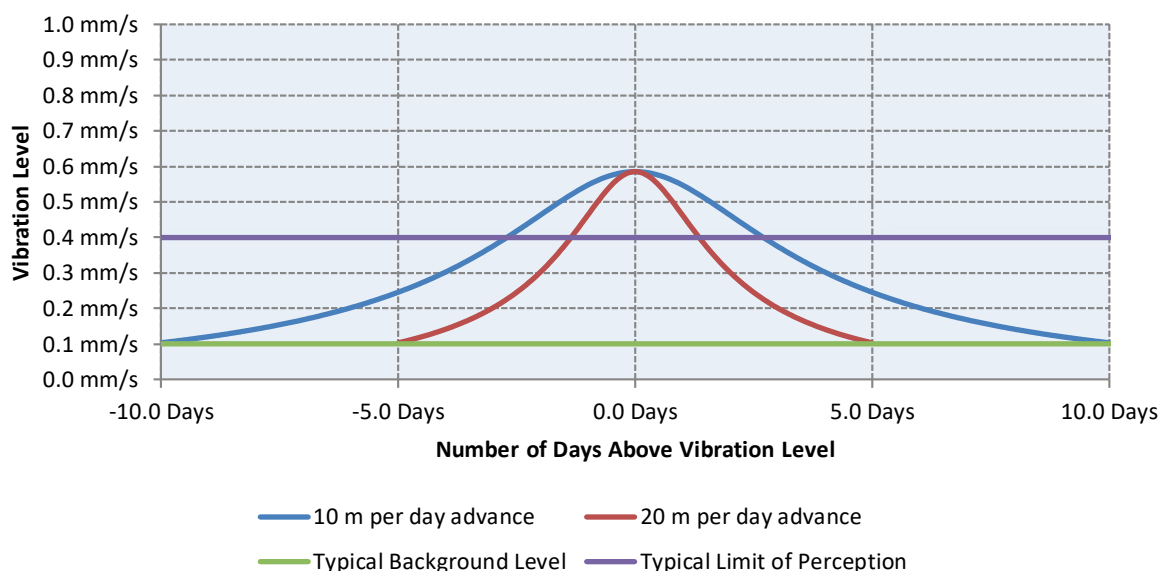


Figure 12-4 Example of predicted vibration envelope near Homewood Court, Rosanna for southbound tunnel

To validate the model during construction, a verification process would be completed each time a new item of equipment that generates measurable levels of vibration is operated. This process would be detailed in a Construction Noise and Vibration Management Plan (CNVMP) (EPR NV4). This process would involve simultaneous monitoring of vibration from construction activity at multiple locations. Monitoring would be supervised to check that recorded values do not reflect other sources of vibration that are not related to construction, such as vehicles or pedestrian traffic. This verification process would provide information that would help to predict potential impacts to sensitive receivers, including:

- The variation in vibration levels for the same equipment type but with different energy levels
- The attenuation, or possible amplification, as vibration passes from an external measurement point to internal locations within a building, and the variation in vibration level as the vibration propagates through a building from the ground floor to other higher floors within the building

- The typical operating characteristics of the equipment, such as the percentage of vibration inducing activities that occur within a 15-minute period
- The relationship between vibration level and regenerated noise
- The correlation between vibration dosage, equipment operating periods and peak vibration levels.

The monitoring results would provide site-specific relationships between distance and vibration levels for each equipment type. These results would be compared with the modelled relationships. If there is a significant discrepancy between the measured and modelled vibration relationships, the level of vibration and regenerated noise would be remodelled to understand the potential impacts and to inform the implementation of mitigation measures.

12.5 Construction impact assessment

This section discusses the vibration and regenerated noise impacts that could occur during construction of the North East Link tunnels, portals and cross passages.

The potential impacts identified of the construction of North East Link relating to tunnelling vibration and regenerated noise are grouped according to four main themes:

- Changes in amenity – the potential impacts of perceptible vibration and audible regenerated noise on people living and working near the construction footprint
- Damage to buildings and structures – the potential for impacts to buildings and structures as a result of vibration
- Damage to infrastructure and utility assets – the potential impacts of vibration on infrastructure (such as retaining walls, tower piers and abutments) and services (such as telecommunications, gas, electricity, water, drainage and sewerage)
- Effects on the operation of sensitive equipment – the potential for vibration and regenerated noise to affect the continued operation of delicate or high resolution equipment.

The potential for impacts associated with these main themes are discussed in the following sections.

12.5.1 Changes in amenity

Vibration and regenerated noise can affect humans in different ways. People may experience a loss of amenity from perceptible vibration and audible regenerated noise that changes their living or working environment. Vibration and regenerated noise also has the potential to affect health by causing discomfort or sleep disturbance. Responses to vibration and regenerated noise are subjective and can vary between individuals.

The assessment of amenity impacts is primarily focused on residential receptors. The assessment has also considered other land uses for which the guideline target levels for vibration are less stringent, including commercial and educational premises within the study area.

Some level of vibration and regenerated noise during construction would be unavoidable. The level of vibration and regenerated noise could differ significantly between buildings depending on their size and construction, the proximity to construction works and the construction methods. Even closely positioned properties may experience different levels of vibration and regenerated noise – for example, in locations where houses on one side of the road are elevated and houses on the other side are not.

As described in Section 12.4, the same property may experience vibration and regenerated noise effects at more than one stage of construction. For example, depending on their location, some properties that are above or within close proximity of the tunnels may notice vibration or regenerated noise effects during construction of the northbound tunnel, the southbound tunnel and the cross passages.

The risk pathways associated with amenity changes due to vibration and regenerated noise are described in Table 12-1.

Risk pathways associated with potential health effects are discussed in Chapter 18 – Human health.

Table 12-1 Risk table – construction – changes in amenity due to vibration and regenerated noise

Risk ID	Risk pathway	Risk rating
Risk TV01	The level of vibration from the equipment cannot be lowered to meet the criteria at the residential properties along the alignment and causes loss of amenity	Low
Risk TV02	The level of regenerated noise from the equipment cannot be lowered to meet the criteria at the residential properties along the alignment and causes loss of amenity	Low
Risk TV03	Residents along the alignment are more sensitive to the vibration and regenerated noise impacts and are affected by levels less than guideline values	Low
Risk TV04	The levels of vibration are elevated at some residential properties because of unforeseen geology, water conditions, surface conditions and so on and cause loss of amenity	Low

Risk ID	Risk pathway	Risk rating
Risk TV05	The levels of regenerated noise are elevated at some residential properties because of unforeseen geology, water conditions, surface conditions and so on and cause loss of amenity	Low
Risk TV06	The rock type is more competent than originally assessed and requires alternative and more energetic equipment types which results in elevated vibration levels that exceed acceptable values	Low
Risk TV07	The rock type is more competent than originally assessed and requires alternative and more energetic equipment types which results in elevated regenerated noise levels that exceed acceptable values	Low
Risk TV08	An accelerated construction schedule results in elevated vibration levels at the residential properties along the alignment and a loss of amenity	Low
Risk TV09	An accelerated construction schedule results in elevated regenerated noise levels at the residential properties along the alignment and a loss of amenity	Low
Risk TV10	The production rates are reduced leading to a greater impact on residents in terms of amplitude and duration to which they are exposed to elevated levels of impact	Low
Risk TV11	The construction of the buildings amplifies vibration levels and results in non-compliant levels and associated loss of amenity	Low
Risk TV12	The construction of the buildings and the internal furnishings amplifies regenerated noise levels and results in non-compliant levels and associated loss of amenity	Low
Risk TV18	Rock mass sufficiently competent that excavation of the cross passages of the northern tunnel portals requires blasting that impacts on the amenity of persons	Low

As described in Section 12.4, a vibration and regenerated noise model was used to estimate the levels of potential vibration and regenerated noise caused by trenching and tunnelling activities during construction of North East Link. The predictions were assessed against the guideline target levels established for the project as outlined in Section 12.3.

The modelling predicted that some residential properties along the alignment could experience a loss of amenity during construction as the level of vibration and regenerated noise would not meet the guideline target levels. Elevated vibration or regenerated noise levels are not anticipated at the educational facilities identified in Section 12.2.3, given their distance from construction works.

This section outlines:

- Modelled vibration and regenerated noise levels at properties along the trench and tunnel alignment
- Mitigation measures and management actions that would be implemented to reduce amenity impacts from vibration and regenerated noise to an acceptable level
- EPRs that incorporate the guideline target levels, provide for the implementation of management actions, and include requirements for ongoing monitoring of noise and vibration levels.

Changes in amenity due to vibration – modelled impacts

Modelling indicates that perceptible vibration may be generated by trenching and tunnelling construction activities where the works would be closer to the surface level, or where there are sensitive receptors located near the alignment, as described in this section.

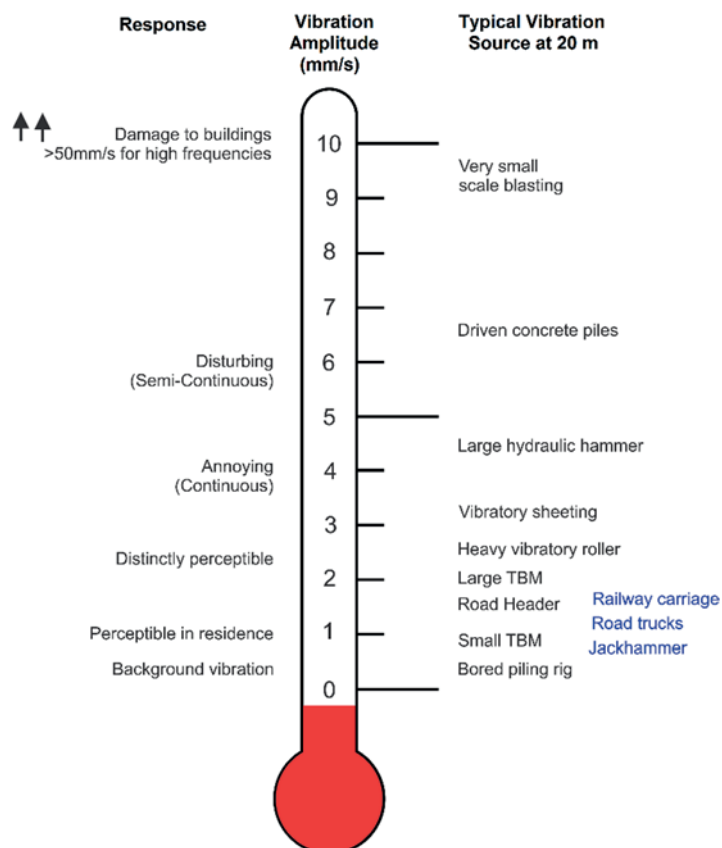
At what levels can vibration be perceived?

The effects of vibration at varying vibration levels are summarised in the British Standard 5228 Code of Practice For Noise and Vibration Control on Construction and Open Sites – Part 2 Vibration (BS5228-2:2009)) and presented below.

Vibration effects at varying vibration levels, based on BS5528-2:2009

Root mean square vibration level	Peak vibration level	Effect of vibration
0.14mm/s	0.4mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration
0.3mm/s	0.7mm/s	Vibration might just be perceptible in residential environments
1.0mm/s	3mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents
10mm/s	30mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level

The figure below illustrates how vibration from tunnelling construction equipment and from some other typical sources of vibration in an urban environment can be perceived.



Cut and cover tunnels and northern tunnel portals: The level of vibration generated by constructing the diaphragm walls north of Lower Plenty Road to Blamey Road would be imperceptible and would not impact upon the amenity of the residential properties in this area. The installation of the bored piers would induce even lower levels of vibration. Vibration levels from diaphragm wall construction and installation of bored piles in this area are anticipated to comply with the guideline target levels for amenity in EPR NV8.

North of Blamey Road, a section of the trench where bored piling activities are planned would pass through land occupied by the Simpson Barracks. The closest building to the trench could receive very low levels of vibration when installation of the bored piers is occurring immediately adjacent. These vibration levels would comply with the guideline target levels for amenity in NV8.

Excavating the material within the walls of the trench with a large excavator could generate elevated levels of vibration at times when the excavator impacts the ground, or where the excavator tracks move across any hard or uneven surfaces. The vibration would be short-term, and in most cases is anticipated to have no impact on overall amenity for people close to the works. Where elevated vibration may occur, it would be restricted to those areas closest to the trench and would not extend to the adjacent properties. The works within Simpson Barracks would generate only momentary instances of vibration levels of 0.5 mm/s, which would be considered imperceptible given their short duration. The level of vibration would still be less than the guideline target levels for amenity in EPR NV8.

If excavation in hard rock in the lower sections of the trench requires the use of a hydraulic hammer, modelling indicates that residential properties on both sides of Greensborough Road could experience vibration levels exceeding 0.5 mm/s (as shown in Figure 12-5 and Figure 12-6), which would be perceptible to residents. The vibration is not predicted to exceed 1 mm/s. This level of vibration would comply with the daytime guideline target levels for amenity in EPR NV8, but may require mitigation to comply with the night-time guideline target levels for amenity. Potential mitigation measures are outlined further in this section.

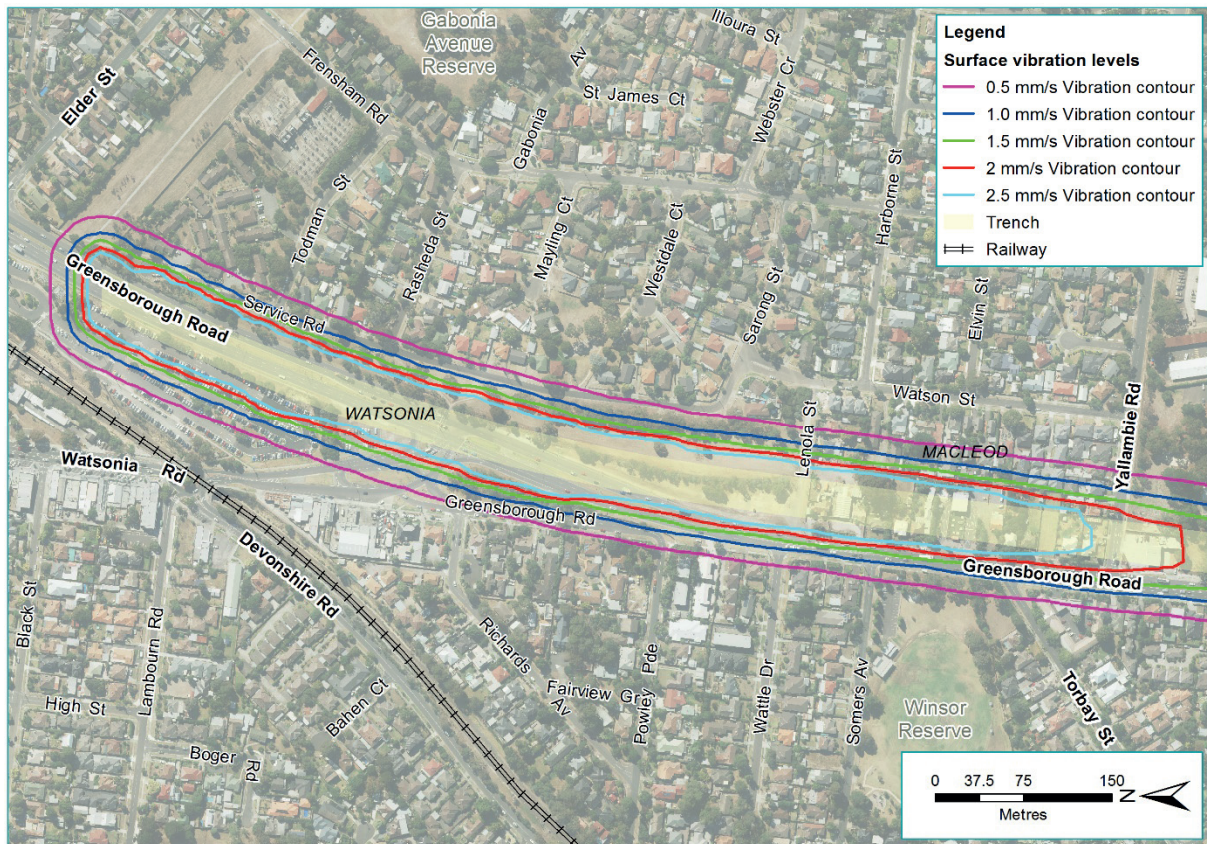


Figure 12-5 Predicted vibration contours for excavation of trench using 45-tonne excavator with hydraulic hammer (north of Simpson Barracks)

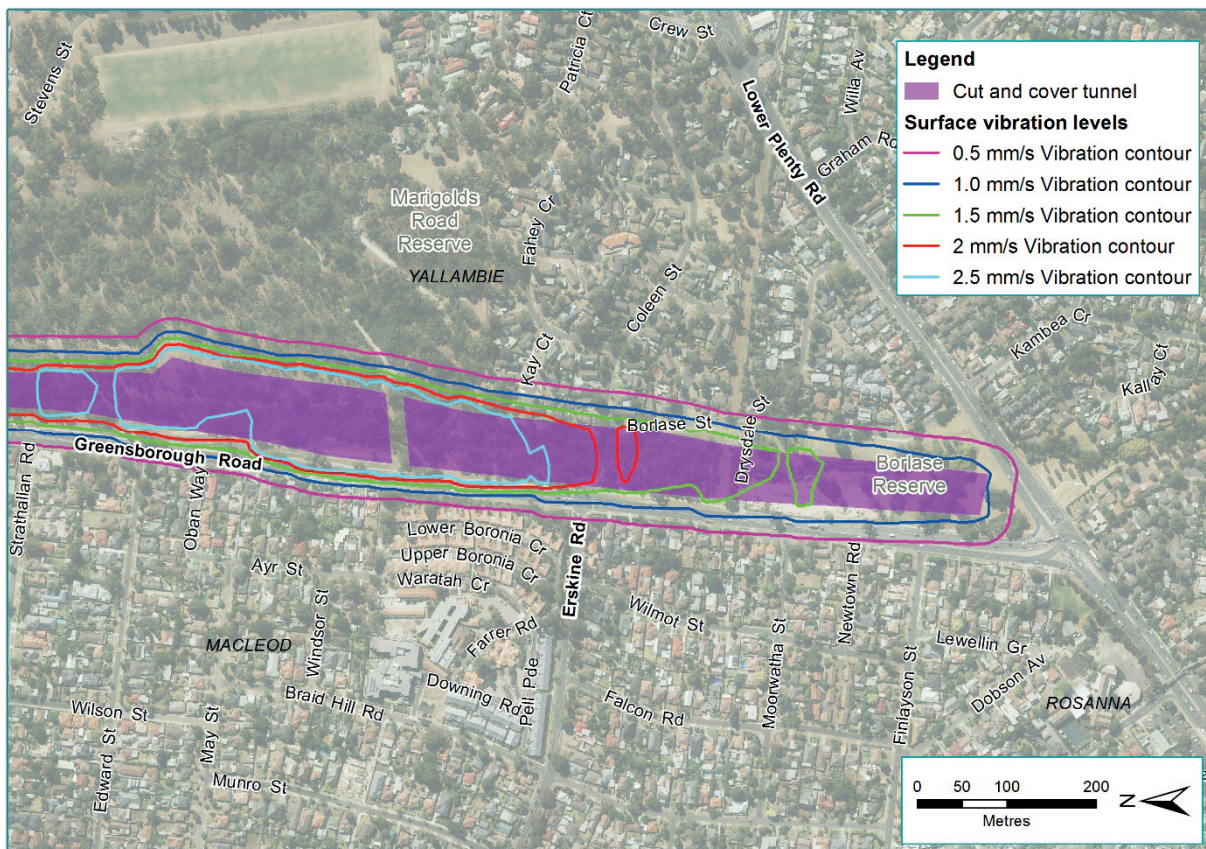


Figure 12-6 Predicted vibration contours for excavation using 45-tonne excavator with hydraulic hammer (south of Simpson Barracks)

The use of a hydraulic hammer for excavation could impact the nearby building on Simpson Barracks with vibration levels of up to 2 mm/s. The elevated levels of vibration would be greater than the guideline target levels for amenity in EPR NV8. Vibration would be noticeable and may require mitigation so that amenity impacts for people occupying this building are acceptable.

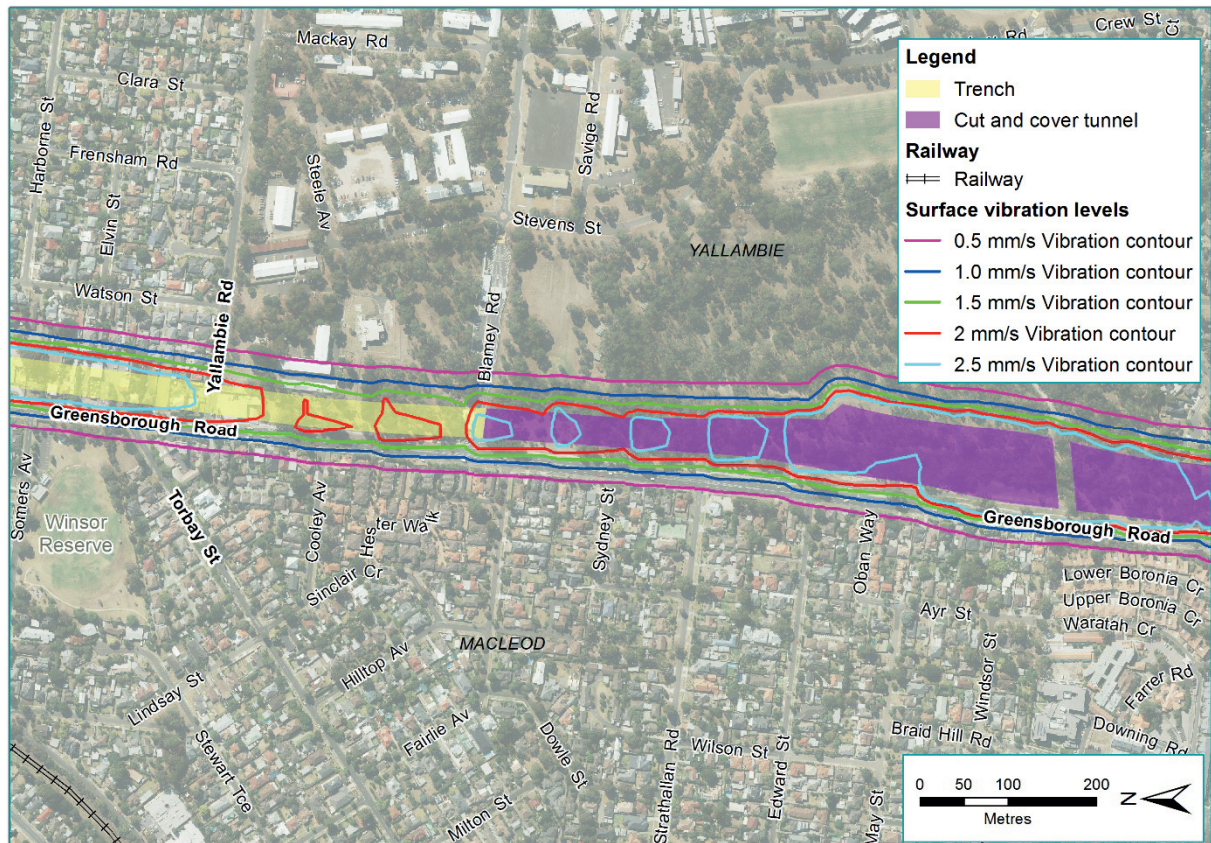


Figure 12-7 Predicted vibration contours for excavation using 45 tonne excavator with hydraulic hammer (at Simpson Barracks)

TBM tunnels: Once operation of the TBM commences, properties within about 35 metres of the tunnel alignment between the northern portals and the area near Homewood Court in Rosanna are predicted to experience levels of vibration varying between 0.5 mm/s and 1.0 mm/s, as shown in Figure 12-8.

The predicted vibration levels in these areas meet the daytime guideline target levels for amenity in EPR NV8, but may exceed the night-time guideline target levels for amenity.

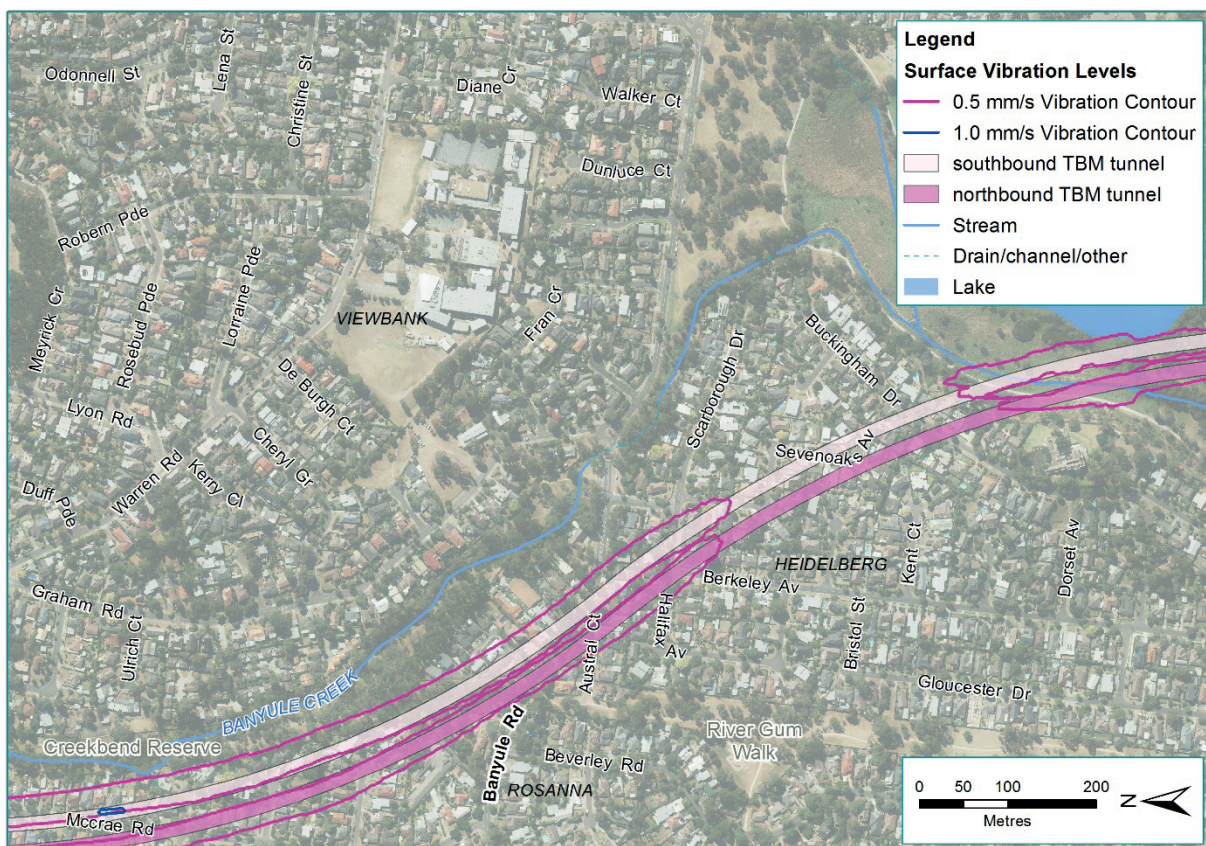


Figure 12-8 Predicted vibration contours for tunnel construction using TBM (showing McCrae Road in Rosanna to Warringal Parklands)

TBM retrieval: As described in section 8.7.5 of Chapter 8 – Project description, if the TBMs are launched from the south, they would be retrieved from the construction compound just north of Lower Plenty Road. However, if the TBMs are launched from the north, they would be retrieved from an area within Banksia Park, north of Bridge Street.

Two shafts approximately 25 metres wide and 50 metres long would be excavated to remove the TBMs after they have completed their respective drives. Softer material could be removed using only excavators, while excavation of harder material is expected to require the use of small to moderate sized excavators (up to 35 tonne) fitted with a hydraulic hammer.

The nearest sensitive receptor to the northbound tunnel TBM retrieval shaft is located on the northern side of Bridge Street. Perceptible vibration is not predicted to occur at this location during excavation of the retrieval shaft. There is a shorter distance between the southbound tunnel TBM retrieval shaft and its nearest sensitive receptor. If excavation with a hydraulic hammer is required, vibration levels at this location may be perceptible, however these would still be low (less than 0.5 mm/s). If the material can be excavated without the use of a hydraulic hammer, the level of vibration during excavation of the retrieval shaft is predicted to be imperceptible to sensitive receptors. Overall, the modelling predicts the excavation of both TBM retrieval shafts could be completed in compliance with the guideline target levels for amenity in EPR NV8.

Manningham Road interchange: Modelling of this cut and cover section was completed for the reference project shown in Figure 12-9 as well as for an alternative design with a vertical alignment approximately 2.5 metres lower. The modelled difference between the designs was negligible. For both designs, excavation of the deeper sections of the cut and cover area between Bridge Street and Golden Way using an excavator with a hydraulic hammer would generate perceptible levels of vibration at residential properties on the eastern side of Bulleen Road in the vicinity of St. Andrews Crescent in Bulleen (approaching 0.5 mm/s). This level of vibration would still be less than the guideline target levels for amenity specified in EPR NV8.

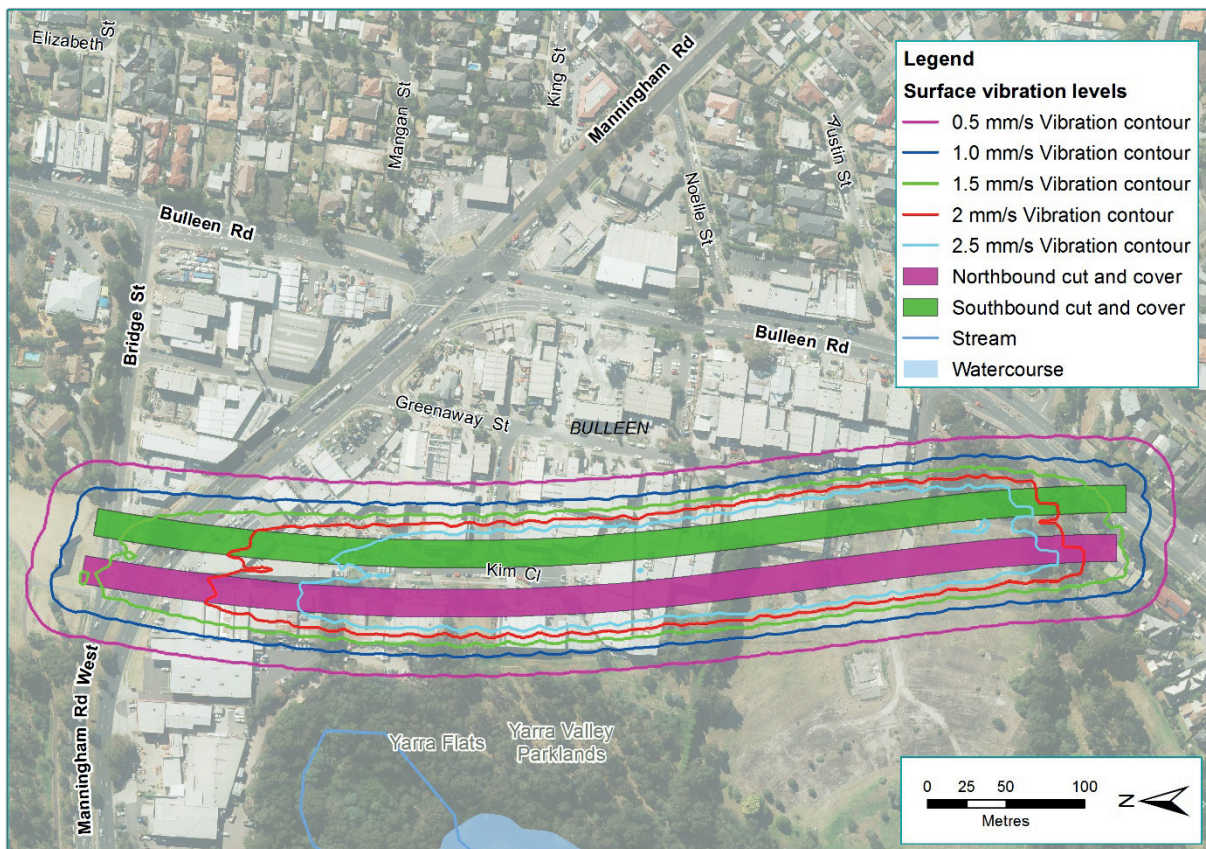


Figure 12-9 Predicted vibration contours for cut and cover area between Bridge Street and Golden Way using 45-tonne excavator with hydraulic hammer

Mined tunnel sections: Properties above the mined sections of the tunnels adjacent to Bulleen Road and south of the Manningham Road interchange, as well as those within 100 metres of the southern tunnel portals, are expected to experience vibration varying between 0.5 mm/s and 1.0 mm/s, as shown in Figure 12-10. This level of vibration would meet the daytime guideline target levels for amenity in EPR NV8, but may exceed the night-time guideline target levels for amenity.

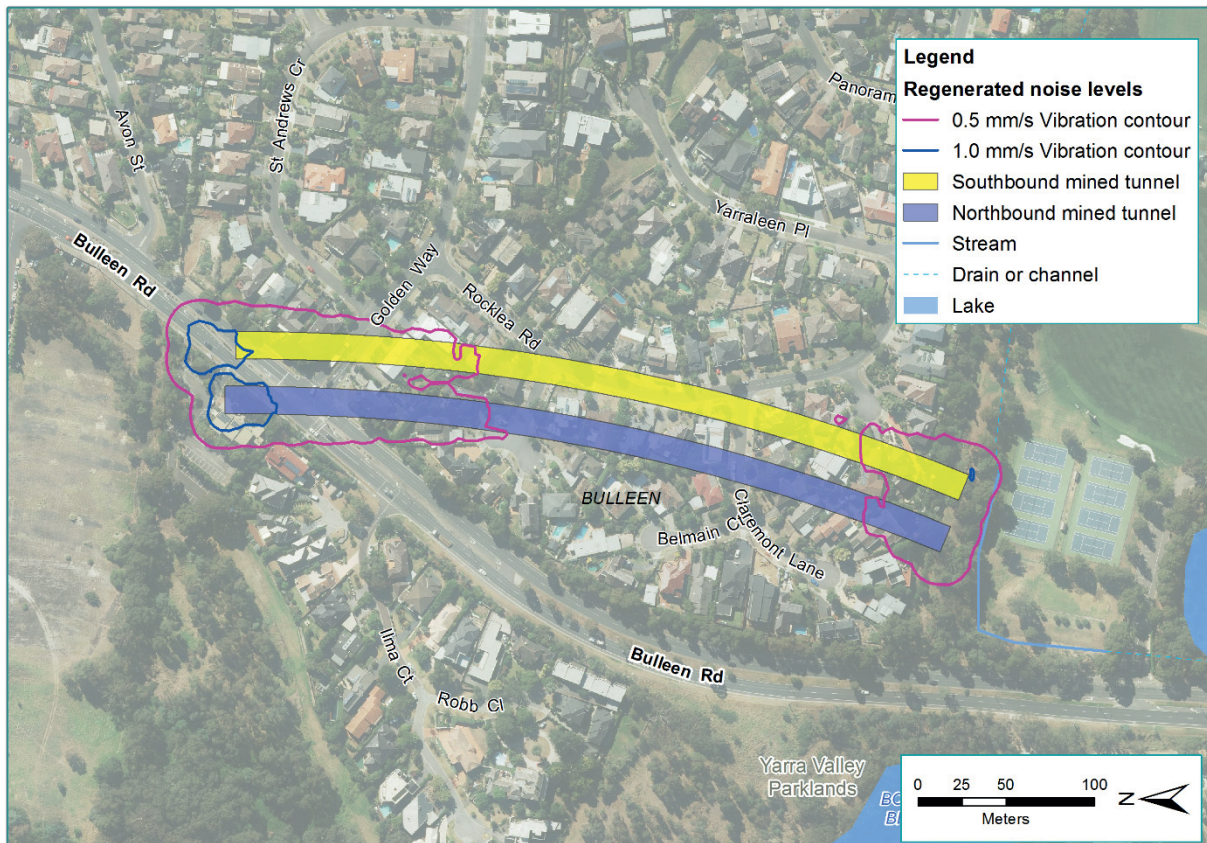


Figure 12-10 Predicted vibration contours for mined tunnel sections

Southern tunnel portals: Excavation of the southern tunnel portals is not predicted to generate perceptible levels of vibration for nearby properties because a hydraulic hammer is not expected to be required for the local geological conditions. It is anticipated the guideline target levels for amenity in EPR NV8 would be met.

Cross passages: The development of the cross passages with a small excavator and hydraulic hammer is expected to generate perceptible levels of vibration at properties above the cross passage. Around 15 properties near cross passages in the northern sections of the tunnels are expected to experience vibration levels greater than 0.5 mm/s. Modelling indicates that during construction of some cross passages, vibration levels would comply with daytime guideline target levels for amenity but exceed the preferred night-time guideline target levels in EPR NV8.

Changes in amenity due to regenerated noise – modelled impacts

Regenerated noise is often heard by the receptor and sometimes considered annoying even when the corresponding level of vibration is considered imperceptible or acceptable. The modelling has confirmed that regenerated noise impacts would be experienced more widely than vibration-related impacts, as outlined in this section. However, it is expected the duration of these impacts would generally be limited to a few days, in some instances increasing to a week.

Cut and cover tunnels and northern tunnel portals: The level of regenerated noise generated by constructing the diaphragm walls north of Lower Plenty Road would be low (around 25 to 30 dBA) and considered indistinguishable from other noise sources in the area. The installation of the bored piers would induce even lower levels of regenerated noise. Regenerated noise levels from diaphragm wall construction and installation of bored piles in this area are anticipated to comply with the guideline target levels for amenity in EPR NV10.

Further north, the building on Simpson Barracks located closest to the trench could receive levels of regenerated noise (up to 45 dBA) when installation of the bored piers is occurring immediately adjacent. These levels may exceed the guideline target levels for amenity in NV10, as shown in Figure 12-11.

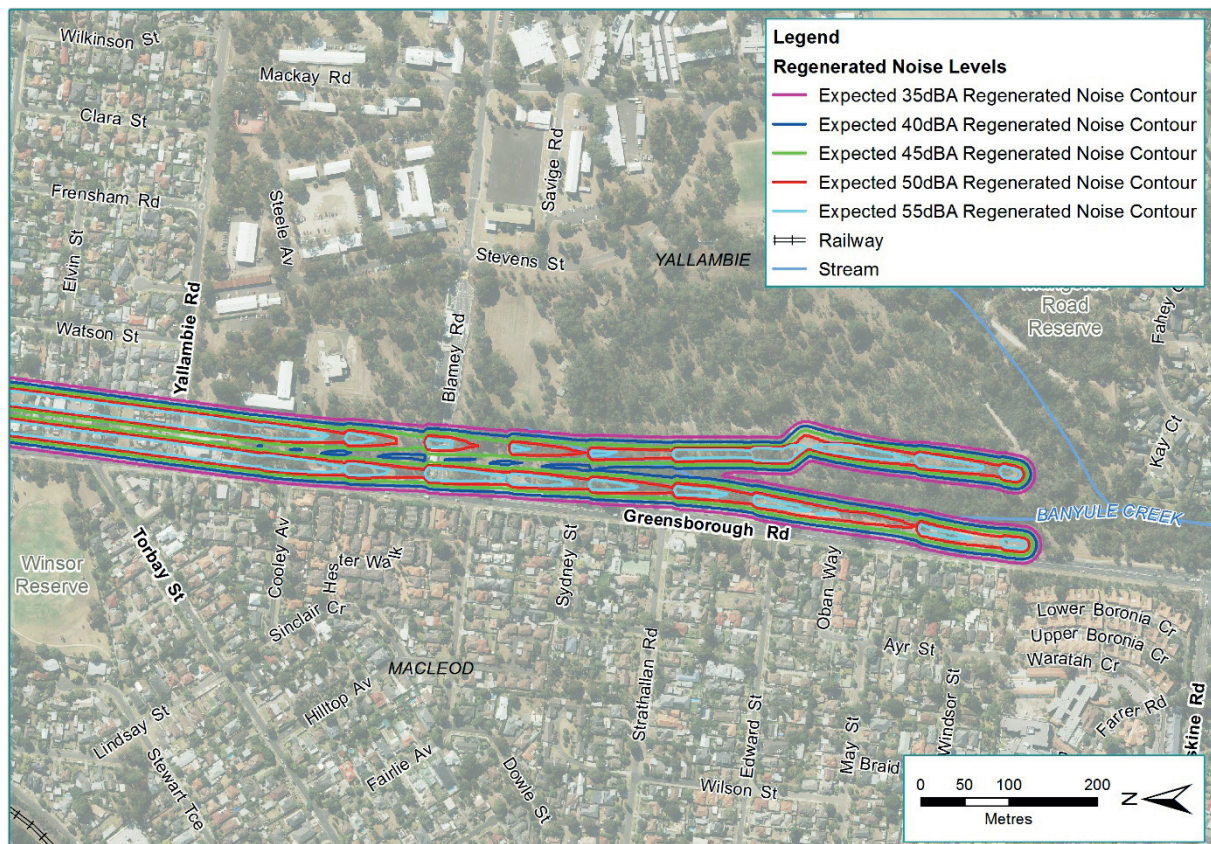


Figure 12-11 Predicted regenerated noise contours for installation of bored piers adjacent to Simpson Barracks

The use of a large excavator to remove the material within the walls of the trench and cut and cover tunnel would result in some regenerated noise, but this is expected to be minor because of its low level and very short duration. The level of regenerated noise at residential properties would be up to 35 dBA, which is less than the guideline target levels for amenity in EPR NV10. The closest building located at Simpson Barracks could be impacted by occasional short-term elevated levels of regenerated noise from excavation of the trench (up to 55 dBA) as the excavator bucket impacts the ground, or where the excavator moves across hard or uneven surfaces.

If excavation in hard rock in the lower sections of the trench requires the use of a hydraulic hammer, modelling indicates that residential properties on both sides of Greensborough Road could experience elevated regenerated noise levels above 45 dBA, as shown in Figure 12-12 and Figure 12-13, which would be noticeable to residents. This elevated level would generally be restricted to the first row of properties closest to the works. The level of regenerated noise could exceed the guideline target levels for amenity in EPR NV10, and may necessitate some changes to equipment size to mitigate the noise effects.

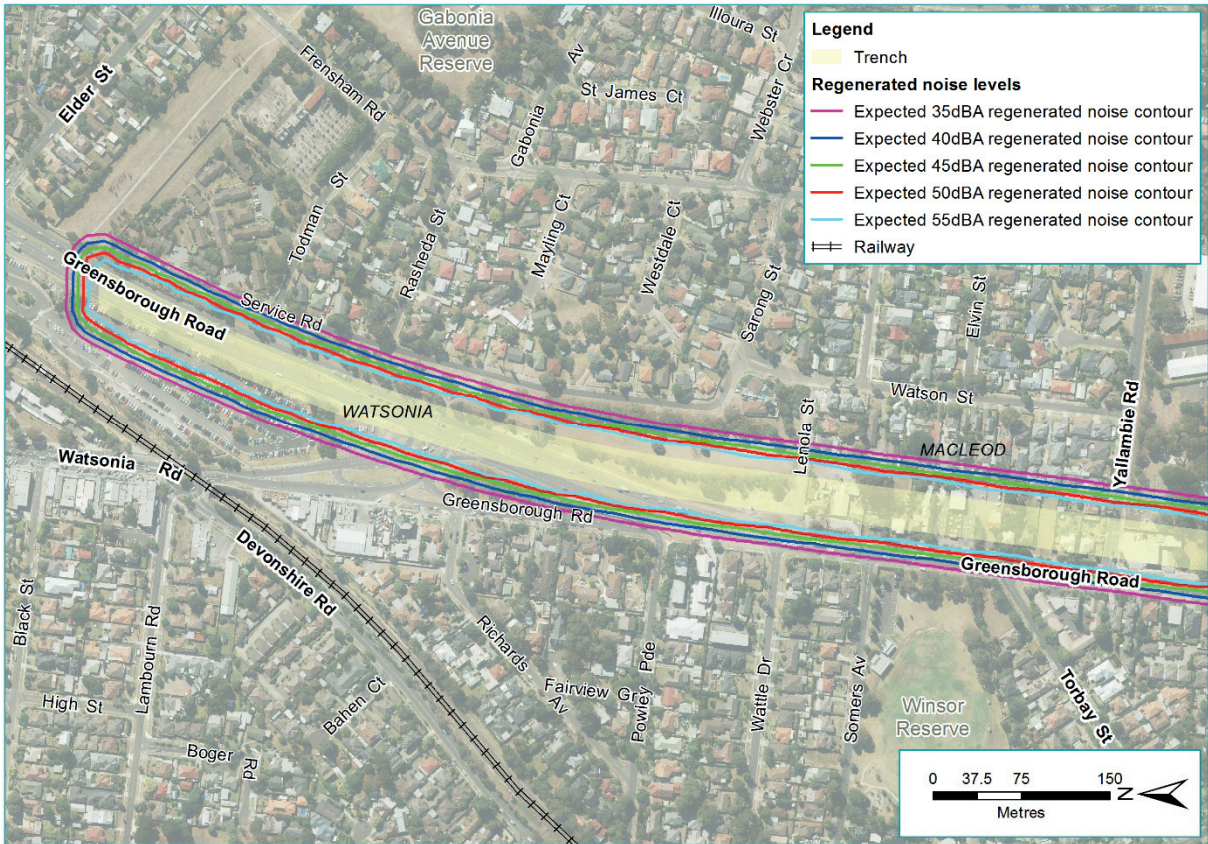


Figure 12-12 Predicted regenerated noise contours for excavation of trench using 45-tonne excavator with hydraulic hammer (north of Simpson Barracks)

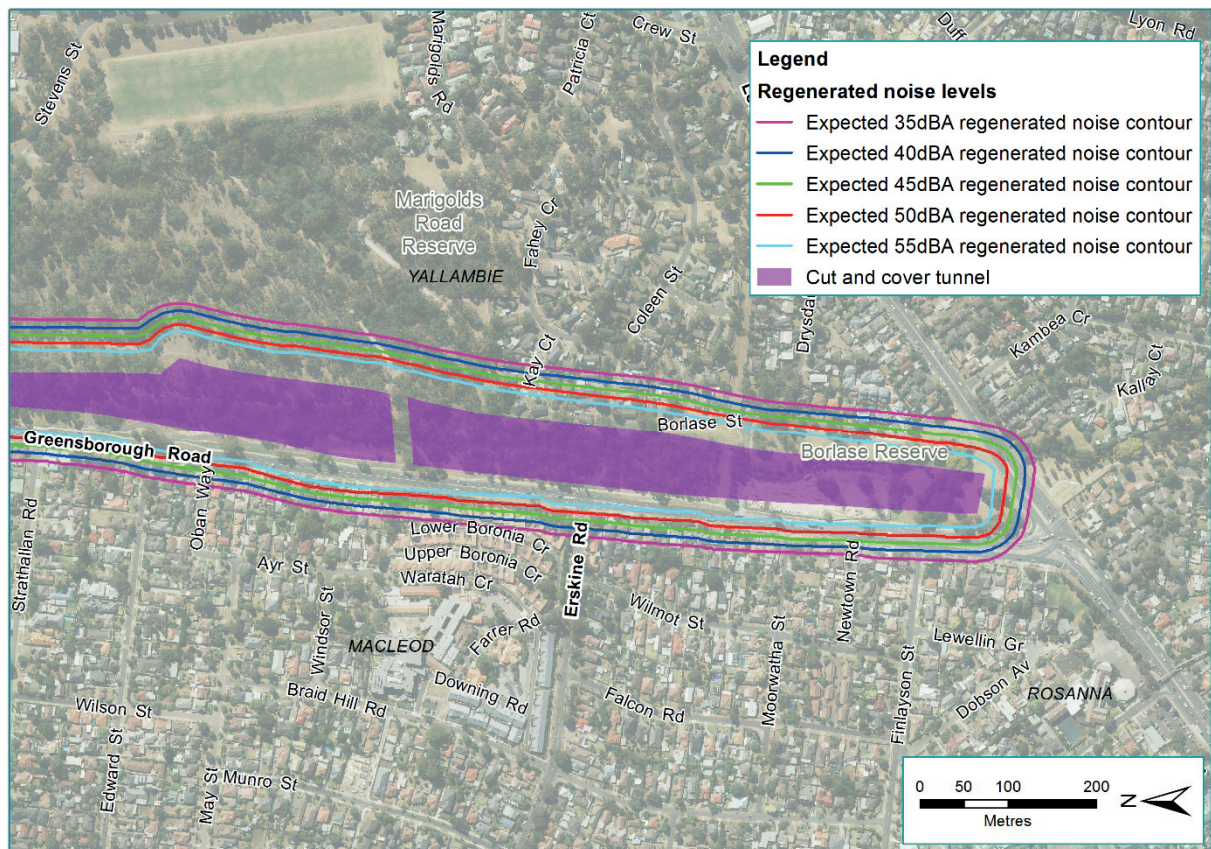


Figure 12-13 Predicted regenerated noise contours for excavation of trench using 45-tonne excavator with hydraulic hammer (south of Simpson Barracks)

The use of a hydraulic hammer for excavation could also impact the nearby building on Simpson Barracks. Elevated regenerated noise levels would be greater than the guideline target levels for amenity in EPR NV10, potentially exceeding 55 dBA on occasion, as shown in Figure 12-14, and may require mitigation to minimise impacts on Barracks personnel.

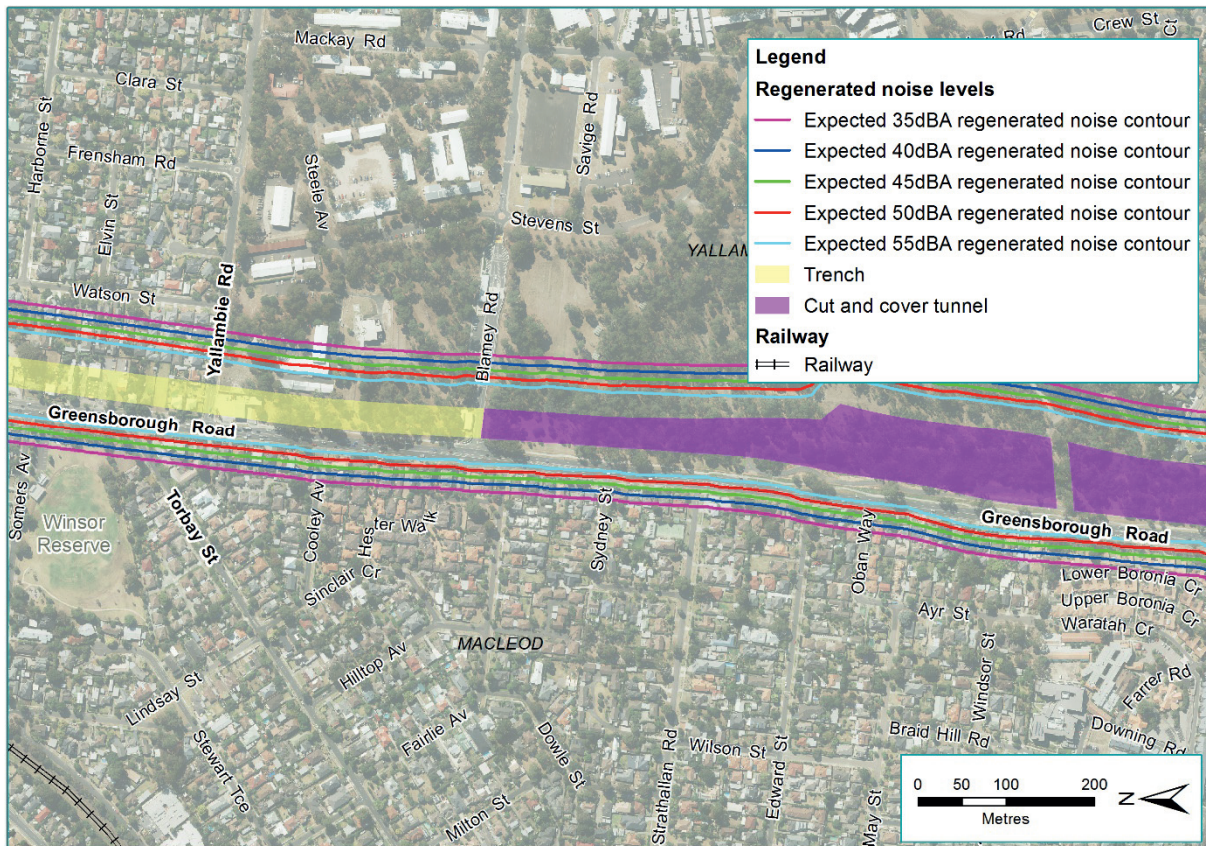


Figure 12-14 Predicted regenerated noise contours for excavation of trench using 45-tonne excavator with hydraulic hammer (at Simpson Barracks)

TBM tunnels: Excavation of the twin tunnels with the TBM was modelled to produce regenerated noise levels along the entire tunnel alignment. Noise levels could be greater than the guideline target levels for amenity in EPR NV10, as follows and as illustrated in Figure 12-15:

- Properties within 25 metres of each tunnel centreline could experience elevated regenerated noise levels above 40 dBA, which is greater than the night-time and evening guideline target levels
- Properties 25 to 35 metres of the tunnel centrelines could experience elevated regenerated noise levels above 35 dBA, which is greater than the night-time guideline target level
- Properties directly above the tunnels within approximately 700 metres of the northern portals could experience elevated regenerated noise levels above 45 dBA, which is greater than the night-time and evening guideline target levels.

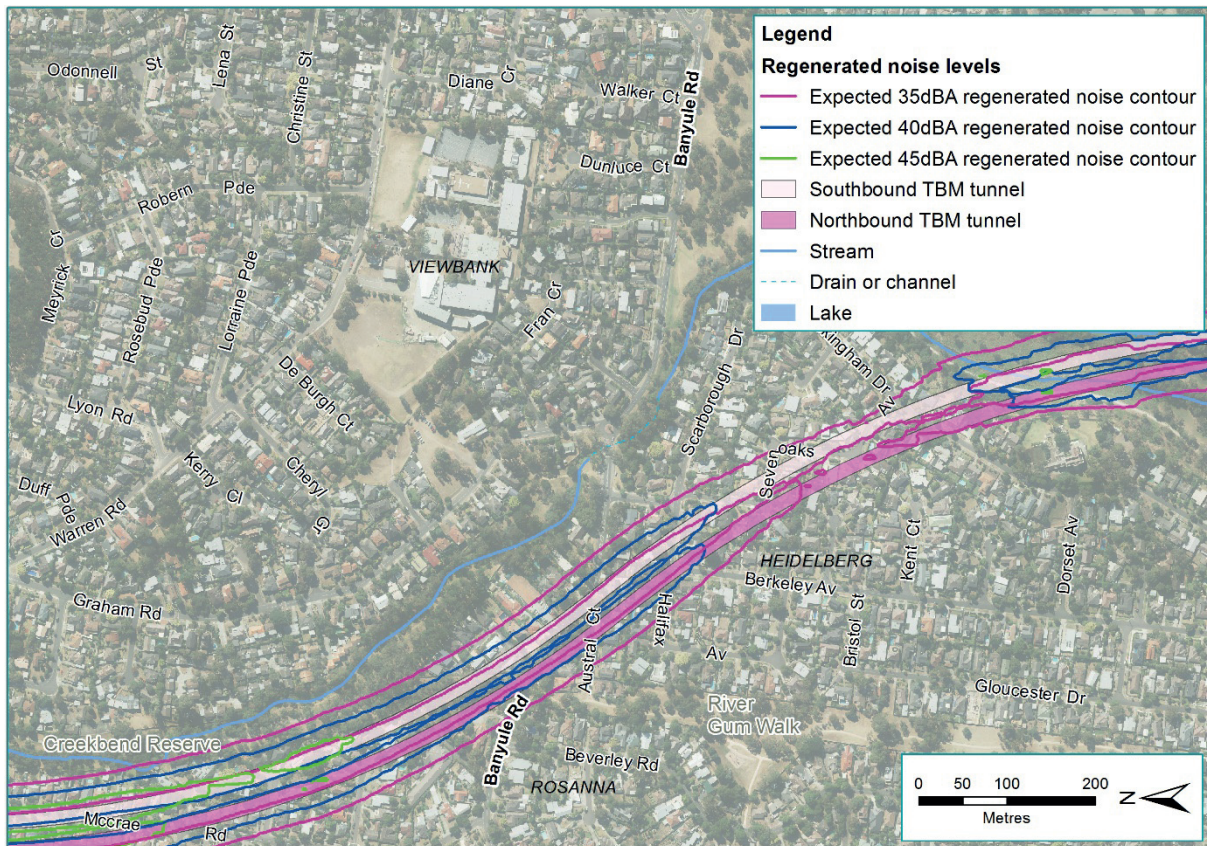


Figure 12-15 Predicted regenerated noise contours for tunnel construction using TBM (showing McCrae Road in Rosanna to Warringal Parklands)

TBM retrieval: It is anticipated that there would be no audible regenerated noise at the nearest sensitive receptor during excavation of the northbound tunnel TBM retrieval shaft in Banksia Park. Excavation of the southbound tunnel TBM retrieval shaft may result in regenerated noise levels of up to 45 dBA at the nearest sensitive receptor if a hydraulic hammer is used. It is predicted there would be no perceptible regenerated noise if this shaft could be excavated without the use of a hydraulic hammer. Overall, the modelling predicts the excavation of both TBM retrieval shafts could be completed in compliance with the guideline target levels for amenity in EPR NV10.

Manningham Road interchange: The cut and cover section from Bridge Street to Golden Way would involve excavation in the weaker alluvium near the surface using medium to large excavators. The level of regenerated noise from these works would be minimal. Residences on the eastern side of Bulleen Road are expected to experience regenerated noise levels less than 35 dBA while this excavation equipment is in use, which would comply with the guideline target levels for amenity (EPR NV10).

In the deeper sections of this cut and cover area, the use of an excavator with a hydraulic hammer could result in regenerated noise exceeding the guideline target levels for amenity in EPR NV10 (up to 45 dBA) for a few properties on the western edge of St. Andrews Crescent, as shown in Figure 12-16.

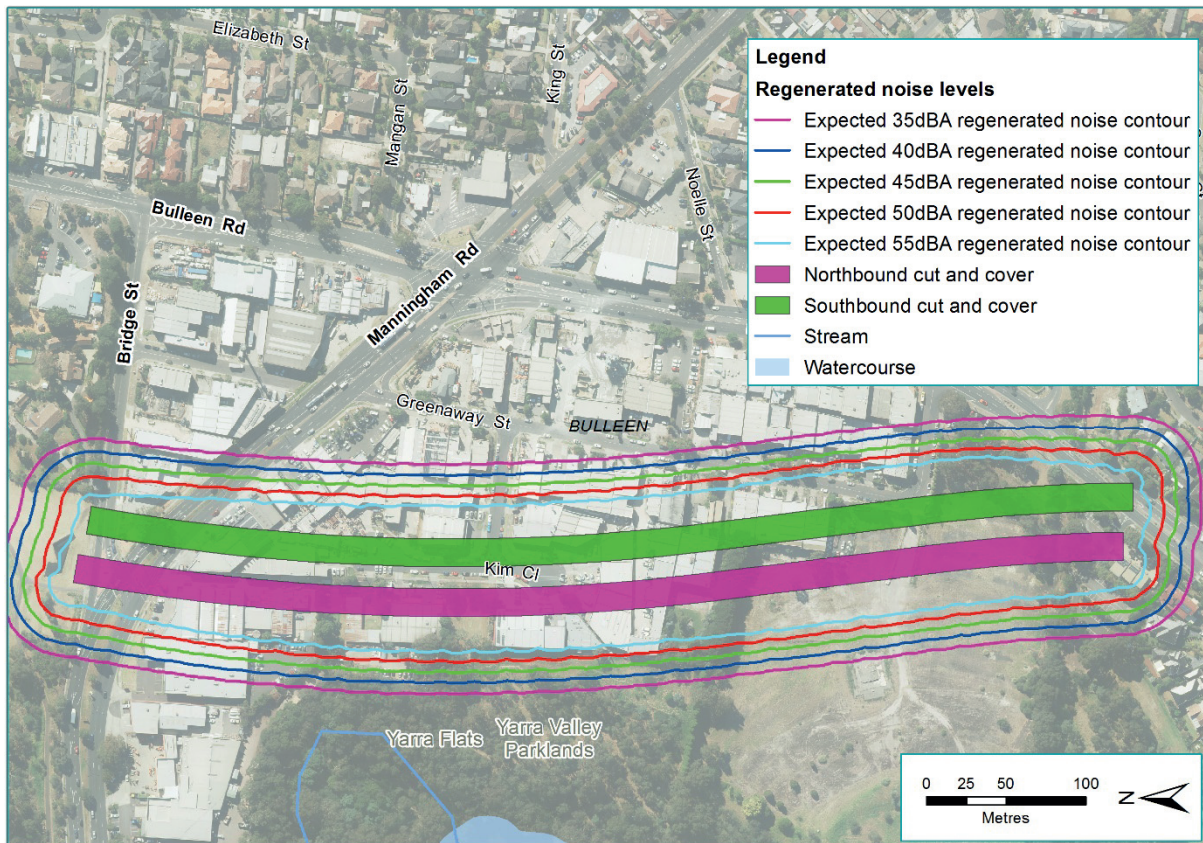


Figure 12-16 Predicted regenerated noise contours for cut and cover between Bridge Street and Golden Way using excavator with hydraulic hammer

Mined tunnel sections: The mined sections of tunnel excavated with a road header are modelled to produce elevated regenerated noise levels exceeding the guideline target levels for amenity in EPR NV10, as follows, and as illustrated in Figure 12-17:

- A corridor of approximately 80 metres width along the mined section could experience elevated regenerated noise levels above 35 dBA, which is greater than the night-time guideline target level
- At both ends of the mined sections where the depth to surface level would be shallower, a few properties are predicted to experience elevated regenerated noise levels of 45 dBA, which is greater than the night-time and evening guideline target levels
- An additional 10 properties along the mined section could receive noise levels up to 40 dBA, which is greater than the night-time and evening guideline target levels.

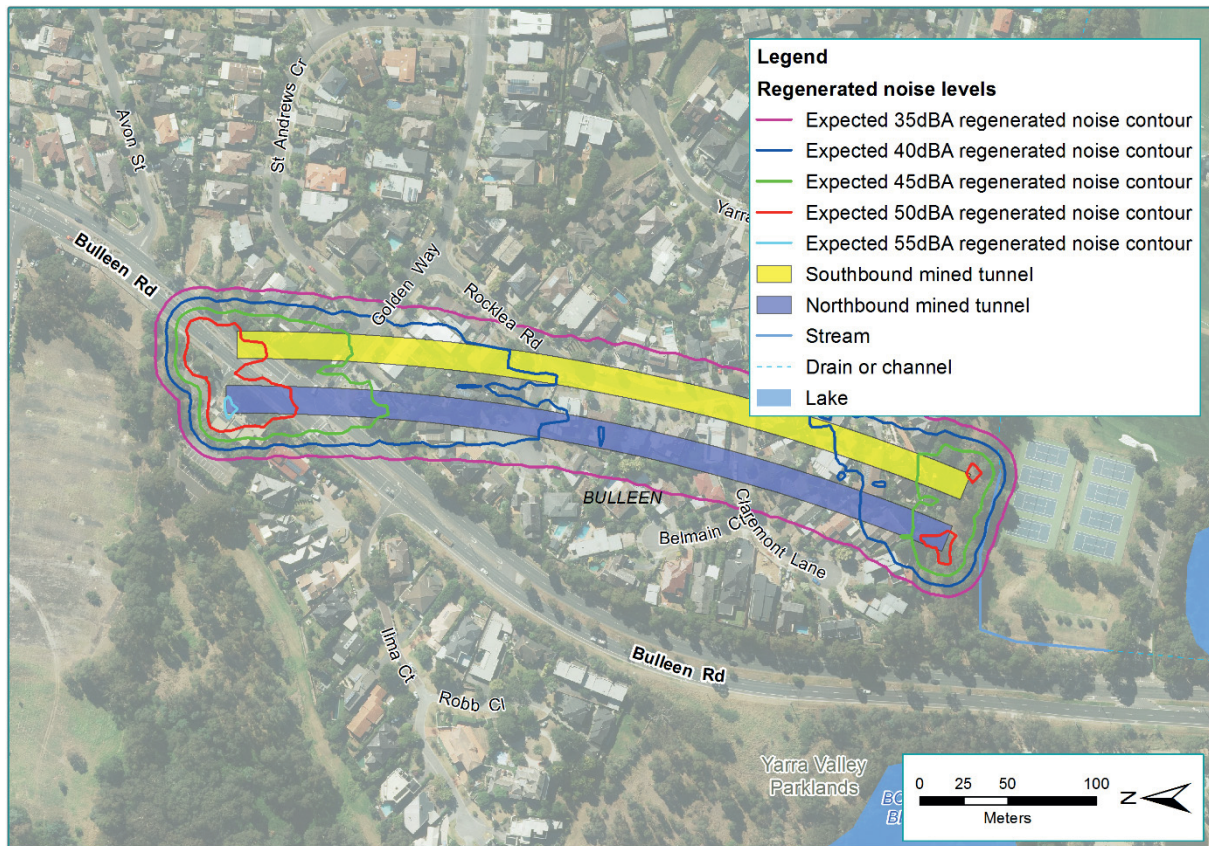


Figure 12-17 Predicted regenerated noise contours for tunnel sections mined using a road header (road header operating at the tunnel crown)

Southern tunnel portals: The southern portal geology suggests that excavation would not require equipment that would generate elevated levels of regenerated noise. Modelling of excavation with a 45-tonne excavator shows regenerated noise levels at the closest sensitive receptors would be less than 35dBA and would comply with the guideline target values for amenity in EPR NV10.

Cross passages: Modelling indicates the guideline target levels for regenerated noise in EPR NV10 could be exceeded during development of the cross passages at certain locations. In particular, construction of cross passages between the Lower Plenty Road interchange and the area near Homewood Court in Rosanna, as well as in the mined tunnel sections, could result in regenerated noise levels above 55 dBA.

Managing vibration and regenerated noise levels to protect amenity

As outlined in the above sections, modelling predicts that vibration and regenerated noise levels would be less than the guideline target levels for amenity in EPR NV8 and EPR NV10 during construction activities at the northern and southern tunnel portals, and where shallow excavation is required in the cut and cover area south of the Manningham Road interchange.

Excavation of the trench section, excavation of the mainline tunnels using a TBM, mining of tunnel sections using a road header and development of cross passages is expected to result in elevated levels of vibration and regenerated noise above the guideline target levels for amenity in EPR NV8 and EPR NV10. Modelling indicates that regenerated noise associated with the installation of bored piers adjacent to Simpson Barracks and the excavation of some sections of the cut and cover area south of Manningham Road interchange would also exceed these guideline target levels.

In addition, it is possible that guideline target levels for vibration and regenerated noise could be exceeded due to circumstances 'on-ground' during construction that were not able to be predicted or incorporated into the modelling. Elevated levels of vibration and regenerated noise during construction could be caused by:

- Construction equipment that is not able to be lowered to meet the guideline target levels for amenity (risks TV01 and TV02)
- Unforeseen geology, water conditions or surface conditions (risks TV04 and TV05)
- Use of different construction equipment to tunnel through hard rock (risks TV06 and TV07)
- An accelerated construction schedule (risks TV08 and TV09)
- Reduction in the TBM tunnelling rate increasing the amplitude and duration of effects (risk TV10)
- Building construction type and internal furnishings (risks TV11 and TV12)
- Blasting required to excavate rock at the location of the northern tunnel portals or for some cross passages (risk TV18).

Some residents along the tunnel alignment may also be more sensitive to vibration and regenerated noise impacts and could be affected by levels less than the guideline target levels (risk TV03).

There are limited opportunities to alter the design of the tunnels to reduce vibration and regenerated noise. The vertical alignment of the tunnels is required to meet grade (steepness) criteria, so it is not possible to further deepen the tunnel to avoid vibration effects. Similarly, the horizontal alignment of the tunnels must comply with curvature specifications as well as interface with the existing road network, so opportunities to change to the horizontal alignment as a vibration and regenerated noise control measure are not viable.

In most cases, it is expected that construction mitigation measures could be implemented to reduce vibration and regenerated noise to within the guideline target levels for amenity, in accordance with EPR NV8 and EPR NV10. This approach could include:

- **Adjustments to construction equipment:** The scale of equipment used to excavate the tunnel portals and the cross passages could be adjusted to control the level of vibration and regenerated noise at nearby sensitive receptors. It is important to note that this would increase the overall duration of equipment operation, which could further impact on amenity. For example, a 5 tonne excavator with a hydraulic hammer might generate 25 per cent of the vibration that a 40 tonne excavator would typically generate, but using this equipment it could take an extra two years to develop the trench section. Adjusting the scale of equipment is not an option for the TBMs, road headers and other critical construction equipment.
- **Real time monitoring:** Ongoing monitoring of vibration and regenerated noise levels would enable comparison of the measured levels of vibration and regenerated noise with predicted values to determine whether there should be reassessment of potential impacts and to inform the implementation of mitigation measures (refer also to Section 12.4). In general, where an exceedance of the guideline target level occurs, the CNVMP would detail a timeframe in which an action should be undertaken.
- **Community information and consultation:** Information would be exchanged with residents and others affected by construction in accordance with a Communications and Community Engagement Plan (CCEP), which would also outline measures concerning complaints management (EPR SC2). The CNVMP would include the processes and measures to be implemented as part of the CCEP and would detail an approach to notifying the community about potential impacts.

Where these mitigation measures cannot reduce vibration or regenerated noise impacts to acceptable values, management actions would need to be undertaken to reduce potential impacts to amenity. Management actions could include the short-term temporary relocation of residents and the provision of alternative accommodation for periods of respite.

These mitigation measures and management actions, as well as processes for notification of affected persons, would be clearly documented in the CNVMP (EPR NV4). EPR NV3 requires that construction noise is managed so that noise and vibration impacts to sensitive receptors are minimised in accordance with the CNVMP (as well as in accordance with EPA Publication 1254 Noise Control Guidelines).

If drilling or blasting is used as an alternative to mechanical construction methods, this would need to comply with the guideline targets levels for amenity detailed in EPR NV11 (for blasting vibration) and EPR NV12 (for overpressure).

The establishment of the guideline target levels and the implementation of mitigation measures as described above are expected to be sufficient in most cases to manage tunnelling vibration and regenerated noise levels. If required, management actions would be implemented to reduce the impacts of vibration and regenerated noise so these are acceptable. This approach is incorporated into the EPRs (listed in Chapter 27 – Environmental management framework) to protect the amenity of receptors within the vicinity of the North East Link tunnels. It is therefore unlikely there would be impacts on amenity at residential or commercial properties that would not be appropriately addressed by the EPRs.

12.5.2 Damage to buildings and structures

Vibration effects have the potential to cause damage to buildings. However, the level of vibration required to cause structural damage is relatively extreme. High levels of vibration can cause superficial damage, such as flaking of paint, cracking of plaster and paint edge separation. The mechanical equipment planned for construction of the North East Link tunnels would not typically generate these high levels of vibration.

The risk pathways associated with damage to buildings and structures are described in Table 12-2 and discussed below.

Table 12-2 Risk table – construction – building damage due to vibration

Risk ID	Risk pathway	Risk rating
Risk TV15	Either residential or commercial buildings along the corridor are structurally less sound than identified in the existing conditions assessment and are damaged by the level of vibration from the construction activities	Low
Risk TV16	The ground mass properties beneath the dwelling along the corridor are affected by the low amplitude vibrations that result in settlement and damage to residential or commercial buildings	Low
Risk TV17	Heritage buildings are damaged by the vibration generated by the construction methods	Low
Risk TV19	Rock mass sufficiently competent that excavation of the cross passages or the northern tunnel portals requires blasting that causes damage to the adjacent properties or other infrastructure	Low

This assessment has considered the potential for trenching and tunnelling to generate levels of vibration that would cause damage to buildings or structures.

EPR NV9 establishes guideline target levels for vibration to protect buildings and structures from damage during construction. The modelled vibration levels are less than these guideline target levels, and below values that represent the onset of superficial damage to buildings.

Some structures, such as heritage buildings, may be more sensitive to vibration than others and there is greater potential for these structures to be damaged by elevated vibration levels (risk TV17). Modelling indicated there may be measurable levels of vibration generated at the Heide Museum of Modern Art buildings and at Banyule House, but the levels of vibration generated at Clarendon Eyre would be indistinguishable from background levels. Vibration levels at all of these heritage buildings would be within the guideline target levels for sensitive structures (see EPR NV9).

The modelled vibration levels and the current understanding of ground conditions indicate that the potential for settlement to occur as a result of vibration is not significant (risk TV16 – refer also to Technical report M – Ground movement).

Based on this assessment, vibration from tunnelling construction activities is not expected to impact the integrity of buildings or structures within the study area.

What are condition assessments?

Condition assessments would be conducted on buildings identified as potentially being impacted by vibration. The purpose is to provide an indicative representation of the condition of buildings and structures before construction activities start.

Condition assessments would be conducted by a registered building surveyor or engineer. A condition assessment would involve an inspection of the existing structural condition of the surrounding buildings and structures before construction started and a further inspection once construction was completed.

Managing vibration levels to protect buildings and structures

It is possible that elevated vibration levels could occur above modelled estimates if there are unforeseen circumstances during construction, such as encountering sections of harder rock which require blasting (TV19).

It is also possible that residential or commercial buildings along the tunnel alignment are less structurally sound than identified in the existing conditions assessment, and could be affected by vibration levels lower than those predicted (risk TV15).

To reduce the potential for damage to buildings or structures during construction, condition assessments would be undertaken at sensitive receptors. The extent of condition assessments would depend on the type of equipment used for construction, and could either be determined according to a set distance from the construction footprint, or based on the expected level of vibration. Condition assessments would need to be undertaken for buildings that could be particularly sensitive to vibration effects. This would include Banyule House and the heritage buildings that form part of the Heide Museum of Modern Art, given their proximity to the construction footprint.

If a building condition assessment identified that a structure was unsound, a detailed investigation would be completed to determine:

- If an alternative guideline target level for vibration should be determined, or
- Whether structural issues should be rectified so that the building could withstand the predicted level of vibration.

The vibration guideline target levels for building protection (EPR NV9) would be applied to all buildings and all construction activities. The CNVMP (EPR NV4) would detail the extent of condition assessments to be undertaken before tunnel construction activities started. This would provide additional protection for residents in relation to instances of damage to their property as a result of construction, and is consistent with EPR NV3 which requires that construction vibration impacts to sensitive receptors be minimised. Compliance with these EPRs would protect buildings along the tunnel alignments from superficial and structural damage.

12.5.3 Damage to infrastructure and utility assets

Vibration can impact upon built infrastructure such as retaining walls, transmission tower piers and abutments, or other utility assets such as telecommunications, water, sewerage, power and gas services. These services exist along the full length of the tunnel alignments, generally serving residential and commercial premises. Damage to these services could affect the continued supply of services.

The risk pathways associated with damage to infrastructure and utility assets due to vibration and regenerated noise are described in Table 12-3 and discussed below.

Table 12-3 Risk table – construction – damage to infrastructure and utility assets due to vibration

Risk ID	Risk pathway	Risk rating
Risk TV14	Infrastructure like retaining walls, services, tower piers and abutments are damaged by the vibration generated by the construction activities	Low

This assessment has considered the potential for trenching and tunnelling to generate levels of vibration that would impact infrastructure or utility assets by causing joint displacement, cracking, leakage or structural failure (risk TV14).

To protect the identified services during construction, guideline target levels for vibration would be established in consultation with infrastructure and utility asset owners or applied in accordance with the guideline target levels in German Standard DIN 4150-3 *Structural Vibration Part 3: Effects of vibration on structures* (EPR NV5). Condition assessments of above and below-ground assets would also be undertaken to establish a baseline from which to assess any potential impacts.

The modelling results indicated that levels of vibration at the locations of identified infrastructure and utility assets would not exceed 2 mm/s. The location of the infrastructure and assets would be confirmed before construction started (in accordance with EPR NV3). The CNVMP would require that vibration levels during construction be monitored to determine compliance with the guideline target levels (EPR NV4).

Managing vibration levels to protect infrastructure and utility assets

It is expected that vibration would generally be able to be managed within the guideline target levels for infrastructure and utility assets. If the guideline target levels are exceeded, management actions would be implemented (as required by EPR NV5). These actions could include:

- Use of alternative construction equipment
- Rectification or strengthening of existing infrastructure to permit an elevated level of vibration
- Strengthening, relining, replacement or relocation of buried assets such as pipelines, cables, fibre optics and others.

Assessment of potential impacts on underground services due to elevated vibration levels may be undertaken via CCTV (closed circuit television).

Compliance with the more stringent guideline target levels for vibration at residential properties that are included in EPR NV9 (as outlined in Section 12.5.2) would also protect infrastructure and utility assets where they are in close proximity to these properties.

It is therefore unlikely that there would be impacts to infrastructure or utility assets as a result of vibration that would not be appropriately addressed by the EPRs.

12.5.4 Effects on the operation of sensitive equipment

Vibration and regenerated noise can impact on the continued operation of very delicate or high resolution equipment, such as electron microscopes or medical imaging equipment.

The risk pathway associated with impacts to the operation of sensitive equipment due to vibration and regenerated noise is described in Table 12-4.

Table 12-4 Risk table – construction – vibration and regenerated noise effects on the operation of sensitive equipment

Risk ID	Risk pathway	Risk rating
Risk TV13	Commercial buildings may contain sensitive equipment which cannot operate effectively with the generated levels of vibration and regenerated noise	Low

The external site assessment did not identify any buildings close to the trench or tunnels that are likely to contain sensitive equipment, such as hospitals, laboratories, or research institutions.

The presence of sensitive equipment would be further investigated before construction is started. If sensitive equipment was identified within proximity of the tunnel alignments, it is anticipated that its operation could be protected by adherence to the requirements of NV8 (construction vibration targets for amenity) and NV10 (ground-borne internal noise targets). If required, mitigation measures could also be implemented to reduce any potential impacts in accordance with EPR NV3.

Mitigation measures could include the use of smaller-scale construction equipment at locations that may be affected, temporary relocation of sensitive equipment, as well as real-time monitoring of vibration and regenerated noise levels.

Mitigation measures would be clearly documented in a Construction Noise and Vibration Management Plan (CNVMP) (EPR NV4). Processes for communicating with equipment owners would be documented in a Communications and Community Engagement Plan (EPR SC2).

12.6 Conclusion

This chapter has identified and assessed existing conditions, risks and potential impacts that could result from vibration and regenerated noise occurring during the construction of the North East Link trench, tunnels, portals and cross passages.

The horizontal alignment of the tunnels, their depth below the surface and the location of the tunnel portals are all well-positioned to minimise vibration and regenerated noise impacts. The tunnels would necessarily pass beneath residential and adjacent to some commercial areas, but they would be located near just three identified heritage building sites (Heide Museum of Modern Art, Banyule House and Clarendon Eyre).

Overall, the assessment indicates that trenching and tunnelling construction activities are expected to produce relatively minor levels of vibration and audible regenerated noise. At locations where works are close to sensitive receptors or where the depth of the tunnel beneath the surface level is shallower, it is anticipated there would be some perceptible levels of vibration and audible regenerated noise.

Application of the project EPRs (described in full in Chapter 27 – Environmental management framework) would reduce the impacts to identified sensitive receptors by controlling vibration and regenerated noise to meet project-specific guideline target levels based on relevant Australian and international standards. These targets for vibration and regenerated noise could be met by the selection of quieter machinery, careful programming of construction activities or the adoption of other standard construction practices for minimising the effect of vibration and regenerated noise levels.

Meeting the guideline target levels would not result in vibration or regenerated noise levels that are imperceptible or inaudible, but in levels that would be acceptable to the majority of people. Meeting the guideline target levels would also control the potential for physical damage to buildings, infrastructure and utility assets.

Where conditions during construction are encountered that could produce vibration and regenerated noise above the guideline target levels, management actions would be implemented to protect the amenity of residents and other building occupiers and to prevent damage to buildings (including heritage buildings), structures, sensitive equipment and utility assets.

In response to the EES evaluation objective described at the beginning of this chapter, vibration and regenerated noise effects on amenity, buildings and structures, sensitive equipment, infrastructure and utility assets have been assessed and EPRs have been identified that would reduce potential impacts.



