Environment
Effects Statement

Technical Report D
Tunnel vibration

North East Link Project

North East Link Environment Effects Statement

Technical report D – Tunnel Vibration and Regenerated Noise

Prepared for North East Link

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Executive summary

This technical report is an attachment to the North East Link Environment Effects Statement (EES). It has been used to inform the EES required for the project, and defines the Environmental Performance Requirements (EPRs) necessary to meet the EES objectives.

Overview

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

On 2 February 2018, the Minister for Planning declared North East Link to be 'public works' under Section 3(1) of the *Environment Effects Act 1978*, which was published in the Victorian Government Gazette on 6 February 2018 (No. S 38 Tuesday 6 February 2018). This declaration triggered the requirement for the preparation of an EES to inform the Minister's assessment of the project and the subsequent determinations of other decision-makers.

The EES was developed in consultation with the community and stakeholders and in parallel with the reference project development. The reference project has been assessed in this EES. The EES allows stakeholders to understand the likely environmental impacts of North East Link and how they are proposed to be managed.

Heilig & Partners was commissioned to undertake a tunnel vibration and regenerated noise impact assessment to inform the EES.

Vibration and regenerated noise context

The scoping requirements for the EES issued by the Minister for Planning set out the specific environmental matters to be investigated and documented in the project's EES, which informs that scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project.

The following evaluation objective is relevant to the tunnel vibration assessment:

> *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.*

A summary of the key assets, values or uses potential affected by the project, and the associated impacts assessment are summarised below.

Existing conditions

Geology influences the type of equipment that could be used for tunnelling, development of the cross passages and the excavation of the dive structures for the portals. Where the North East Link tunnels and surface works would be in competent rock types, the equipment required would be higher energy input than for sections in less competent materials. For the dive structures, where the geology varies from alluvium to weathered siltstone to fresh siltstone, the size of the excavating equipment would also increase in size and energy. While an excavator could reasonably dig through the alluvium, a hydraulic hammer would likely be required as the degree of weathering for the rock mass reduces. The geological summary and its interpretation with respect to vibration and regenerated noise is based on the geotechnical investigations.

The existing vibration conditions in the study area are typical of a quiet residential area with minimal sources of elevated vibration. Any current instances of perceptible vibration would likely result only from a combination of heavy vehicle movements coupled with uneven road pavement surfaces.

All buildings in the study area would be considered sensitive receptors, along with all infrastructure and potentially sensitive equipment.

The project alignment has sections of the tunnels that pass beneath residential buildings, the open space of Banyule Flats, Warringal Parklands and Bulleen Park, including adjacent to the heritage-listed Heide Museum, Banyule House and Clarendon Eyre. Including these three heritage properties, the level of vibration from the project construction activities would have no impact upon the integrity of the structure. A further section of residential development is above the tunnels for the section between Bulleen Road and the southern portal at the Trinity Grammar School Sporting Complex.

Many of these dwellings are well established houses constructed from timber or brick with some more recently constructed properties throughout the residential sub-divisions. Although the type and construction of the properties vary, their condition externally appears appropriate for their age and there is no indication they would require a vibration criterion to manage the levels of vibration that is more stringent than commonly applied for standard residential properties.

Building-specific vibration criterion is not proposed nor considered. There are no buildings that would preclude the use of the generic building categories and the generally applied vibration conditions.

Impact Assessment

The North East Link tunnels would extend from north of Lower Plenty Road through to a southern portal located in the playing field south of the Veneto Club and west of Bulleen Road. Project components relevant to the tunnel vibration and regenerated noise assessment are:

- Northbound and southbound main tunnels
- Northbound and southbound mined tunnels
- Cut and cover tunnel section
- Northern trench structure
- Southern portal dive structure
- Northern portal dive structure
- Safety cross passages.

The study area comprises the full length of the tunnels, between and including both dive structures and includes an area approximately 200 metres either side of the carriageway.

Construction would likely include activities and equipment that could produce vibration and regenerated noise levels, which are elevated when compared with the existing background environment. Principal vibration-inducing activities are either continuous, or at least semi-continuous, as characterised by a Tunnel Boring Machine (TBM), a road header, excavator with a hydraulic hammer attachment, or bored piling. No modelling of drilling and blasting excavation methods has been completed. Should blasting be used, the most likely area would be for the development of the northern dive structure or for several of the cross passages.

The type of construction equipment, the geological conditions and the proximity of sensitive receptors define the level of tunnel vibration impacts.

A risk assessment identified risk pathways specific to the project. These pathways identified several threats the project could generate together with the possible effects on the asset or use. Environmental Performance Requirements (EPRs) have been specified to address these risks.

They include:

- Minimising the environmental impact of construction activities by controlling vibration and regenerated noise to levels that meet international standards and guidelines for a short-term construction project
- Protecting the amenity of residents and other building occupiers
- Preventing short-term and long-term damage to adjacent public utilities, structures, heritage items and buildings from vibration and air overpressure.

The EPRs are consistent with international standards and guidelines that seek to protect amenity, building integrity and equipment usage.

Vibration and regenerated noise models were applied and assessments completed to estimate vibration and regenerated noise impacts. The outcomes were assessed against the quantitative criteria given in the initial EPRs. The analyses included:

- The construction of the mainline tunnels where construction would utilise a TBM
- The construction activities for surface works, cut and cover sections and open trenches which could utilise excavators or excavators with a hydraulic hammer for the harder, more competent rock material, including the construction of diaphragm walls and bored piles
- The construction of the mined tunnel section between Bridge Street and Bulleen Road with a road header
- The development of the cross passages with a smaller hydraulic hammer.

The construction of main tunnels, cross passages and portal dive structures would produce perceptible but generally acceptable and manageable levels of vibration and regenerated noise. Where impacts are potentially unacceptable, mitigation measures are available and include adjustments to the scale of the works, real-time monitoring and community consultation. Where measures cannot reduce vibration or regenerated noise levels to acceptable values, other measures such as temporary relocation, vibration isolation devices or noise amelioration measures may be required.

Other large-scale tunnelling projects have been completed using approaches consistent with that applied for the North East Link. The EPRs specify management plans, including a Construction Noise and Vibration Management Plan (CNVMP) and a Communication Plan as part of the Construction Environmental Management Plan (CEMP). These plans would specifically address construction methods and how they would be managed to minimise impact and how information would be exchanged with residents and others affected by construction.

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Glossary and abbreviations

Term	*Description*
A weighting	The human ear responds more to frequencies between 500 Hz and 8 kHz and is less sensitive to very low-pitch or high-pitch noises. The frequency weightings used in sound level measurements are often related to the response of the human ear to ensure that the meter better responds to what you actually hear
Airborne vibration	Structural vibration induced by low frequency sound
Amplification factor	For ground vibration: means the ratio of the vibration amplitude at a particular point on a building or structure, to the vibration amplitude measured at the base or on the foundation, of the building or structure
CEMP	Construction Environmental Management Plan
Component particle velocity	The instantaneous particle velocity of a particle at each orthogonal component axis (transverse, longitudinal and vertical)
Continuous vibration	A vibration source that is continuous in nature during an assessment period (may be constant or variable). ISO10137 defines continuous vibration as having a duration of more than 30 minutes per 24-hour period
Crest factor	The ratio between the peak amplitude and the maximum RMS amplitude of a signal
Damping	Any means of dissipating vibration energy in a vibrating system. The dissipation of energy with time or distance. The term is generally applied to the attenuation of vibration in a structure owing to the internal dissipating properties of the structure or to the addition of dissipative materials.
decibel	A unit used to measure the intensity of a sound or the power level by comparing it with a given level on a logarithmic scale. For noise, the base value is 20 microPascals, or $20x10^{-6}$. The level is calculated according to: $$dB = 20Log_{10}\left(\frac{P}{20x10^{-6}}\right)$$ where P is the measured pressure level in Pascals
Department of Transport	The Victorian Department of Transport is responsible for delivering the government's transport infrastructure agenda. It was formed on 1 January 2019 when the former Victorian Department of Economic Development, Jobs, Transport and Resources transitioned into the Department of Transport and the Department of Jobs, Precincts and Regions.
Dive Structure	Section of roadway where the tunnel portal gradually rises in elevation to meet the existing road network
EES	Environment Effects Statement. Provides a comprehensive framework for assessing the effects of major projects in Victoria. The guidelines state the objective of the assessment process is to provide for the transparent, integrated and timely assessment of projects capable of having a significant effect on the environment
EPR	Environmental Performance Requirement
Frequency	The rate per second of a vibration constituting a wave, either in the rock mass material (as in vibration) or in the air (as in sound waves), The number of cycles per unit of time, commonly per second, is called the frequency. The measurement is reported in Hertz (Hz).
Groundborne vibration	Vibration transmitted from a source to a receptor via the ground. (See also structure-borne vibration)
Hydraulic hammer	A rock breaker/hydraulic hammer is a percussion hammer fitted to an excavator for excavating rocks material. It is powered by an auxiliary hydraulic system from the excavator.

Term	*Description*
Impulsive vibration	A vibration source (continuous or intermittent) which has a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping).
Intermittent vibration	Interrupted periods of continuous (eg a drill) or repeated periods of impulsive vibration (eg a pile driver), or continuous vibration that varies significantly in magnitude. ISO10137 define intermittent vibration as more than 10 excitations per 24-hour period
Major Transport Infrastructure Authority	The Major Transport Infrastructure Authority (MTIA) is the proponent for the North East Link project. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.
Melbourne Formation	Interbedded siltstone and fine sandstone. Typically weathered in the upper part and low strength. Basement geology, underlies entire project area at significant depth
MIC	Maximum Instantaneous Charge and corresponds to the quantity of explosive initiated in a single column of explosive detonated with a unique nominal initiation time. The quantity is measured in kilograms
NELP	North East Link Project
North East Link Project	North East Link Project is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP was formerly known as the North East Link Authority prior to 1 January 2019. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.
OEMP	Operations Environmental Management Plan
Particle displacement, velocity and acceleration	Vibration can be characterised by measurement of the displacement, velocity or acceleration of a representative point (a ‘particle’) of the ground or structure affected by the disturbance. For measurements of ground motion (or for other surfaces) the particle displacement is defined as the distance that the ground (or other surface) is displaced from its mean (or static) position during the course of a vibration. The particle velocity is simply rate of change of displacement of the ground or floor, and the particle acceleration the rate of change of that velocity.
Peak Component Particle Velocity (PCPV)	The maximum instantaneous velocity of a particle at any one of the three orthogonal component axes during a given time interval. Also represented by the notation vi in DIN 4150-3.
Peak Particle Velocity (Resultant PPV)	The maximum instantaneous velocity of a particle at a point during a given time interval. The Resultant PPV is the vector sum of the three orthogonal component particle velocities (component PV)
PPV	Peak Particle Velocity
Propagation Velocity	For vibration: means the speed with which the vibratory disturbance (a wave) propagates in the medium in which it travels. For vibrations of the air (sound), the propagation velocity is the ‘speed of sound
PVS	Peak vector sum level of vibration where the amplitude is the time-synchronised velocity components of the three orthogonal sensors directly measured by the instrument. Where not measured directly, it may be determined by the following equation: $$VS = \sqrt{v_x{}^2 + v_y{}^2 + v_z{}^2}$$ Where v_x, v_y, v_z are the synchronised instantaneous velocity components of the x, y and z axes respectively. PVS is the maximum of the VS. the value is reported in mm/s
Resonance	Resonance of a system in forced oscillation exists when any change in the frequency of excitation causes a decrease in a response of the system

Term	*Description*
RMS	Root Mean Square Amplitude (RMS) is the square root of the average of the squared values of the waveform. In the case of the sine wave, the RMS value is 0.707 times the peak value, but this is only true in the case of the sine wave.
RMS Particle Acceleration	The root mean square, particle acceleration
RMS Particle Velocity	The root mean square particle velocity, commonly used (with the RMS acceleration) to assess human response to vibration. Unless otherwise specified, RMS particle velocity (denoted v_{RMS}) refers to the overall vector sum RMS particle velocity rather than to any particular component of the RMS particle velocity.
Roadheader	A roadheader, also called a boom-type roadheader, road header machine, road header or just header machine, is a piece of excavating equipment consisting of a boom-mounted cutting head, a loading device usually involving a conveyor, and a crawler travelling track to move the entire machine forward into the rock face.
TBM	A tunnel boring machine (TBM) is a machine used to excavate tunnels with a circular cross section through a variety of soil and rock strata. They may also be used for micro-tunnelling. They can excavate through anything from hard rock to sand.
Transient Vibration	Vibration in which the oscillatory displacement of the ground or structure reaches a peak and then decays rapidly towards zero
VDV	Vibration Dose Value can be used for assessing intermittent vibration it is necessary to use the vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period. Measurement is the preferred method as the vibration may vary and in many cases be intermittent. If the vibration level is 'steady' then shorter measurements of the acceleration may be used in the following formulae. The VDV formulae uses the RMS Acceleration raised to the fourth power and is known as the Root-mean-quad method. This technique ensures the VDV is more sensitive to the peaks in the acceleration levels. $$VDV = \left(\int_0^T a^4(t)dt\right)^{1/4}$$ VDV is the vibration dose value in $m/s^{1.75}$, a(t) is the frequency weighted Acceleration in m/s^2 and T is the total measurement period in seconds.
Vibration	Vibration of the ground or of structures and buildings, that is, the oscillatory displacement of the ground or of structures and buildings.
X-axis vibration	(pertaining to whole body vibration). Mechanical vibration acting along the postero-anterior (back to front) axis of the human body
Y-axis vibration	(pertaining to whole body vibration). Mechanical vibration acting laterally (sideways) on the body
Z-axis vibration	(pertaining to whole body vibration). Mechanical vibration acting along the caudocephalic (foot to head) axis of the human body

1. Introduction

1.1 Purpose of this report

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's metropolitan ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

North East Link was declared as Public Works to the Minister for Planning on 12 January 2018. On 2 February 2018, the Minister issued a decision confirming that an Environment Effects Statement (EES) is required for the project due to the potential for significant environmental effects.

Similarly, the project was referred to the Australian Government's Department of the Environment and Energy on 17 January 2018. On 13 April 2018 the project was declared a 'controlled action', requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act'). Separate to this EES, a Public Environment Report (PER) is required to be prepared to satisfy the EPBC Act requirements, and assess the impacts of the project on Commonwealth land and matters of national environmental significance (MNES).

The purpose of this report is to assess the potential tunnel vibration impacts associated with North East Link and to define the Environmental Performance Requirements (EPRs) necessary to meet the EES objectives.

The assessment considers only construction activities specifically related to the tunnelling and trench construction. No tunnelling vibration or regenerated noise impacts are anticipated on North East Link during operation. Surface noise and vibration impacts of the project during the project's construction and operation are discussed and assessed EES Technical report relating C – Surface noise and vibration.

1.2 Why understanding noise and vibration is important

The construction of North East Link would involve activities that generate noise and vibration. Management of noise and vibration is important to minimise amenity impacts on affected sensitive uses and to prevent vibration-induced damage to property assets and other infrastructure. The planned method of construction for the project's tunnels, cross passages and dive structures would determine the vibration they generate. The proximity to the adjacent sensitive areas would likewise determine the potential for impact.

People may feel vibration in a building structure or it may produce audible regenerated noise in the building. Vibration generally reduces as it passes from the ground into the columns and foundations of a building. It also reduces in magnitude as it travels up the building from floor to floor. Regenerated noise is caused by vibration in floor and wall elements that radiates into a room. The effects of regenerated noise cannot be readily reduced by closing windows and doors but they can be anticipated and ameliorated by timetabling activities in times of reduced community sensitivity, and by responding rapidly to complaints. Regenerated noise is more difficult to predict than noise that is transmitted through the air. Its transmission depends on the ground strata, structure of the building and internal acoustic characteristics of the buildings affected.

2. EES scoping requirements

2.1 EES evaluation objectives

The scoping requirements for the EES issued by the Minister for Planning set out the specific environmental matters to be investigated and documented in the project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project.

The following evaluation objective is relevant to the tunnel vibration and regenerated noise assessment:

> *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.*

2.1 EES scoping requirements

The aspects from the scoping requirements relevant to the tunnel vibration and regenerated noise evaluation objective are shown in Table 2-1 below as well as the location where these items have been addressed in this report.

Table 2-1 Scoping requirements relevant to tunnel vibration

Aspect	*Scoping requirements*	*Report scope*	*Section addressed*
Key issues	• Generation of airborne, ground borne or regenerated vibration from construction that could adversely affect residential amenity or infrastructure.	Ensuring the vibration and regenerated noise levels are controlled to values that ensure the amenity of persons around the alignment is not affected. Ensure the vibration from the construction activities does not affect the integrity of adjacent buildings, services or other key infrastructure.	Environmental Performance Requirements: Section 9
Priorities for characterising the existing environment	• Identify residences, and other sensitive land uses, property assets or infrastructure that may be vulnerable to air borne, ground borne or regenerated vibration from construction activities. • Characterise existing ground vibration conditions through measurement and describe geological conditions that might influence the transmission of vibrations and regenerated noise from construction works.	Identify relevant standards, site inspection to identify potentially sensitive infrastructure	Existing conditions: Section 6

Aspect	*Scoping requirements*	*Report scope*	*Section addressed*
Design and mitigation measures	• Propose design, mitigation and management measures to control generation of airborne or ground borne vibrations from construction.	Assess expected level of vibration and regenerated noise from the planned equipment and compare with relevant standards to assess likely mitigation measures. Review other projects to understand the mitigation measures that have been necessary.	Impact assessment: Section 8
Assessment of likely effects	• Analyse potential for vibration to cause disturbance to occupants of residential buildings or other sensitive land uses or cause adverse effects on property and infrastructure.	Identify potential risk pathways for vibration and regenerated noise from tunnelling, and evaluate risks. Model vibration and regenerated noise levels based upon the reference project and provides results as a series of predicted vibration and regenerated noise contours for comparison with the relevant EPRs.	Risk assessment: Section 7 Appendix B Impact assessment: Section 8 Appendices C, D and E Appendices F and G
Approach to manage performance	• Describe the environmental performance requirements to set air quality, traffic noise and vibration outcomes that the project must achieve.	Environmental performance requirements in relation to vibration and regenerated noise impacts.	Environmental Performance Requirements: Section 9

2.2 Linkages to other reports

This report relies on or informs the technical assessments as indicated in Table 2-2.

Table 2-2 Linkages to other technical reports

Specialist report	*Relevance to this impact assessment*
Technical report C – Surface noise and vibration	Lists the permissible noise criteria for surface generated noise and the appropriate mitigation measures
Technical report K – Historical heritage	Identifies the heritage infrastructure along the alignment, including the potentially sensitive elements and the existing condition. Provides details of the Heide Museum, Banyule House and Clarendon Eyre as the closest heritage elements to the tunnel alignment
Technical report M – Ground movement	Provides vibration values are expected from the different construction equipment. These values are used to offer comment on the possibility of settlement, subsidence or other ground impacts form the construction process

3. Project description

3.1 Overview

The North East Link alignment and its key elements assessed in the Environment Effects Statement (EES) include:

- M80 Ring Road to the northern portal – from the M80 Ring Road at Plenty Road, and the Greensborough Bypass at Plenty River Drive, North East Link would extend to the northern portal near Blamey Road utilising a mixture of above, below and at surface road sections. This would include new road interchanges at M80 Ring Road and Grimshaw Street.
- Tunnels: Northern portal to southern portal – from the northern portal the road would transition into twin tunnels that would connect to Lower Plenty Road via a new interchange, before travelling under residential areas, Banyule Flats and the Yarra River to a new interchange at Manningham Road. The tunnels would then continue to the southern portal located south of the Veneto Club.
- Eastern Freeway – from around Hoddle Street in the west through to Springvale Road in the east, modifications to the Eastern Freeway would include widening to accommodate future traffic volumes and new dedicated bus lanes for the Doncaster Busway. There would also be a new interchange at Bulleen Road to connect North East Link to the Eastern Freeway.

The project would also improve existing bus services from Doncaster Road to Hoddle Street with the Doncaster Busway as well as pedestrian connections and the bicycle network with connected shared use paths from the M80 Ring Road to the Eastern Freeway.

For a detailed description of the project, refer to EES Chapter 8 – Project description.

These areas are illustrated in Figure 3-1.

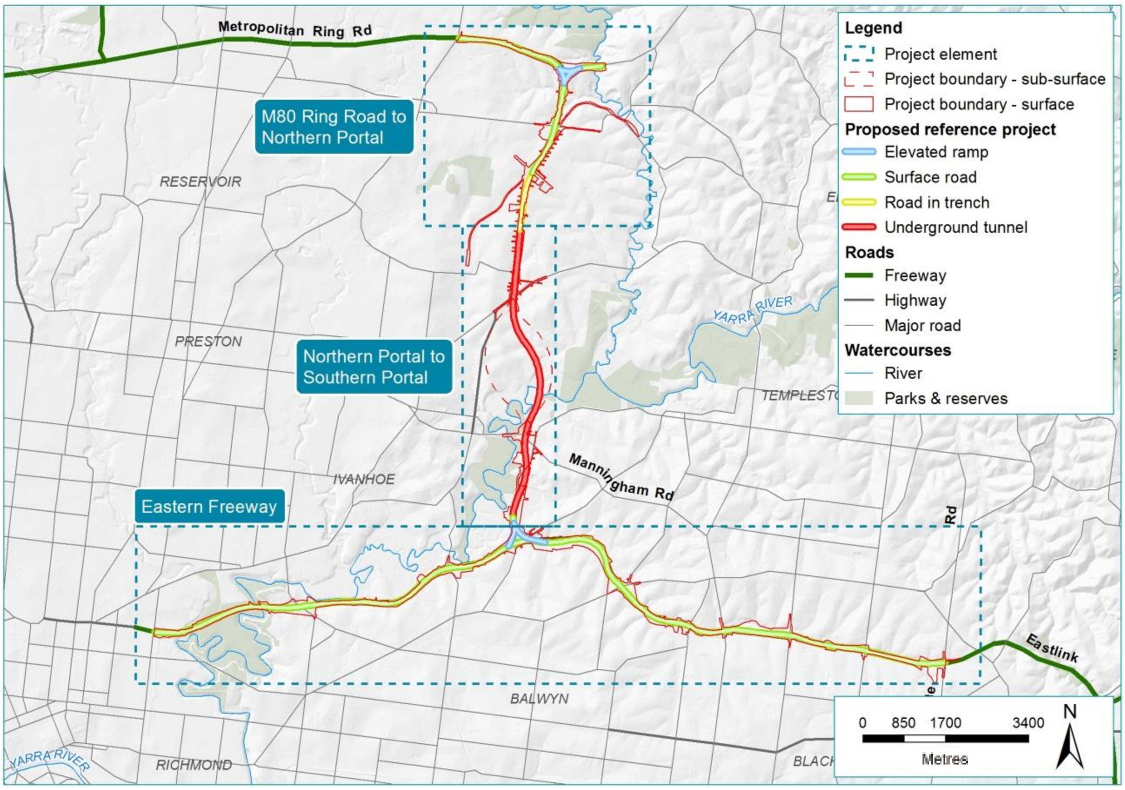


Figure 3-1 Overview of North East Link

3.2 Construction

Key construction activities for North East Link project would include:

- General earthworks including topsoil removal, clearing and grubbing vegetation
- Relocation, adjustment or installation of new utility services
- Construction of retaining walls and diaphragm walls including piling
- Ground treatment to stabilise soils
- Tunnel portal and dive shaft construction
- Storage and removal of spoil
- Construction of cross passages, ventilation structures and access shafts
- Installation of drainage and water quality treatment facilities
- Installation of a Freeway Management System
- Tunnel construction using tunnel boring machines (TBMs), mining and cut and cover techniques
- Installation of noise barriers
- Restoration of surface areas.

3.3 Operation

Following construction of North East Link, the key operation phase activities would include:

- Operation and maintenance of new road infrastructure
- Operation and maintenance of Freeway Management System
- Operation of North East Link motorway control centre
- Operation and maintenance of the tunnel ventilation system
- Operation and maintenance of water treatment facilities
- Operation and maintenance of the motorways power supply (substations)
- Maintenance of landscaping and Water Sensitive Urban Design (WSUD) features.

4. Legislation, policy, guidelines and criteria

4.1 Legislation, policy and guidelines

Numerous legislative, policy and guidance documents are relevant to this tunnel vibration impact assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to the tunnel vibration impact assessment for the project are summarised in Table 4-1 below.

Table 4-1 Key legislation, policy and guidelines

Legislation/policy/guideline	*Relevance to this impact assessment*
• Australian Standard AS2436-2010	• Overarching standard for guide to noise and vibration control on construction, demolition and maintenance sites. Standard provides links and references to other standards or guidelines that should be followed.
• Australian Standard AS2187.2-2006	• Well-referenced document specifically addressing vibration from impulsive activities like blasting but provides reference to vibration levels for personal amenity and building damage.
• British Standard BS5528-2:2009	• Standard referenced with respect to vibration guidelines applicable for construction projects for amenity and building damage. Referenced document in AS2436.
• British Standard BS6472-1:2008	• Most widely referenced standard for assessing amenity with respect to vibration. Standard used as a guide to evaluate human exposure to vibration in buildings for vibration sources other than blasting.
• British Standard BS7385-2: 1993	• British Standard for evaluation and measurement of vibration in buildings with respect to building damage levels from ground-borne vibration. Standard referenced in AS2436 and AS2187.
• Department of Environment and Conservation for New South Wales (NSW) DEC – Assessing vibration: A technical guideline	• References dosage for assessing vibration amenity. Refers to the BS6472-1 standard.
• German Standard DIN4150-3:1999	• In combination with the British Standard BS7385, the German Standard is very widely used for the protection of infrastructure from vibration damage.
• Noise Control Guidelines, EPA Victoria Publication 1254 (2008)	• While applicable to commercial, industrial and some large-scale residential construction projects, these guidelines provided a basis for determining construction noise targets to reduce noise impacts.
• NSW Interim Construction Noise Guidelines	• These guidelines are specifically aimed at managing noise from construction works and can assist in setting statutory conditions in licences or other regulatory instruments.

The Australian Standard AS2436-2010 is an over-arching qualitative guide to noise and vibration control on construction, demolition and maintenance sites. The standard does not directly propose permissible levels of vibration but references other Australian Standards such as AS2187.2, the British Standards such as BS6472-1, BS7385-2 and BS5528-2:2009 and guidelines such as the NSW Assessing Vibration technical guide (NSW technical guide).

4.2 Guidelines for continuous vibration

People have different tolerances to vibration. Acceptable vibration values depend on social and cultural factors, psychological attitudes and expected interference with privacy. Commonly observed problems with human comfort criteria include: a less than zero tolerance for some persons can lead to complaints about very low levels of vibration; personal interest; and mistaking or substituting vibration for other impacts such as noise or dust. Complaints should still be anticipated at vibration levels less than those recommended. Equally, a high-quality community engagement program may lead to an acceptance of vibration levels greater than those recommended.

BS6472-1:2008 provides a range of values to account for these expected variations. It also notes that for critical areas, the proposed magnitudes of acceptable vibration pertain to periods of time when critical work is being performed. At other times, magnitudes as high as those for other building uses are satisfactory if there is due agreement and warning.

Given the wide variation in tolerance to vibration, the values for personal amenity are considered trigger values. Exceeding these values would initiate discussions between the contractor and affected persons, the implementation of mitigation actions, and an increased level of measurement and review.

BS6472-1:2008 provides information to identify a vibration value that should be expected to have no adverse comments, sensations or complaints for most people. Vibration magnitudes in Table 4-2 below are expressed as levels which might result in different likelihood of adverse comment from people in residential buildings. These values are considered to represent the best judgement criteria currently available.

The dosage concept for protection of personal amenity is generally sound. It limits activities that generate higher vibration activities to shorter durations than other activities that induce lower, but prolonged periods of vibration.

Table 4-2 Vibration dose value ranges which might result in various probabilities of adverse comment in residential buildings (British Standards BS6472-1:2008)

Place and Time	*Low probability of adverse comment ms$^{-1.75}$*	*Adverse comment possible ms$^{-1.75}$*	*Adverse comment probable ms$^{-1.75}$*
Residential buildings 16-hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8-hour night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

For other building uses such as offices and workshops, multiplying factors of 2 and 4 respectively are applied for a 16-hour day, as shown in Table 4-3 below.

Table 4-3 Vibration dosage values for different types of building occupation (British Standards BS6472-1:2008)

	Vibration dosage value (m/s$^{-1.75}$)			
	Day – 16 Hour		*Night – 8 Hour*	
Location	*Preferred value*	*Maximum value*	*Preferred value*	*Maximum value*
Residences	0.20	0.40	0.10	0.20
Offices, schools, educational institutions, places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

The British Standard BS6472-1:2008 and the Department of Environment and Conservation for New South Wales (DEC) both propose vibration dose values that are appropriate for the protection of personal amenity. The permissible levels vary according to the activity of the persons within the building as well as the time of the activity (day or night). The condition also notes that the dosage values can be adjusted to reflect an equivalent vibration value in the velocity metric; that is, a value measured in mm/s. The latter measurement parameter is often more favourable as it is more easily modelled to allow an assessment of the likely effects of the construction activity, as well as being more easily measured with the commonly available vibration monitoring equipment.

The British Standard BS5528-2:2009 indicates the proposed dosage values may be converted to vibration values in the velocity domain to better allow predictive assessments. This would commonly occur within a Construction Noise and Vibration Management Plan (CNVMP).

The British Standard BS5528-2:2009 indicates:

> *'Whilst the assessment of the response to vibration in BS6472-1 is based on the VDV (vibration dosage value) and weighted acceleration, for construction it is considered more appropriate to provide guidance in terms of the PPV (peak particle velocity), since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage, Furthermore, since many of the empirical vibration predictors yield results in terms of PPV, it is necessary to understand what the consequences might be of any predicted levels in terms of human perception and disturbance'.*

The guidance values of BS5528-2:2009 are summarised in Table 4-4.

Table 4-4 Summary of vibration effects at varying vibration levels (Table B1 - BS5528-2:2009)

RMS vibration level	*Peak vibration level*	*Effect of vibration*
0.14 mm/s	0.4 mm/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
0.3 mm/s	0.7 mm/s	Vibration might just be perceptible in residential environments
1.0 mm/s	3 mm/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
10 mm/s	30 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level

Unlike noise levels which can be readily compared to values listed on common household electrical equipment, any information on vibration levels and their corresponding source or the likely impact is far less common. Figure 4-1 indicates some of the more common representative vibration levels.

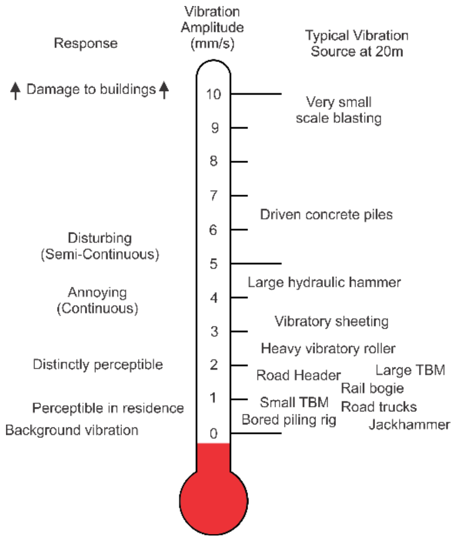


Figure 4-1 Representative vibration levels

While vibration dosage is a useful method of assessing human comfort in that it follows the commonly observed view that lower levels of vibration can be tolerated for longer periods, or elevated levels of vibration for shorter durations, it is however complex in that it incorporates an amplitude component as well as a duration component in the assessment. Assessing the impact of the different construction activities directly against dosage is difficult as it requires knowledge of the equipment-operating schedule and at what distance it will operate from the sensitive receptor. It is therefore proposed that:

- Each construction activity that produces measurable levels of vibration will be assessed to determine the level of vibration that will be generated as a function of distance

- The results will be presented as a series of predicted vibration contours around the planned works area
- Based upon the duration the equipment would operate, the equivalent vibration dosage will be calculated from a table, graph or spreadsheet. The equivalent dosage value would subsequently be compared with appropriate dosage value according to the occupancy type and time frame.

As an example, Figure 4-2 below shows how dosage varies as a function of vibration level, measured in mm/s, as well as operating duration in hours.

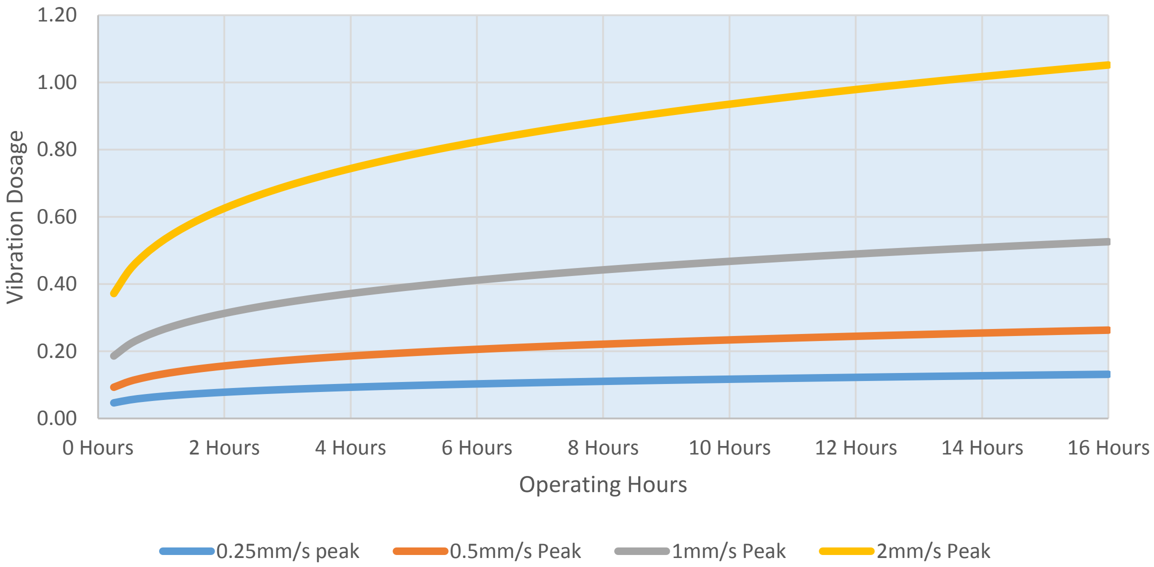


Figure 4-2 Estimated vibration dosage as a function of peak vibration level and operating time for a TBM

In Figure 4-2 above, the following can be observed:

- Where a TBM generates a peak level of vibration of 2 mm/s, it is restricted to operate for approximately 30 minutes within in a 16-hour period to comply with a dosage value of 0.4 $m/s^{-1.75}$
- Where a TBM operates further from the sensitive receptor and induces a reduced peak vibration level of 1 mm/s, the equipment can operate for six hours with an equivalent dosage of 0.4 $m/s^{-1.75}$
- At further distances where the induced peak vibration level of 0.5 mm/s or lower, the equipment can operate for the complete 16-hour period and comply with the 0.4 $m/s^{-1.75}$ dosage value.

The vibration prediction in mm/s and the relationship between vibration and operational duration is the preferred approach and will be followed in this assessment. This approach is consistent with the recommendations of the British Standard BS5528-2:2009. However, the conversion between dosage and vibration level expressed in the velocity domain is affected by multiple factors and equivalent values should be confirmed through a comparison between the assumed key parameters and actual field observations.

The vibration dosage value reflects the level that persons would be exposed to and therefore it would be reasonable to undertake the monitoring at the point where the persons are located. At night-time, the bedroom would be appropriate and during the daytime, the living areas. It has generally been observed that measurements within a property are unreliable as they become 'contaminated' by the vibration from normal household activities. Measurements external to the property are therefore generally preferred with an adjustment to reflect attenuation or possible amplification though the property.

The following elements affect the relationship between vibration dosage, vibration level and impact:

- The frequency spectrum of vibration waveform
- The crest factor, also sometimes called the 'peak-to-RMS-ratio', is defined as the ratio of the peak value of a waveform to its RMS value. The crest factor of a pure sine wave is 1.41. That is, the peak value is 1.41 times the RMS value. For complex vibration waveforms, the value increases. A crest factor of approximately 3 to 5 is typical of a mechanically induced vibration.
- The duration in a day or night period the equipment operates
- The effectiveness of transfer of vibration from the ground into the structure. Different building constructions, such as piered, elevated, strip footings or 'slab on ground' will result in different levels outside and inside the building.
- Any soft furnishings in the building that may further attenuate the level of vibration.

The measured vibration would inevitably include vibration from sources unrelated to works activities, such as local traffic, people or animals. To account for this, equivalent guideline values in the velocity metric should be complied with at a percentile limit. That is, say 95 per cent of the measured values should be less than the calculated equivalent dosage value before the trigger actions are initiated. A 95-percentile limit recognises that in most environments there would be some instances of elevated vibration unrelated to the project. However in total, the extraneous sources are unlikely to exceed around one hour per day. In quiet environments, where there are minimal external sources of vibration, it would be appropriate to increase the percentile. Similarly, in areas where existing environment has pronounced sources of external vibration, a lower percentile limit may be necessary.

4.3 Guidelines for blasting

AS2436-2010 and the referenced AS2187.2-2006 are applicable for the protection of personal amenity from blasting.

The timing of any blasting would be best determined through interaction with the appropriate authorities. Discussions with the authorities may decide it is a safer option to blast during a period when less people are potentially affected. The decisions around determining the preferred blasting time are complex and would necessarily involve discussions with multiple groups.

The human comfort criteria presented above are not applicable to impulsive, short-term vibration such as that generated by blasting activities. These activities are universally assessed using a measure of the peak level of vibration and comparing this measure to acceptable values as shown in Table 4-5 below.

Table 4-5 Ground vibration levels for human comfort (reproduced from AS2187.2-2006)

Category	*Type of blasting operations*	*Peak component particle velocity (mm/s)*
Sensitive site	Operations lasting longer than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher level may apply
Sensitive site	Operations lasting less than 12 months or less than 20 blasts	10 mm/s maximum unless agreement is reached with occupier that a higher level may apply
Occupied non-sensitive sites such as factories and commercial premises	All blasting	25 mm/s maximum value unless agreement is reached with occupier that a higher level may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation

The purpose of the measurement is to measure the magnitude of ground vibration that is transmitted to the structure at ground level. Ground vibrations should normally be measured on the ground near the point of concern.

In addition to ground-borne vibration, pulses are also propagated through the air and the effect termed 'air overpressure' or 'airblast'. The effect is like that of natural phenomena such as cyclones, wind and thunder that often exceed the guideline values for many hours at a time.

AS 2187.2-2006 recognises this overpressure effect can cause discomfort to persons. Exposure at any single residence would not likely be more than several seconds per blast. AS2187.2-2006 levels are shown in Table 4-6.

Table 4-6 Overpressure levels for human comfort (reproduced from AS2187.2-2006)

Category	*Type of blasting operations*	*Peak overpressure value (dBL)*
Sensitive site	Operations lasting longer than 12 months or more than 20 blasts	115 dBL for 95% blasts per year. 120 dBL maximum unless agreement with occupier that a higher level may apply
Sensitive site	Operations lasting less than 12 months or less than 20 blasts	120 dBL for 95% blasts per year. 125 dBL maximum unless agreement with occupier that a higher level may apply
Occupied non-sensitive sites such as factories and commercial premises	All blasting	125 dBL maximum value unless agreement is reached with occupier that a higher level may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation

The overpressure measurements should be undertaken external to the building. The location should also be located away from structures that may produce reflections and cause spurious readings.

4.4 Guidelines for building damage

With respect to building damage, the British Standard BS7385-2:1993 indicates levels of vibration for prevention of cosmetic damage, noting that cosmetic damage occurs at vibration values well less than those corresponding to structural damage The British Standard suggests values are appropriate for transient vibration values that do not give rise to resonant response in structure, as well as for low-rise buildings. The latter would typically cover normal residential houses of up to several floors. Where the dynamic loading caused by continuous vibration, as could be generated by mechanical equipment like a TBM, road header or hydraulic hammer is such as to induce dynamic magnification due to resonance, the British Standard suggests the guide values may need to be reduced. Appropriate values for continuous vibration are given in Table 4-7.

Table 4-7 Continuous vibration guide values for cosmetic damage where there is the possibility of resonance within the building (reproduced from BS7385.2:1993

Type of building	*Peak component particle velocity in frequency range of predominant pulse*	
	4 Hz to 15 Hz	*15 Hz and above*
Reinforced or framed structures. Industrial and heavy commercial buildings	25 mm/s at 4 Hz and above	
Un-reinforced or light framed structure. Residential or light commercial type buildings	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building. Where this is not feasible, the measurements should be obtained on the outside of the building		

Based on the likely range of frequencies from the hydraulic hammer and the TBM unit, the frequencies are expected to lie above 15 Hz. The minimum value is therefore 10 mm/s for an unreinforced structure and 25 mm/s for a reinforced industrial or heavy commercial building.

AS2436-2010 and the associated BS7385.2-1993 is applicable for the protection of buildings. BS7385-2:1993 indicates levels for prevention of cosmetic damage, as shown in Table 4-8.

Table 4-8 Transient vibration guide values for cosmetic damage (reproduced from BS7385-2:1993)

Type of building	*Peak component particle velocity in frequency range of predominant pulse*	
	4 Hz to 15 Hz	*15 Hz and above*
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structure. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building. Where this is not feasible, the measurements should be obtained on the outside of the building		

If it is identified that some infrastructure is not appropriately addressed by the categories identified in the BS7385.2 Standard (the infrastructure that is particularly susceptible to vibration), the values in the German Standard DIN4150 could be considered. The German standard provides three curves for permissible vibration levels: commercial, residential, and heritage. This is shown in Table 4-9 below.

Table 4-9 Guideline values for the vibration velocity to be used when evaluating the effects of short-term vibration on structures (DIN4150)

Type of structure	*Guideline values for velocity (mm/s)*			
	Vibration at the foundation at a frequency of			*Vibration at horizontal plane of highest floor*
	1–10 Hz	*10–50 Hz*	*50–100 Hz**	*All frequencies*
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of intrinsic value (such as heritage buildings)	3	3 to 8	8 to 10	8
*At frequencies > 100 Hz, the values given in this column may be used as a minimum				

Irrespective of whether the vibration levels from the British or German standard are adopted, where elevated levels of vibrations are predicted to occur, the infrastructure should be assessed and an appropriate guide value applied to ensure that vibration does not affect upon the integrity of the infrastructure. Vibration levels exceeding the vibration guideline values given in either the British or German standards may be acceptable where a review demonstrates that damage to the infrastructure would not occur. There may also be occasions where poorly managed infrastructure necessitates a lower level of permissible vibration to prevent further degradation. The German Standard DIN 41503 specifies lower levels of vibration than the British standard and is commonly considered an appropriate conservative guide value should further assessments to justify alternative vibration values not be undertaken.

4.5 Guidelines for services

Values for each asset or service should be based on the asset owners' guidelines. Where these do not exist, either the BS5528-2:2009 or the DIN4150-3 values could be applied.

BS5528-2:2009 provides some specific information on services and structures. However, it indicates that because of the variability in use, condition and vibration characteristics, they should be assessed on a case-by-case basis. Notwithstanding this, it does provide guidance for some scenarios.

Retaining walls – Because of their geometry, retaining walls may result in substantial amplification of vibration in the horizontal mode normal to the plane of the wall. Amplifications between three and five are common. For slender and potentially sensitive masonry walls, BS5528-2:2009 recommends a threshold level of 10 mm/s at the toe of the wall and 40 mm/s at the crest. Propped, tied walls or gravity walls can be subjected to values up to twice these levels. Steel pile or reinforced concrete retaining walls can be subjected to similar levels.

Underground services – BS5528-2:2009 proposes levels in the absence of asset owner guidelines:

- A maximum PPV for intermittent or transient vibration of 30 mm/s
- A maximum PPV for continuous vibration of 15 mm/s.

A PPV of 30 mm/s gives rise to a dynamic stress that is equivalent to approximately 5 per cent of the allowable working stress in typical concrete and less in iron or steel.

BS5528-2:2009 further notes that in the event of aged or dilapidated brickwork sewers, the base level should be reduced by 20 per cent to 50 per cent. For most metal and reinforced concrete sewers pipes however, the values above are expected to be appropriate.

The German Standard DIN4150-3 also provides guideline values for the effects of vibration on buried pipework. The proposed values in the DIN4150-3 standard assume that the pipe has been laid using current technology and that no reduction for stress concentration because of geometry are required. The values therefore exceed the suggested values in BS5528-2:2009. The guideline values provided in the DIN4150-3 for assessing short-term vibration on buried pipework are given in Table 4-10.

Table 4-10 Guideline values for vibration velocity when evaluating the effects of short-term vibration in buried pipework

Pipe Material	*Guideline values for velocity measured on the pipe*
Steel (including welded pipes)	100 mm/s
Clay, concrete, reinforced concrete, pre stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s
Note 1: When carrying measurements on pipework, sensors shall be placed directly on the pipes whenever possible. As an alternative, the sensor may be placed on the ground surface directly above the pipe Note 2: The values presented are the maximum of the values recorded on three orthogonal sensor directions	

4.6 Guidelines for regenerated noise

Regenerated noise, or ground-borne noise, is an associated effect of the small vibration related displacements that occur on hard surfaces within buildings. The measured regenerated value is affected by the amplitude and frequency of the vibration generated by the mechanical construction equipment as well as the characteristics of the building. Regenerated noise levels depend on the construction of the structure of the building and of its foundation, and the dimension of the radiating elements (walls, floors). Rooms with soft furnishing such as carpets, wall hangings, furniture and the like, would result in lower levels of regenerated noise when compared with other building fit-outs that do not have these elements. Estimating the level of regenerated noise is therefore difficult without some knowledge of the building characteristics. A conservative approach is therefore adopted where it is assumed that minimal internal attenuation exists, which in most situations will lead to predicted values that are up to 5 dB higher than actual experienced conditions.

Acceptable regenerated noise levels are provided in the Interim Construction Noise Guideline prepared by the NSW Department of Environment and Climate Change. The proposed values are identified as noise levels for residences when management actions should be implemented. The levels recognise the temporary nature of construction and are only applicable when the ground-borne noise levels are higher than the airborne noise levels. These internal noise levels have also been adopted for recent tunnel projects in Victoria (Metro Tunnel and West Gate Tunnel Project).

The ground-borne noise levels are presented for evening and night-time periods only, as the objectives are to protect amenity and sleep of people when they are at home. The levels are given in Table 4-11.

Table 4-11 Regenerated noise values for personal amenity based on NSW Interim Construction Noise Guidelines

Time of day	*Internal noise level measured at the most affected habitable room*
Evening (6 pm to 10 pm)	$L_{Aeq\ (15\ minute)}$ = 40 dBA
Night (10 pm to 6 am)	$L_{Aeq\ (15\ minute)}$ = 35 dBA

The location of the noise measurements can influence the measured values. The monitoring point should be cautiously identified so that values are not strongly affected by room effects and subsequently results in poor representativity and higher uncertainty in the values.

4.7 Development of guideline target levels

The relevant Australian and international guidelines outlined in this section have been applied to the development of guideline target levels for vibration and regenerated noise. These guideline target levels are included in the EPRs listed in Section 9.

5. Method

5.1 Overview of method

This section describes the method that was used to assess the potential impacts of North East Link. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects. Figure 5-1 shows an overview of the assessment method.

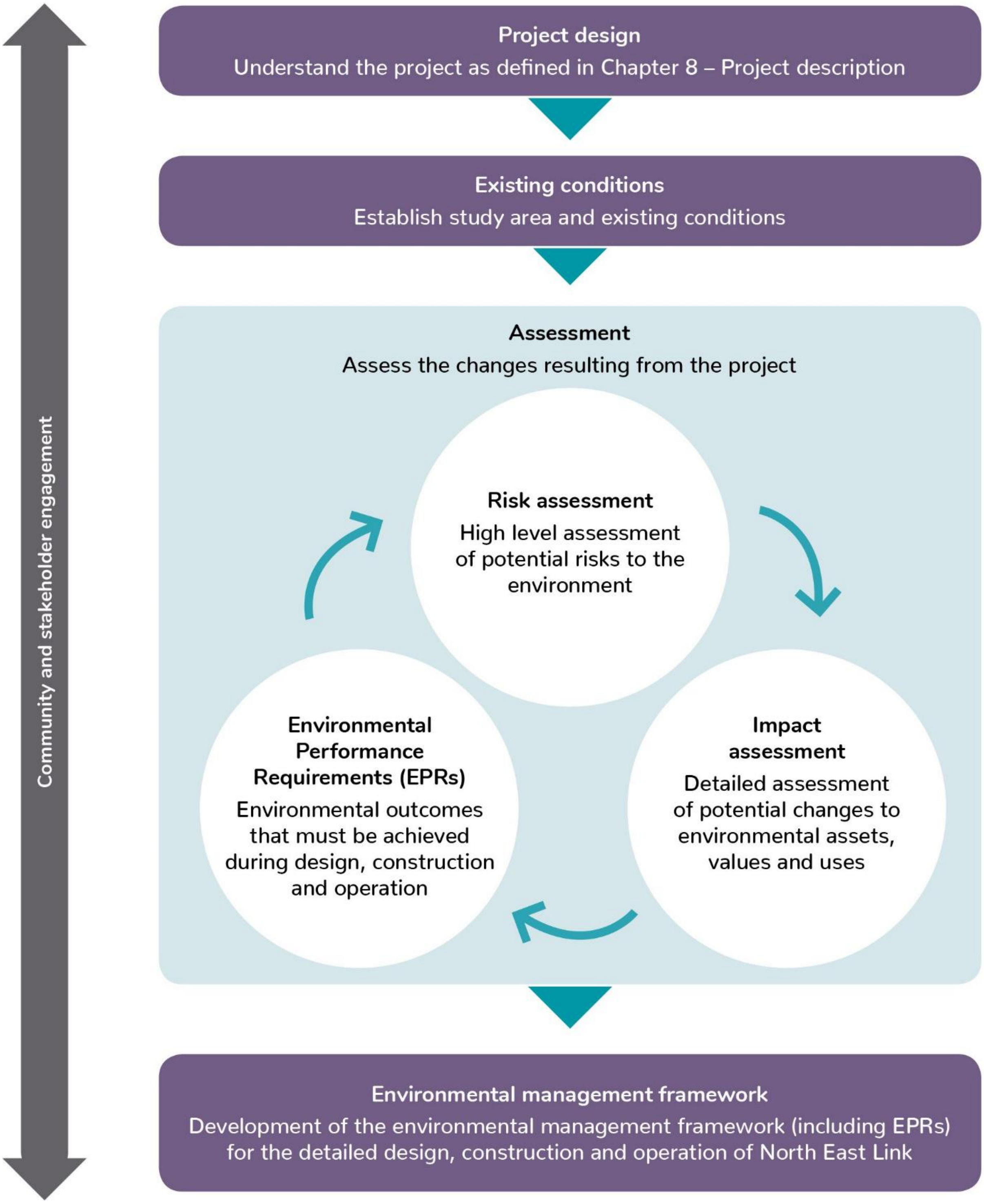


Figure 5-1 Overview of assessment method

The following sections outline the method adopted for the impact assessment.

5.2 Study area

An assessment of the impacts of constructing the North East Link tunnels, dive structures and cross passages covers the area between Lower Plenty Road and Bulleen Road. The study area included a zone approximately 200 metres north of Blamey Road to allow an assessment of the dive structure for the northern portal. Similarly, the assessment area also included a zone extending approximately 600 metres south of Bulleen Road where the dive structure for the southern portal would be located. On either side of the tunnel alignment, a corridor of approximately 200 metres (approximately 450 metres in total width) was applied for assessing the potential effects of vibration and regenerated noise on properties and possible impacts of vibration of properties, services and other infrastructure. Beyond this analysed zone, the level of impact from vibration and/or regenerated noise will have reduced to zero.

The approximate study area is shown in Figure 5-2.

Figure 5-2 Study area relevant to tunnel vibration assessment

5.3 Existing conditions

The existing environment partially defines the impact of the construction activities on the persons, adjacent dwellings and infrastructure. The key existing conditions include:

- The geological setting
- The key sensitive receptors
- The existing vibration environment.

The geology along the project alignment has been included in the assessment of the tunnel vibration impacts by incorporating the geological model developed for the project. A section along the tunnel alignment has identified the various rock mass units through which vibration pulses propagate through as they attenuate from the source to the receiver. The vibration attenuation characteristics of these rock types has been estimated from their generalised parameters. The geological model therefore describes the different units through which the dive structures, mainline tunnels, cut and cover section and the mined tunnel would pass. The model shows the rock mass and the expected degree of weathering. These data have been relied upon for quantifying the effects of vibration. No additional drilling or seismic profiling has been included in the assessment with respect to vibration.

The sensitive receptors along the alignment are critical in identifying whether changes to the construction equipment, methods or scheduling could be required to ensure that tunnels would not impact amenity and infrastructure. Different receptors link with different performance criteria. The types of the sensitive receptors were identified by walking the alignment and identifying the different infrastructure within approximately 200 metres of the proposed carriageway or dive structure limits. The walk-over was limited to an external review of the property type and did not extend to any internal assessment of the property. The walk-over also served to identify whether any adjacent infrastructure could require specific performance requirements according to the building type or the activity that occurs within the structure.

The existing vibration environment helps to define the appropriateness of project EPRs and whether they could be adequately administered. It would be difficult to administer vibration criteria along the alignment where the existing vibration environment is elevated. Where EPRs are based around allowable small changes in vibration level, establishing the existing environment is necessary to determine whether these criteria are applicable. Specifying a permissible level of vibration for tunnelling activities that is presently exceeded would be inappropriate as a performance criterion. Unlike noise performance requirements, vibration guidelines do not generally include a background component, but rather an absolute permissible value.

The 20 locations for background vibration measurements were primarily selected according to their acceptance of having instrumentation placed within the property for a period of one to two weeks. These locations were generally the same property where background noise measurements were collected. The locations represented the properties along the project alignment that could be influenced by existing vibration sources, such as heavy vehicle movements. Aside from trucks and cars, there are no other sources of repeatable vibration.

The vibration monitors were placed in the property and configured to record vibration levels over several days to one week. The equipment was configured to record the peak vibration level each minute. The data were recorded to the internal memory of the vibration unit and later analysed to determine the vibration statistics.

5.4 Risk assessment

An environmental risk assessment has been completed to identify environmental risks associated with construction and operation of North East Link. The risk-based approach is shown in Figure 5-3 and is integral to the EES as required by the scoping requirements and the *Ministerial guidelines for assessment of the environmental effects under the Environment Effects Act 1978*.

Specifically the EES risk assessment aimed to:

- Systematically identify the interactions between project elements and activities and assets, values and uses
- Focus the impact assessment and enable differentiation of significant and high risks and impacts from lower risks and impacts
- Inform development of the reference project to avoid, mitigate and manage environmental impacts
- Inform development of EPRs that set the minimum outcomes necessary to avoid, mitigate or manage environmental impacts and reduce environmental risks during delivery of the project.

This section presents an overview of the EES risk assessment process. EES Attachment III Environmental risk report describes each step in the risk assessment process in more detail and contains a consolidated risk register.

This technical report describes the risks associated with the project on [technical discipline]. Wherever risks relating to this study are referred to, the terminology 'risk XX01' is used. Wherever EPRs relating to this study are referred to, the terminology 'EPR XX1' is used. The risk assessment completed for this study is provided as Appendix B.

Rating assessment process

The risk assessment process adopted for North East Link is consistent with AS/NZS ISO 31000:2009 Risk Management Process. The following tasks were undertaken to identify, analyse and evaluate risks:

- Use existing conditions and identify applicable legislation and policy to establish the context for the risk assessment
- Develop likelihood and consequence criteria and a risk matrix
- Consider construction and operational activities in the context of existing conditions to determine risk pathways
- Identify standard controls and requirements (Environmental Performance Requirements (EPRs)) to mitigate identified risks
- Assign likelihood and consequence ratings for each risk to determine risk ratings considering design, proposed activities and standard EPRs.

While there are clear steps in the risk process, it does not follow a linear progression and requires multiple iterations of risk ratings, pathways and EPRs as the technical assessments progress. Demonstrating this evolution, a set of initial and residual risk ratings and EPRs are produced for all technical reports. Figure 5-3 shows this process.

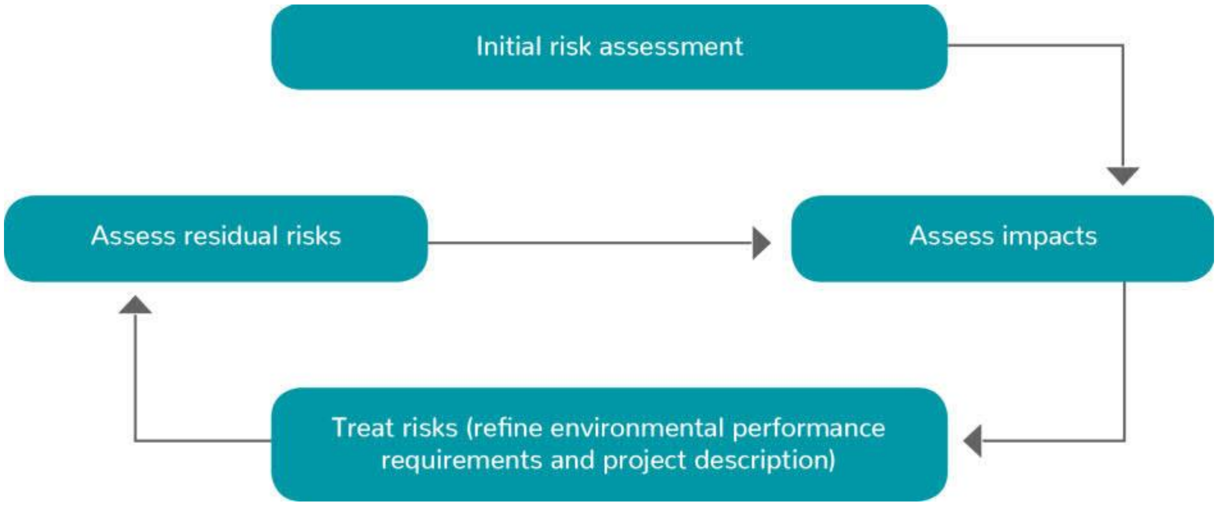


Figure 5-3 Risk analysis process

Rating risk

Risk ratings were assessed by considering the consequence and likelihood of an event occurring. In assessing the consequence, the extent, severity and duration of the risks were considered. These are discussed below.

Assigning the consequences of risks

'Consequence' refers to the maximum credible outcome of an event affecting an asset, value or use. Consequence criteria as presented in Chapter 4 – EES assessment framework, were developed for the North East Link EES to enable a consistent assessment of consequence across the range of potential environmental effects. Consequence criteria were assigned based on the maximum credible consequence of the risk pathway occurring. Where there was uncertainty or incomplete information, a conservative assessment was made on the basis of the maximum credible consequence.

Consequence criteria have been developed to consider the following characteristics:

- Extent of impact
- Severity of impact
- Duration of threat.

Severity has been assigned a greater weighting than extent and duration as this is considered the most important characteristic.

Each risk pathway was assigned a value for each of the three characteristics, which were added together to provide an overall consequence rating.

Further detail on the consequence criteria are provided Chapter 4 – EES assessment framework.

Assigning the likelihood of risks

'Likelihood' refers to the chance of an event happening and the maximum credible consequence occurring from that event. The likelihood criteria are presented in Table 5-1.

Table 5-1 Likelihood of an event occurring

Planned	The event is certain to occur
Almost certain	The event is almost certain to occur one or more times a year
Likely	The event is likely to occur several times within a five-year timeframe
Possible	The event may occur once within a five-year timeframe
Unlikely	The event may occur under unusual circumstances but is not expected (ie once within a 20-year timeframe)
Rare	The event is very unlikely to occur but may occur in exceptional circumstances (ie once within a 100-year timeframe)

Risk matrix and risk rating

Risk levels were assessed using the matrix presented in Table 5-2.

Table 5-2 Risk matrix

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Severe
Rare	Very low	Very low	Low	Medium	Medium
Unlikely	Very low	Low	Low	Medium	High.
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	Medium	High	Very high
Almost certain	Low	Medium	High	Very high	Very high
Planned	Planned (negligible consequence)	Planned (minor consequence)	Planned (moderate consequence)	Planned (major consequence)	Planned (severe consequence)

Planned events

North East Link would result in some planned events, being events with outcomes that are certain to occur (ie planned impacts such as land acquisition), as distinct from risk events where the chance of the event occurring and its consequence is uncertain. Although planned events are not risks, these were still documented in the risk register as part of Attachment III – Risk report for completeness and assigned a consequence level in order to enable issues requiring further assessment or treatment to be prioritised.

These planned events were assessed further through the impact assessment process.

Risk evaluation and treatment

The risk assessment process was used as a screening tool to prioritise potential impacts and the subsequent level of assessment undertaken as part of the impact assessment. For example, an issue that was given a risk level of medium or above, or was identified as a planned event with a consequence of minor or above, would go through a more thorough impact assessment process than a low risk.

Where initial risk ratings were found to be ‘medium’ or higher, or were planned events with a consequence of ‘minor’ or higher, options for additional or modified EPRs or design changes were considered where practicable. It should be noted that the consequence ratings presented in the risk register are solely based on the consequence criteria presented in Attachment III – Risk report. Further analysis and evaluation of the impacts potentially arising from both risks and planned events and information on how these would be managed is provided in Section 8.

5.5 Impact assessment

Tunnelling is often considered in determining an efficient transport corridor. The two main factors that help determine the effective tunnel corridor are the alignment constraints and the environmental considerations. The tunnel alignment must allow for entrance and exit portals that can be constructed to ensure their long-term stability as well as a location that permits interconnectivity with other road networks. The portals are typically an area of intense activity during construction and have the potential to generate significant impacts associated with noise, vibration and dust.

Tunnels typically pass beneath some sections of green space as well as residential and commercial infrastructure. Where tunnels pass beneath residential areas there are some unavoidable impacts. Vibration and regenerated noise are two unavoidable effects.

The alignment of a tunnel is guided by a range of factors. While the vibration and regenerated noise in a dwelling or other receptor depends on depth of cover above the tunnel crown and the horizontal separation distance between the tunnel and the receptor, the vertical alignment must also meet grade (steepness) criteria so deepening the tunnel to avoid vibration is not effective nor achievable. Similarly, the horizontal alignment must also comply with curvature specifications and interface with existing road networks. This means that changing a tunnel’s alignment as a vibration and noise control measure is constrained by other requirements.

Some vibration and noise are inevitable and so it is important that a set of EPRs are established to ensure the impacts are monitored, managed to acceptable values, and to establish when mitigation measures are necessary.

The EPRs should be based upon peer-reviewed research or international standards. Importantly the guideline values in these standards do not propose values that are imperceptible or inaudible, but rather values that are acceptable to the majority of persons. Similarly, guideline values for damage reflect values below which damage has not been credibly observed, rather than values that represent the onset of infrastructure damage.

This assessment identifies the expected impacts from the tunnelling and compares them with the project EPRs to highlight any areas where mitigation measures may be required. This approach ensures the project can be best delivered with respect to minimising impacts on the community.

5.6 Vibration-regenerated noise model

As vibration from mechanical equipment such as a TBM, roadheader or hydraulic hammer propagates through the ground strata, regardless of its source, the amplitude decreases because of the combined action of two factors – geometric spreading and frictional losses. Geometric spreading doesn't reduce the vibrational energy but merely disperses it across a wider wavefront. Frictional losses account for loss of vibrational energy through the non-elasticity in the rock mass. High modulus, high competency rock types exhibit a low internal friction, while unconsolidated spoil types have high frictional losses and a more rapid attenuation of vibrational energy.

Equations used to describe the loss in amplitude of a vibration wave vary considerably, but an accurate relationship to represent the level of vibration from a mechanical source simplifies to:

$$PPV = \frac{K}{d} e^{-\alpha d}$$

where:

- PPV is the velocity of vibration measured in mm/s
- d is the distance between the source of vibration and the point of measurement measured in metres, and
- K and α are site-specific constants which address the level of vibration very near to the source and the degree of attenuation respectively. A higher K value generally refers to a more energetic source. An increased α value normally refers to a ground mass where the level of vibration attenuates more rapidly as the vibration pulse travels from the source.

The rate of the decay in vibration generally varies for different types of operating equipment (TBM, road header, hydraulic hammer) because of the different dominant vibration frequencies. The rate of decay as well as the level of vibration as a function of the equipment energy in different rock masses have been collated from many hundreds of projects and this library of data has been consulted in assessing the impacts of the North East Link construction activities.

A considerable amount of data is available regarding the vibration from hydraulic hammers, vibratory rollers, pile driving and so on. However, less information is available on the rate of decay with distance of vibration level from mechanical equipment like TBMs, given their limited application in Melbourne siltstone rock masses. Data from international literature was sought and adjusted to reflect the different size of the equipment as well as the expected rock mass conditions.

Relationships between distance and vibration level were determined from other construction projects completed in similar rock masses. The level of vibration is affected by many factors, such as fracturing of the rock mass and the degree of water saturation, and can only be accurately estimated through site-specific measurements. The vibration distance relationship for various previous projects that have used a TBM to construct tunnels is shown in Figure 5-4. The proposed North East Link relationship is also shown.

The relationship shown is considered an accurate upper estimate of vibration as a function of distance and accounts for the likely details of the TBM that could be used to deliver the North East Link. The equation has been adjusted from that describing vibration attenuation to reflect the expected attenuation of vibration through the competent siltstone strata, as well accounting for the energy from a hard rock machine developing a large diameter tunnel.

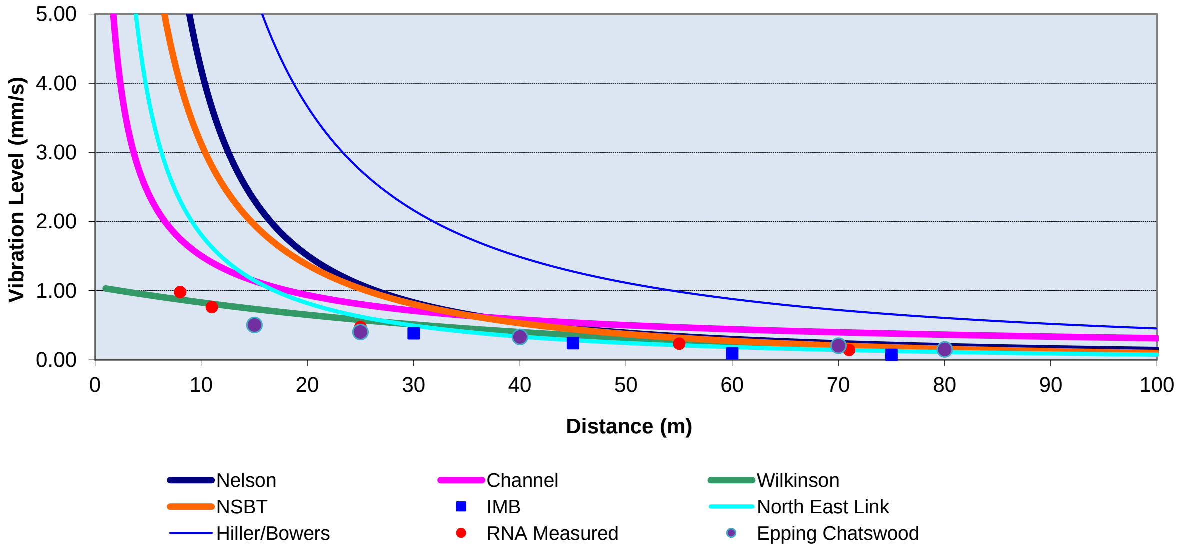


Figure 5-4 Estimated level of vibration as a function of distance from the TBM cutter head

The data in Figure 5-5 show a comparison of the variability in vibration level for a TBM that could be used to excavate the tunnels, dive structures and cross passages.

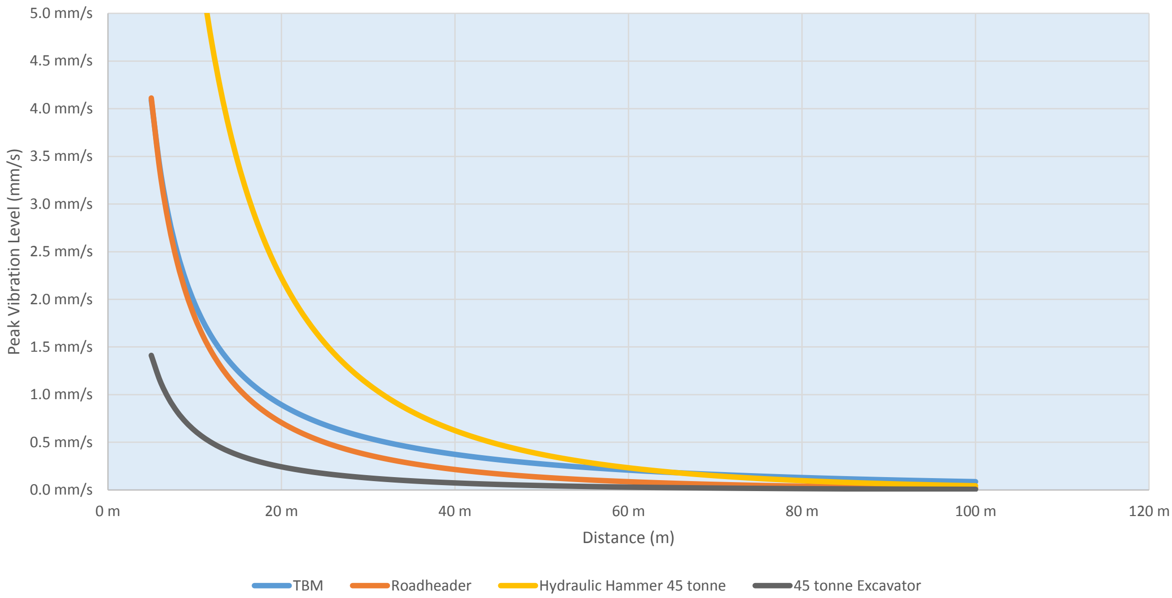


Figure 5-5 Estimated level of vibration as a function of distance from the excavation equipment

5.7 Modelling assumptions

Site-specific relationships between distance and vibration for equipment types appropriate to North East Link have not been developed explicitly for siltstone rock masses known to lie in the area of the tunnel. Rather, these relationships for the TBM, road header and hydraulic hammer have been estimated based on knowledge of attenuation rates in similar rock masses.

Effects such as degree of fracturing, extent of water saturation and overall competency of the rock mass all influence the transmission of vibration. The energy delivered to the cutter head, rotating drum or hammer tool also affects the level of vibration. While best engineering practices have been used to identify suitable relationships, only site-specific measurements can accurately indicate vibration as a function of distance.

Some variation in the expected levels should be expected, although the modelled levels are based up measurements expected to comply with 95% of all measurements. Lower values than predicted are also likely.

5.8 Verification of the model

Verification of the model is based on a comparison of calculated distances between the receptor and the vibration source (either tunnel or surface works) and those values independently calculated from other spatial databases. Based on the distance, the predicted level of vibration is manually calculated by applying the vibration relationships for the mechanical equipment and comparing them against the modelled data. The predicted levels are compared with those measured from similar equipment operating at other projects.

5.9 Rationale

The amenity-based vibration EPRs are based upon metrics presented in the international standards. In these standards, vibration can be presented in the velocity domain and displaying values in mm/s, or by using a more complicated dosage regime and returning values in $ms^{-1.75}$.

Vibration dosage is a useful method of assessing human comfort in that it follows the commonly observed view that lower levels of vibration can be tolerated for longer periods, or elevated levels of vibration for shorter durations. However, it is complex in that this method incorporates an amplitude component as well as a duration component.

While the dosage metric can be more challenging, it is considered a preferable EPR as it allows the contractor to determine the preferred approach; that is, elevated vibration for a shorter period or lower vibration for a longer duration.

The assessment of building-related damage would remain in the velocity metric (mm/s) which is consistent with the standards and all commonly employed methods in Australia.

The tunnel vibration assessment has been based on the equipment that is expected to be used to deliver the tunnel, dive structures and cross passages. Equipment other than that assessed could also be used. Drilling and blasting could also remain an option for excavating the harder more competent rock mass that could be encountered in the northern sections of the tunnel cross passages.

5.10 Limitations, uncertainties and assumptions

The effects of construction equipment that could be used to deliver the project have been assessed based upon other sourced information. These regressed data have been adjusted to reflect the different equipment types and geology along the tunnel alignment. The modelling results specifically relate to the proposed areas of excavation (tunnel, portal/tunnel dive structures or cross passages). In some areas of the project, more than one method of excavation has been proposed. In these locations, the results for each method of excavation are presented.

The model to assess vibration and regenerated noise from the tunnelling activities considers the project as a series of vibration sources (from equipment such as TBM, road headers and hydraulic hammers), a series of receptors that may have varying levels of permissible vibration, a series of geological blocks that exhibit different degrees of a vibration attenuation and a surface DEM (digital elevation model). Based upon known source energies and vibration transmissions characteristics, the model develops a net over the entire project and predicts levels at vibration at these different locations. The varying vibration levels at the different gridded positions are contoured to show the results presented as a series of different figures for vibration and for regenerated noise.

The impacts of the tunnelling are completed through an assessment of the expected level of vibration and regenerated noise that involves best available engineering methods and practices. Nevertheless, the approach assumes a set of criteria that can only ever be fully specified once the tunnelling activities have started and some measurement are undertaken. Best practices therefore continually review the vibration and regenerated noise levels against the modelled predictions, and adjust the model parameters based on their correlation. The same assessment procedure has been applied in the assessment and delivery phases for each of the major tunnels completed in Melbourne, Sydney and Brisbane. The preliminary assessments have been reasonable and have provided guidance as to the key areas requiring further assessment, monitoring and adjustments during the construction of North East Link.

The limitations or confidence in the predictions centre around the accuracy of the parameters that are estimated during the assessment phase. One of the key limitations remains the variability in the geology and its interaction with the vibration transmission through the rock mass. The assessments presented in this report are based upon best available information for the Melbourne rock masses. They rely on relationships between vibration and distance that have been developed from other equipment operating in similar rock masses. Where necessary, the differing energy of the equipment has also been incorporated into the assessment.

While the above assessments have been shown for other tunnelling projects to be within accepted levels, it would remain important that measurements of vibration and regenerated noise occurred during the initial stages of North East Link and a comparison with the expected results undertaken.

5.11 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of the North East Link EES and to inform the development of the project and understanding of potential impacts. Table 5-3 below lists specific engagement activities that have occurred in relation to tunnel vibration and regenerated noise, with more general engagement activities occurring at all stages of the project. Feedback received during community consultation sessions is summarised in Section 5.12.

Table 5-3 Stakeholder engagement undertaken for noise and vibration

Activity	*When*	*Matters discussed*	*Outcome*
Meeting with Heide Museum of Modern Art	20 April 2018	Review of museum and facilities to identify any instances where displays could be affected by ground-induced vibration	No matters identified that would require more specific vibration criteria in addition to the proposed EPRs

The discussion confirmed that the structure of the Heide Museum of Modern Arts, its contents, displays and art exhibitions would be appropriately protected by the EPRs. It was identified there would be no requirement to establish specific EPRs to Heide.

5.12 Community feedback

In addition to consultation undertaken with specific stakeholders, consultation has been ongoing with the community throughout the design development and the EES process. Feedback relevant to the tunnel vibration and regenerated noise assessment is summarised in Table 5-4, along with where and how we have addressed those topics in this report.

Table 5-4 Community consultation feedback addressed by tunnel vibration assessment

Issues raised during community consultation	*How it's been addressed*
Information about the final tunnel alignment to provide home owners with greater certainty about potential impacts	Section 8.6 reports on the likelihood of damage from the construction works with Sections 8.4 and 8.5 addressing amenity with respect to vibration and regenerated noise respectively. The EES has modelled the alignment that has been identified. Variations in the alignment may produce varying levels of vibration and/or regenerated noise. However, the levels would be compared against the EPRs which are developed to protect the amenity of persons as well as the integrity of adjacent infrastructure and buildings. A review of the assessment corridor has not identified any locations or infrastructure where the proposed EPRs would be inadequate.
Concerns about damage to residential properties (including swimming pools) and other buildings located above the tunnel alignment.	An assessment of the expected levels of vibration from equipment that is consistent with that used to develop other similar sized tunnels has been completed and the results presented and discussed in Section 8.6. These vibration values have been compared with information presented in the Australian Standards and other peer-reviewed documents. The results show that while in some locations the vibration may be perceptible, there are no instances along the alignment where the vibration could impact the integrity of the buildings, swimming pools or other infrastructure.

Issues raised during community consultation	*How it's been addressed*
Concerns about damage to homes with deep foundations on Rocklea Road and requests to check building records with local council	The energy of the vibration that would be induced into the area around the tunnel would be incapable of damaging footings to the buildings, including those that could be classed as deep foundations. While the levels of vibration and regenerated noise could vary in those properties with deep foundations because of the better connectivity to the structure, the EPRs for the project are protective of amenity and infrastructure integrity and would continue to remain appropriate.
Building inspections prior to tunnelling to be offered to residents.	Where vibration predictions have identified that elevated levels of vibration could occur, condition surveys to document the condition of the properties would be conducted. This would provide security to the home owner as well as protect the contractor from inappropriate claims for project-related damage.
Assurance that any property damage related to tunnel vibration during construction would be addressed and appropriate repairs or compensation arranged.	Reported claims for damage to buildings or other infrastructure would be independently assessed. The assessment would include a comparison with any relevant condition survey documents, vibration monitoring records and the nature of the reported damage. Where it was confirmed the damage has occurred due to project-related activities, measures to rectify the damage, or appropriate compensation, would be undertaken.
Impacts to native fauna living in areas above tunnel construction.	Vibration levels would be monitored at representative locations along the project alignment. Some of these monitoring sites would address potential impacts on native fauna. Where the levels of vibration were elevated, the measured values would be compared with the limits presented in the international literature for the fauna type. The project EPRs do not propose acceptable values with respect native fauna.

6. Existing conditions

The existing conditions assessment addresses three key areas:

- Geology along the alignment
- Key sensitive receptors
- Existing vibration environment.

6.1 Geology

Geology influences the type of equipment that could be used for tunnelling and to develop the cross passages and to excavate the dive structures for the portals. Where the tunnels and surface works are in competent rock types, the equipment required would be higher energy input than for sections in less competent materials. For the same type of equipment, as the energy to the point of interface with the rock increases, the level of vibration generally increases. However, the specifications of the TBM must accommodate all rock types along the project alignment.

For the dive structures, where the geology varies from alluvium to weathered siltstone to fresh siltstone, the size of the excavating equipment would also increase in size and energy. While an excavator could reasonably dig through the alluvium, a hydraulic hammer would likely be required as the degree of weathering for the rock mass reduces.

The geological summary and its interpretation with respect to vibration and regenerated noise is based on the geotechnical investigations by GHD. The long section has been prepared by GHD and is shown in Figure 6-1 below. The design level and crown of the tunnel is shown as the pink-coloured lines in the Figure.

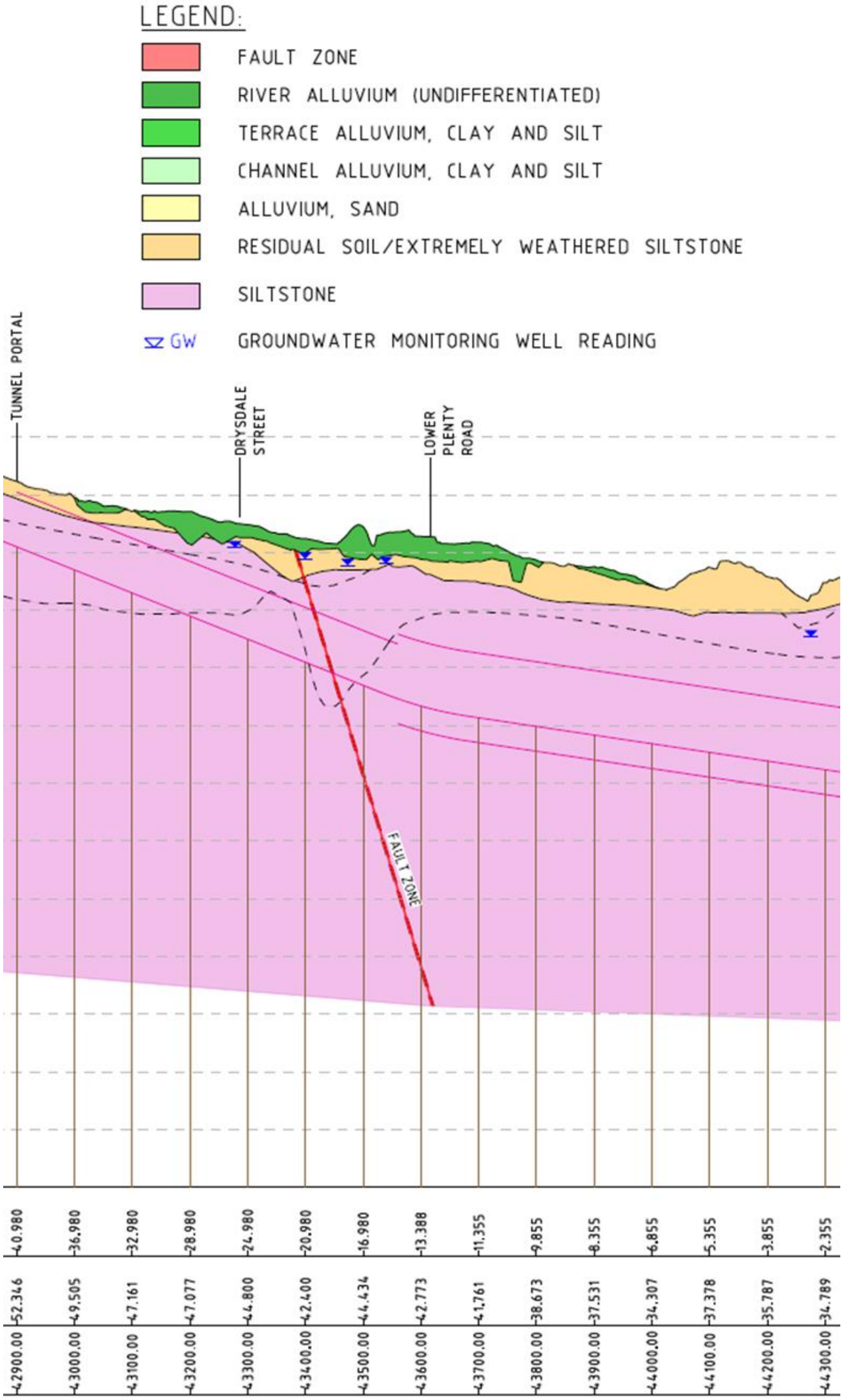


Figure 6-1 Geological section as prepared by GHD (Chainage CH42900 to CH44300)

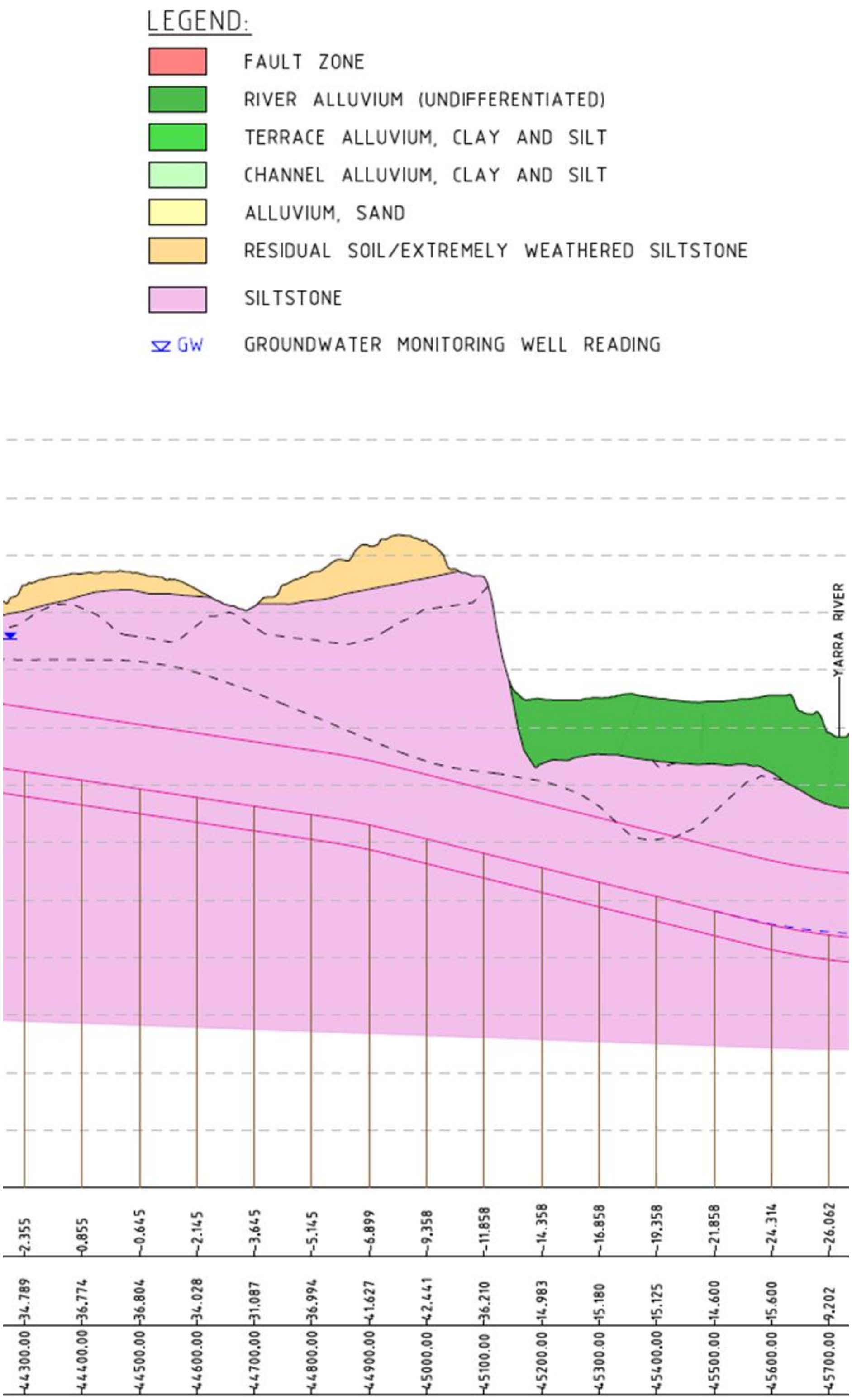


Figure 6-2 Geological section as prepared by GHD (Chainage CH44300 to CH45700)

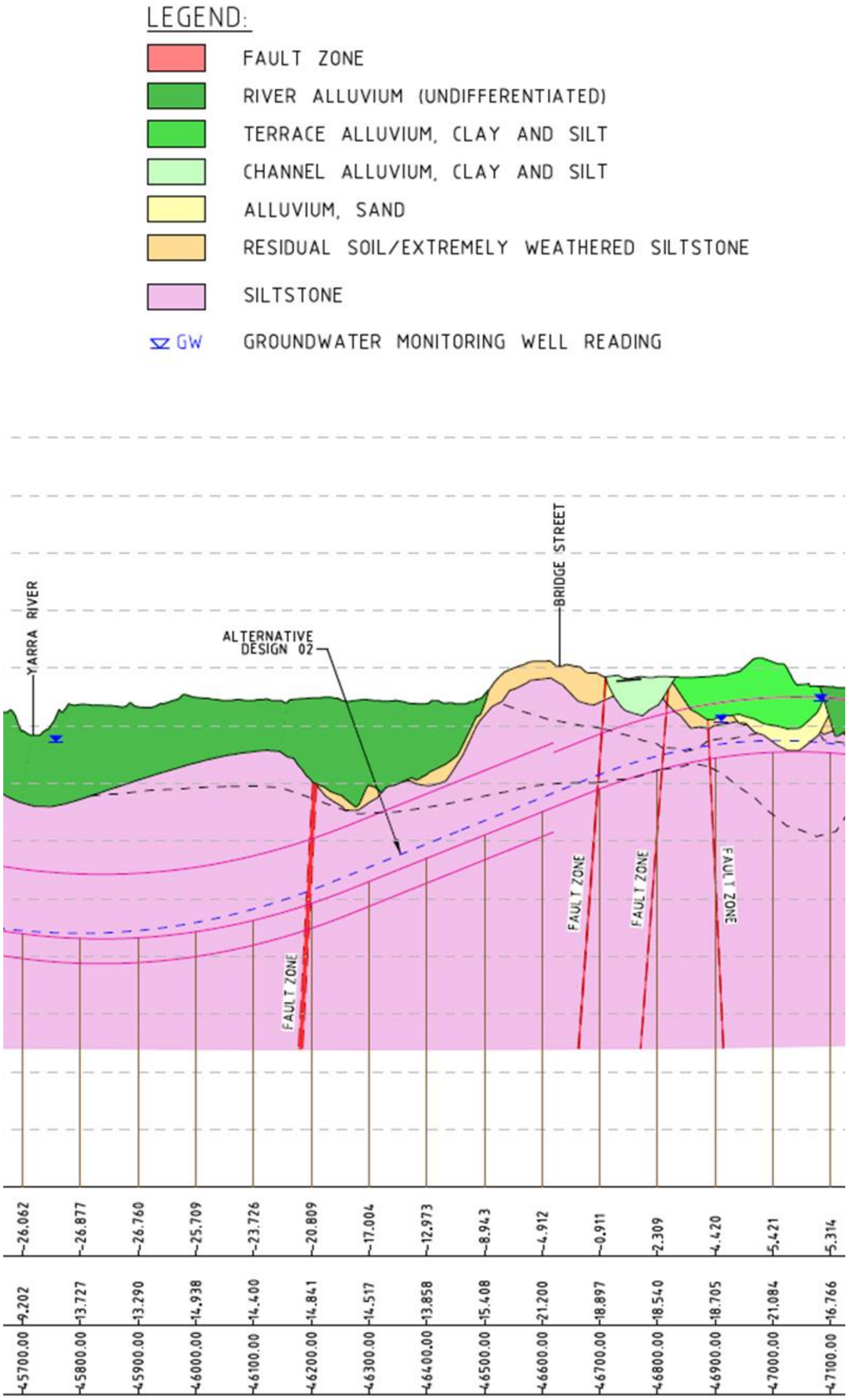


Figure 6-3 Geological section as prepared by GHD (Chainage CH45700 to CH47100)

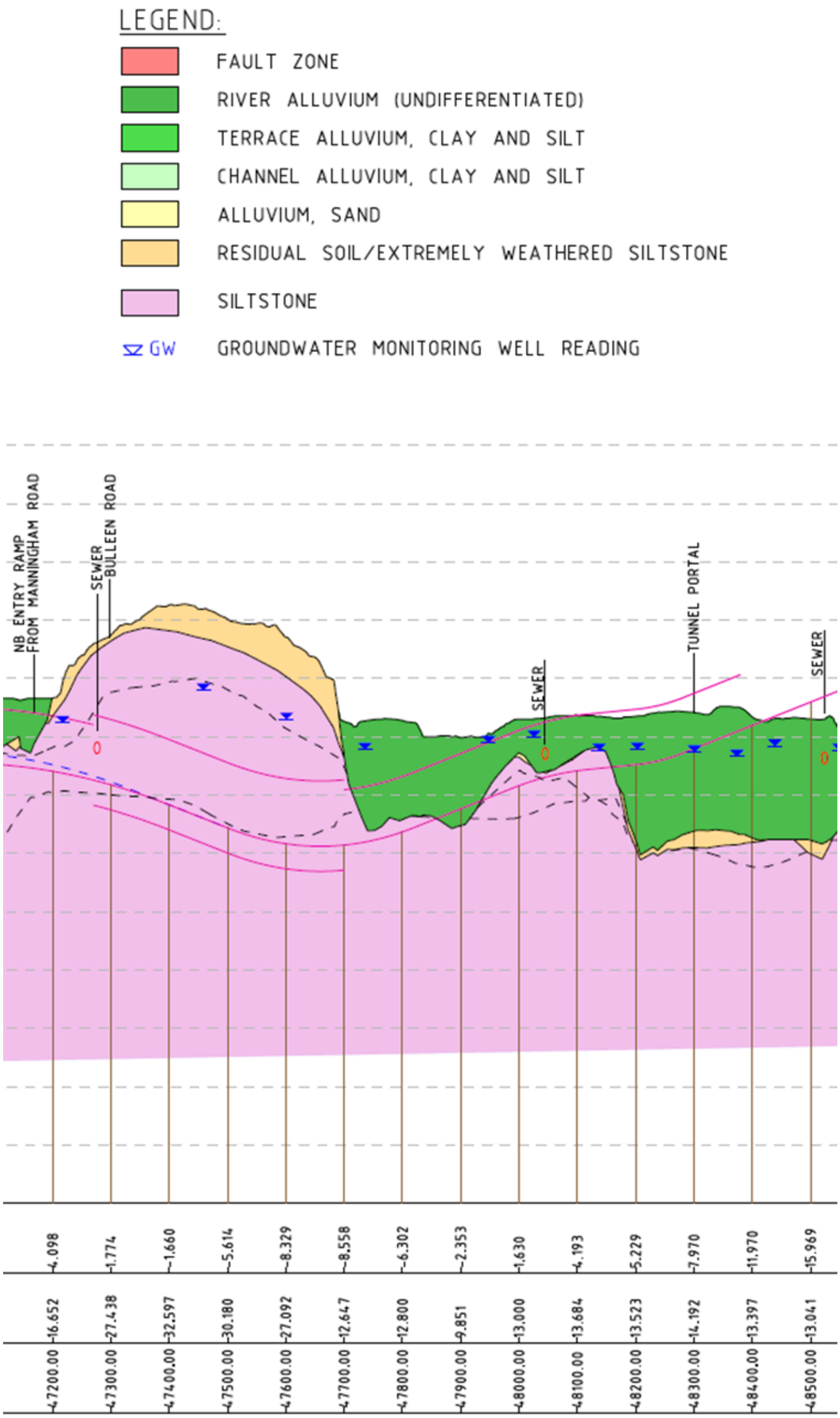


Figure 6-4 Geological section as prepared by GHD (Chainage CH47100 to CH48500)

The excavatability of the rock mass is based upon the competency of the rock units supplied by GHD. The data in Table 6-1 has been used to optimise the vibration model and allow for the corresponding predicted levels of vibration and regenerated noise.

Table 6-1 Rockmass profile along tunnel alignment based upon GHD assessment

Chainage	*Rockmass profile*	*Impact of excavation*
Ch43000 to Ch43640	• Slightly weathered to fresh siltstone (Sw-Fr) overlain by approximately 10 metres of extremely weathered to highly weathered siltstone. Possible highly faulted zone with frequent shear zones and soil-like geotechnical properties intersects surface at Lower plenty Road.	• Excavation of dive structure within the competent rock unit and expected to require use of hydraulic hammer. Surface at RL43. Upper 10 metres likely to be excavated with dozer or excavator.
Ch43640 to Ch45100	• Slightly weathered to fresh siltstone overlain by 20 to 30 metres of extremely weathered to highly weathered siltstone. Borders on alluvium	• Tunnel passes through the rock mass at depth to ensure it lies in the slightly weathered to fresh siltstone. Tunnel has approximately 10 metres of similar descriptor siltstone above the crown
CH45100 to Ch46200	• Alluvium layers for the Banyule Flats Reserve up to 20 metres in thickness. Tunnel crown varies in depth of up to 10 metres beneath the interface of the alluvium and the slightly weathered to fresh siltstone. An altered fault zone of 10 metres passes through the tunnel in the area around the Heide Museum	• Tunnel passes at depth in the slightly weathered to fresh siltstone.
Ch46200 to C46850	• Slightly weathered to fresh siltstone that is overlain by approximately 10 metres of the less competent moderately weathered siltstone. Small sections (less than 5 metres) of the older alluvium and fill above the moderately weathered siltstone	• Tunnel rises in grade through the section from the slightly weathered/fresh siltstone into the moderately weathered material.
Ch46850 to Ch47700	• Complex geology consisting of bands of slightly weathered to fresh siltstone, moderately weather, extremely weathered, older alluvium and possible landslide material (progressing from the tunnel floor to the surface)	• Tunnel passes through bands of the slightly weathered to fresh and into the moderately weathered siltstone
Ch47700 to Ch48400	• Trinity Grammar School Sporting Complex consisting of layers of sand alluvium, clays, sand and fill clay.	• Tunnel dive structure expected to be completed without use of hydraulic hammer

6.2 Key sensitive receptors

Sections of the tunnel along the North East Link alignment would pass beneath residential areas south of Lower Plenty Road for approximately 1,500 metres before passing beneath the green space of Banyule Flats and Warringal Parklands and Yarra Valley Country Club. The tunnel would continue below parkland areas for around another 1,500 metres until cross beneath Bridge Street where a cut and cover section is planned for the section until Bulleen Road. Adjacent to the green space section here are the Heide Museum of Modern Art buildings and parklands. A further section of residential development is above the tunnels for the section between Bulleen Road and the southern portal at the Trinity Grammar School Sporting Complex.

Many of these dwellings are well-established houses constructed with timber or brick with some more recently constructed properties throughout the residential sub-divisions. Most houses appear to be located on standard size blocks with a setback from the road of less than 20 metres. There is no indication that the dwellings would require a vibration criterion that is more stringent than commonly applied for standard residential properties.

The topography of the area varies significantly in some locations with instances where properties on one side of the road may differ in elevation by more than 10 metres compared with those immediately opposite. Some variation in vibration and regenerated noise levels are therefore expected for even closely positioned properties.

Examples of the building types adjacent along the North East Link alignment are shown in Figure 6-5. The buildings are generalised according to residential with commercial buildings in the cut and cover tunnel section of the project south of Manningham Road. No other significant infrastructure has been identified in the general vicinity of the alignment.

Building-specific vibration criterion is not proposed nor considered. There are no buildings that would preclude the use of the generic building categories and the associated vibration criterion given in the generally applied vibration conditions.

Figure 6-5 Typical example of properties that exist along the proposed North East Link alignment

6.3 Heritage buildings

The heritage parks, open spaces, buildings and other infrastructure along the proposed North East Link tunnel alignment are shown in Figure 6-6.

There are two heritage properties within the vicinity of the tunnel alignment that may be subject to measurable levels of vibration:

- Heide Museum of Modern Art, approximately 70 metres from the tunnel
- Banyule House, approximately 40 metres from the tunnel.

The next closest heritage property, Clarendon Eyre, is separated from the proposed works by approximately 180 metres. The vibrations caused by the planned excavation methods for constructing the mined section of the tunnel and the associated cross passages would be indistinguishable from background levels of vibration.

Aside from these three properties, the level of vibration from the project's construction activities at other heritage infrastructure would be immeasurable and would not impact the integrity of the structures.

A condition survey of the Heide Museum and Banyule House would be completed before the project's construction started.

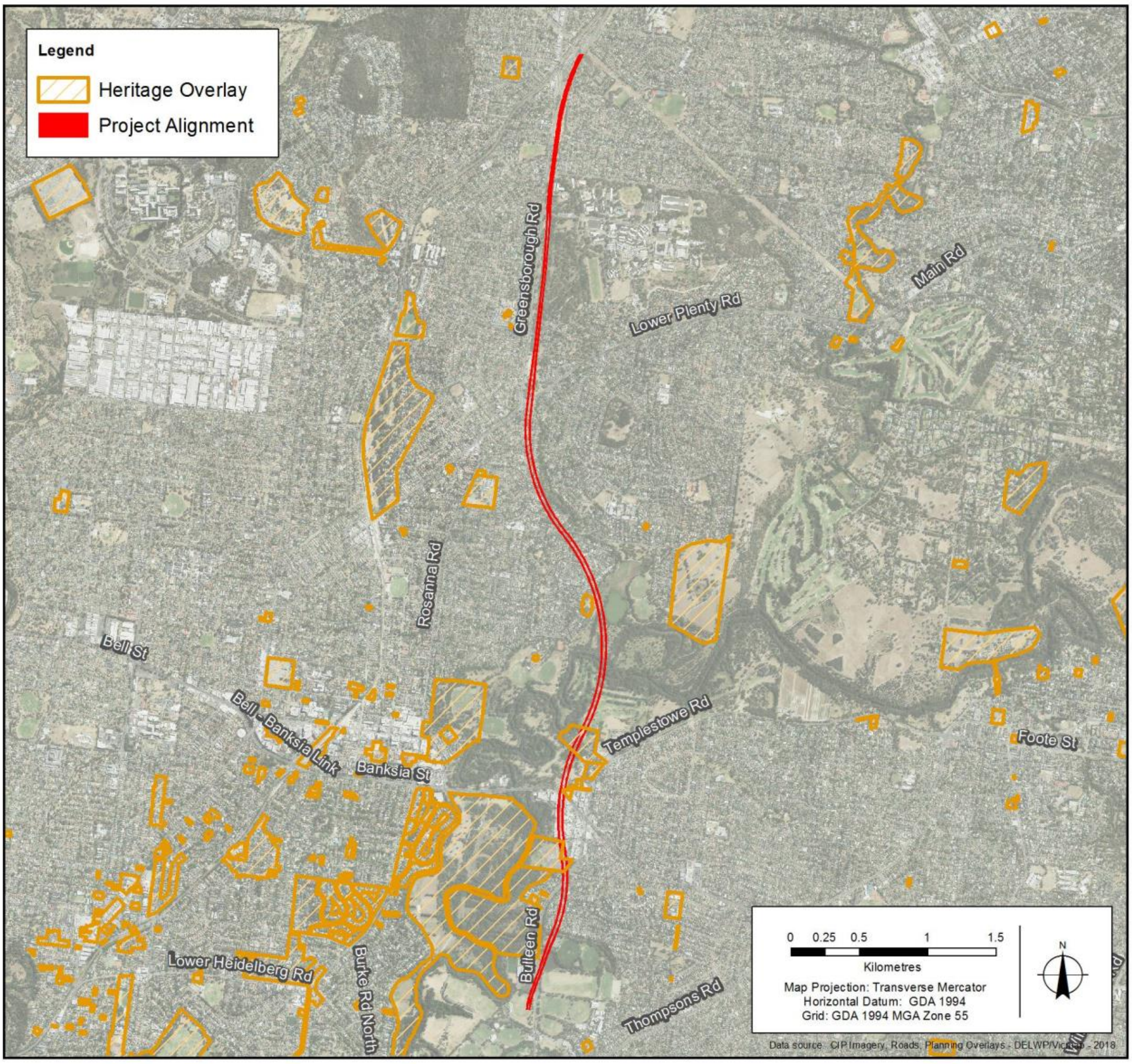


Figure 6-6 Heritage infrastructure around the planned tunnel alignment

6.4 Heide Museum of Modern Art

The Heide Museum of Modern Art is the most significant State-owned building near the North East Link alignment. The public museum and gallery museum comprise three distinct exhibition buildings set within 6.5 hectares of heritage gardens and a sculpture park. Two domestic buildings of historical importance, and an additional purpose-built gallery, are used to exhibit works.

The museum occupies the site of a former dairy farm that was purchased by the prominent Melbourne art benefactors John and Sunday Reed in 1934 and became the gathering place for a collective known as the Heide Circle, which included many of Australia's best-known modernist painters, including Albert Tucker, Sidney Nolan, Joy Hester, who often stayed in the former farmhouse.

Heide I was built circa 1870 and renovated several times since the initial construction with the most recent being in 2010. The former farmhouse is dedicated to exhibitions and displays from the Heide Collection and Archive.

Heide II was commissioned by the Reed's and constructed between 1964 and 1967 as 'a gallery to be lived in'. The building is considered one of the best examples of modernist architecture in Victoria. It is currently used to display works from the Heide Collection and on occasion projects by contemporary artists.

Heide III was constructed in 1993 and extended 2005. The Heide Cafe was redeveloped in 2009.

The photographs in Figure 6-7 illustrate the typical nature of the different building elements at the Heide Museum of Modern Art.

Figure 6-7 Buildings typical of the Heide Museum of Modern Art

While the Heide Museum of Modern Art is the closest significant State element of infrastructure near to the project alignment, the buildings are further than 65 metres in plan distance from the southbound tunnel and more than 90 metres from the northbound tunnel. In addition, there would be approximately 20-metres between the tunnel crown and the closest Heide III building platforms. The older Heide I building is approximately 145 metres from the closest planned tunnelling activities.

6.5 Banyule House

The cultural heritage assessment for Banyule House indicates that Banyule House is a two-storey rendered brick structure with sandstone footings. The house was originally constructed in 1846 and underwent subsequent extensions including the addition of a connecting annex section and a rear courtyard. The surrounding grounds have been developed and comprise lawn surfaces, a tennis court, an in-ground swimming pool, and a gravelled carpark located in the southern area. Paved and gravelled pathways surround the house and a horse-shoe shaped driveway enters and exits along the western property margin.

While the property is near the planned tunnelling activities, there are no planned surface works in the vicinity that would generate perceptible or measurable levels of vibration. The potential impacts on the structure are limited to ground borne vibration.

There are no indications from the available information that the condition of the property or the structural soundness of Banyule House would be affected by the construction activities.

A condition survey would be completed before the project's construction activities started to confirm whether any adjustments to practices were required.

The photographs in Figure 6-8 highlight the typical nature of the different building elements of Banyule House that can be identified from Buckingham Drive.

Figure 6-8 Banyule House

6.6 Clarendon Eyre

Clarendon Eyre was constructed on the escarpment above the Bolin Swamp in the 1870s and the property included a section of the Yarra River to the west and extended to the east. The residence is likely to have been constructed in two phases, with a single-storey section to the north and the more-resolved Italianate two-storied section to the south. The residence is unusual in that its double-height veranda elevation is orientated to the south away from the river. The historical heritage values of Clarendon Eyre are identified as being 'architecturally of State significance with unusual massing and details'. Once part of the property, the Moreton Bay Fig is now on a separate Heritage Overland to the north-east of Clarendon Eyre. Figure 6-9 shows a photograph of Clarendon Eyre.

Figure 6-9 Clarendon Eyre (Victorian Heritage database report)

6.7 Other adjacent sensitive infrastructure

There are schools, aged care facilities and kindergartens along the North East Link alignment. A survey of the area shows the following educational centres:

- Macleod College (>2000 metres)
- Greensborough Road Early Learning Centre (>60 metres)
- St. Martins of Tours School (>150 metres)
- Viewbank College (>320 metres)
- Goodstart Early Learning Centre (>30 metres)
- Banyule Primary School (>200 metres).

Two aged care facilities—the ACSAG Nursing Home and the Assis Centre for Aged Care—are more than 250 metres from the project alignment and would not be impacted.

There are no identified building uses along the alignment that would necessitate a requirement for a vibration class consistent with sensitive equipment categories, as commonly required for hospitals, laboratories and research institutions.

However, the presence of sensitive equipment would however be further investigated before the project's construction started. If sensitive equipment was identified within the proximity of the tunnels, it is anticipated that adherence to the requirements of EPR NV8 (construction vibration targets for amenity) and EPR NV10 (ground-borne internal noise targets) would prevent any impact on the equipment. 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).

6.8 Adjacent services

There are telecommunications, gas, electricity, water, drainage and sewer services along the proposed alignment. Correspondence with asset owners generally shows acceptance of a higher vibration level than appropriate for residential properties. In many cases the asset owners have their own guidelines which should be followed during construction.

Utility services would be identified through the '*Dial Before You Dig'* service or other specific communications with the asset owners.

The study area has assessed a zone of approximately 450 metres in width. These analyses have not identified any services, above ground or below ground that would not be appropriately protected by EPR NV5. The combination of the low energy mechanical construction methods, such as a TBM, road header or hydraulic hammer, and the robustness of most services to vibration-related effects means that the services and any small adjustments to the alignment of the tunnels are inconsequential with respect to damage. Providing the alignment lies within the 450-metre wide study corridor, a further impact assessment on services is not expected.

6.9 Existing vibration environment

The existing vibration conditions around North East Link are typical of a quiet residential area with minimal sources of elevated vibration. Any instances of perceptible vibration would likely result only from a combination of heavy vehicle movements combined with uneven road pavement surfaces. Only under these combined conditions would elevated vibration occur. Even then, it would be limited to areas immediately around the road and not measurable at the property given the setback distance of the property to the road. A review of the roads above most of the tunnel alignment are in reasonable condition and not frequently used by heavy transport. The roads near the northern and southern portals are more frequently used by heavy vehicles although the vibration is unlikely to be elevated to the level of perception.

Background vibration in the assessment area of the tunnel has been assessed with data collected at 19 locations to quantify the existing vibration environment.

Vibration sensors (geophones) were positioned at residential locations and the level of vibration recorded for each one-minute interval during the monitoring period. Monitoring at each location varied from 2 to 12 days. Each location was monitored for one or two continuous periods. Monitoring locations are shown in Figure 6-10. The red line represents the tunnel and dive structures.

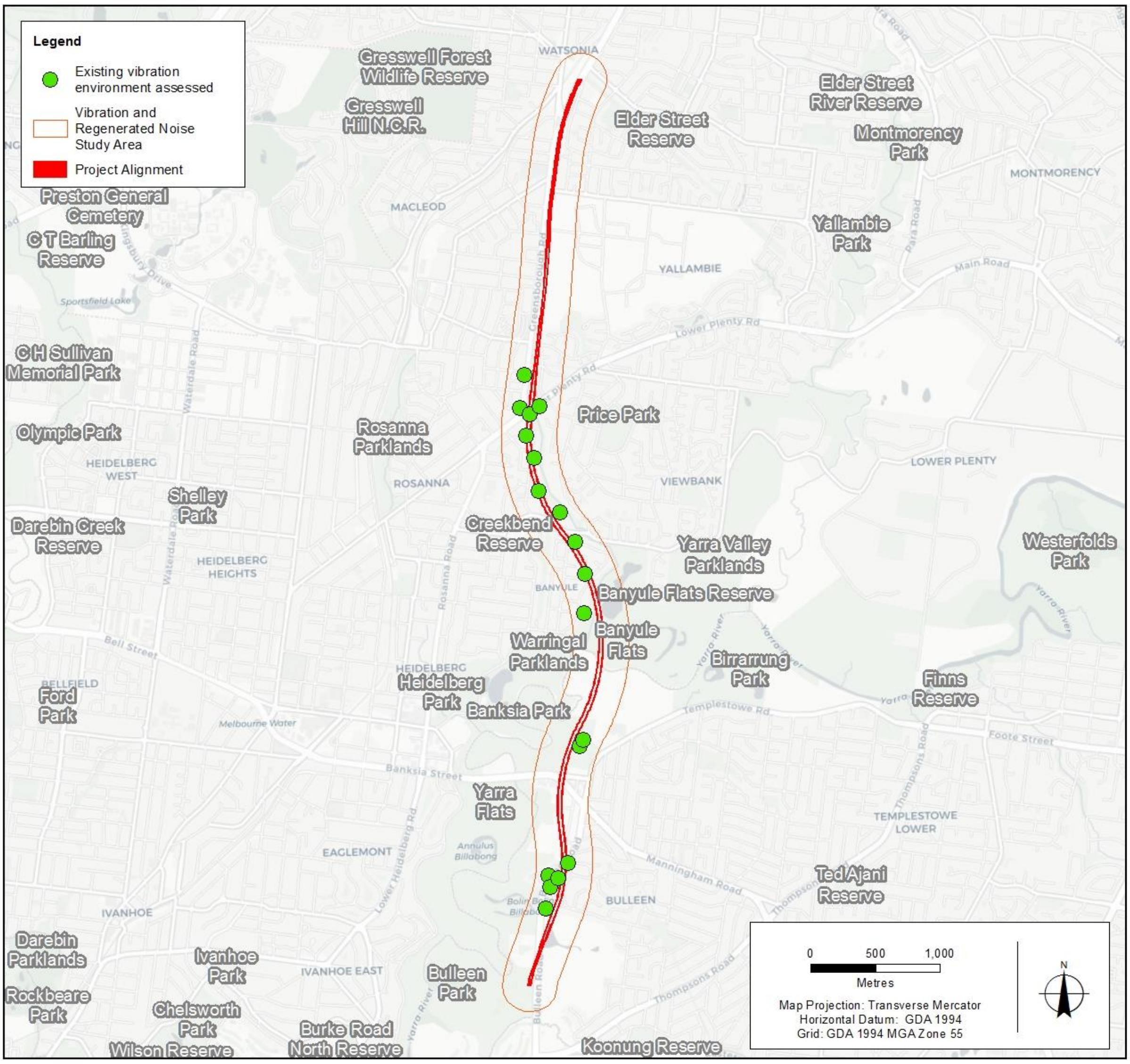


Figure 6-10 Locations where the existing vibration environment has been assessed

The tunnel alignment is generally characterised by low vibration. The analyses show existing vibration levels for each of these properties for daytime and evening periods. Day is from 6 am to 10 pm and night from 10 pm to 6 am.

The values provide information on how often there are levels of vibration higher than the constant background level. For example, L_{99} shows the level of vibration that is higher than the levels for 99 per cent of the time, and so on. The minimum, median and maximum-recorded values are also calculated. The maximum value is generally of little relevance because it typically comes from a localised effect, such as an impact to the sensor. It is not related to the actual existing conditions.

Around 0.3 to 0.5 mm/s could be considered as the threshold for human perception from continuous vibration. Impulsive vibration would be higher and semi-continuous in between the two. The existing environment is characterised by low levels of vibration, with measurements at 19 of the locations below the threshold. A few properties (3 Ilma Court, 5 Belmain Court and 4 Derwent Square) have daytime L_{99} levels (exceeds 99 per cent of measured values) of 0.5 mm/s or greater. However the instances of elevated vibration are infrequent and most likely attributable to localised effects such as walking, gardening, animals or direct impact near the monitor. They do not reflect the wider ambient background vibration level.

At all background locations, vibrations are higher in daytime than at night. No locations had a background L_{99} level of vibration during the night that exceeded 0.7 mm/s.

Appendix A shows the recorded background vibration data for each location.

There is no requirement the existing vibration environment is considered in defining the EPR values.

6.10 Previous reports on other tunnelling projects

Methods of predicting and analysing vibration and regenerated noise effects for other tunnelling projects have been reviewed. These other reports provide information on the geological setting, attenuation characteristics of the different rock masses and vibration performance criteria.

The *Legacy Way* road project in Brisbane involved developing twin 12 metre diameter tunnels in hard rock formation beneath residential properties. The length of the tunnels is approximately six kilometres. Their depth varies from 25 metres to more than 50 metres below surface level. The portals are located in areas of generally minimum residential impact. No significant underground excavations were required. Vibration levels from the TBM and hydraulic hammers during construction varied up to 2 mm/s. Blasting produced vibration levels up to 25 mm/s. Regenerated noise values were measured up to 60 dBA. Tenants (occupiers) from several households were relocated through the project, either because of the TBM activities or cross passage developments.

The *North South Bypass Tunnel (Clem 7)* is a 4.8-kilometre twin tunnel that passes beneath the Brisbane River as well as commercial and residential properties. The depth of the tunnels is similar depth to the Legacy Way project although more than half of the tunnel pass beneath commercial properties where vibration and regenerated noise was less critical. No adjustments to the TBM operating schedule, other than planning regular maintenance during evening hours, or the TBM operating parameters (thrust and cutter head rotation) were implemented. Higher regenerated noise levels occurred and were mitigated through relocations and other compensation. Sections of the tunnel accesses were developed using road headers that were associated with similar regenerated noise measurements and mitigation options to the TBM.

The *Airport Link* project in Brisbane was a significant construction project and includes tunnels that extend more than seven kilometres. Large caverns and intersections with on and off ramps resulted in extended periods of construction that focused on key sections of the project. The extensive surface works affected a large catchment area and required relocation as a key mitigation measure. Commercial properties were affected to an extent greater than initially expected.

A report prepared on the M5 East project in Sydney indicated that regenerated noise levels associated with the night-time road header tunnelling operations were expected to be acceptable to most building occupants (below 40 dBA) at offset distances of about 37 metres or more. At 30 metres, there was expected to be adverse comment from affected residents.

A report prepared for the Epping to Chatswood rail link in Sydney that involved the construction of two 7.2-metre diameter tunnels evaluated the potential impacts of regenerated noise levels. The level of tolerable noise within the homes was set at 40 dBA. Noise levels that measured more than 40 dBA were identified as the point at which residents and families would be offered alternative accommodation until the machines had passed. The report indicated that along the first half of the alignment, some 130 homes were identified as being within the field of TBM noise and vibration. The report also indicated the noise from a TBM starts being heard and felt at about 100 metres off and remains evident for another 100 metres or so once a TBM has passed. There were no data within the document to support or verify the conclusions.

7. Risk assessment

A risk assessment of project activities was performed in accordance with the methodology described in Section 5 above. The risk assessment has been used as a screening tool to prioritise the focus of the impact assessments and development of the project EPRs. The risk pathways link project activities (causes) to their potential effects on the environmental assets, values or uses that are considered in more detail in the impact assessment in Section 8. Risks were assessed for the project's construction and operation phases.

The identified risk pathways and associated residual risk ratings are listed in Table 7-1. The likelihood and consequence ratings determined during the risk assessment process and the adopted EPRs are presented in Appendix B.

There are no planned events within the tunnel vibration and regenerated noise impact assessment.

Table 7-1 Tunnel noise and vibration risks

Risk ID	*Potential threat and effect on the environment*	*Risk rating*
Construction		
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 TV05	The levels of regenerated noise are elevated at some residential properties as a consequence 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 at the residential properties 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 building and the internal finishing amplifies regenerated noise levels and results in non-compliant values and associated loss of amenity	Low

Risk ID	*Potential threat and effect on the environment*	*Risk rating*
Risk TV13	Commercial buildings may contain sensitive equipment which cannot operate effectively with the generated levels of vibration and regenerated noise	Low
Risk TV14	Infrastructure like retaining walls, services, tower piers and abutments are damaged by the vibration generated by the construction activities	Low
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 dwellings along the corridor are affected by the low amplitude vibrations that results in settlement and damage to the residential or commercial buildings	Low
Risk TV17	Heritage buildings are damaged by the vibration generated by the construction methods	Low
Risk TV18	Rock mass sufficiently competent that excavation of the cross passages or the northern dive structure development requires blasting that impacts on the amenity of persons	Low
Risk TV19	Rock mass sufficiently competent that excavation of the cross passages or the northern dive structure development requires blasting that that causes damage to the adjacent properties or other infrastructure	Low
Risk TV20	Construction activities induce vibration levels which could impact upon the integrity and serviceability of existing services	Low

8. Impact assessment

Vibration and regenerated noise can affect humans in different ways including:

- Loss of amenity
- Discomfort
- Adverse health effects (such as stress, nervousness, anxiety, unease, loss of concentration)
- Sleep disturbance.

Responses are subjective and can vary between individuals.

Vibration can also impact building and underground services (joint displacement, cracking, leakage, structural failure of underground brickwork), and relatively extreme levels of vibration can cause structural damage to buildings. High levels of vibration (that typically exceed that which can be generated by mechanical equipment) can cause superficial damage: flaking of paint, cracking of plaster and paint edge separation are common examples.

Vibration may impact the continued operation of very delicate or high-resolution equipment, such as electron microscopes or medical imaging equipment.

8.1 Modelled excavation scenarios

The expected level of vibration and regenerated noise from a range of excavation scenarios have been modelled. The scenarios address the possible equipment that could deliver the mainline tunnels, the dive structures at the northern and southern portals and the cross passages between the northbound and southbound tunnels. The scenarios are given in Table 8-1.

Table 8-1 Modelled scenarios based on planned alignment and equipment options

Scenario	*Description*	*Chainage*	*Equipment*
A	Construction of the northern trench north of Lower Plenty Road and adjacent to Greensborough Road – approximate length of 500 m.	Ch41000 to Ch43575	45-tonne excavator 45-tonne excavator with hydraulic hammer
B	Construction of the mainline tunnels using a 15.-m diameter TBM between Lower Plenty Road and Bridge Street – approximate length of 3,100 m.	Ch43575 to Ch46620	TBM
C	Construction of the cut and cover section for northbound and southbound tunnels between south of Bridge Street and north of Bulleen Road – approximate length of 700 m.	CH46620 to Ch47275	45 tonne excavator 45 tonne- excavator with hydraulic hammer
D	Construction of the mined tunnel section for northbound and southbound tunnels between south of Bulleen Road to Trinity Marles playing fields at Trinity Grammar School Sporting Complex – approximate length of 400 m.	CH47275 to Ch47700	Roadheader
E	Construction of the southern dive structure through Trinity Marles playing fields Trinity Grammar School Sporting Complex – approximate length of 600 m.	Ch47700 to Ch48380	45-tonne excavator

Scenario	*Description*	*Chainage*	*Equipment*
F	Construction of the cross passages along the tunnel completed with the TBM and the additional mined section.	Ch43575 to Ch46620 CH47275 to Ch47700	20-tonne excavator with hydraulic hammer

Scenarios B, C and D have also been assessed for two options, referred to as Option 1 and Option 2.

- Options 1 and 2 have a similar horizontal alignment
- Option 1 and Option 2 have almost identical vertical alignments for the northern and southern dive structures
- Option 2 has a lower vertical alignment with the design level approximately two metres lower across Scenario B, C and D when compared with Option 1.

The modelled vibration and regenerated noise levels for Option 1 are presented in Appendices C and D respectively for each of the six scenarios presented in Table 8-1 above. The modelled results for the alternative vertical alignment (Option 2) for construction of the cut and cover section between Bridge Street and Bulleen Road (Scenario C) are provided in Appendix E.

8.2 Vibration and regenerated noise modelling results

Modelling results are shown as a series of contours of differing vibration levels varying from 0.5 mm/s to 2.5 mm/s on 0.5 mm/s increments. The regenerated noise results are similarly shown as a series of contours varying from 35 dBa to 55 dBa in 5 dBA increments.

In simple terms, where a vibration contour of 1 mm/s is shown, all properties between the works area and the zone marked by this contour are predicted to receive vibration exceeding 1 mm/s. If a contour is not shown, it infers the level of vibration is not reached. Full results are shown in Appendices C, D and E.

Table 8-2 shows the construction methods along with the potential impacts and means of managing them.

Table 8-2 Summary of vibration and regenerated noise effects from construction

Area	*Description*	*Mitigation options*
Northern trench and cut and cover structure	Excavation with 45-tonne excavator. Excavation with 45-tonne excavator and 3,300-kilogram hammer	Community liaison Vibration and noise monitoring Temporary relocation and respite
Mainline TBM (northbound and southbound)	TBM	Community liaison Vibration and noise monitoring Temporary relocation and respite
Cut and cover between Bridge Street and Bulleen Road	Excavation with 45-tonne excavator. Excavation with 45-tonne excavator and 3,300-kilogram hammer	Community liaison Vibration and noise monitoring Temporary relocation and respite

Area	*Description*	*Mitigation options*
Mined tunnel between Bulleen Road southern portal	Roadheader	Community liaison Vibration and noise monitoring Temporary relocation and respite
Southern dive structure	45-tonne excavator	Community liaison Vibration and noise monitoring
Cross passage development	20-tonne excavator with hydraulic hammer	Community liaison Vibration and noise monitoring Temporary relocation and respite

Best practices continually review the vibration and regenerated noise levels against the modelled predictions, and adjust the model parameters based on their correlation. It is important that measurements of vibration and regenerated noise occur during the initial stages of the project and a comparison with the expected results undertaken.

8.3 Disturbance effects

Vibration increases as a TBM approaches before it reaches a maximum value when immediately beneath or adjacent to a property, then reduces as the TBM moves away. TBM advance rates would necessarily affect the duration of any vibration and/or regenerated noise impact. While the level of vibration may vary slightly depending on TBM advance rates, a faster TBM advance rate would result in a reduced exposure time for potentially affected persons. TBM rates vary according to the machine specifications, rock type, support installation type and so on. TBM advance rates along the North East Link tunnels would therefore vary along their alignment, but for the purposes of establishing impact envelopes an advance rate of 10 metres per day is chosen. TBM advance rates from other similar scale projects show values varying from 5 to 50 metres per day depending upon ground conditions.

Vibration envelopes have been developed for 70 representative properties above the tunnels as shown in Figure 8-1.

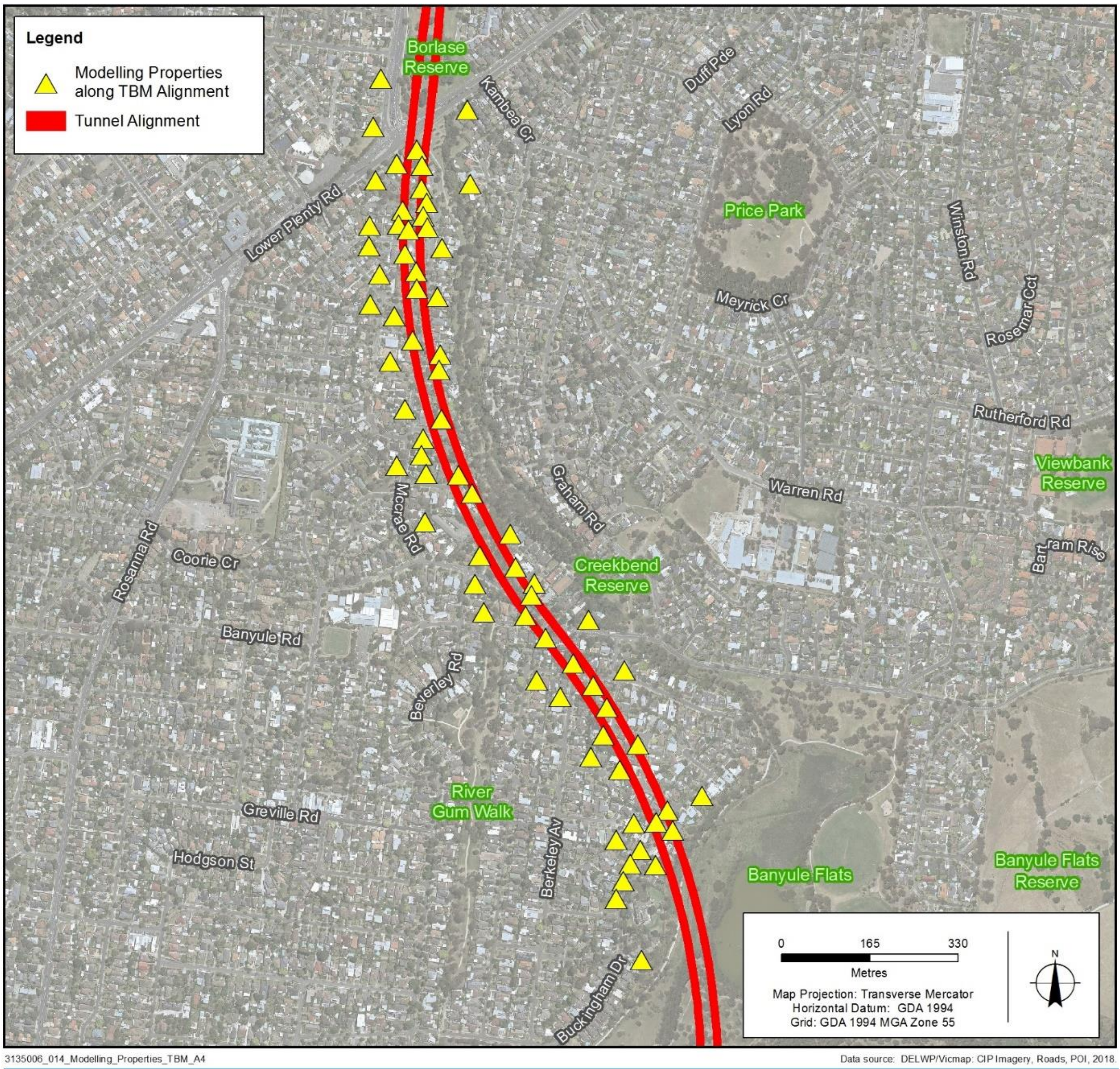


Figure 8-1 Location of representative modelling properties along the TBM alignment

Disturbance envelopes for the northbound and southbound TBM activities at each of the 70 representative properties are provided in Appendix F for the northbound tunnel and Appendix G for the southbound tunnel. A table for each property showing the expected duration of vibration and regenerated noise levels above a range of values is also shown.

Figure 8-2 shows an example of predicted vibration envelope for a representative property calculated with an advance rate for the TBM of 10 or 20 metres per day. The time where the TBM is at the nearest point to the property is referred to as Day 0 in Figure 8-2. The modelling parameters are consistent with a property around 20 metres above the crown of the tunnel, as is typical of some residences around Homewood Court. Figure 8-2 also shows levels of vibration representing the typical background value and the limit of perception in a residential environment.

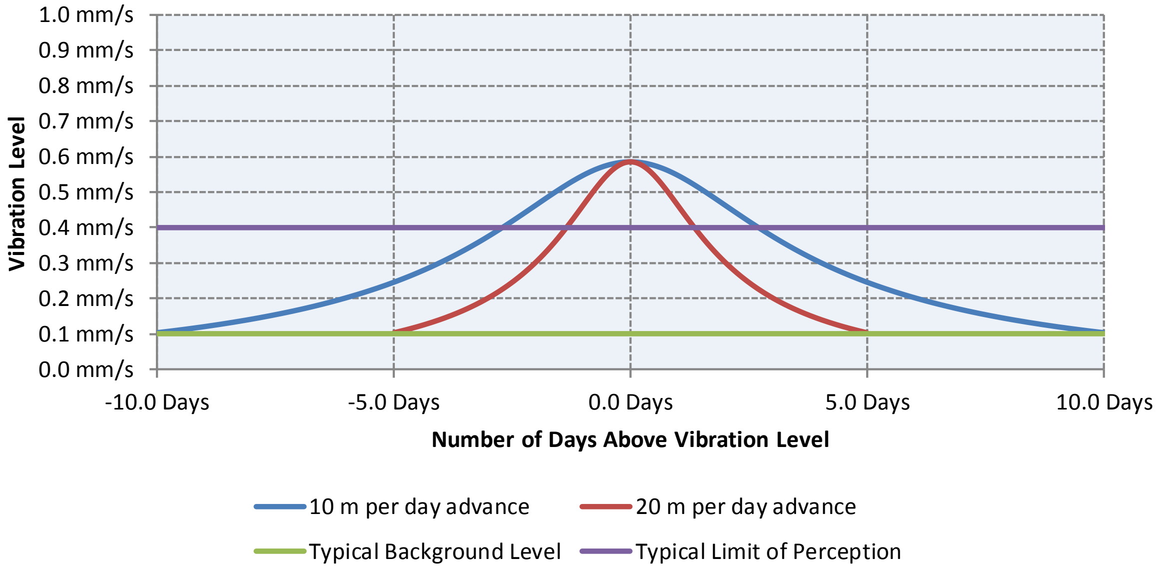


Figure 8-2 Vibration envelope for the southbound tunnel

At this location, vibration levels would approach 0.6 mm/s. At a rate of advance for the TBM of 10 metres per day, the vibration would reach a vibration level of 0.5 mm/s approximately two days before the TBM passes beneath the property, reach a maximum of around 0.6 mm/s when the TBM is directly beneath the property with the vibration subsequently reducing to less than 0.5 mm/s after another two days as the TBM continues to advance from the property. At an accelerated TBM advance rate of 20 metres per day, the period of above 0.5 mm/s is reduced to 1 day either side of the maximum vibration value.

A similar vibration envelope would also be applicable to show the range and duration of vibration levels that could be expected during the construction of the northbound tunnel. Other possible impacts, such as those generated by the construction of the cross passages, would also occur at some locations.

8.4 Vibration resulting in loss of amenity

The impact assessment has considered the potential for the construction activities to induce elevated levels of vibration that could affect the amenity of persons around the tunnel alignment (risks TV01, TV04 and TV06). Variation in the vibration levels because of unexpected water conditions, different geology, vary vibration attenuation and so one could also affect the extent of vibration impact (risk TV04). Changes to the construction schedule that could require different equipment or affect the duration of an activity to an extent other than that identified under the initial assessment could also change the predicted level of impact, resulting in either an improvement or reduction in amenity (risks TV08 and TV10). The project EPRs have been developed to manage these instances when elevated vibration levels could occur.

Compliance with EPR NV3 requires the management of noise and vibration at these sensitive receptors in accordance with the developed Construction Noise and Vibration Management Plan (CNVMP) which is required in EPR NV4. A component of EPR NV4 requires that noise and vibration sensitive receptors are identified.

Within the study area, there are a mix of single-storey dwelling homes, multi-storey residential apartment buildings, churches, schools and a range of business premises. The energy delivered by the cutter head of the TBM, the tool of the hydraulic hammer or the rotating cutter drum of the road header necessarily imparts a percentage of the energy as a vibrational component. Where the tunnels pass beneath residential areas there would be some unavoidable elevated levels of vibration.

Section 5.6 explained the objectives of modelling and how the model was developed to predict levels of vibration. Appendices C and E presented the figures showing the predicted vibration contours for the alignment which define the level of vibration and the extent of receptors potentially affected. In a broad sense, as the construction activities progress from the northern dive structure, through the driven tunnel, the cut and cover section, the mined tunnel and finally the southern portal, the modelling of vibration levels indicates:

- The northbound and southbound TBMs would generate perceptible levels of vibration for the initial 780 metres, or to around Homewood Court, from the northern tunnel portal for those properties above the alignments of the tunnels. The vibration for these properties within 35 metres of the alignment is expected to exceed 0.5 mm/s, although not expected to exceed 1 mm/s. The levels comply with EPR NV8 daytime guideline values but may require some mitigation to comply with the EPR NV8 night criterion. The types of mitigation could include a reduced operating period during the night or scheduling of maintenance during the night-time. When neither of these methods are effective, temporary relocation for a period of several days would be considered. The vibration would comply with EPR NV5 and EPR NV9.
- The cut and cover section between Bridge Street to Bulleen Road has been assessed using a 45-tonne excavator with a 3,300-kilogram hydraulic hammer and shown to produce elevated levels of vibration for those properties around St. Andrews Crescent. The modelled vibration levels approach 0.5 mm/s although the duration of the elevated vibration is anticipated to be no more than a few days. The vibration is modelled to be compliant with the conditions of EPRs NV5, NV8 and NV9.
- The mined section of tunnel between Bulleen Road and the southern portal would produce elevated vibration more than 1 mm/s at the two residential properties on the western side Bulleen Road, immediately near the portal. This occurs because of the shallow depth of cover. Other properties above the alignment and within 100 metres of the portals are expected to receive vibration varying from 0.5 mm/s to 1.0 mm/s. The effect is calculated to be less than a few days. Tunnelling would likely require some form of mitigation, such as reduced operating hours. Where mitigations steps involving scheduling are not effective, temporary relocation could be considered.
- The southern portal would not be expected to generate perceptible levels of vibration on the basis that no work with a hydraulic hammer would be required. The vibration is modelled so it complies with the conditions of EPRs NV5, NV8 and NV9.
- The development of the cross passages with a small excavator and matched hydraulic hammer is expected to induce perceptible levels of vibration at residences above the cross passage. For each of the northern cross passages, around 15 properties are expected to receive vibration greater than 0.5 mm/s. For some of the cross passages, the modelled vibration levels are calculated as compliant with daytime guidelines but would exceed the preferred night-time levels. The vibration would comply with EPRs NV5, NV8 and NV9 (services and building damage). The expected mitigation could include excavation during the daytime only, or temporary relocation when night-time works are required.

The northern trench and cut and cover tunnel would extend from just north of Lower Plenty Road, where the TBMs would complete their tunnelling, through to around Elder Street, Watsonia. The TBMs would be dismantled just north of Lower Plenty Road and a cut and cover tunnel approximately 1.4-kilometres long would be constructed heading north to Blamey Road. From Blamey Road north to Elder Street, Watsonia, the roadway would be in an open trench. The trench would be predominantly open cut with land bridges allowing east-west connections between Watsonia and Greensborough. These land bridges would be located between Yallambie Road and Watsonia Rail Station. The land bridges would be created by covering sections of the open cut trench although the methods used to cover the trench would have no effect on the level of vibration or regenerated noise induced by its construction activities. The geology varies through the trench and cut and cover tunnel with the upper (shallower) sections of the ground expected to be removed using excavators while the lower (deeper) sections may involve excavation of any competent material with hydraulic hammers.

Construction work along the trench and cut and cover tunnel would involve both a stability phase, such as the installation of the diaphragm and pile walls, and excavation phase associated with removing the material within the walls using excavators and possibly hydraulic hammers.

The analyses have considered the entire structure, including the main box structure that would comprise the northbound and southbound accesses to the tunnel, together with the on and off ramps that merge with the main structure.

The construction activities associated with the northern trench and cut and cover tunnel works that are expected to induce measurable levels of vibration or regenerated noise include:

- Construction of a 1,000-millimetre wide diaphragm wall on both sides of the cut and cover tunnels extending vertically from the surface to approximately seven metres below the finished road deck and horizontally for the section of the cut and cover tunnels between the TBM portal (where the TBMs complete their tunnelling just north of Lower Plenty Road) and approximately 650 metres further north
- Installation of large-diameter bored piers (up to 1,200 millimetres) at regular spacings along the edges of the trench and cut and cover tunnel. The piers would extend from the northern end of the diaphragm wall to the trench end around Elder Street, Watsonia
- Removal of the material within the cut and cover tunnel structure using a 40-tonne excavator
- Excavation of any competent material that requires the use of a large excavator and hydraulic hammer.

Piled columns of varying diameter would also be positioned inside the structure and used for supporting the roof structure of the cut and cover tunnels. In addition, a regular network of tension piles (750–1,050-millimetre diameter) are also positioned in the floor of the excavation for stability.

The assessment of vibration impacts on persons and infrastructure for the northern trench and cut and cover tunnel has only considered the outermost extents of the diaphragm wall or bored piles. Where other walls or piers are located within the trench structure, these have not been separately assessed as the effects would not be predicted to be greater than the piling activities located along the outer edge of the excavations. This is due to the outer extents of piles being the closest to sensitive receptors and adjoining buildings and structures.

Other activities, such as site establishment works, off road trucks, concreting works and crane lifts are also planned, but the level of vibration and regenerated noise from these activities would be immeasurable at distances further than several metres. These works are therefore not further assessed.

The northern trench and cut and cover tunnels are located on the eastern side of and approximately parallel to Greensborough Road. Along the full length of the excavation, residential properties are built on the western side of Greensborough Road. Including their setback from the road, the properties vary from 40 to 55 metres from the western wall of where excavations would occur. At the southern end of where the cut and cover tunnels would be, there is a pocket of residential development accessed from Lower Plenty Road, with the closest properties 5 to 50 metres from the diaphragm wall works.

The vibration modelling results for each of the four key phases of construction equipment have been modelled and the results presented as a series of contours in Appendix C. A summary of these figures indicate:

- The vibration generated by constructing the diaphragm wall north of Lower Plenty Road would be imperceptible and would not impact upon the amenity of persons residing in the properties around this area. Vibration levels are anticipated to comply with the guideline target levels for amenity in EPR NV8.
- The installation of the bored piers would induce lower levels of vibration than the diaphragm works and is therefore modelled to have no impact on amenity for adjacent residents, or on the integrity of any adjacent buildings. Vibration from the works is expected to be less than the guideline target levels for amenity in EPR NV8 and EPR NV10.
- Excavating the material within the walls of the trench or cut and cover tunnels with a large excavator would on occasions generate elevated levels of vibration as the bucket impacted with the ground or where the excavator tracks moved across hard or uneven surfaces. The vibration would be short term, and even where elevated, the duration would minimise the effect and in most cases have no impact on overall amenity for persons close to the works. Where elevated vibration may occur, it would be restricted to those areas closest to the excavation and would not extend to the adjacent properties.
- Any competent rock in the lower sections of the excavation may require the use of a hydraulic hammer. Vibration and regenerated noise modelling have been based upon a 40-tonne excavator with a 3,300-kilogram hydraulic hammer. The possible impacts are based on a worst-case scenario that the hammer could be used at all locations along the trench or cut and cover tunnels: a scenario that is not likely but justified in terms of establishing the potential impacts of the excavation. Under this scenario, the modelling has indicated the vibration at the residential properties on the western side of Greensborough Road and the other residential developments along the eastern side could experience vibration levels exceeding 0.5 mm/s which could be perceptible to residents. The vibration is not predicted to exceed 1 mm/s. The vibration would therefore be assessed as compliant with the amenity-based EPR NV8 daytime criteria but may require mitigation to comply with the night-time guideline target levels for amenity.

The modelling has identified some areas along the project alignment where the shallower depth of cover and/or the proximity of receptors to the work could result in vibration that is perceptible by the receptor. The potential area is limited to the TBM, mined section of tunnel and cross passages.

The project would prepare a Construction Environment Management Plan (CEMP) to identify the potentially affected properties as well as to set out the requirements and methods for managing those isolated areas where some form of mitigation is required (EPR NV4). The Communications Plan would detail the required of correspondence with affected persons.

EPRs NV5, NV8 and NV9 are based around requiring mitigation measures where the elevated vibration levels would occur. They are protective of the amenity of the receptor. It is therefore unlikely there would be an amenity issue on residential or commercial properties that would not be appropriately addressed by the EPRs. The risk is considered low.

8.5 Regenerated noise resulting in loss of amenity

The assessment has considered the potential for the construction activities to induce elevated levels of regenerated noise that could affect the amenity of persons around the alignment of the tunnels (risks TV02, TV03 and TV07).

Like the variation in the vibration that could occur because of unexpected water conditions, vibration attenuation would also affect the level of regenerated noise impact (risk TV05). Changes to the construction schedule that could require different equipment or affect the duration of an activity to an extent other than that identified under the initial assessment could also change the predicted level of impact, resulting in either an improvement or reduction in amenity (risks TV09 and TV10). The project EPRs have been developed to manage the instances when elevated vibration levels could occur.

Compliance with EPR NV3 requires noise and vibration at these sensitive receptors is managed in accordance with the developed Construction Noise and Vibration Management Plan (CNVMP) which is required in EPR NV4. A component of EPR NV4 requires that noise and vibration sensitive receptors are identified.

Regenerated noise occurs because of the momentary deflections of hard surfaces inducing audible sound waves. The audibility is dependent upon the frequency of the amplitude and frequency of the vibration pulse as well as the sound characteristics of the building. Buildings with multiple hard surfaces will generate regenerated noise that is more audible than buildings with carpets, soft furnishings and curtains. Estimating the level of regenerated noise is therefore difficult without some knowledge of the building characteristics. A conservative approach is adopted where it is assumed that minimal internal attenuation exists which in most situations would predict values that are up to 5 dB higher than actual experienced conditions.

Section 5.6 above explained the modelling and the predictive capabilities. The model calculates an expected regenerated noise level based upon the level of vibration for an assumed set of audible characteristics of a building. Appendices D and E contain the figures showing the predicted regenerated noise contours for the alignment of the tunnels. In a broad sense, as the construction activities progress from the northern dive structure, through the driven tunnel, the cut and cover section, the mined tunnel and finally the southern portal, the modelling of regenerated noise indicate:

- The regenerated noise generated by the constructing the diaphragm wall north of Lower Plenty Road is minor and would not impact the amenity of persons residing in the properties around this area. However, the regenerated noise levels are modelled to comply with EPR NV10.

- Excavating the material within the walls of the trench or cut and cover tunnels with a large excavator would on occasions generate higher levels of regenerated noise as the bucket impacted with the ground or where the excavator tracks moved across any hard or uneven surfaces. The noise would be short term, and even where elevated, the duration would minimise the effect.
- Any competent rock in the lower sections of the excavation may require the use of a hydraulic hammer. Regenerated noise levels are modelled to be elevated at properties either side of Greensborough Road. The noticeable regenerated noise impacts would generally be restricted to the first row of properties closest to the works and may necessitate some changes to the excavation schedule or equipment size to mitigate the noise effects.
- Development of the main tunnels with the TBM is modelled to produce elevated levels of regenerated noise along their entire alignment. Levels could exceed 40 dBA for those properties within 25 metres laterally of each tunnel centre line. Properties that lie off the centre line by more than 25 metres but less than 35 metres could receive elevated levels above 35 dBA. For the section of the tunnels within approximately 700 metres of the northern portal, the modelling also indicates the properties directly above the tunnels could receive generated noise exceeding 45 dBA. The night-time guideline value in NV10 of 35 dBA may be exceeded and require additional forms of mitigation depending upon the degree of any attenuation that may occur in the building because of floor coverings and furnishings. The mitigation could include limiting the tunnelling work during the night-time or the temporary relocation of residents. The duration that a resident could be affected is expected to be less than five days.
- The cut and cover section of the project between Bridge Street and Bulleen Road could 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 and comply with EPR NV10. The residents around Bulleen Road are expected to receive regenerated noise levels less than 35 dBA.
- In the deeper sections of the same cut, the use of a 45-tonne excavator with a matched hydraulic hammer could develop regenerated noise levels up to 45 dBA for a few properties on the western edge of St. Andrews Crescent. Minor adjustments to the scheduling would promote compliance with EPR NV10. The expected duration of the elevated noise levels would be short-term and no longer than one to two days.
- The mined section of the tunnels excavated with a road header could produce regenerated noise levels exceeding 35 dBA for a corridor along the length and approximately 80 metres in width. At both ends where the depth of cover is shallower, the noise levels would increase to 45 dBA although only a couple of properties would be affected. An additional 10 properties could receive noise levels up to 40 dBA. The night-time guideline value in EPR NV10 of 35 dBA may be exceeded and require additional forms of mitigation. These measures could include reduced operating periods during the night-time or this if this remains ineffective, temporary relocation of residents for several days.
- The southern portal geology suggests the excavation would not require equipment that would generate elevated levels of regenerated noise. Modelling of a 45-tonne excavator shows regenerated noise levels at the closest sensitive receptors would be less than 35 dBA. Compliance with EPR NV10 is expected.

It is generally noted from other tunnelling projects that regenerated noise would be heard by the receptor and sometimes considered annoying when the corresponding level of vibration would be considered imperceptible or acceptable. The modelling has confirmed the potential extents of regenerated noise are greater than for vibration-related impacts.

At certain locations, the level of regenerated noise would exceed the guideline values but this would not occur at all cross passages along the alignment of the tunnels. At some locations, the works may not comply with the evening criteria but they are expected to comply with daytime guideline values.

The modelling has identified the regenerated noise from the TBM activities, the mined tunnels and the cross passages could require measures to be incorporated into the construction schedule to limit the regenerated noise effects. These measures could include reduced periods of operation during the night-time or the night-time scheduling of maintenance activities. Construction techniques that produce lesser effects in terms of vibration and regenerated noise are not available or commercially feasible.

The disturbance envelope modelling has shown that where elevated levels of regenerated noise would occur, their duration would be relatively short and generally limited to a few days, in some instances increasing to a week. The short duration allows for a range of mitigation options to be successfully implemented. The project would prepare a Construction Environment Management Plan (CEMP) to identify the potentially affected properties and the duration and time they may be affected. The CEMP would also detail the requirements and methods for managing those isolated areas identified above where some form of mitigation would be required (EPR NV4). The Communications Plan would detail the required of correspondence with the affected persons.

The EPRs listed as NV5 and NV10 ensure mitigation measures are introduced when the elevated noise levels occurred. They are therefore protective of the amenity of the receptor. It is unlikely there would be an amenity issue on residential or commercial properties that would not be appropriately mitigated and addressed by the project EPRs. The risk is calculated as low.

8.6 Vibration damage to buildings

The assessment has considered the potential for the construction activities to induce elevated levels of vibration to adjacent buildings (risk TV15). The assessment also considered the possibility that heritage buildings could be damaged by the vibration generated by the construction methods (risk TV17). The potential for the ground mass to be affected by low amplitude vibrations that cause settlement has been addressed in the geotechnical report (risk TV16).

The modelling has calculated the levels of vibration from the tunnelling activities and shown these as a series of predicted vibration contours along the alignment of the tunnels. The results are presented in Appendix C and Appendix E. The level of vibration at a building could be estimated by identifying the contour value that intersects to property of concern.

The expected maximum level of vibration from the tunnelling activities is calculated as less than 1.5 mm/s. The vibration may be perceptible to some persons along the alignment of the tunnels, but the level is below the values presented in the international literature and standards as potentially representing the onset of superficial damage to buildings. These values are reflected in EPR NV9.

The CEMP would be prepared before any construction works started and would detail the extent of any condition surveys that would be undertaken before tunnelling-related activities started. This would provide additional protection for residents in regarding to identifying any instances of damage to their property. This is consistent with EPR NV4.

The possibility of vibration from controlled tunnelling and other excavation methods associated with the dive structure and cross passage development is low. The vibration levels would comply with EPR NV9.

The risk of damage to buildings along the alignment, including the Heide Museum of Modern Art, Banyule House and Clarendon Eyre, is identified as low.

8.7 Vibration-related damage to services

The assessment has considered the potential for the construction activities to induce elevated levels of vibration to adjacent services, thereby affecting their usability and continued supply of service.

Telecommunications, water, sewerage, power and gas services exist along the entire alignment of the tunnels, generally serving the residential and commercial premises. The available GIS, DBYD or asset supplied data bases has not identified any sensitive exchanges or reservoirs within 100 metres of the alignment. The proximity of other residential properties and the stringent requirements of EPR NV9 that would apply to these properties is considered sufficient to ensure the integrity of these services is maintained. The modelling results presented in Appendices C and E indicate that levels of vibration at the identified services would not exceed 2 mm/s.

The risk of damage to services along the alignment is identified as low. Compliance with EPR NV5 would be achieved.

8.8 Drilling and blasting

The geological rock mass conditions along the alignment of the tunnels have indicated the material can be excavated using mechanical methods such as TBM, road headers, excavators or hydraulic hammers. Drilling and blasting could be undertaken by the contractor as an alternative to the mechanical equipment in sections where the competency of the rock mass suggests the rate of progress would be reduced to unacceptable values, or the analyses identifies the impact on amenity to sensitive receptors would reduce through the alternative non-mechanical method (risks TV18 and TV19).

EPRs specifically addressing the impacts of blasting on amenity have been developed to manage the instances when blasting could occur. The conditions are referred to as EPR NV11 and EPR NV12 for blasting vibration and overpressure respectively. The elimination of damage to adjacent underground services and infrastructure will be addressed through EPR NV5 and EPR NV9 respectively.

8.9 Mitigation options

In locations where guideline values cannot be met and alternative construction equipment is not feasible, other measurements should be considered as detailed within a CEMP (EPR NV4), including:

- Adjusting the scale of the construction equipment to control the level of vibration and regenerated noise at properties close to the works

- Real time monitoring of the level of vibration and regenerated noise to assess whether the activity complies with the EPRs
- Comparing the measured level of vibration and regenerated noise with the predicted value to determine whether there should be any reassessment of future impacts and proposed mitigation measures
- Vibration isolation devices for specific equipment or isolated areas
- Rectification or strengthening of existing infrastructure to permit an elevated level of vibration or the use of alternative construction methods
- Assessment of underground services with other techniques (CCTV) to confirm the possible impact of activities should the level of vibration exceed the guideline value
- Community consultation.

In areas where the above amelioration measures are inappropriate or cannot reduce vibration levels to acceptable values, other measures such as temporary relocation may be required.

For buried assets (such as pipelines, cables, fibre optic), possible mitigation strategies could include strengthening/relining, replacement or relocation.

8.10 Building condition surveys

The purpose of a condition survey is to provide an indicative representation of the condition of infrastructure before any construction activities. The condition survey protects the property owner against inappropriate construction activities as well as protecting the contractor against inappropriate claims. A condition survey addresses the risk that residential or commercial buildings or other infrastructure such as retaining walls, abutments and piers could be structurally unsound and damaged by the level of vibration from the construction activities (risks TV14 and TV15).

The extent of the condition surveys (that is, the distance the surveys are completed from the works) should be determined according to the type of equipment that would be used. It could either be determined according to a set distance from the works or according to the expected level of vibration, generally a percentage of the applicable minimum performance criteria. The condition surveys should be undertaken by an appropriately qualified person. Building condition surveys would be communicated to the property owners.

The guideline values for building protection (EPR NV9) would be applied to all buildings and all construction activities with the objective that compliance with these levels virtually ensures the project would be safely completed without superficial or structural damage to adjacent properties. Should a condition survey of a building identify the structure is unsound, a detailed investigation would be completed and an alternative vibration level determined, or the faulty building elements rectified.

All appropriate information, including the data from the condition surveys of buildings, their proximity to the works area and the expected level of vibration would be considered in the assessment.

The risk of damage to buildings along the alignment of the tunnels is identified as low.

8.11 Alternative design options

Although the reference project for North East Link has largely been finalised, there are currently two design options being considered for the arrangement of the Manningham Road interchange, and two locations for the launch of the tunnel boring machine (TBM) being considered. For information on the design options, refer to EES Chapter 8 – Project description.

This section explains how the potential impacts associated with the alternative design options would differ from the impacts associated with the project design assessed in Section 8.1 to Section 8.10 above.

8.11.1 Northern tunnel boring machine (TBM) launch

The potential tunnel vibration and regenerated noise impacts of the alternative TBM launch site have been reviewed.

For a given diameter TBM, vibration effects for the project are assessed based upon the separation distance to the vibration source. Analyses for other tunnelling projects have shown while there may be some anomalies with respect to the attenuation of vibration in different directions around the vibration source, there is no discernible differences relating to whether vibration levels are measured fore or aft of the cutter head. In this regard, the direction of travel of the TBM has no impact upon the predicted levels of vibration.

Within Banksia Park, north of Bridge Street, two shafts approximately 25 metres wide x 50 metres long would be excavated to remove the TBMs after they have completed their respective drives. The TBM retrieval shafts would be excavated from surface. A total of approximately 90,000 m^3 of spoil would be excavated and removed from this location.

The method of excavation is expected to involve removal of the softer material using excavators in conjunction with small to moderate size excavators (up to 35 tonnes) fitted with a hydraulic hammer for any harder more competent material. The hammer size is proposed to be small and is not expected to exceed 1 tonne, or the equivalent of a Caterpillar H115 unit.

The level of vibration and regenerated noise has been modelled based upon the two retrieval shaft locations. The modelling considers that excavation over the entire shaft would necessitate the use of a H115 hydraulic hammer and is therefore considered a worst-case scenario. Where areas of the shaft can be developed without the use of a hydraulic hammer, the impacts would be less than the modelled results. The results are presented as a series of vibration and regenerated noise contours that show the maximum expected levels.

The level of vibration and regenerated noise from the TBM retrieval shaft for the northbound traffic tunnel at Banksia Park are given in Figures 1 and 2 of Appendix H. The results show the nearest sensitive receiver on the northern side of Bridge Street would not receive perceptible levels of vibration or audible regenerated noise from the excavation of the retrieval shaft.

The levels of vibration and regenerated noise from the TBM retrieval shaft for the southbound traffic tunnel would be marginally higher at the closest receiver because of the reduced separation distance, however the levels are low and less than 0.5 mm/s and 45 dBA. The results are shown in Figures 3 and 4 of Appendix H. The values shown in both plates are expected only if excavation with a hydraulic hammer is required. If the material can be removed without the use of a hydraulic hammer, the level of vibration as well as the regenerated noise would be lower and imperceptible to adjacent occupants.

The modelling has addressed the excavation of the shaft with potentially competent rock extending from the surface. The assessment presented in Appendix H is therefore applicable irrespective of whether the slightly deeper tunnel alignment is adopted. The modelled levels of vibration and regenerated noise would be highest in the upper sections of shaft because of the reduced separation distance.

The modelling confirms the excavation of both retrieval shafts can be completed within the EPR specified permissible levels for vibration and regenerated noise. The EPRs address building damage and amenity.

9. Environmental Performance Requirements

Table 9-1 below lists the recommended Environmental Performance Requirements relevant to tunnel vibration assessment.

Table 9-1 Environmental Performance Requirements

<table>
<tr><th>EPR ID</th><th>Environmental Performance Requirement</th></tr>
<tr><td>NV3</td><td>
Minimise construction noise impacts to sensitive receptors
Construction noise and vibration must be managed in accordance with the Construction Noise and Vibration Management Plan (CNVMP) required by EPR NV4.
<u>Non-residential sensitive receptors</u>
For sensitive land uses (based on AS/NZS 2107:2016) implement management actions as per EPR NV4 if construction noise is predicted to or does exceed the internal and external noise levels below, and a noise sensitive receptor is adversely impacted. If construction exceeds the noise levels below:

Consider the duration of construction noise
Consider the existing ambient noise levels
Consult with the owner or operator of the noise sensitive receptor
Consider any specific acoustic requirements of land uses listed below to determine whether a noise sensitive receptor is adversely impacted.

<table>
<tr><th>Land use</th><th>Construction noise management level, $L_{Aeq\ (15\ minute)}$ applies when properties are in use)</th></tr>
<tr><td>Classrooms in schools and other educational institutions</td><td>Internal noise level 45 dB(A)</td></tr>
<tr><td>Hospital wards and operating theatres</td><td>Internal noise level 45 dB(A)</td></tr>
<tr><td>Places of worship</td><td>Internal noise level 45 dB(A)</td></tr>
<tr><td>Active recreation areas characterised by sporting activities and activities which generate their own noise, making them less sensitive to external noise intrusion</td><td>External noise level 65 dB(A)</td></tr>
<tr><td>Passive recreation areas characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example reading, meditation</td><td>External noise level 60 dB(A)</td></tr>
<tr><td>Community centres</td><td>Depends on the intended use of the centre. Refer to the recommended maximum internal levels in AS/NZS 2107:2016 for specific uses</td></tr>
<tr><td>Industrial premises</td><td>External noise level 75 dB(A)</td></tr>
<tr><td>Offices, retail outlets</td><td>External noise level 70 dB(A)</td></tr>
<tr><td>Other noise sensitive land uses as identified in AS/NZS 2107:2016</td><td>Refer to the noise levels in AS/NZS 2107:2016</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>EPR ID</th><th>Environmental Performance Requirement</th></tr>
<tr><td></td><td>
<u>Residential receptors</u>
For residential dwellings, management actions must be implemented as per EPR NV4 if noise from construction works during normal working hours is predicted to or does exceed the noise management levels for normal working hours below.
Noise from construction works during weekend/evening work hours and the night period must meet the weekend/evening and night period noise guideline targets in the table below unless they are Unavoidable Works.
<table>
<tr><th>Time of day</th><th>Construction noise guideline targets</th></tr>
<tr><td>Normal working hours:
7 am – 6 pm Monday to Friday
7 am – 1 pm Saturday</td><td>Noise affected: Background L_{A90}+10 dB
Highly noise affected: 75 dB(A)
Source: NSW Interim Construction Noise Guideline (ICNG) Chapter 4.1.1 Table 2.
The noise affected level represents the point above which there may be some community reaction to noise. The highly noise affected level represents the point above which there may be strong community reaction to noise.</td></tr>
<tr><td>Weekend/evening work hours:
6 pm – 10 pm Monday to Friday
1 pm – 10 pm Saturday
7 am – 10 pm Sunday and public holidays</td><td>Noise level at any residential premises not to exceed background noise (L_{A90}) by:
• 10 dB(A) or more for up to 18 months
• 5 dB(A) or more after 18 months
Source: EPA Publication 1254 Section 2</td></tr>
<tr><td>Night period:
10 pm – 7 am Monday to Sunday</td><td>Noise inaudible within a habitable room of any residential premises
Source: EPA Publication 1254 Section 2 and EPA Publication 480 Section 5</td></tr>
</table>
Note
Where any reference is made to the rating background level (RBL) or background L_{A90}; the ‘average background’ over the assessment period as per Victorian noise policy practices is to be used.
This applies to all receptors and all time periods.
Unavoidable Works may include:
• The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
• Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
• Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
• Tunnelling works including mined excavation elements and the activities that are required to support tunnelling works (ie spoil treatment facilities)
• Road and rail occupations or works that would cause a major traffic hazard
• Other works where a contractor demonstrates and justifies a need to operate outside normal working hours and exceed the noise guideline targets such as work that once started cannot practically be stopped.
</td></tr>
</table>

EPR ID	*Environmental Performance Requirement*
NV4	**Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts** Prepare, implement and maintain a Construction Noise and Vibration Management Plan (CNVMP) in consultation with EPA Victoria and relevant councils. The CNVMP must comply with and address the Noise and Vibration EPRs, be informed by the noise modelling and monitoring results and must include (but not be limited to): • Identification of noise and vibration sensitive receptors along the project alignment, including habitat for listed threatened fauna, likely to be impacted by the project • Construction noise and vibration targets as per EPRs NV3, NV5, NV8, NV9, NV10, NV11 and NV12, including any details of conversions between alternative metrics • Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities that have the potential to generate airborne noise and/or surface vibration impacts on surrounding sensitive receivers • How construction noise (including truck haulage) and vibration would be minimised (see EPR T2) • A requirement for preliminary tests using the actual equipment to validate modelling for vibration and regenerated noise and review, with predictions to be remodelled as necessary and confirm prevention/mitigation/remediation measures confirmed • Management actions and notification and mitigation measures to be implemented with reference to the Appendix B and Appendix C of the New South Wales Roads and Maritime Services Construction Noise and Vibration Guideline 2016 (CNVG) • Any processes and measures to be implemented as part of the Communications and Community Engagement Plan including measures concerning complaints management (see EPR SC2) • Requirements to assess and manage vibration impacts to scientific or medical establishments to the higher of ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook), or manufacturers equipment levels (unless by agreement with occupant) • Measures to ensure effective monitoring of noise and vibration associated with construction with consideration to the construction noise and vibration targets • Measures to minimise noise and vibration impacts from temporary traffic diversions and altered access to parking facilities • The Unavoidable Works that would be undertaken, including their location, timing and duration. The CNVMP must either include a clear rationale for defining works or a list of the type of planned works that constitute Unavoidable Works and response strategies to mitigate the impacts of these Unavoidable Works, with reference to EPA Victoria Publication 1254 Noise Control Guidelines and Appendix B and Appendix C of the CNVG. The Independent Environmental Auditor must verify that the proposed Unavoidable Works meet the definition of Unavoidable Works for each instance they are undertaken. Details of Unavoidable Works must be made publicly available. For emergency Unavoidable Work, a rationale must be provided to the satisfaction of the Independent Environmental Auditor as soon as practicable.

EPR ID	*Environmental Performance Requirement*
NV5	**Establish vibration guidelines to protect utility assets** Prior to construction undertake condition assessments of above and below ground utility assets (EPR GM3) and consult with asset owners to establish and agree construction vibration guidelines to maintain asset integrity. In all cases the asset owner's criteria takes precedence. Where construction vibration guidelines are not proposed by the asset owner, reference should be made to the relevant sections of German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (2016) for guideline assessment procedures for buried pipework or underground infrastructure. The integrity of the asset should be reviewed and assessed (by the contractor, in conjunction with the asset owner) to confirm these values are appropriate. If necessary, based on this assessment, limits must be reduced to the level necessary to maintain asset integrity. Monitor vibration levels during construction to demonstrate compliance with agreed vibration guidelines. Identify contingency measures to be implemented if guidelines are not met. Where necessary rectify any defects that are attributable to the project. An overview of the key vibration guidelines values is presented below. In all cases, the supporting documentation within the Standard which describes, clarifies and sometimes modifies the tables below should be considered.

Table 2 Guideline values for vi, max, for evaluating the effects of short-term vibration on the lining of underground cavities

Line	*Lining material*	*Guideline values for vi, max, in mm/s perpendicular to lining surface*
1	Reinforced or sprayed concrete, tubbing segments	80
2	Concrete, stone	60
3	masonry	40
NOTE The guideline values were measured during nearby mine blasting operations and apply only to the lining of underground structures, but not to any associated installations.		

Table 3 Guideline values for vi, max, for evaluating the effects of short-term vibration on buried pipework

Line	*Pipe material*	*Guideline values for vi, max, in mm/s at pipe*
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

EPR ID	*Environmental Performance Requirement*
NV8	**Minimise construction vibration impacts on amenity**

Implement management actions if the following guideline target levels for continuous vibration from construction activity to protect human comfort of occupied buildings (including heritage buildings) are not achieved (levels are calculated from the British Standard BS6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting).

Type of space occupancy	*Vibration Dose Values (m/s1.75)*			
	Day (7am to 10pm)		*Night (10pm to 7am)*	
	Preferred Value	*Maximum Value*	*Preferred Value*	*Maximum Value*
Residential	0.2	0.4	0.1	0.2
Offices, schools, educational institutions, places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Notes

1. The Guideline Targets are non-mandatory; they are goals that should be sought to be achieved through the application of practicable mitigation measures. If exceeded then management actions would be required
2. The Vibration Dose Values may be converted to Peak Particle Velocities within a noise and vibration construction management plan.

EPR ID	*Environmental Performance Requirement*
NV9	**Manage construction vibration impacts on structures** Construction vibration targets for structures based on German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (2016) must be adopted. All sections of the German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (2016) standard apply, noting the guideline levels detailed in Section 5 and Section 6 (and any references sections). An overview of the key vibration guidelines values is presented below. In all cases, the supporting documentation within the Standard which describes, clarifies and sometimes modifies the tables below should be considered.

Table 1 Guideline values for vibration velocity, vi, max, for evaluating the effects of short-term vibration on structures

		Guideline values for vi, max in mm/s				
		Foundation, all directions, i = x, y, z, at a frequency of			*Topmost floor, horizontal direction, i = x, y*	*Floor slabs, vertical direction, i = z*
	Type of structure	*1 Hz to 10 Hz*	*10 Hz to 50 Hz*	*50 Hz to 100 Hz a*	*All frequencies*	*All frequencies*
Column Line	1	2	3	4	5	6
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20 b

Notes

Even if guideline values as in line 1, columns 2 to 5, are complied with, minor damage cannot be excluded.

1. At frequencies above 100 Hz, the guideline values for 100 Hz can be applied as minimum values.
2. Paragraph 2 of 5.1.2 shall be observed.

EPR ID	*Environmental Performance Requirement*

Table 4 Guideline values for vi, max, for evaluating the effects of long-term vibration on buildings

	Type of building	*Guideline values for velocity (mm/s) Vibration at horizontal plane of highest floor – All frequencies*	
		Topmost floor, horizontal direction, all frequencies	*Floor slab, vertical direction, all frequencies*
Column Line	1	2	3
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	10	10
2	Residential buildings and buildings of similar design and/or occupancy	5	10
3	Structures that, because of their particular sensitivity to vibration cannot be classified under lines 1 and 2 and are of intrinsic value (eg listed buildings)	2.5	10 a

Note

Even if guideline values as in line 1, column 2, are complied with, minor damage cannot be ruled out.

1. Section 6.1.2 shall be observed.

NV10

Minimise impacts from ground-borne (internal) noise

Implement management actions in consultation with potentially affected land owners to protect amenity at residences where the following ground borne noise guideline targets based on Section 4.2 of the New South Wales Interim Construction Noise Guidelines are exceeded during construction.

Time of Day	*Internal noise level measured at the centre of the most affected habitable room*
Evening (6 pm to 10 pm)	$L_{Aeq(15 minute)}$ = 40 dBA
Night (10 pm to 6 am)	$L^{Aeq(15 minute)}$ = 35 dBA

Notes

1. Levels are only applicable when ground borne noise levels are higher than airborne noise levels.
2. Management actions include community consultation to determine acceptable level of disruption and provision of respite accommodation in some circumstances.

<table>
<tr><th>EPR ID</th><th>Environmental Performance Requirement</th></tr>
<tr><td>NV11</td><td>
Minimise amenity impacts from blast vibration
Implement management actions if the following vibration values are not achieved. Blasting activities must comply with Australian Standard AS2187.2-2006, Explosives – Storage and use Part 2 – Use of explosives for all blasting.
<table>
<tr><th>Category (as defined in AS 2187.2-2006)</th><th>Type of blasting operations</th><th>Peak component particle velocity (mm/s)</th></tr>
<tr><td>Sensitive site</td><td>More than 20 blasts</td><td>5 mm/s for 95% blasts per year
10 mm/s maximum (unless by agreement with occupier)</td></tr>
<tr><td>Sensitive site</td><td>Less than 20 blasts</td><td>10 mm/s maximum (unless by agreement with occupier)</td></tr>
<tr><td>Non-sensitive site (with occupants)</td><td>All blasting</td><td>25 mm/s maximum value (unless by agreement with occupier).</td></tr>
<tr><td>Scientific equipment</td><td>All blasting</td><td>Existing ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook) (whichever is the higher) or manufacturers equipment levels (unless by agreement with occupier)</td></tr>
</table>
</td></tr>
<tr><td>NV12</td><td>
Minimise amenity impacts from blast overpressure
Implement management actions if the following overpressure values are not achieved. Blasting activities must comply with Australian Standard AS2187.2-2006, Explosives – Storage and use Part 2 – Use of explosives for all blasting.
<table>
<tr><th>Category (as defined in AS 2187.2-2006)</th><th>Type of blasting operations</th><th>Peak Overpressure Value (dBL)</th></tr>
<tr><td rowspan="2">Sensitive Site</td><td>More than 20 blasts</td><td>115 dBL for 95% blasts
120 dBL maximum (unless by agreement with occupier)</td></tr>
<tr><td>Less than 20 blasts</td><td>120 dBL for 95% blasts
125 dBL maximum (unless by agreement with occupier)</td></tr>
<tr><td>Occupied non-sensitive sites such as factories and commercial premises</td><td>All blasting</td><td>125 dBL maximum (unless by agreement with occupier).
For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturers specification or levels that can be shown to adversely affect the equipment operation</td></tr>
</table>
</td></tr>
</table>

10. Conclusion

The purpose of this report is to provide the tunnel vibration and regenerated noise impact assessment to inform the preparation of the EES required for the project.

A summary of the key assets, values or uses potential affected by the project, and the associated impacts assessment are summarised below.

10.1 Existing conditions

A detailed review of the existing conditions shows the alignment of the tunnels is well positioned with respect to minimising impacts during the project's construction. The portals are located in an area that minimises the number of persons subjected to elevated levels of vibration and regenerated noise. While the construction process necessarily induces some levels of disturbance, these are minimised through the appropriate positioning of the alignment, including the horizontal alignment and depth of the tunnels below the surface. The tunnels would necessarily pass beneath residential and adjacent to some commercial areas, but limited in nearness to heritage infrastructure. The three significant heritage items—Heide Museum, Banyule House and Clarendon Eyre—are a sufficient distance from the tunnel works to remain unaffected.

The existing vibration environment is typical of a residential area and characterised by low vibration values with only occasional elevated vibration that result from localised effects. There are no areas where the project EPRs would likely be exceeded by the existing activities.

A risk assessment defining impact pathways has helped to define the EPRs that would ensure the tunnel construction activities are appropriately administered and controlled. These EPRs are consistent with international guidelines and standards.

10.2 Impact assessment

This assessment confirms the construction of the North East Link tunnels according to the proposed alignment would produce relatively minor, but at some locations perceptible levels of vibration and audible regenerated noise.

Construction techniques that produce lesser effects in terms of vibration and regenerated noise are either not available or commercially feasible. The assessed construction methods are considered to induce the overall minimum disturbance. The impact of any disturbance depends on the proximity of a property to the construction activity. Those properties closer to the alignment would experience higher levels of vibration and/or regenerated noise than those further away.

EPRs are recommended based on appropriate local and international standards that would restrict vibration or regenerated noise to levels that are acceptable to most people. Although the performance requirements would not restrict the amenity affects to imperceptible or inaudible, they are considered to prevent vibration-induced damage to property and other infrastructure. Controlling impacts that relate to personal amenity necessarily limit physical damage to assets. Where amenity concerns are irrelevant, the integrity of structures or services would be enabled through appropriate damage-based criteria.

These short-term perceptible impacts would be managed through a Construction Environment Management Plan (CEMP). Where compliance could not be achieved with the proposed excavation methods, mitigation measures would be used, such as reducing the size of the equipment or changing the operating characteristics, if this is technically viable. Where these measures continue to result in levels of disturbance above the performance requirements, short-term relocation could be considered. The tunnel vibration impacts are summarised in Table 10-1.

Table 10-1 Summary of impacts along tunnel alignment

Asset/value	*Impact*	*EPR*	*Performance requirement*	*Possible mitigation measures*
Residential and commercial properties along alignment	Vibration and regenerated noise	NV4 NV8 NV9 NV10 NV11 NV12	Protect the amenity of residents and other building occupiers Prevent superficial and structural damage to buildings Prevent damage to building contents	Temporary relocation Temporary removal of sensitive items Rectification of structures to permit increased vibration
Telecommunication, drainage, water, sewerage, gas services	Vibration	NV4 NV5	Prevent damage to services and allow continued uninterrupted operation	CCTV survey to asses vulnerability of service Flow monitoring (to mitigate consequences of damage), strengthening/rehabilitation, replacement/relocation of assets
Heritage infrastructure including Heide Museum and Banyule House	Vibration	NV9 NV11 NV12	Prevent superficial and structural damage	Rectification of structures to permit increased vibration

11. References

AS2187.2-2006, 'Australian Standard Explosives Storage and Use of explosives', Australian Standards, SAI Global.

AS2436-2010, 'Guide to noise and vibration control on construction, demolition and maintenance sites', Australian Standards, SAI Global.

BS5528-2:2009, 'Code of practice for noise and vibration control on construction and open sites Part 2: Vibration', British Standard.

BS6472-1:2008, 'Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting', British Standard.

BS7385-2: 1993, 'British Standard Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration'.

DECC 2006 Department of Environment and Conservation for New South Wales (NSW), *Assessing vibration: A technical guideline*.

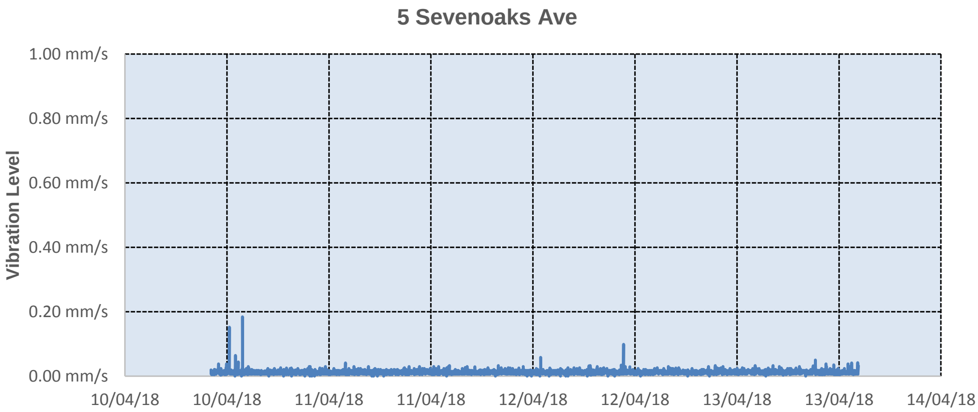
Department of Environment and Climate Change NSW, 1999, *Interim Construction Noise Guideline*.

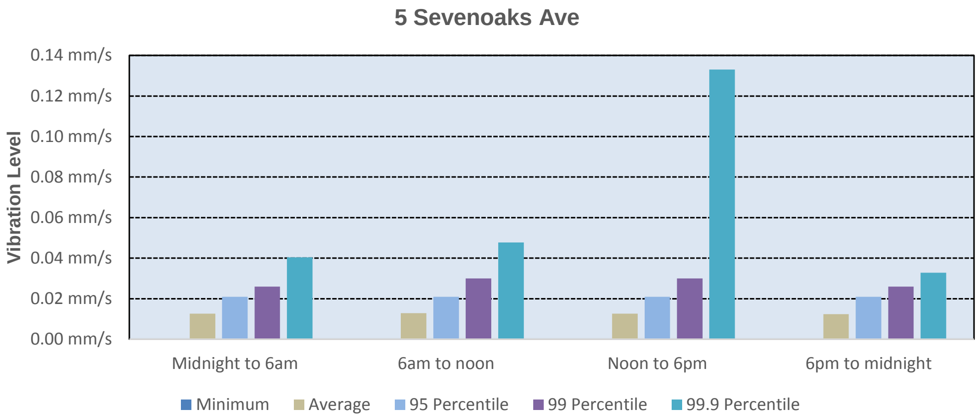
DIN4150-3:1999, 'Structural vibration Part 3: Effect of vibration on structures', German Standards ICS91.120.25.

Appendix A Background vibration assessment

A.1 11 Greensborough Road

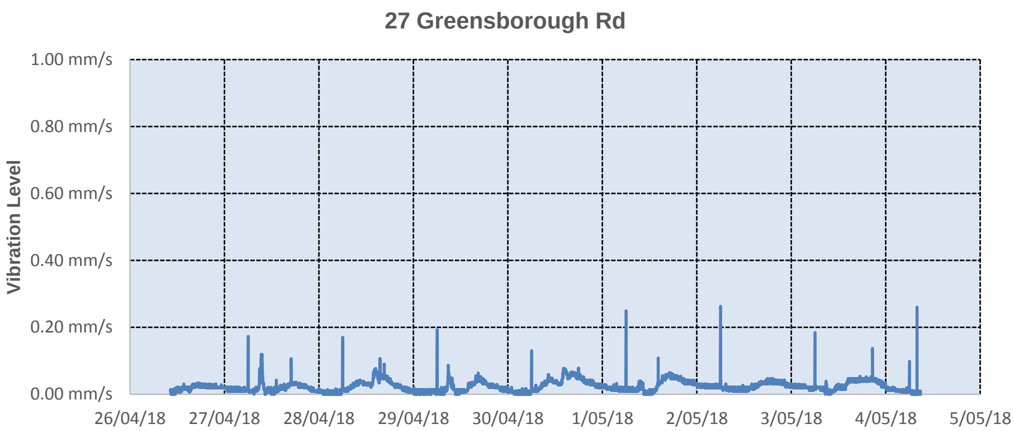
11 Greensborough Road – Existing vibration assessment	
Period of monitoring	11 April 2018 to 18 April 2018
Number of measurements	4569
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.05 mm/s

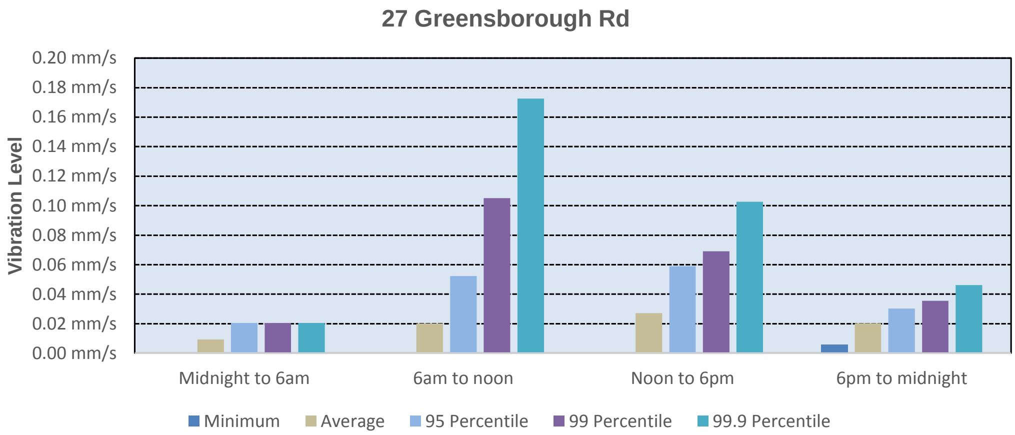




A.1 27 Greensborough Road

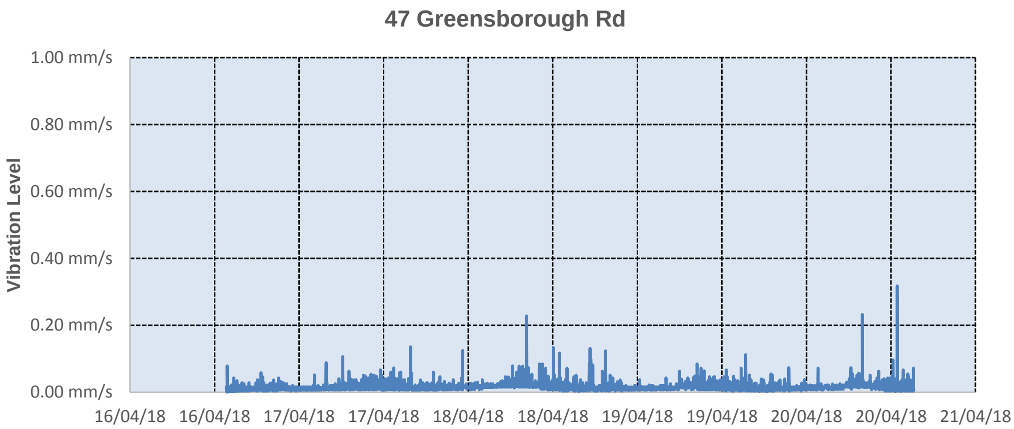
27 Greensborough Road – Existing vibration assessment	
Period of monitoring	26 April 2018 to 4 April 2018
Number of measurements	11427
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.05 mm/s
Level exceeding 99% of measurements	0.07 mm/s
Level exceeding 99.9% of measurements	0.11 mm/s

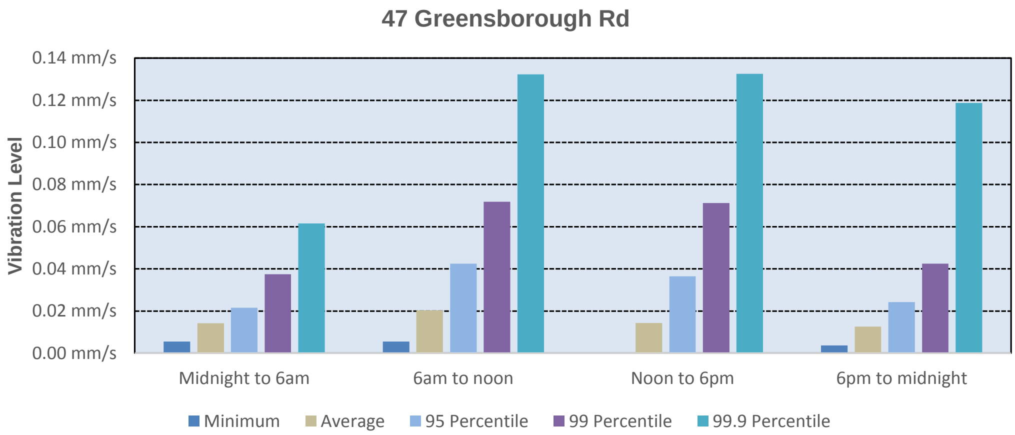




A.2 47 Greensborough Road

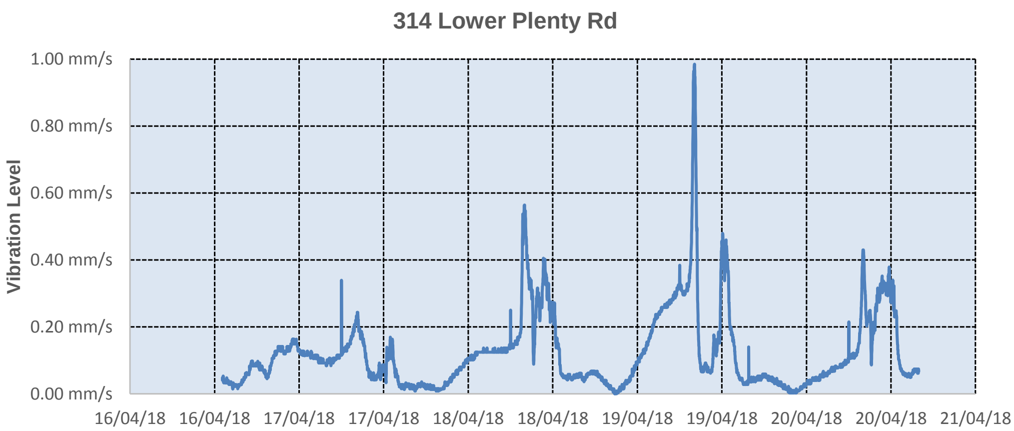
47 Greensborough Road – Existing Vibration Assessment	
Period of Monitoring	16th April, 2018 to 20th April, 2018
Number of Measurements	5858
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.03 mm/s
Level exceeding 99% of measurements	0.06 mm/s
Level exceeding 99.9% of measurements	0.13 mm/s

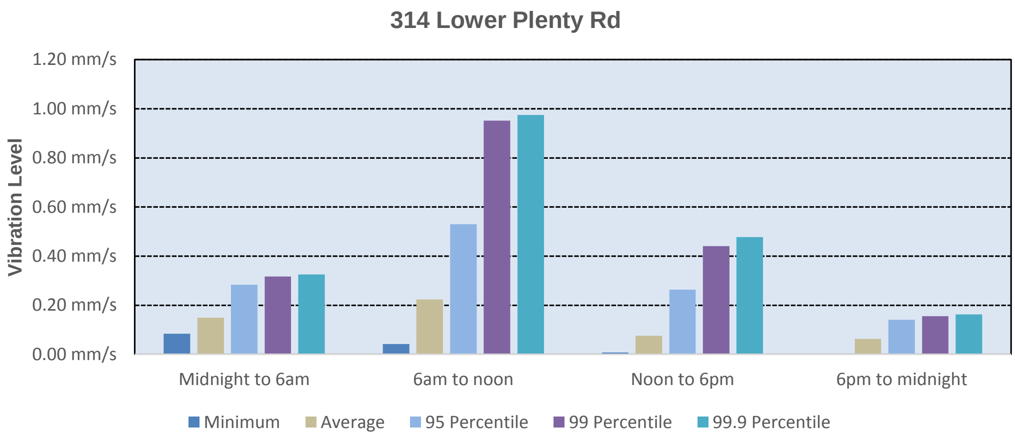




A.3 314 Lower Plenty Road

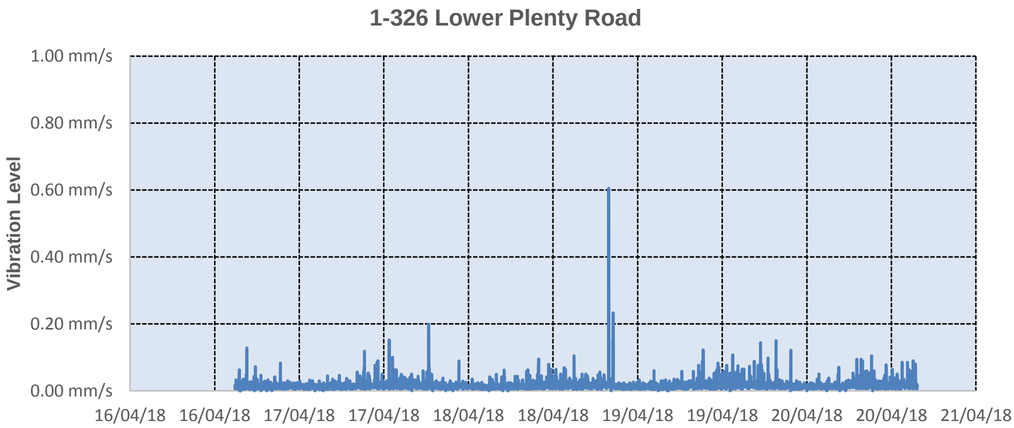
314 Lower Plenty Road – Existing Vibration Assessment	
Period of Monitoring	16th April, 2018 to 20th April, 2018
Number of Measurements	5929
Average level of vibration	0.12 mm/s
Level exceeding 95% of measurements	0.33 mm/s
Level exceeding 99% of measurements	0.51 mm/s
Level exceeding 99.9% of measurements	0.96 mm/s

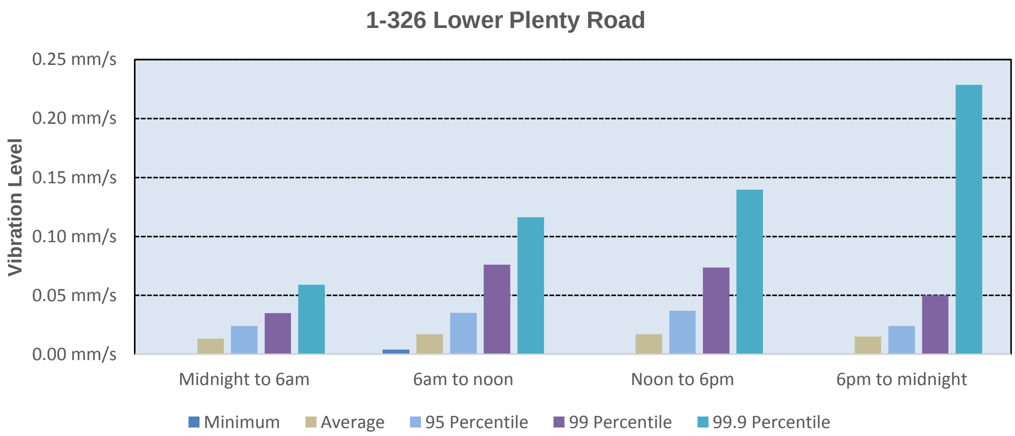




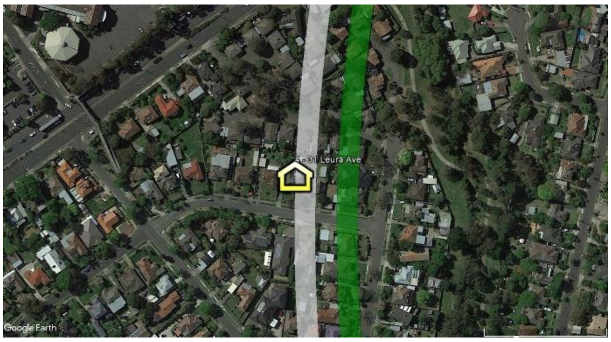
A.4 326 Lower Plenty Road

326 Lower Plenty Road – Existing Vibration Assessment	
Period of Monitoring	16th April, 2018 to 20th April, 2018
Number of Measurements	5807
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.03 mm/s
Level exceeding 99% of measurements	0.06 mm/s
Level exceeding 99.9% of measurements	0.15 mm/s

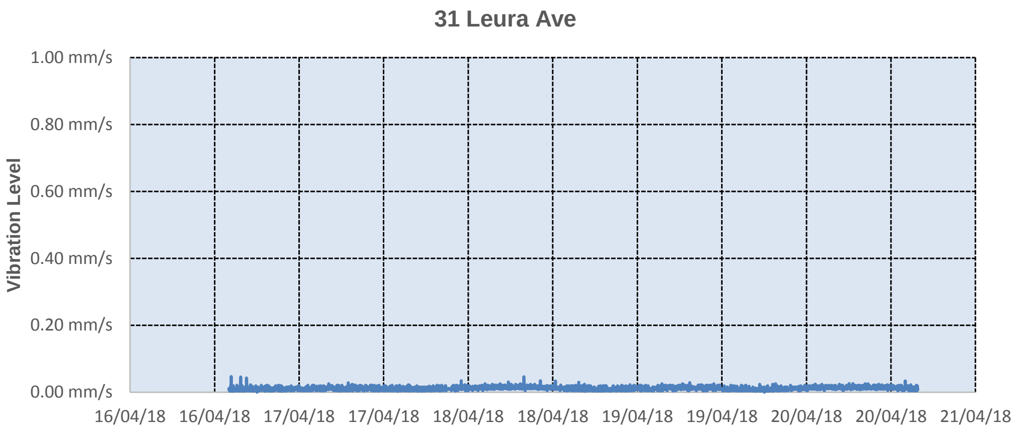


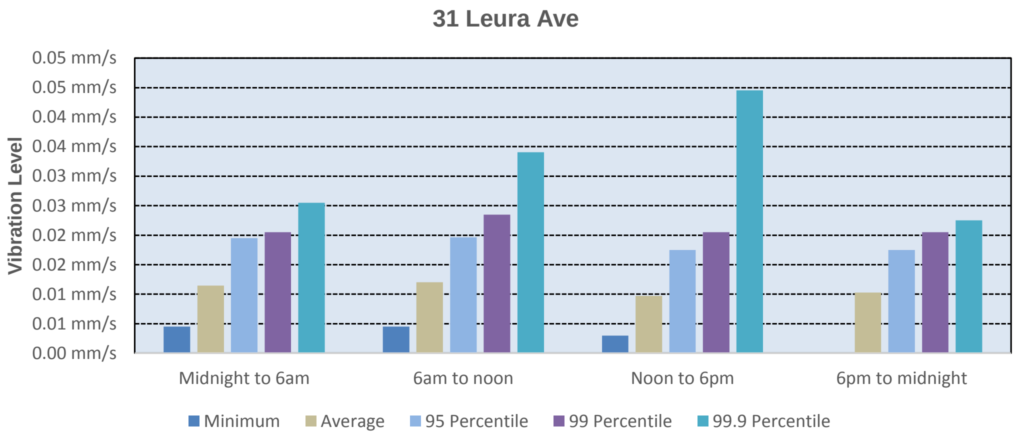


A.5 31 Leura Avenue

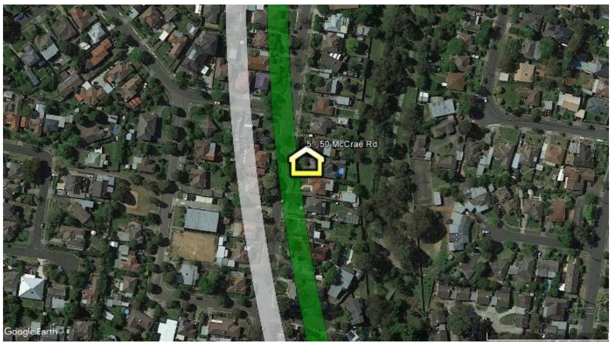


31 Leura Avenue – Existing Vibration Assessment	
Period of Monitoring	16th April, 2018 to 20th April, 2018
Number of Measurements	5866
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.02 mm/s
Level exceeding 99.9% of measurements	0.03 mm/s

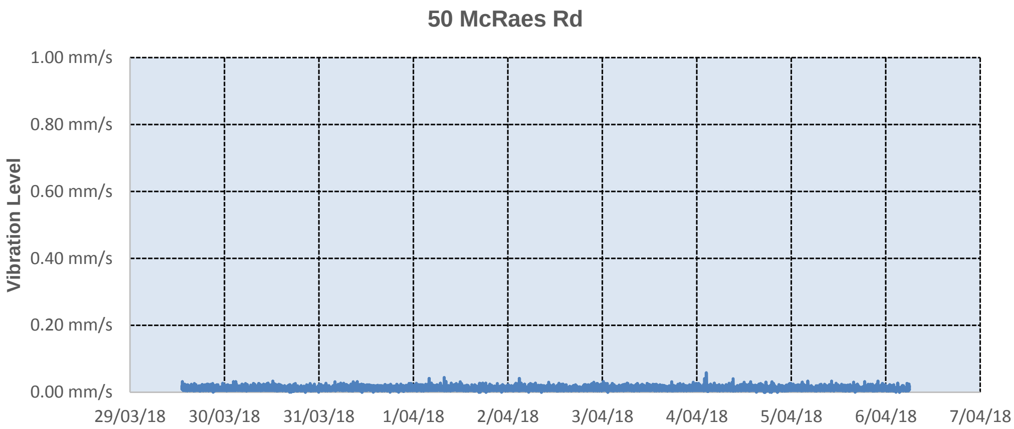


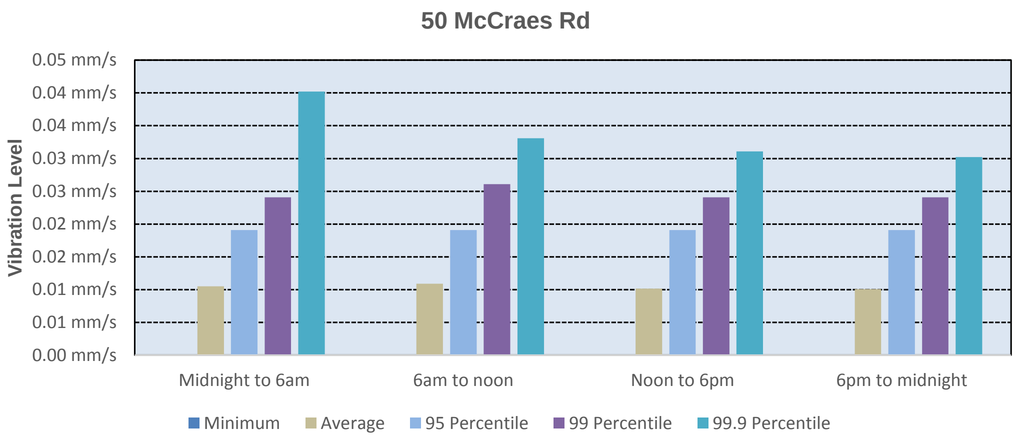


A.6 50 McCraes Road

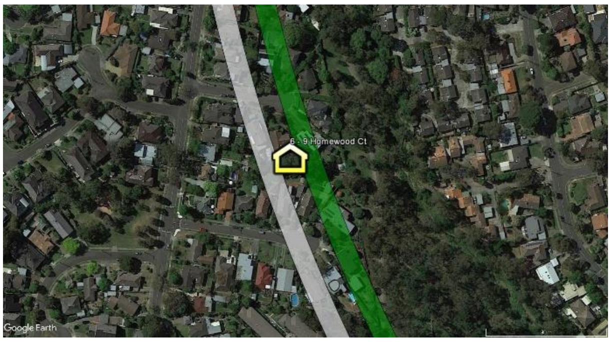


50 McCraes Road – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11094
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.02 mm/s
Level exceeding 99.9% of measurements	0.03 mm/s

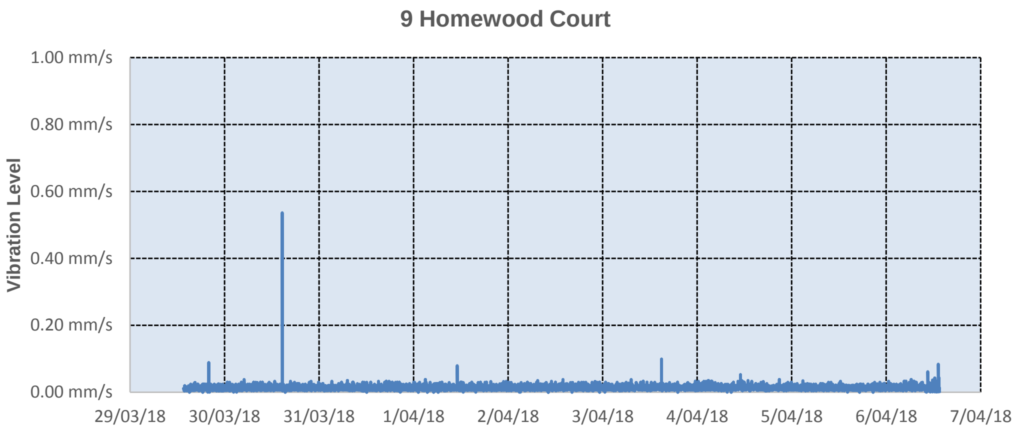


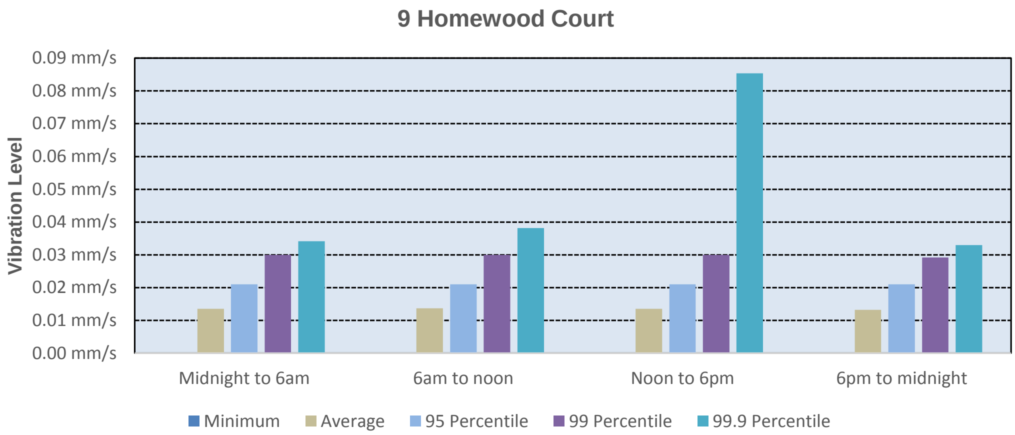


A.7 9 Homewood Court

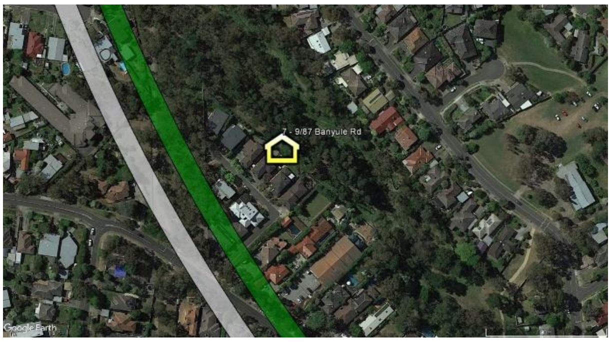


9 Homewood Court – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11631
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.04 mm/s

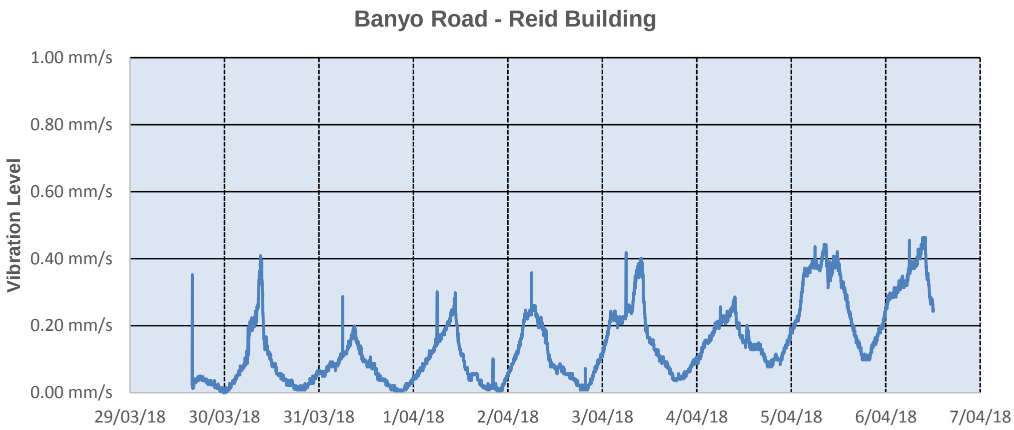


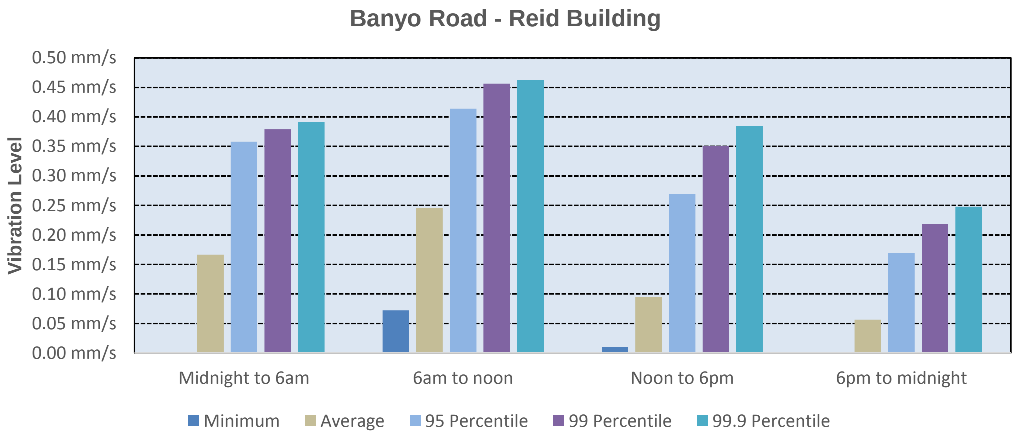


A.8 9.87 Banyule Road

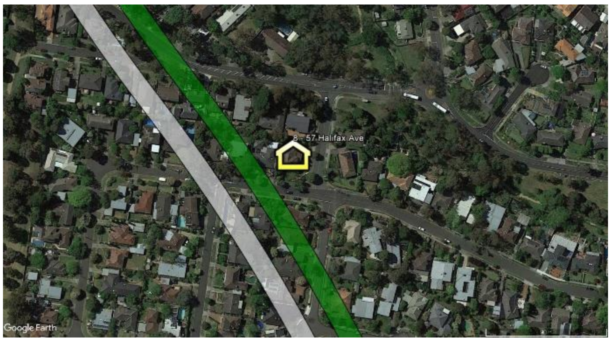


Banyule Road – Reid Building – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11291
Average level of vibration	0.14 mm/s
Level exceeding 95% of measurements	0.37 mm/s
Level exceeding 99% of measurements	0.43 mm/s
Level exceeding 99.9% of measurements	0.46 mm/s

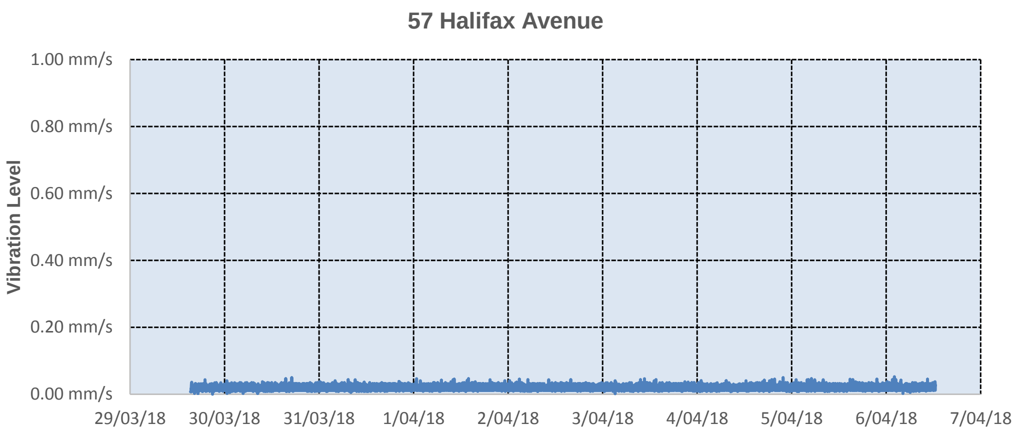


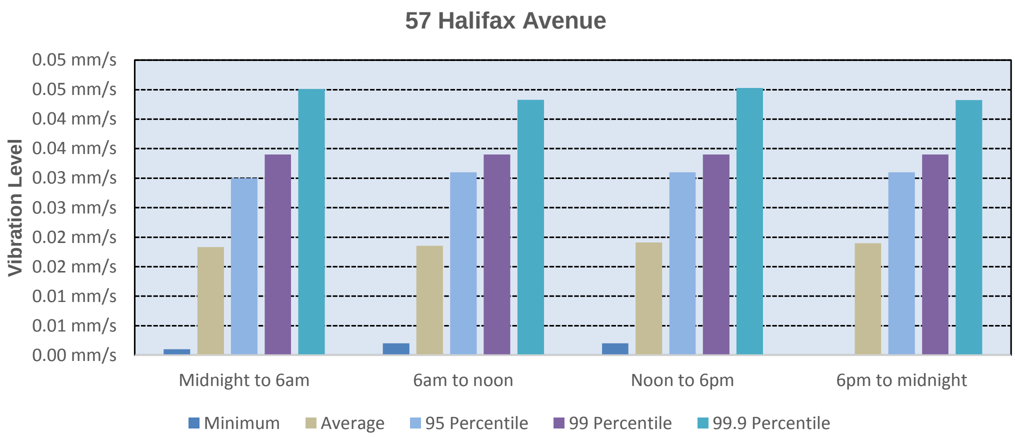


A.9 57 Halifax Avenue

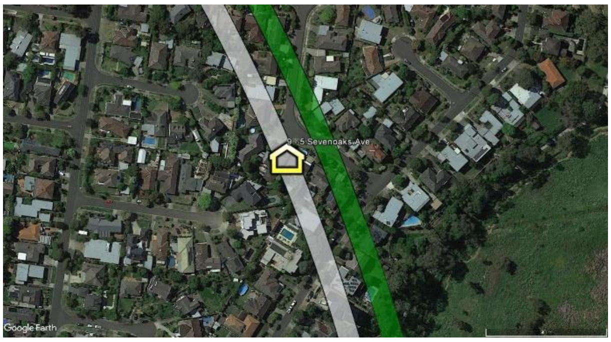


57 Halifax Avenue – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11343
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.03 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.05 mm/s

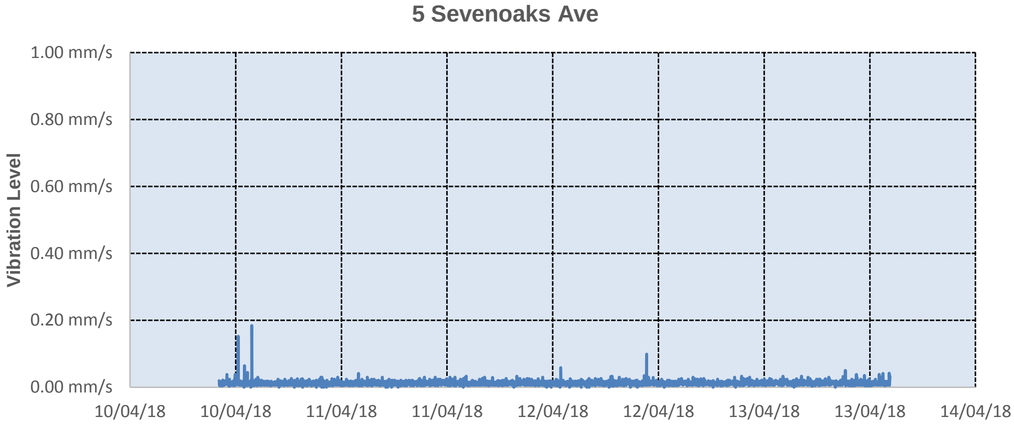


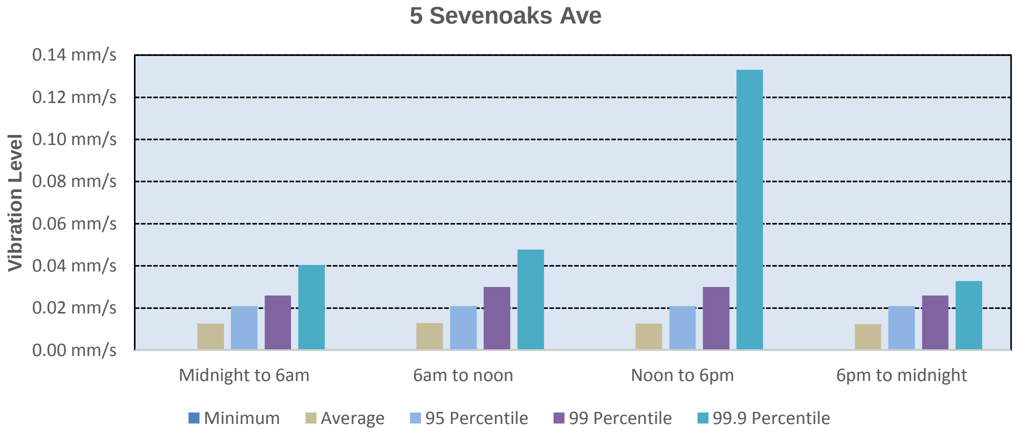


A.10 5 Sevenoaks Avenue



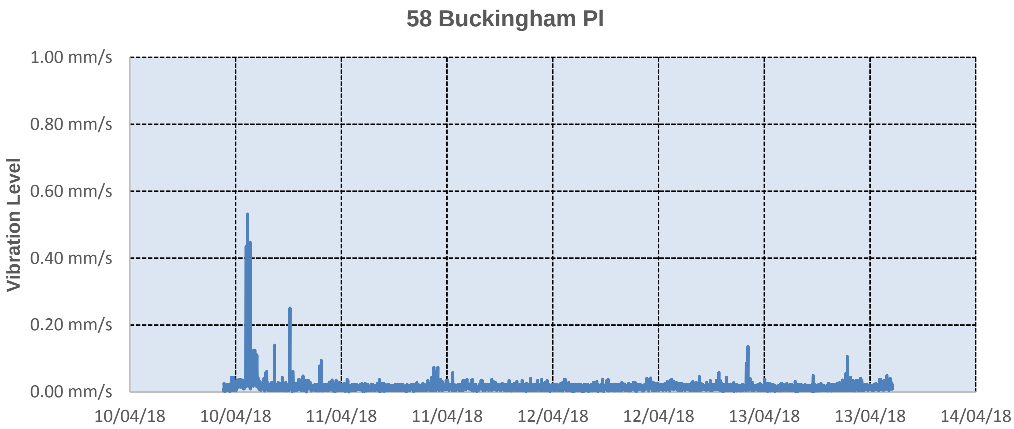
5 Sevenoaks Avenue – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 13th April, 2018
Number of Measurements	4569
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.05 mm/s

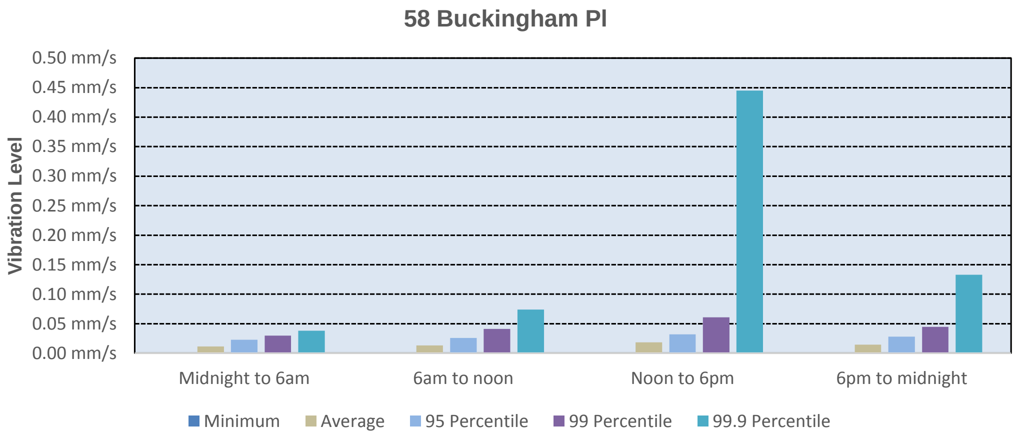




A.11 58 Buckingham Place

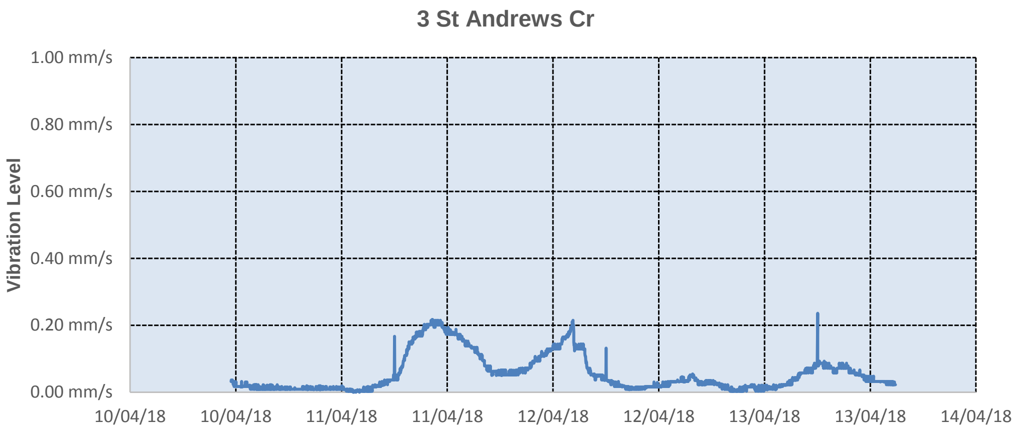
58 Buckingham Place – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 13th April, 2018
Number of Measurements	4555
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.03 mm/s
Level exceeding 99% of measurements	0.04 mm/s
Level exceeding 99.9% of measurements	0.17 mm/s

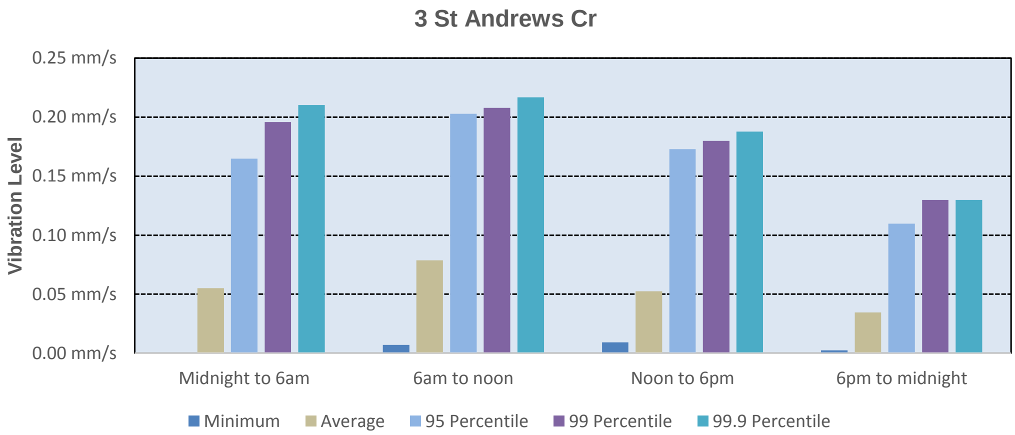




A.12 3 St. Andrews Court

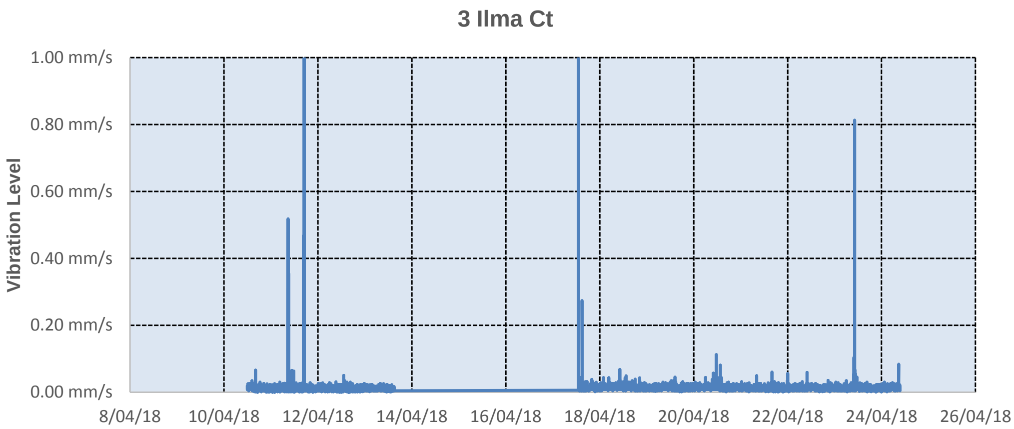
3 St. Andrews Court – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 13th April, 2018
Number of Measurements	4523
Average level of vibration	0.06 mm/s
Level exceeding 95% of measurements	0.18 mm/s
Level exceeding 99% of measurements	0.20 mm/s
Level exceeding 99.9% of measurements	0.21 mm/s

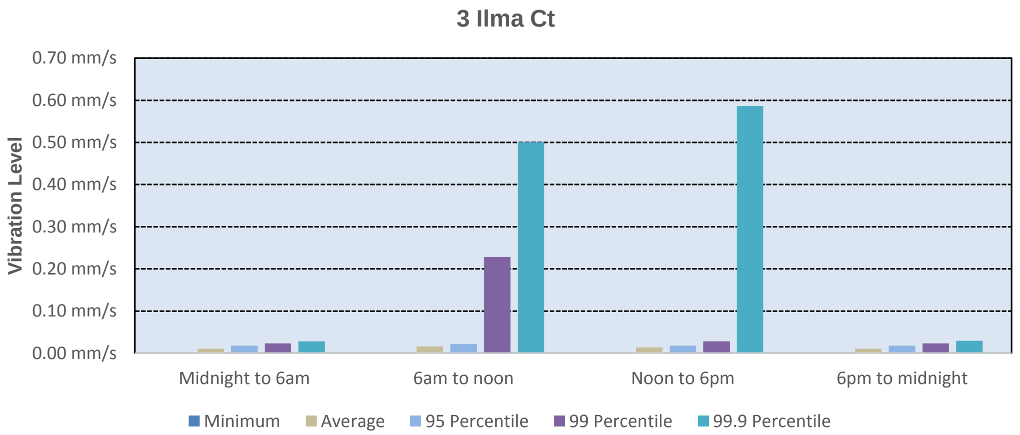




A.13 3 Ilma Court

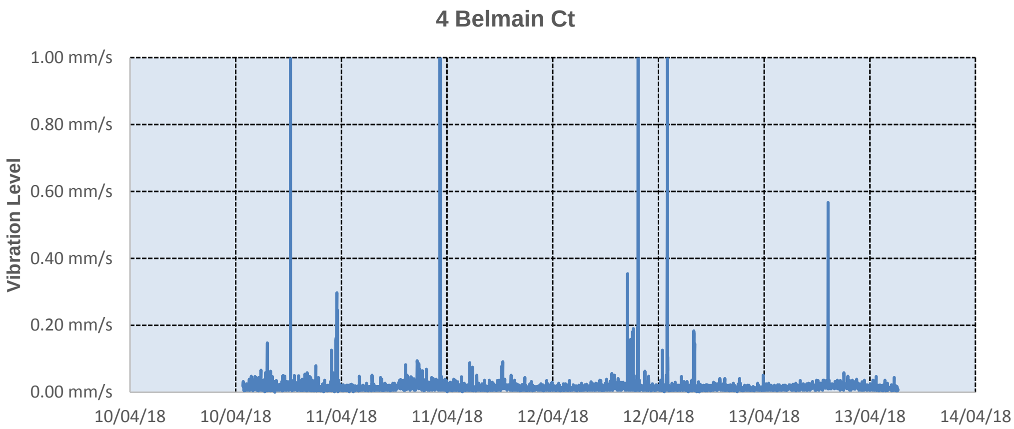
3 Ilma Court – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 24th April, 2018
Number of Measurements	14361
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.29 mm/s

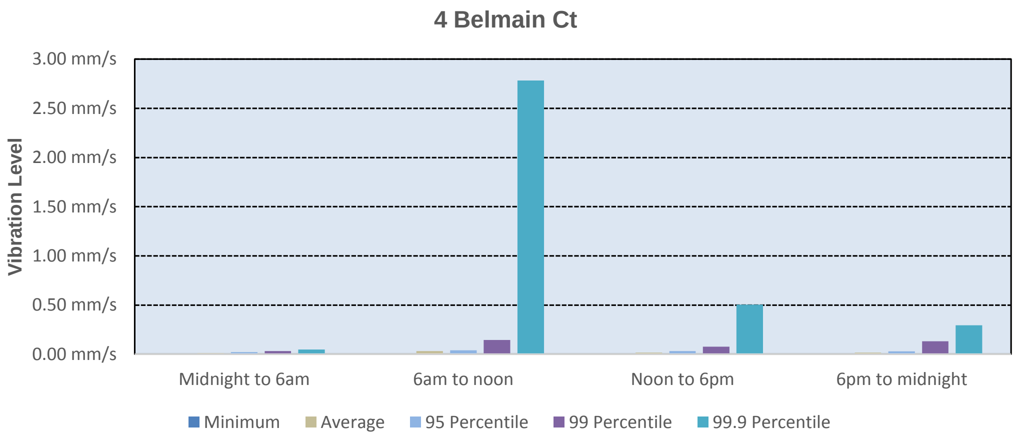




A.14 4 Belmain Court

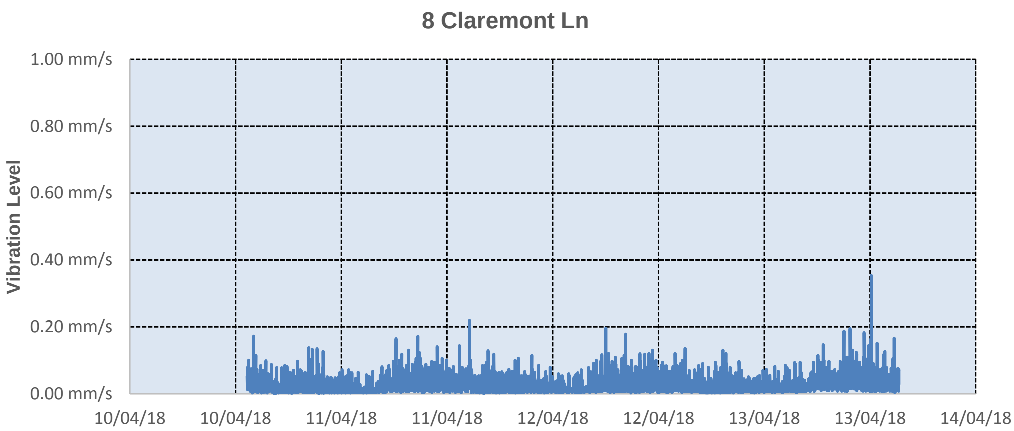
4 Belmain Court – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 13th April, 2018
Number of Measurements	4462
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.03 mm/s
Level exceeding 99% of measurements	0.08 mm/s
Level exceeding 99.9% of measurements	0.58 mm/s

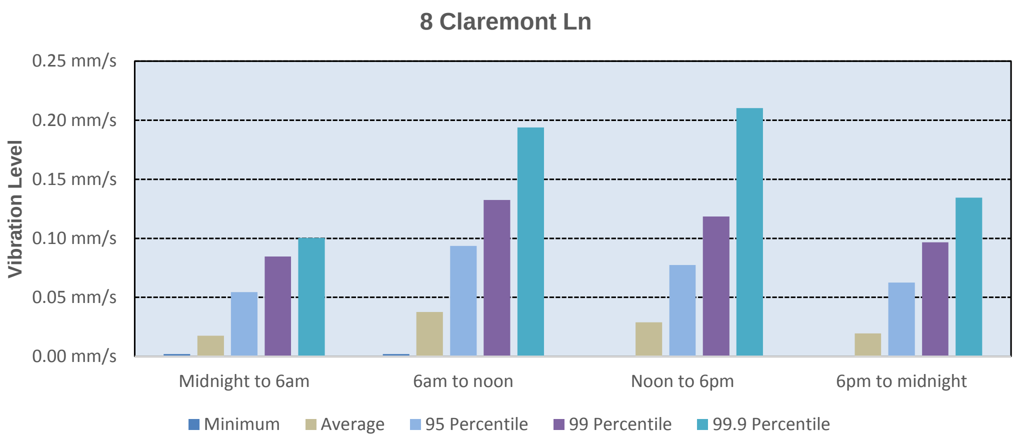




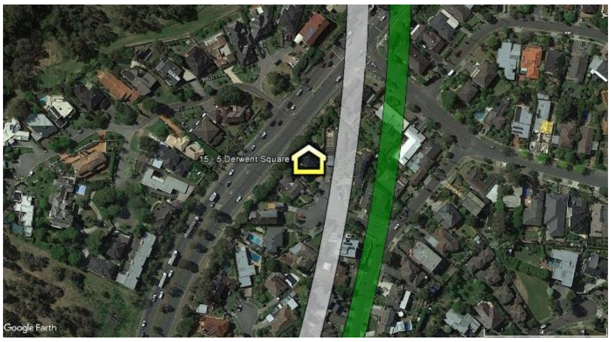
A.15 8 Claremont Lane

11 Greensborough Road – Existing Vibration Assessment	
Period of Monitoring	11th April, 2018 to 18th April, 2018
Number of Measurements	4441
Average level of vibration	0.03 mm/s
Level exceeding 95% of measurements	0.07 mm/s
Level exceeding 99% of measurements	0.11 mm/s
Level exceeding 99.9% of measurements	0.19 mm/s

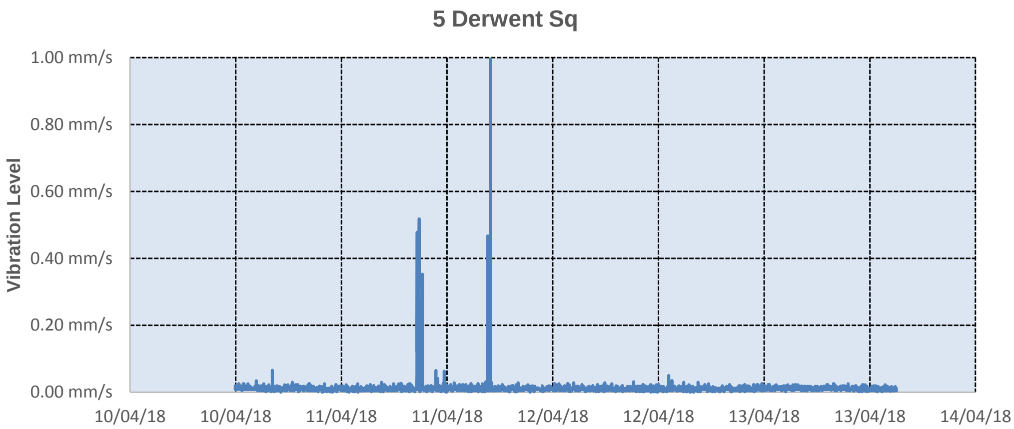


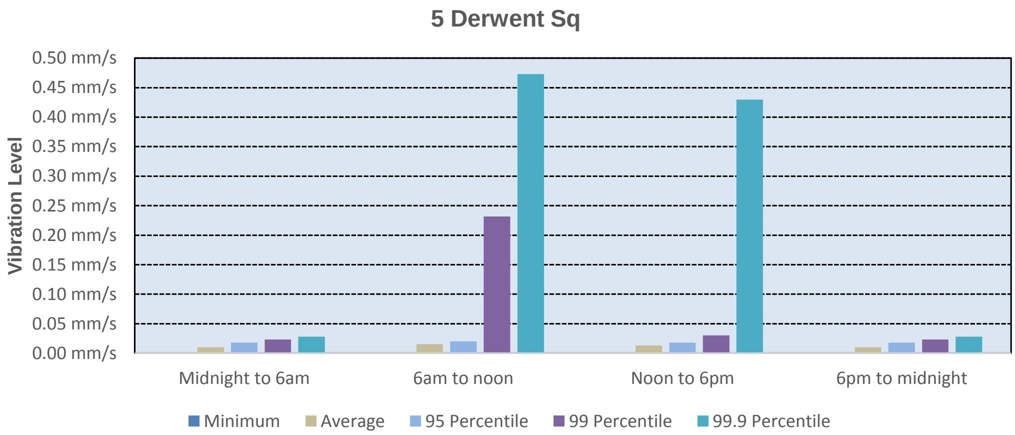


A.16 5 Derwent Square

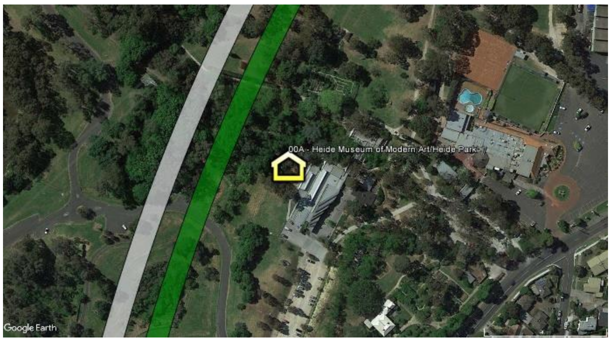


5 Derwent Square – Existing Vibration Assessment	
Period of Monitoring	10th April, 2018 to 13th April, 2018
Number of Measurements	4508
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.39 mm/s

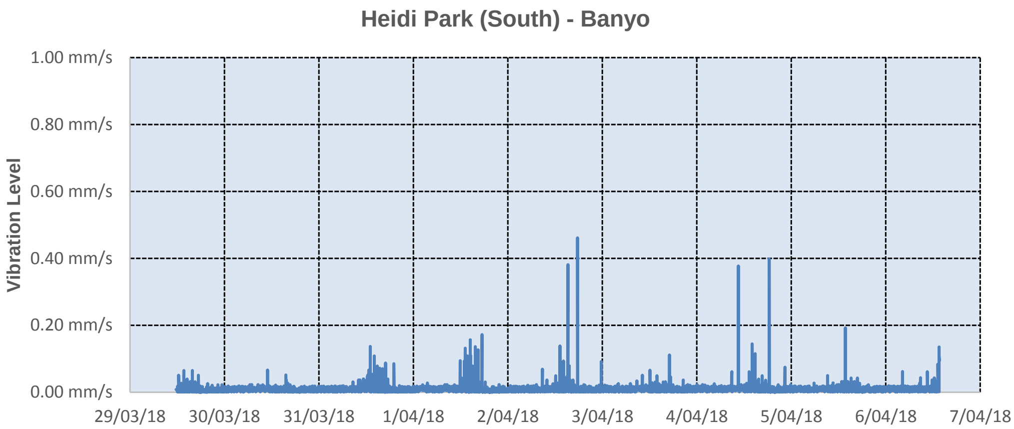


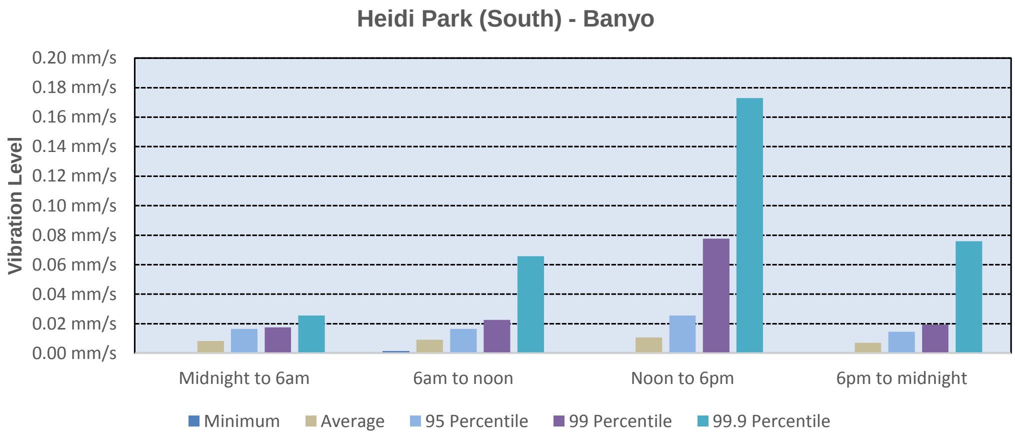


A.17 Heide Park (South)

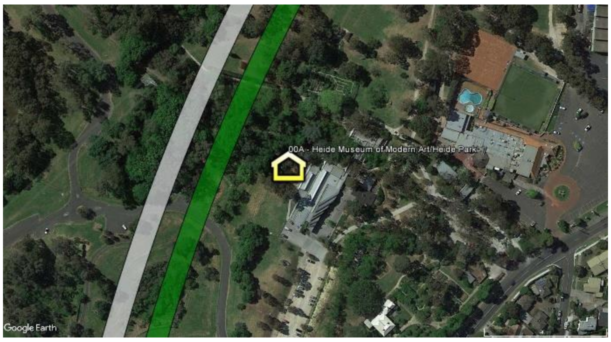


Heide Park (South) – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11637
Average level of vibration	0.01 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.13 mm/s

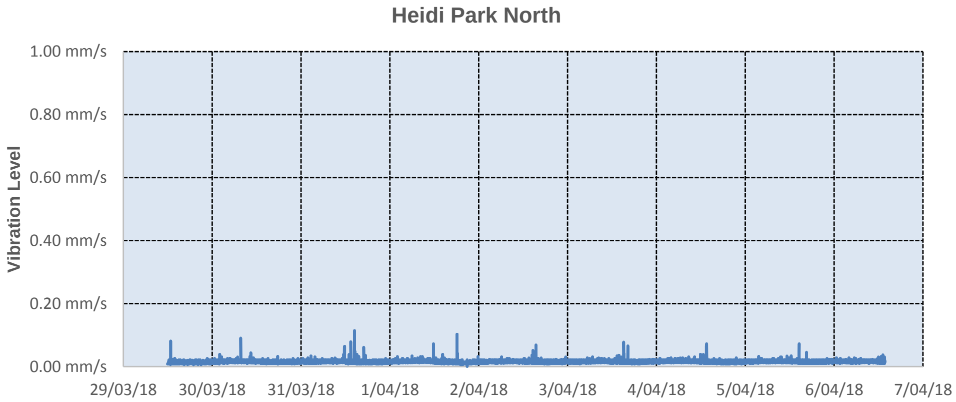


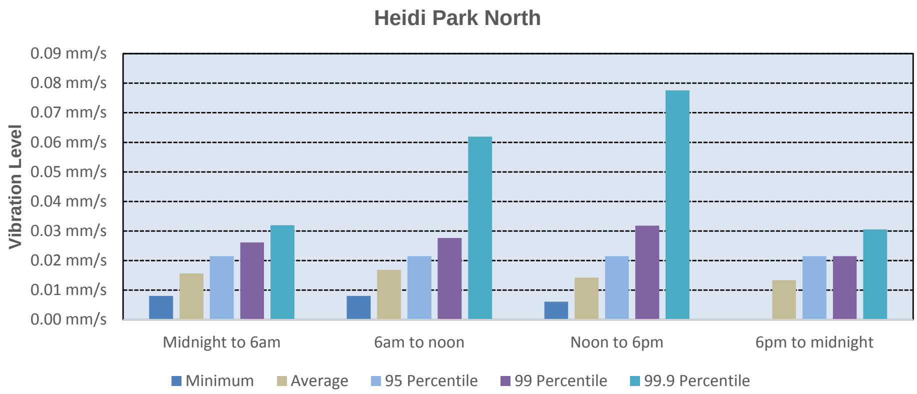


A.18 Heide Park (North)



Heide Park (North) – Existing Vibration Assessment	
Period of Monitoring	29th March, 2018 to 6th April, 2018
Number of Measurements	11631
Average level of vibration	0.02 mm/s
Level exceeding 95% of measurements	0.02 mm/s
Level exceeding 99% of measurements	0.03 mm/s
Level exceeding 99.9% of measurements	0.07 mm/s





Appendix B Risk assessment

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Risk ID	*Potential threat and effect on the environment*	*Initial Risk*									*Residual Risk*								*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*	*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*		
			Extent	*Severity*	*Duration*						*Extent*	*Severity*	*Duration*					
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR SC2 Community and stakeholder engagement management plan	Local	High	0–3 months	Moderate	Possible	Medium	• No actual data from large diameter in Melbourne rock mass available to confirm vibration levels • Modelling based on expected interaction between cutter head and ground types for different energies • A minimum energy required to deliver TBM advance and further reductions may not be possible • Few mitigation options available for TBM. Thrust and rotation speed changes not effective	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Medium	0–3 months	Minor	Possible	Low		Continual review of vibration levels during the construction phase and comparison with predicted results. • Remodelling as considered necessary based upon correlation. • Community liaison with affected residents and resident mitigation policy implemented
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	High	0–3 months	Moderate	Possible	Medium	• No actual data from large diameter in Melbourne rock mass available to confirm vibration levels • Modelling based on expected interaction between cutter head and ground types for different energies • A minimum energy required to deliver TBM advance and further reductions may not be possible • Few mitigation options available for TBM. Thrust and rotation speed changes not effective	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Medium	0–3 months	Minor	Possible	Low		Continual review of vibration levels during the construction phase and comparison with predicted results. • Remodelling as considered necessary based upon correlation. • Community liaison with affected residents and resident mitigation policy implemented

Risk ID	*Potential threat and effect on the environment*	*Initial Risk*									*Residual Risk*								*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*		*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*		
			Extent	*Severity*	*Duration*							*Extent*	*Severity*	*Duration*					
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Low	0–3 months	Negligible	Almost certain	Low	• Residents have expectation of nil affects rather than acceptable affects and may be annoyed by any impact • Vibration and regenerated complaints can be linked to other effects, such as dust, and therefore irrespective of permissible level • Dissatisfaction with the overall project can lead to spurious complaints		EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Low	0–3 months	Negligible	Likely	Low		• Continual monitoring and review of vibration levels at representative properties along the alignment • Active community liaison team present in the neighbourhood • 1800 number available for residents

Risk ID	*Potential threat and effect on the environment*	*Initial Risk*									*Residual Risk*								*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*		*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*		
			Extent	*Severity*	*Duration*							*Extent*	*Severity*	*Duration*					
Risk TV04	The levels of vibration are elevated at some residential properties as a consequence of unforeseen geology, water conditions, surface conditions and so on and cause loss of amenity.	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Almost certain	Medium	• No actual data from large diameter in Melbourne rock mass available • Modelling based on expected interaction between cutter head and ground types for different energies • Ground conditions vary along the alignment and can lead to different vibration levels • Weather conditions can influence degree of water saturation • Potential localised areas of unfavourable geology		EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts PR NV8 Minimise construction vibration impacts on amenity. EPR SC2 Implement a Communications and Community Engagement Plan.	Local	Low	0–3 months	Negligible	Almost certain	Low		• Modelling in advance to consider updated local geology • Continual review of vibration levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation. • Community liaison with affected residents and resident mitigation policy implemented
Risk TV05	The levels of regenerated noise are elevated at some residential properties as a consequence of unforeseen geology, water conditions, surface conditions and so on and cause loss of amenity	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Almost certain	Medium	• No actual data from large diameter in Melbourne rock mass available • Modelling based on expected interaction between cutter head and ground types for different energies • Ground conditions vary along the alignment • Weather conditions can influence degree of water saturation • Potential localised areas of unfavourable geology		EPR NV3 Minimise noise and Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Low	0–3 months	Negligible	Almost certain	Low		• Modelling in advance to consider updated local geology • Continual review of regenerated noise levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Community liaison with affected residents and resident mitigation policy implemented

Risk ID	*Potential threat and effect on the environment*	*Initial Risk*								*Residual Risk*							*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*	*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	
			Extent	*Severity*	*Duration*						*Extent*	*Severity*	*Duration*				
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Likely	Medium	• Calculations are based upon the inferred geology and variations are therefore very likely • Higher input energies required to excavate more competent rock types. Vibration a per cent of the delivered energy • Changes in equipment may be from a compliant smaller energy unit (ie 30-t excavator) to a larger unit still vibration compliant unit (ie 50-t excavator) but the number of people affected may increase (ie more people receive vibration)	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Low	0–3 months	Negligible	Possible	Low	• Continual review of vibration levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Considered scheduling of activities that result in elevated levels • Community liaison with affected residents and resident mitigation policy implemented
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 at the residential properties exceed acceptable values	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Likely	Medium	• Calculations are based upon the inferred geology and variations are therefore very likely • Higher input energies required to excavate more competent rock types. Vibration a per cent of the delivered energy • Changes in equipment may be from a compliant smaller energy unit (ie 30-t excavator) to a larger unit still noise compliant unit (ie 50-t excavator) but the number of people affected may increase (ie more people receive noise)	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Low	0–3 months	Negligible	Possible	Low	• Continual review of regenerated noise levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Considered scheduling of activities that result in elevated levels • Community liaison with affected residents and resident mitigation policy implemented

<table>
<tr><th rowspan="3">Risk ID</th><th rowspan="3">Potential threat and effect on the environment</th><th colspan="9">Initial Risk</th><th colspan="8">Residual Risk</th><th rowspan="3">Reasoning</th></tr>
<tr><th rowspan="2">Initial EPR</th><th colspan="3">Magnitude of Consequence</th><th rowspan="2">Overall Consequence</th><th rowspan="2">Likelihood</th><th rowspan="2">Risk Level</th><th rowspan="2">Reasoning</th><th rowspan="2">Final EPR</th><th colspan="3">Magnitude of Consequence</th><th rowspan="2">Overall Consequence</th><th rowspan="2">Likelihood</th><th rowspan="2">Risk Level</th></tr>
<tr><th>Extent</th><th>Severity</th><th>Duration</th><th>Extent</th><th>Severity</th><th>Duration</th></tr>
<tr><td>Risk TV08</td><td>An accelerated construction schedule results in elevated vibration levels at the residential properties along the alignment and a loss of amenity</td><td>EPR NV3 Noise and vibration impacts to sensitive receptors (construction)
EPR NV4 Construction noise and vibration management plan (CNVMP)
EPR NV8 Construction vibration targets (amenity)
EPR SC2 Community and stakeholder engagement management plan</td><td>Local</td><td>Medium</td><td>0–3 months</td><td>Minor</td><td>Likely</td><td>Medium</td><td>• Accelerated construction schedule requires increased energy input and associated vibration increase
• Schedule requires using larger equipment
• Changes in equipment may be from a compliant smaller energy unit (ie 30-t excavator) to a larger unit still vibration compliant unit (ie 50-t excavator) but the number of people affected may increase (ie more people receive vibration)</td><td>EPR NV3 Minimise construction noise impacts to sensitive receptors.
EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts.
EPR NV8 Minimise construction vibration impacts on amenity.
EPR SC2 Communications and community engagement plan.</td><td>Local</td><td>Medium</td><td>0–3 months</td><td>Minor</td><td>Possible</td><td>Low</td><td>• Continual review of vibration levels during the construction phase and comparison with predicted results
• Remodelling as considered necessary based upon correlation
• Active community team in the neighbourhood
• Community liaison with affected residents and resident mitigation policy implemented</td></tr>
<tr><td>Risk TV09</td><td>An accelerated construction schedule results in elevated regenerated noise levels at the residential properties along the alignment and a loss of amenity</td><td>EPR NV3 Noise and vibration impacts to sensitive receptors (construction)
EPR NV4 Construction noise and vibration management plan (CNVMP)
EPR NV8 Construction vibration targets (amenity)
EPR SC2 Community and stakeholder engagement management plan</td><td>Local</td><td>Medium</td><td>0–3 months</td><td>Minor</td><td>Likely</td><td>Medium</td><td>• Accelerated construction schedule requires increased energy input and associated vibration increase
• Schedule requires using larger equipment</td><td>EPR NV3 Minimise construction noise impacts to sensitive receptors.
EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts.
EPR NV8 Minimise construction vibration impacts on amenity.
EPR SC2 Implement a Communications and Community Engagement plan.</td><td>Local</td><td>Medium</td><td>0–3 months</td><td>Minor</td><td>Possible</td><td>Low</td><td>• Continual review of vibration levels during the construction phase and comparison with predicted results
• Remodelling as considered necessary based upon correlation
• Active community team in the neighbourhood
• Community liaison with affected residents and resident mitigation policy implemented</td></tr>
</table>

Risk ID	*Potential threat and effect on the environment*	*Initial Risk*									*Residual Risk*								*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*		*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*		
			Extent	*Severity*	*Duration*							*Extent*	*Severity*	*Duration*					
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) PR NV8 Construction vibration targets (amenity) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Likely	Medium	• Unfavourable geology (competent or weak) requires reduced production rates and equipment operating near to properties for longer periods		EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Medium	0–3 months	Minor	Possible	Low		• Continual review of vibration levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Active community team in the neighbourhood • Community liaison with affected residents and resident mitigation policy implemented
Risk TV11	The construction of the buildings amplifies vibration levels and results in non-compliant levels and associated loss of amenity	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Likely	Medium	• Construction of buildings on a dwelling by dwelling basis are unknown • Construction is assumed to follow standard practices		EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Medium	0–3 months	Minor	Possible	Low		• Continual review of vibration levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Active community team in the neighbourhood • Condition survey of properties along alignment • Community liaison with affected residents and resident mitigation policy implemented

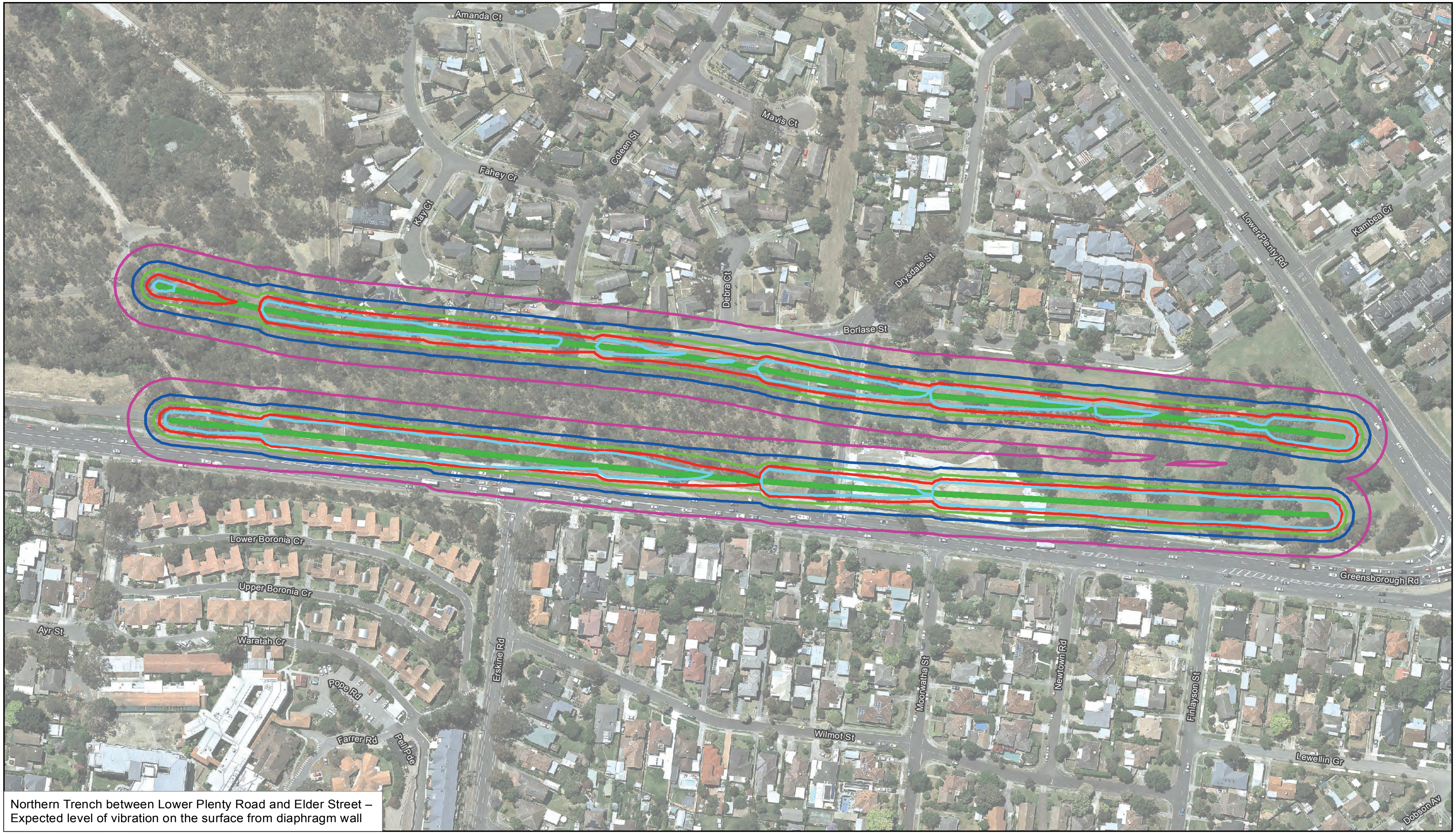
Risk ID	*Potential threat and effect on the environment*	*Initial Risk*								*Residual Risk*							
			Magnitude of Consequence								*Magnitude of Consequence*						
		Initial EPR	*Extent*	*Severity*	*Duration*	*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*	*Final EPR*	*Extent*	*Severity*	*Duration*	*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*
Risk TV12	The construction of the building and the internal finishing amplifies regenerated noise levels and results in non-compliant values and associated loss of amenity	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	Medium	0–3 months	Minor	Likely	Medium	• Internal finishing of dwelling influences regenerated noise levels to high degree • Assumed that dwelling will have some internal features to minimise noise, such as carpets, wall hangings and pictures, soft furnishings etc	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	Medium	0–3 months	Minor	Possible	Low	• Continual review of vibration levels during the construction phase and comparison with predicted results • Remodelling as considered necessary based upon correlation • Active community team in the neighbourhood. • Condition survey of properties along alignment • Community liaison with affected residents and resident mitigation policy implemented
Risk TV13	Commercial buildings may contain sensitive equipment which cannot operate effectively with the generated levels of vibration and regenerated noise	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) PR NV4 Construction noise and vibration management plan (CNVMP) EPR NV8 Construction vibration targets (amenity) EPR NV10 Ground-borne (internal) noise targets EPR SC2 Community and stakeholder engagement management plan	Local	High	0–3 months	Moderate	Possible	Medium	• General area of works identified by walk over as residential • No sensitive buildings identified in walk over but not all individually assessed for type of activity • Utilities providers expected to inform of any key or aged assets	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV8 Minimise construction vibration impacts on amenity. EPR NV10 Minimise impacts from ground-borne (internal) noise. EPR SC2 Implement a Communications and Community Engagement plan.	Local	High	0–3 months	Moderate	Unlikely	Low	• Condition survey of buildings to identify sensitive building uses and equipment • Active community to discuss with groups as to the expected vibration and regenerated noise impacts • Community team to review building uses as part of area review

Risk ID	*Potential threat and effect on the environment*	*Initial Risk*								*Residual Risk*							*Reasoning*
		Initial EPR	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	*Reasoning*	*Final EPR*	*Magnitude of Consequence*			*Overall Consequence*	*Likelihood*	*Risk Level*	
			Extent	*Severity*	*Duration*						*Extent*	*Severity*	*Duration*				
Risk TV14	Infrastructure like retaining walls, services, tower piers and abutments are damaged by the vibration generated by the construction activities	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV9 Construction vibration targets (structures)	Local	High	0–3 months	Moderate	Unlikely	Low	• Walk over did not identify sensitive infrastructure from street but possible infrastructure exists below ground or at rear of property	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV9 Minimise construction vibration impacts on structures.	Local	High	0–3 months	Moderate	Unlikely	Low	• Discussions with asset owners prior to commencement of works • Assessment of area prior to commencement of vibration intensive works to identify potentially affected infrastructure • Condition surveys of key infrastructure to identify condition • Engineering assessment prior o works to establish possible zone of influence
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	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV9 Construction vibration targets (structures)	Local	High	0–3 months	Moderate	Unlikely	Low	• Condition of building observed from walk over as opposed to individual condition survey assessment	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV9 Minimise construction vibration impacts on structures.	Local	Medium	0–3 months	Minor	Unlikely	Low	• Condition survey of buildings to identify sensitive building uses and equipment • Active community to discuss with groups as to the expected vibration and regenerated noise impacts. • Community team to review building uses as part of area review

Risk ID	Potential threat and effect on the environment	*Initial Risk* Initial EPR	Magnitude of Consequence: Extent	Severity	Duration	Overall Consequence	Likelihood	Risk Level	Reasoning	*Residual Risk* Final EPR	Magnitude of Consequence: Extent	Severity	Duration	Overall Consequence	Likelihood	Risk Level	Reasoning
Risk TV16	The ground mass properties beneath the dwellings along the corridor are affected by the low amplitude vibrations that results in settlement and damage to the residential or commercial buildings	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP)	Local	High	3 months to 2 years	Moderate	Unlikely	Low	• Ground mass assumed to be capable of withstanding induced vibration based upon age and rock mass parameters but individual pockets of variable ground are possible • Discussions with geotechncial group required to confirm not an issue. Has been raised in other projects	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts.	Local	High	3 months to 2 years	Moderate	Unlikely	Low	• Engineering assessment by geotechnical team to discuss possible settlement requirements • Input from vibration model to allow assessment of expected levels of vibration
Risk TV17	Heritage buildings are damaged by the vibration generated by the construction methods	EPR NV3 Noise and vibration impacts to sensitive receptors (construction) EPR NV4 Construction noise and vibration management plan (CNVMP) EPR NV9 Construction vibration targets (structures)	Local	High	0–3 months	Moderate	Unlikely	Low	• Heritage buildings not individually assessed during initial stages • Buildings not considered more susceptible to damage as a result of heritage stature • All key buildings and infrastructure should be separately assessed as per previous hearing statements	EPR NV3 Minimise construction noise impacts to sensitive receptors. EPR NV4 Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts. EPR NV9 Minimise construction vibration impacts on structures.	Local	High	0–3 months	Moderate	Unlikely	Low	• Assessment of area prior to commencement of vibration intensive works to identify potentially affected infrastructure • Condition surveys of key infrastructure to identify condition • Engineering assessment prior o works to establish possible zone of influence
Risk TV18	Rock mass sufficiently competent that excavation of the cross passages or the northern dive structure development requires blasting that impacts on the amenity of persons	Review of modelled data against the AS2436 (2010) and AS2187.2.	Local	Medium	0–3 months	Moderate	Possible	Medium		EPR NV11 Minimise amenity impacts from blast vibration. EPR NV12 Minimise amenity impacts from blast overpressure.	Local	Medium	0–3 months	Moderate	Unlikely	Low	• Continual review of vibration levels during the construction phase and comparison with predicted results. Remodelling as considered necessary based upon correlation. • Compliance with vibration criteria specified in the AS2436 (2010) and AS2187.2 would be met.

Risk ID	Potential threat and effect on the environment	Initial Risk								Residual Risk							Reasoning
		Initial EPR	Magnitude of Consequence			Overall Consequence	Likelihood	Risk Level	Reasoning	Final EPR	Magnitude of Consequence			Overall Consequence	Likelihood	Risk Level	
			Extent	Severity	Duration						Extent	Severity	Duration				
Risk TV19	Rock mass sufficiently competent that excavation of the cross passages or the northern dive structure development requires blasting that that causes damage to the adjacent properties or other infrastructure		Local	Medium	0–3 months	Moderate	Possible	Medium		EPR NV11 Minimise amenity impacts from blast vibration. EPR NV12 Minimise amenity impacts from blast overpressure.	Local	Medium	0–3 months	Moderate	Unlikely	Low	• Continual review of vibration levels during the construction phase and comparison with predicted results. • Remodelling as considered necessary based upon correlation. • Compliance with vibration criteria specified in the AS2436 (2010) and AS2187.2 and German Standard Din4150.2
Risk TV20	Construction activities induce vibration levels which could impact upon the integrity and serviceability of existing services	Review modelled vibration levels against NV5	Local	Medium	0–3 months	Moderate	Possible	Medium		EPR NV5 Establish vibration guidelines to protect utility assets.	Local	Medium	0–3 months	Moderate	Unlikely	Low	• Continual review of vibration levels during the construction phase and comparison with predicted results. • Remodelling as considered necessary based upon correlation. • Compliance with vibration criteria in German Standard DIN4150.2 or asset provider specifications

Appendix C Predicted vibration for option 1 (reference project)



Northern Trench between Lower Plenty Road and Elder Street –
Expected level of vibration on the surface from diaphragm wall

Paper Size A3

0 20 40 60 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Diaphragm Wall

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Appendix C –
Vibration Contours for Option 1

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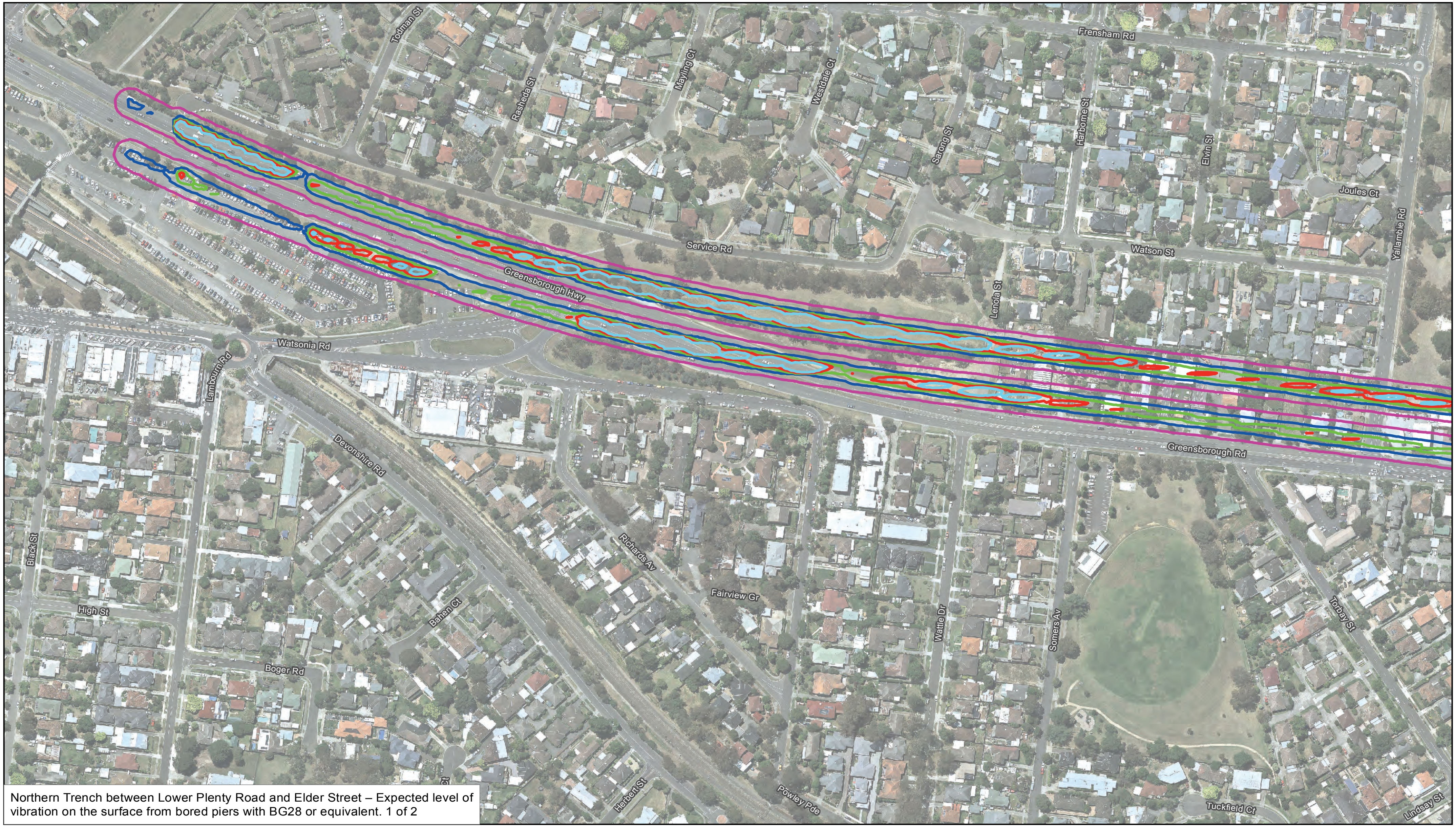
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of vibration on the surface from bored piers with BG28 or equivalent. 1 of 2

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Northern Trench between Lower Plenty Road and Elder Street – Expected level of vibration on the surface from bored piers with BG28 or equivalent. 2 of 2

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

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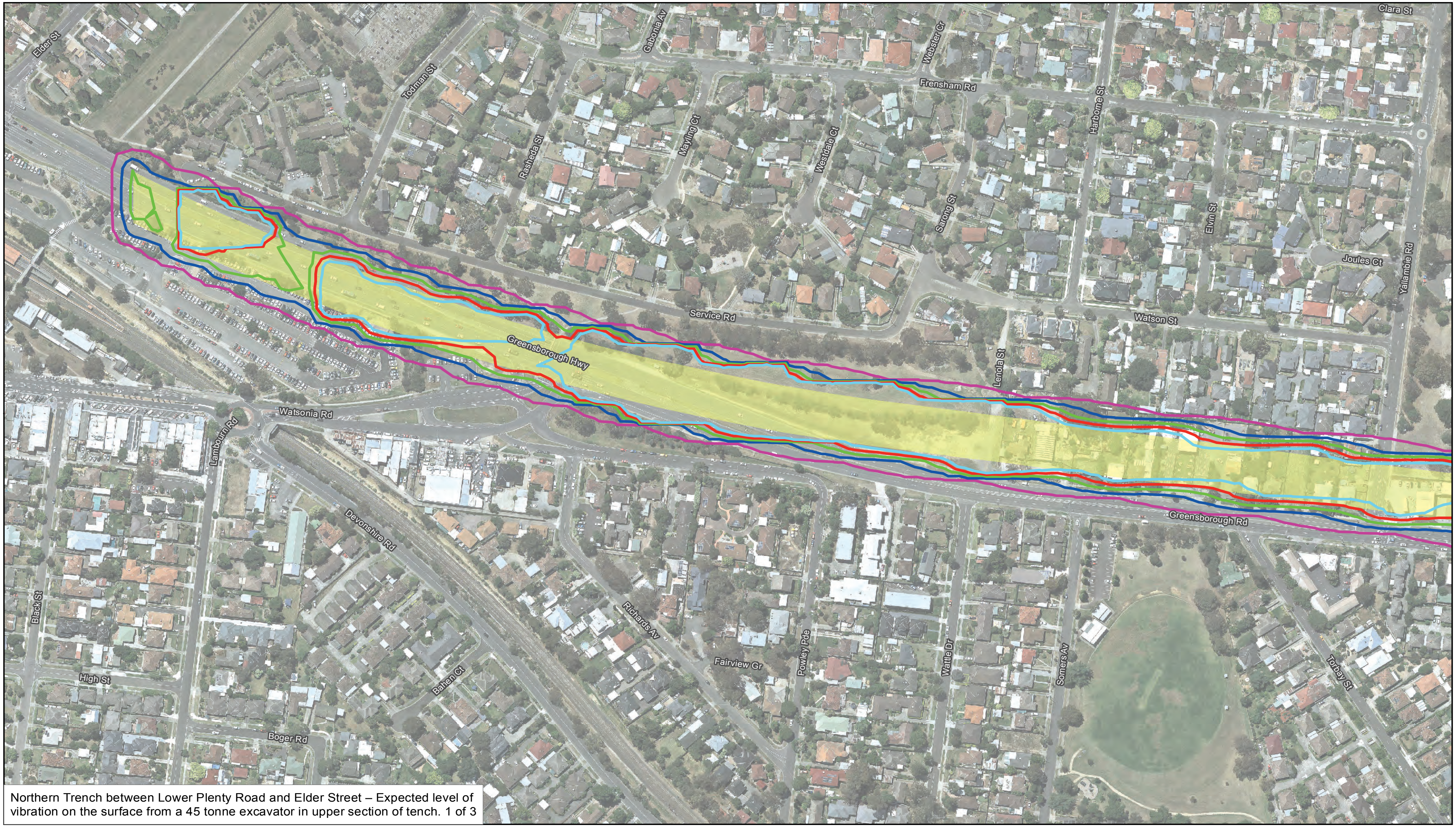

Northern Trench between Lower Plenty Road and Elder Street – Expected level of vibration on the surface from a 45 tonne excavator in upper section of tench. 1 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour
1.0 mm/s Vibration Contour
1.5 mm/s Vibration Contour
2 mm/s Vibration Contour
2.5 mm/s Vibration Contour

Trench

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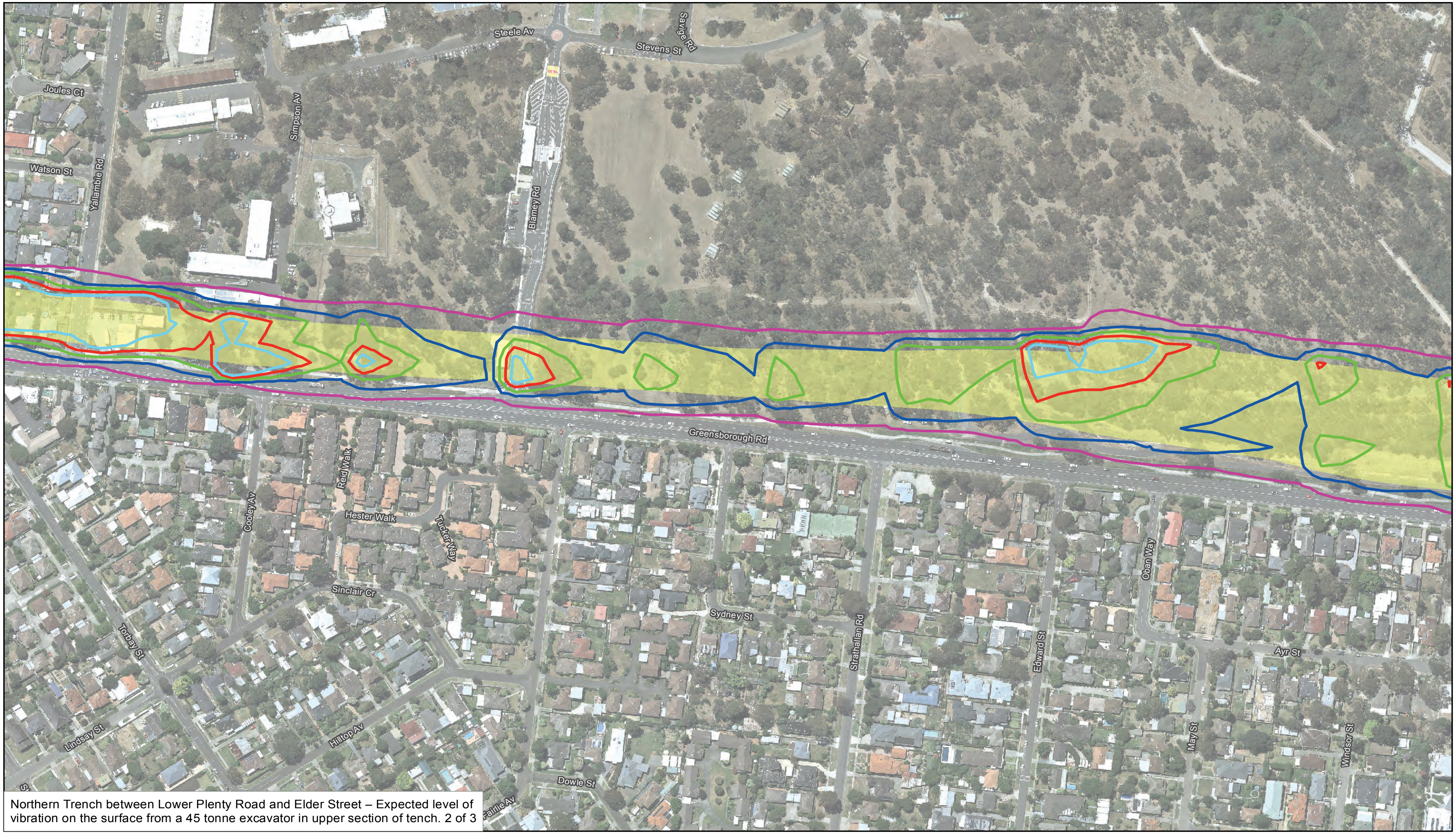

Northern Trench between Lower Plenty Road and Elder Street – Expected level of vibration on the surface from a 45 tonne excavator in upper section of tench. 2 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Trench

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Vibration Contours for Option 1

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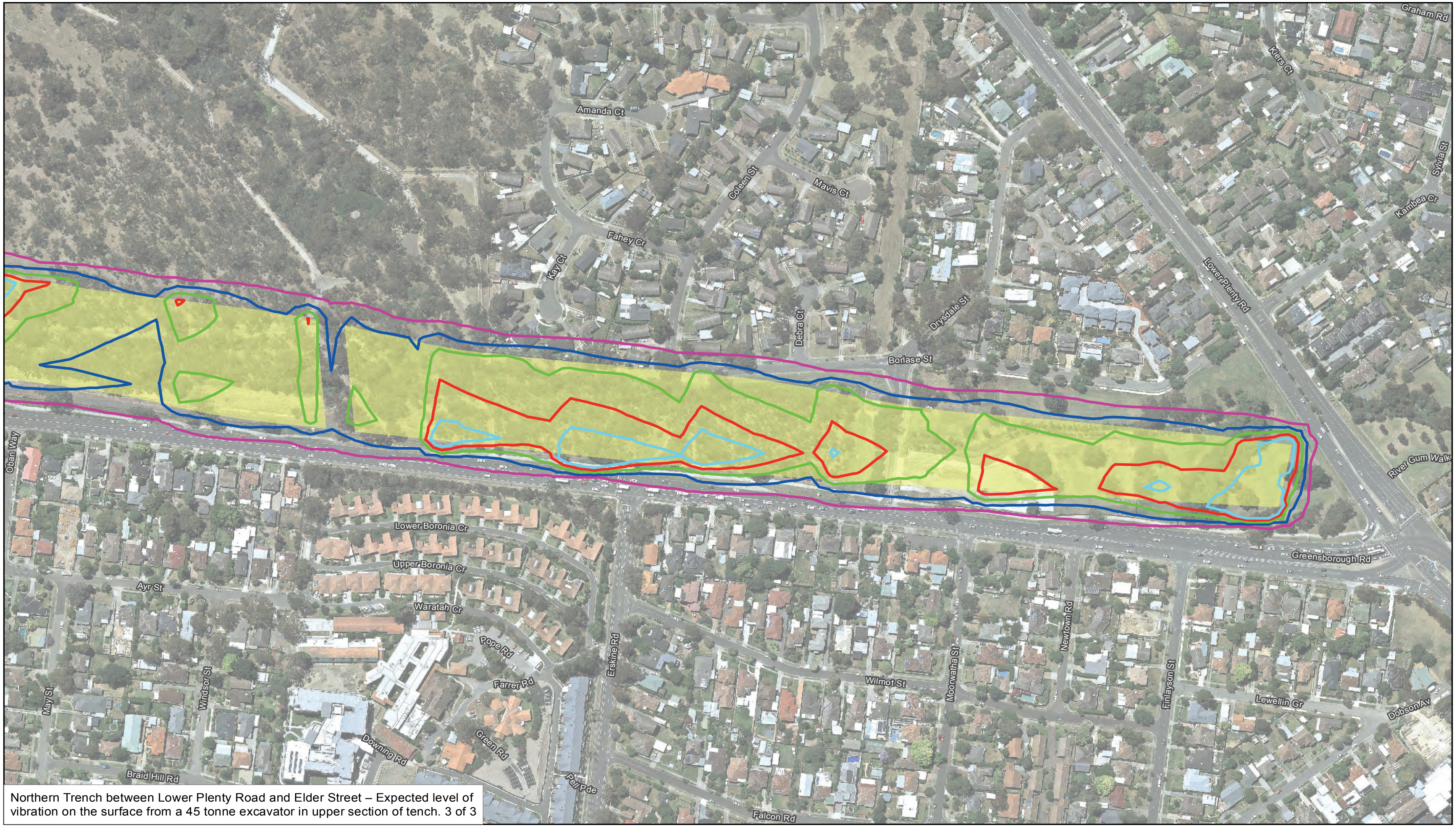

Northern Trench between Lower Plenty Road and Elder Street – Expected level of vibration on the surface from a 45 tonne excavator in upper section of tench. 3 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Trench

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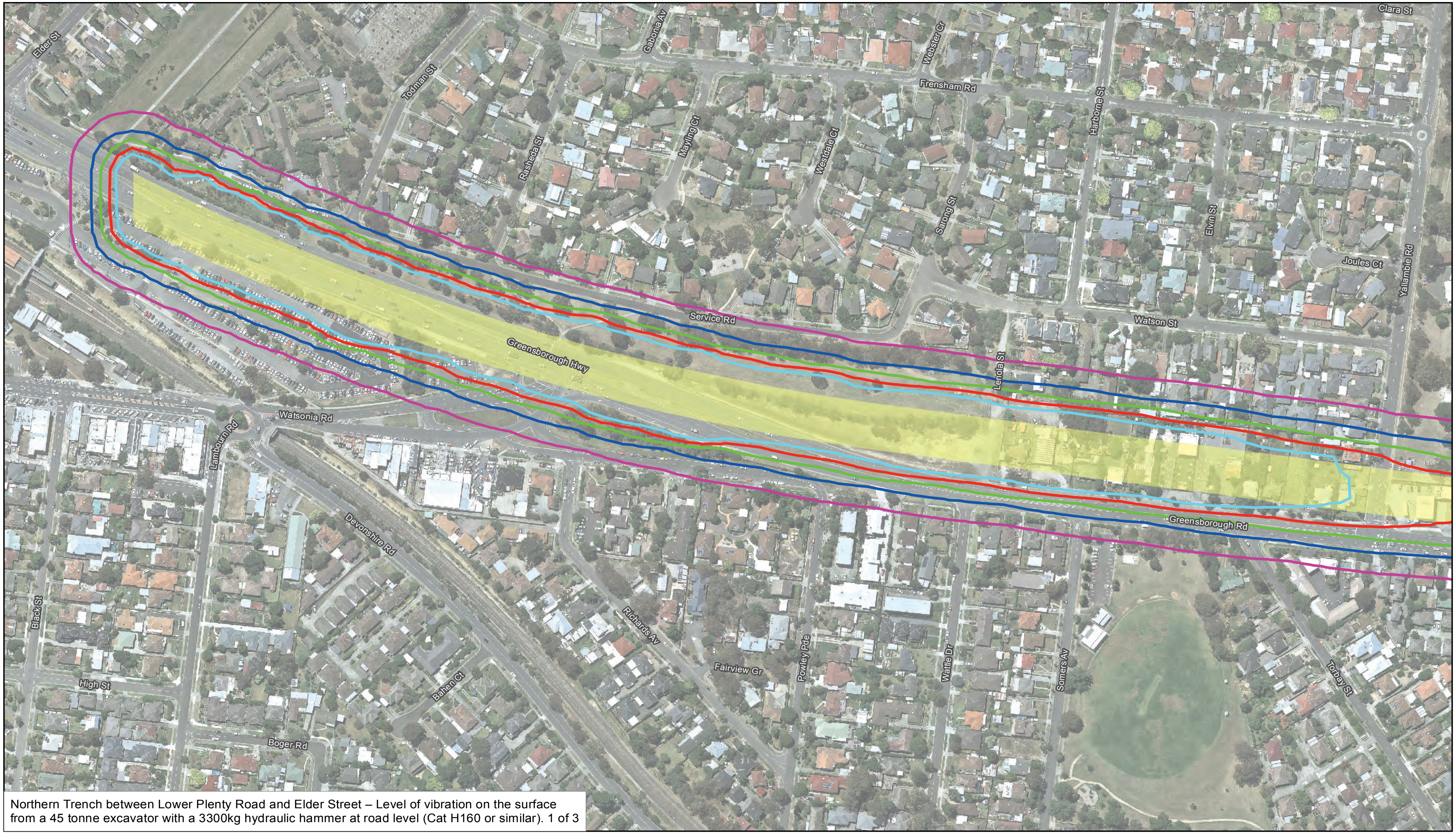

Northern Trench between Lower Plenty Road and Elder Street – Level of vibration on the surface from a 45 tonne excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 1 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Trench

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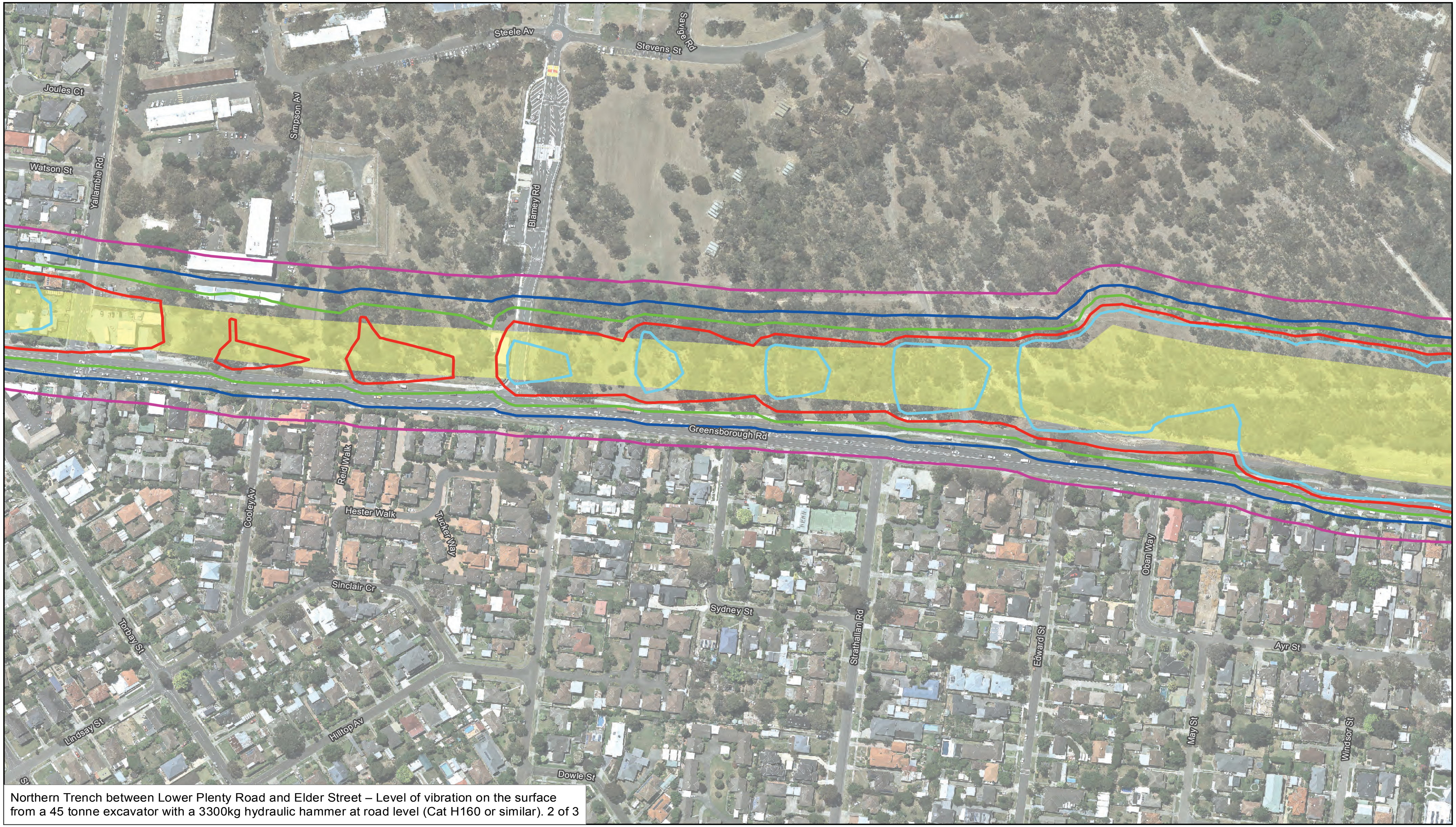
Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Level of vibration on the surface from a 45 tonne excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 2 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

Trench

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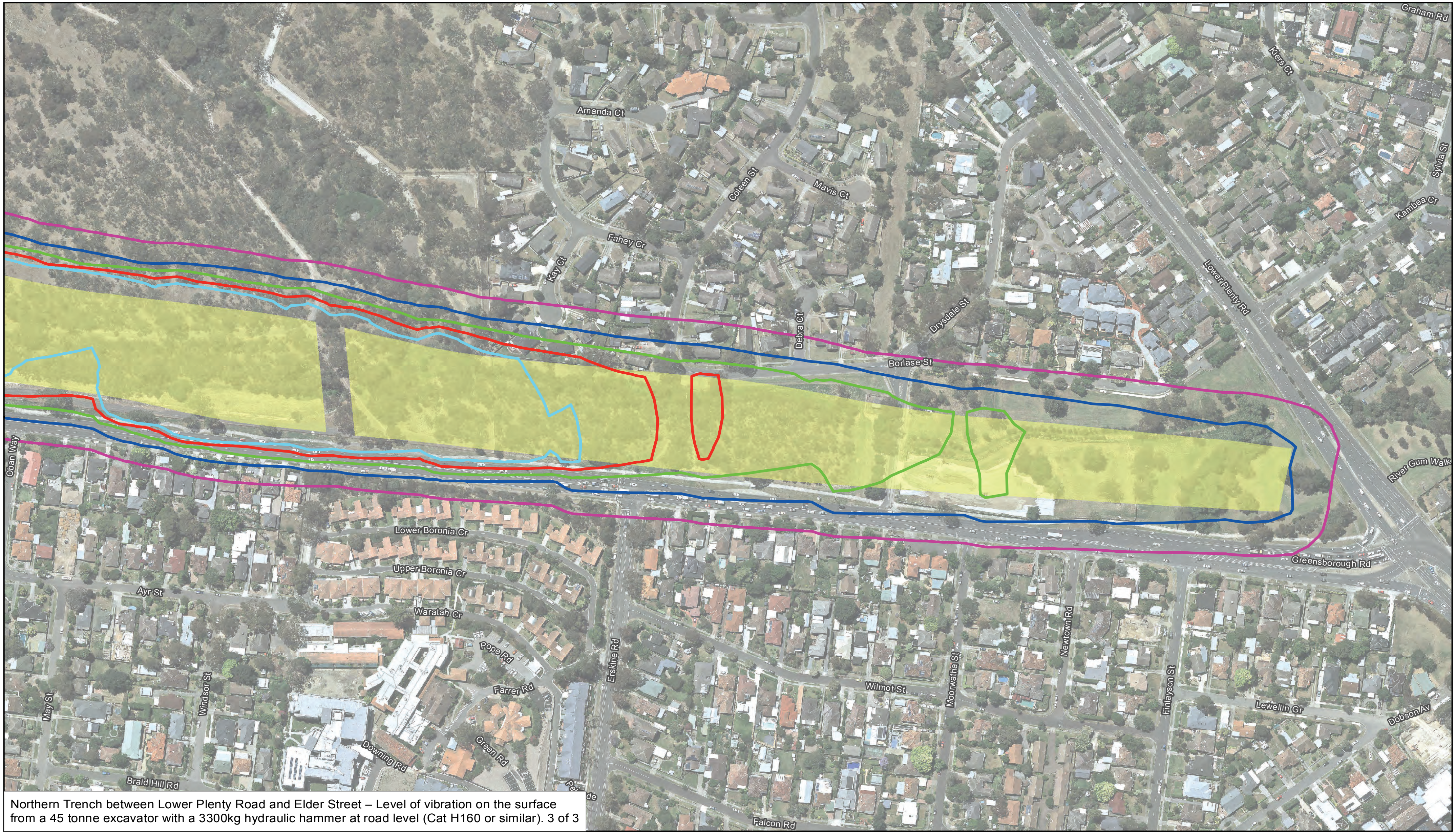
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Level of vibration on the surface from a 45 tonne excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 3 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Trench

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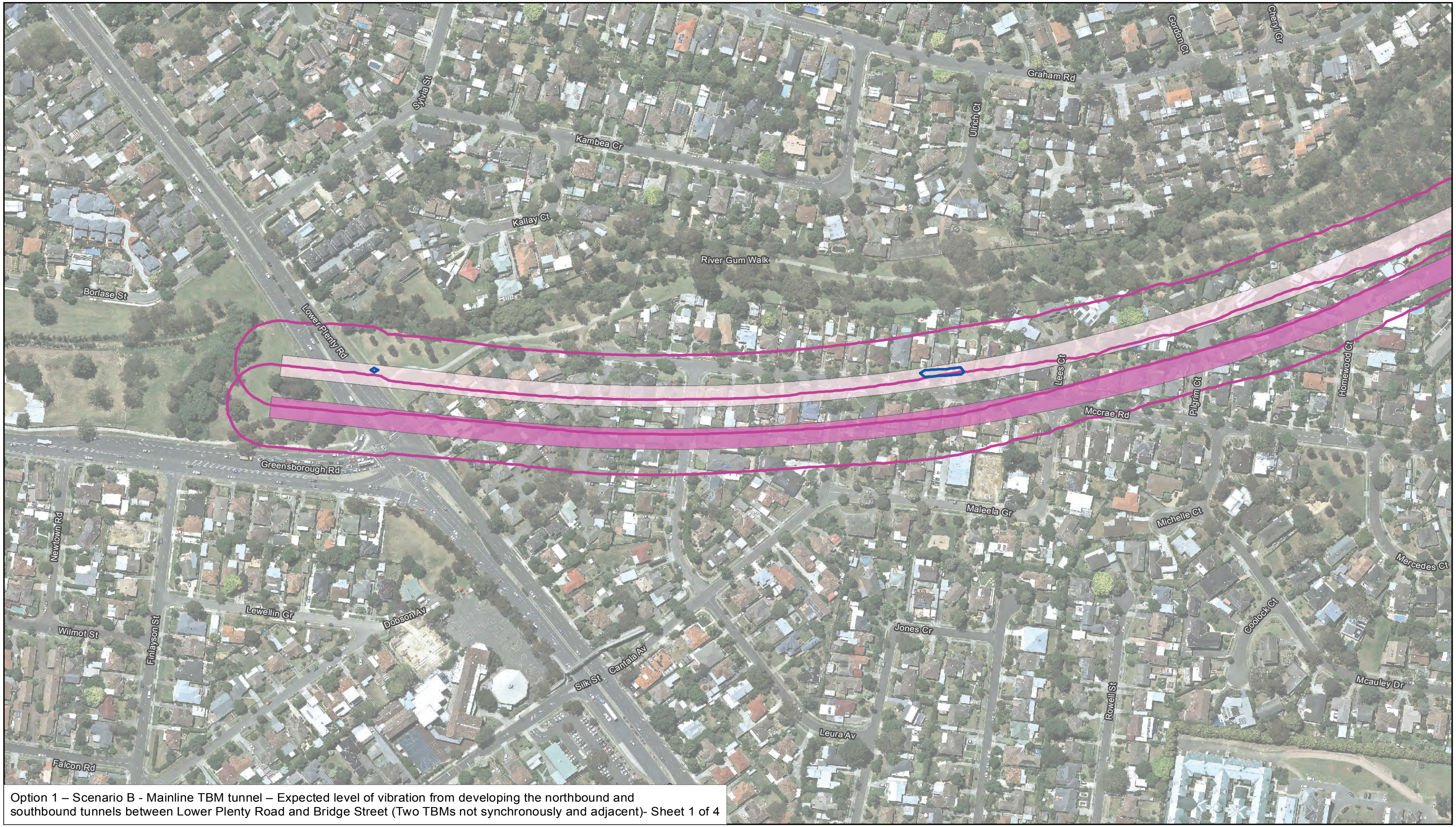
Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario B - Mainline TBM tunnel – Expected level of vibration from developing the northbound and southbound tunnels between Lower Plenty Road and Bridge Street (Two TBMs not synchronously and adjacent)- Sheet 1 of 4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels
- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

Tunnel Northbound
- kml_id_doc_1.1.45.15

Tunnel Southbound
- kml_id_doc_1.1.45.16

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario B - Mainline TBM tunnel – Expected level of vibration from developing the northbound and southbound tunnels between Lower Plenty Road and Bridge Street (Two TBMs not synchronously and adjacent) - Sheet 2 of 4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels
- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

Tunnel Northbound
- kml_id_doc_1.1.45.15

Tunnel Southbound
- kml_id_doc_1.1.45.16

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

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Option 1 – Scenario B - Mainline TBM tunnel – Expected level of vibration from developing the northbound and southbound tunnels between Lower Plenty Road and Bridge Street (Two TBMs not synchronously and adjacent) - Sheet 3 of 4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels
- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

Tunnel Northbound
- kml_id_doc_1.1.45.15

Tunnel Southbound
- kml_id_doc_1.1.45.16

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario B - Mainline TBM tunnel – Expected level of vibration from developing the northbound and southbound tunnels between Lower Plenty Road and Bridge Street (Two TBMs not synchronously and adjacent) - Sheet 4 of 4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15

Tunnel Southbound

kml_id_doc_1.1.45.16

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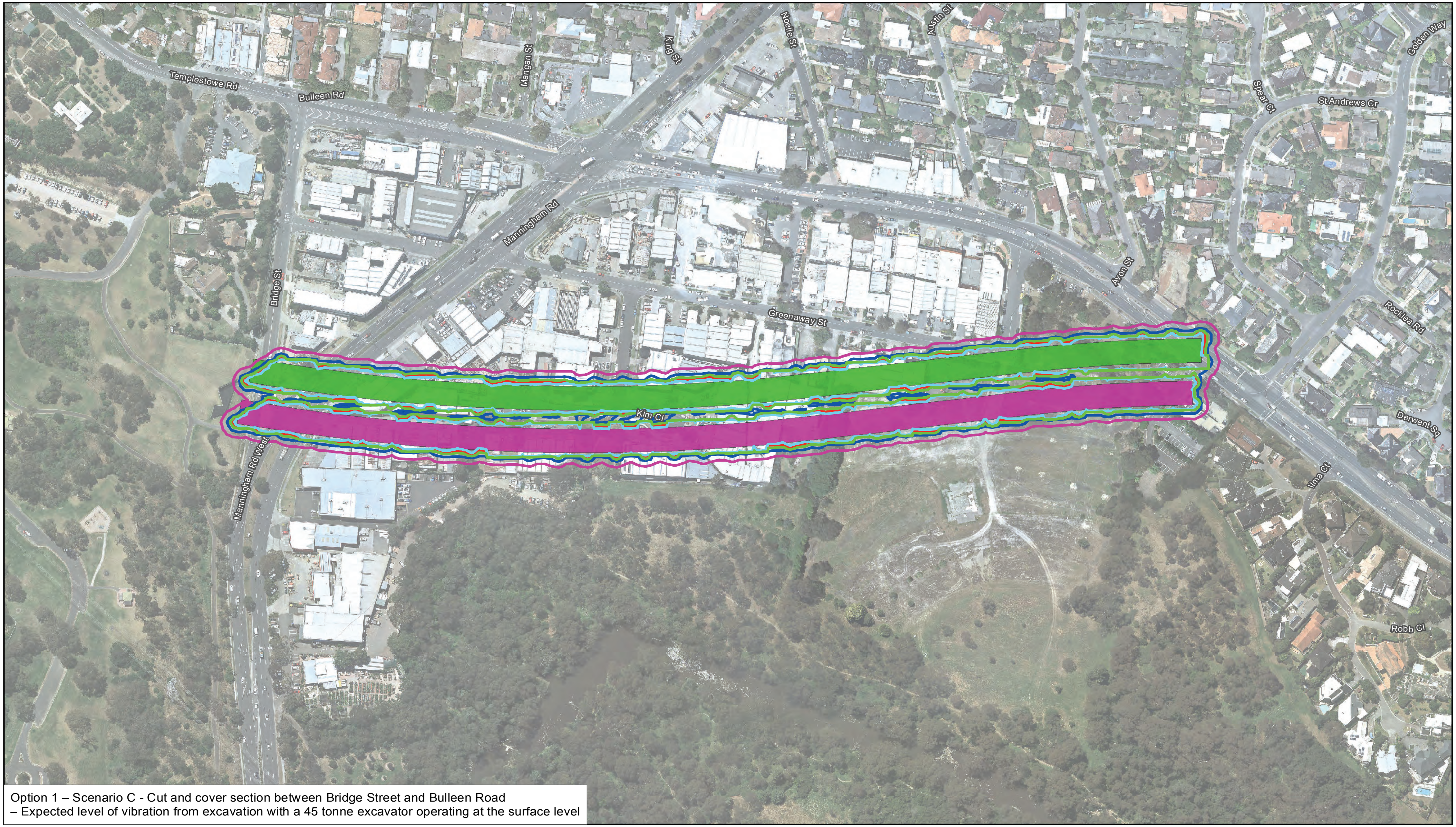

Option 1 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road
– Expected level of vibration from excavation with a 45 tonne excavator operating at the surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- NB Cut and Cover Floor 2 Option 1
- SB Cut and Cover Floor 2 Option 1

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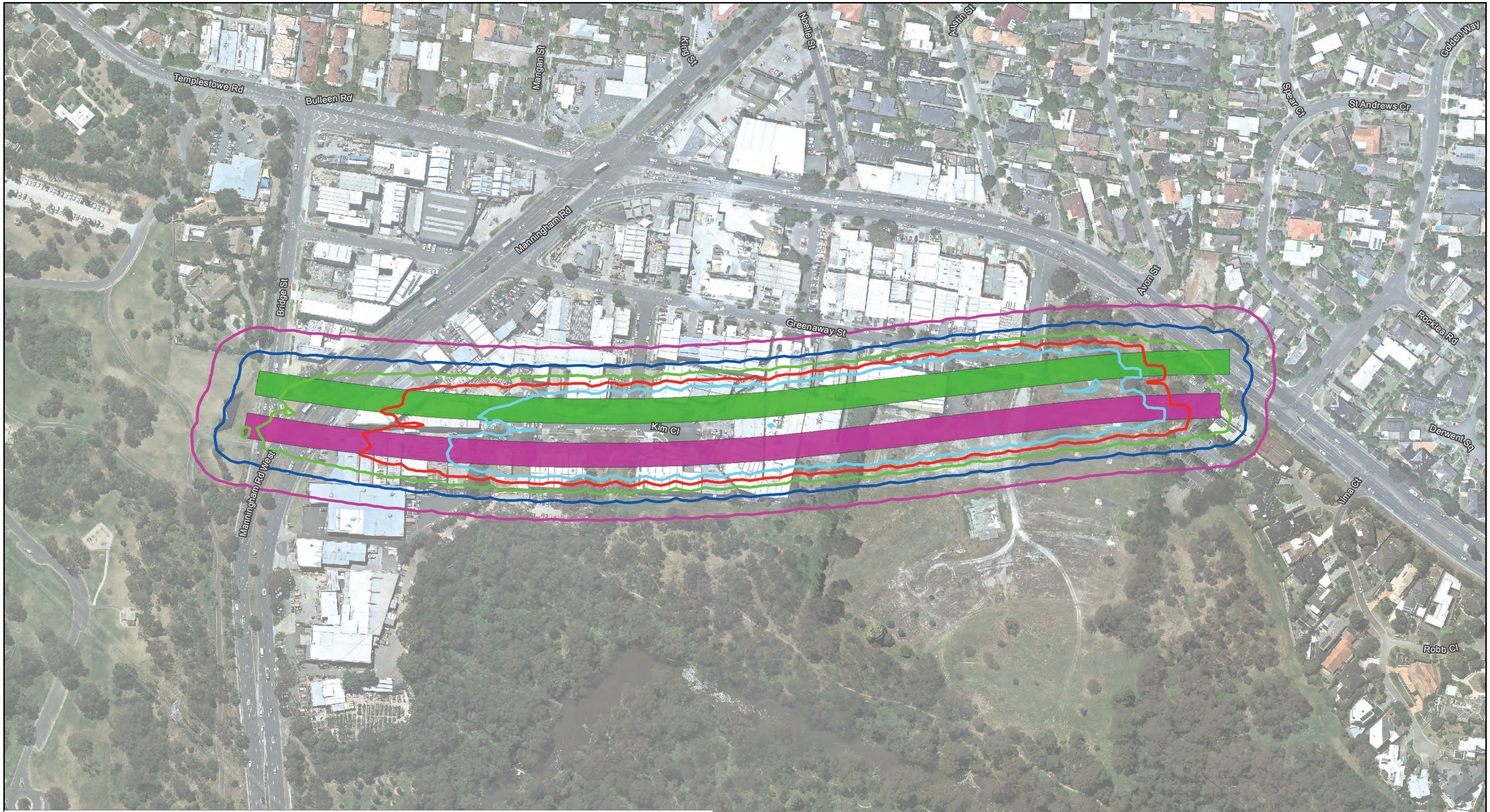
Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road – Expected level of vibration from excavation with a 45 tonne excavator with a 3300 kilogram hydraulic hammer operating at the design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- NB Cut and Cover Floor 2 Option 1
- SB Cut and Cover Floor 2 Option 1

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario D - Mined tunnel section between Bulleen Road to Trinity Marles playing fields (southern portal) – Expected level of vibration from excavation with a road header operating at the crown of the tunnel

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour

Tunnel Northbound

- kml_id_doc_1.1.45.15_N

Tunnel Southbound

- kml_id_doc_1.1.45.16_N

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

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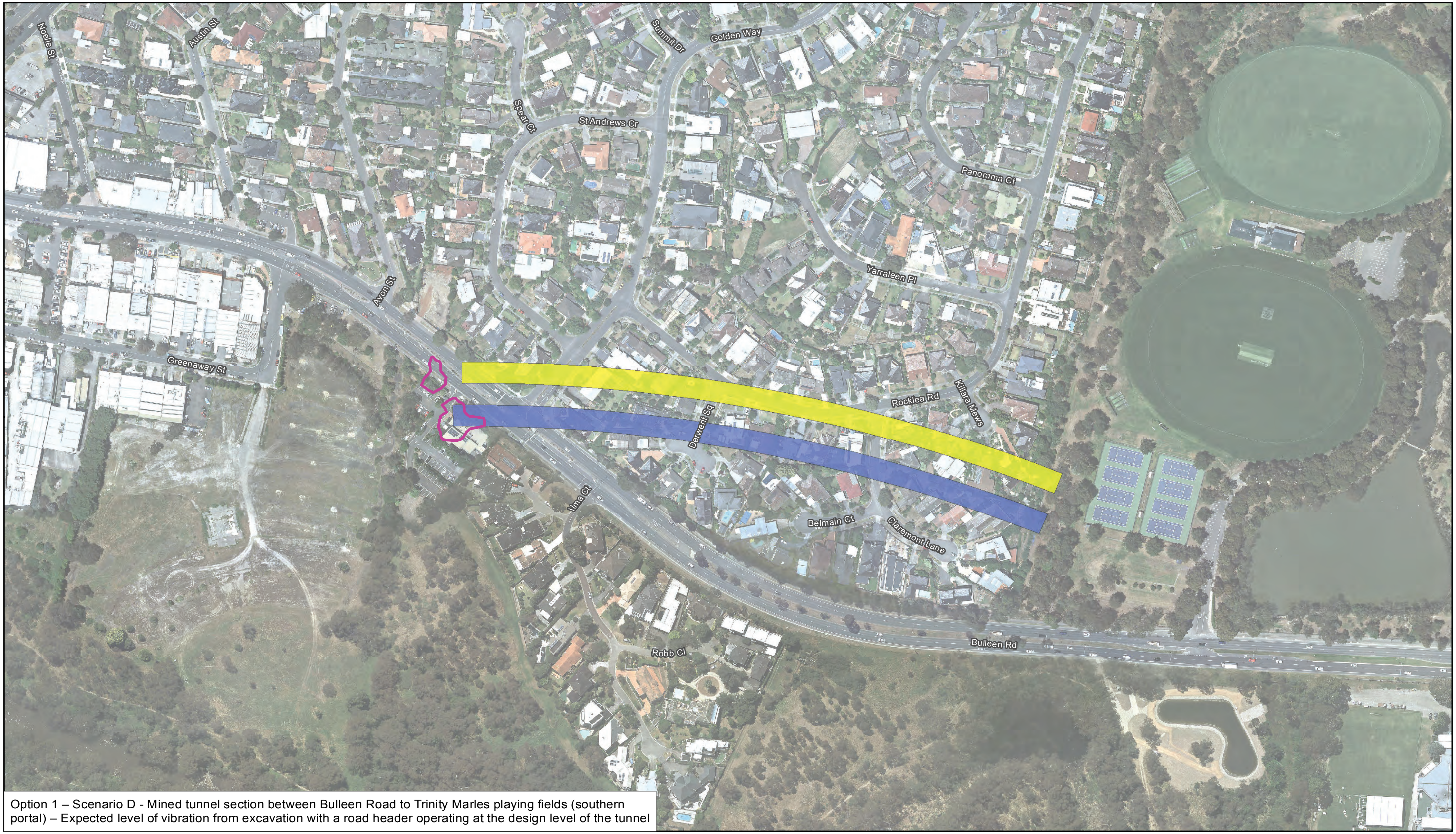

Option 1 – Scenario D - Mined tunnel section between Bulleen Road to Trinity Marles playing fields (southern portal) – Expected level of vibration from excavation with a road header operating at the design level of the tunnel

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15_N

Tunnel Southbound

kml_id_doc_1.1.45.16_N

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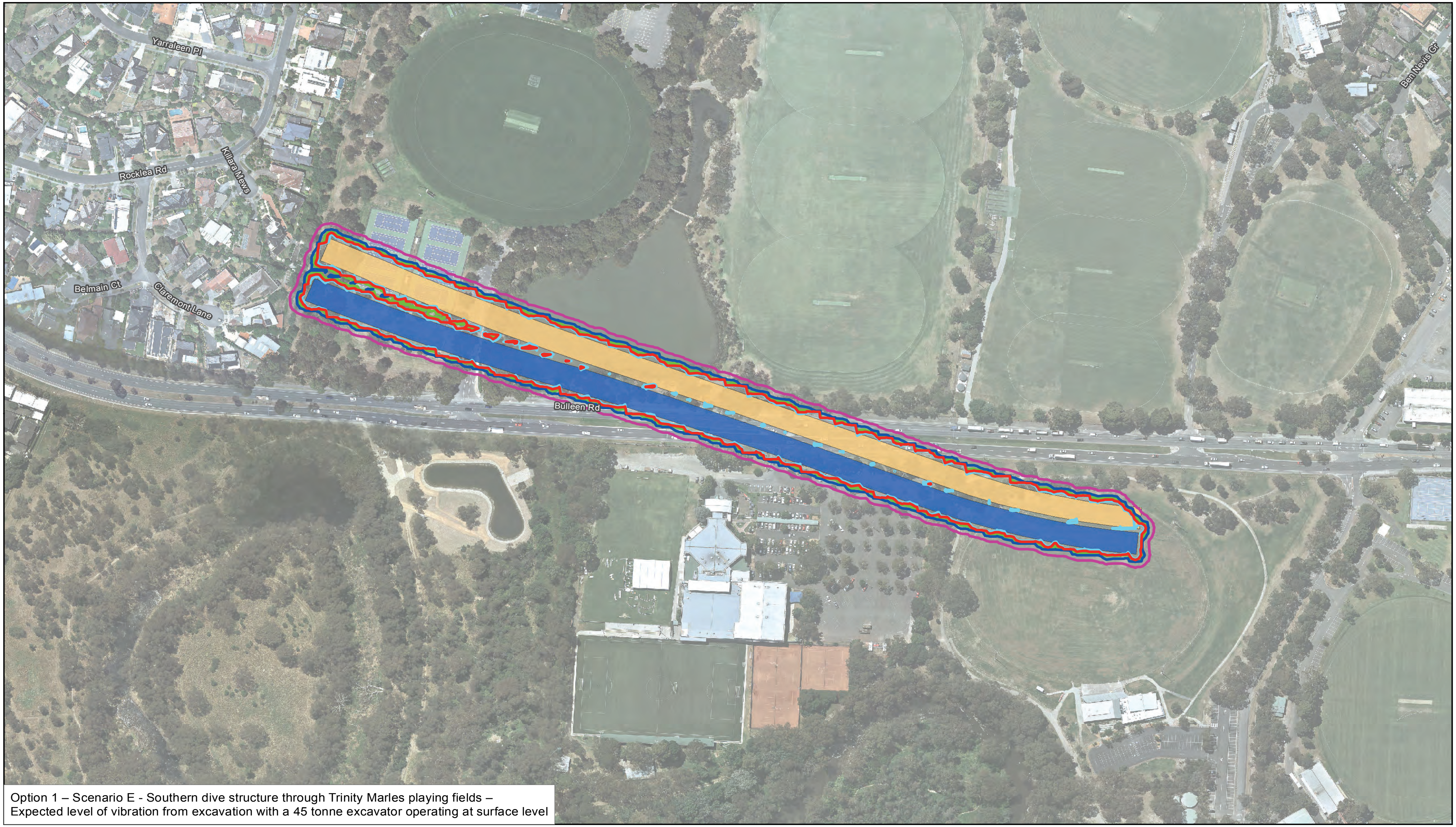
Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario E - Southern dive structure through Trinity Marles playing fields –
Expected level of vibration from excavation with a 45 tonne excavator operating at surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- NB Cut and Cover Floor 3 Option 1
- SB Cut and Cover Floor 3 Option 1

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario E - Southern dive structure through Trinity Marles playing fields –
Expected level of vibration from excavation with a 45 tonne excavator operating at design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour

NB Cut and Cover Floor 3 Option 1

SB Cut and Cover Floor 3 Option 1

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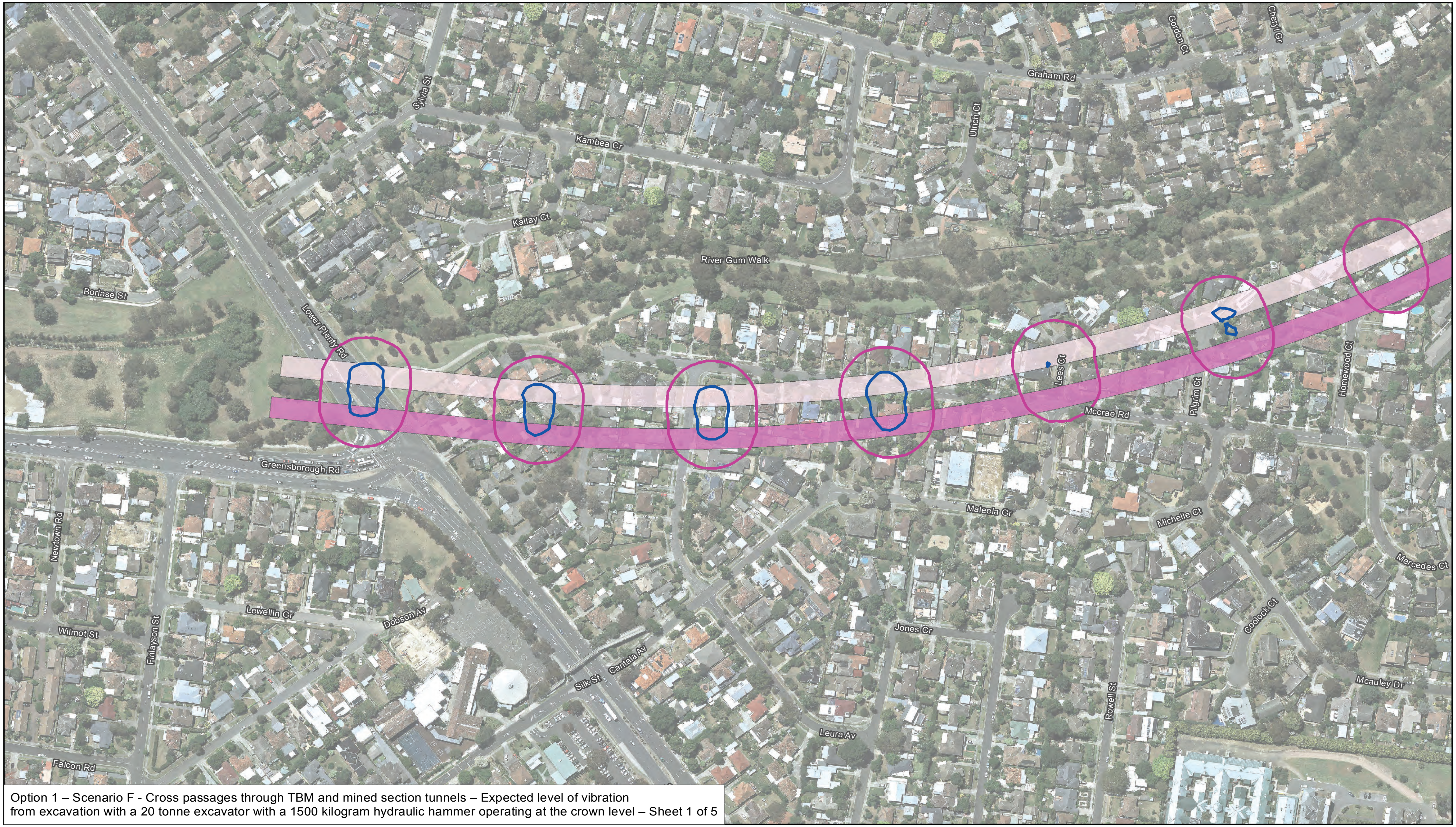

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of vibration from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 1 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour

1.0 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15

Tunnel Southbound

kml_id_doc_1.1.45.16

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Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of vibration from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 2 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour

1.0 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15

Tunnel Southbound

kml_id_doc_1.1.45.16

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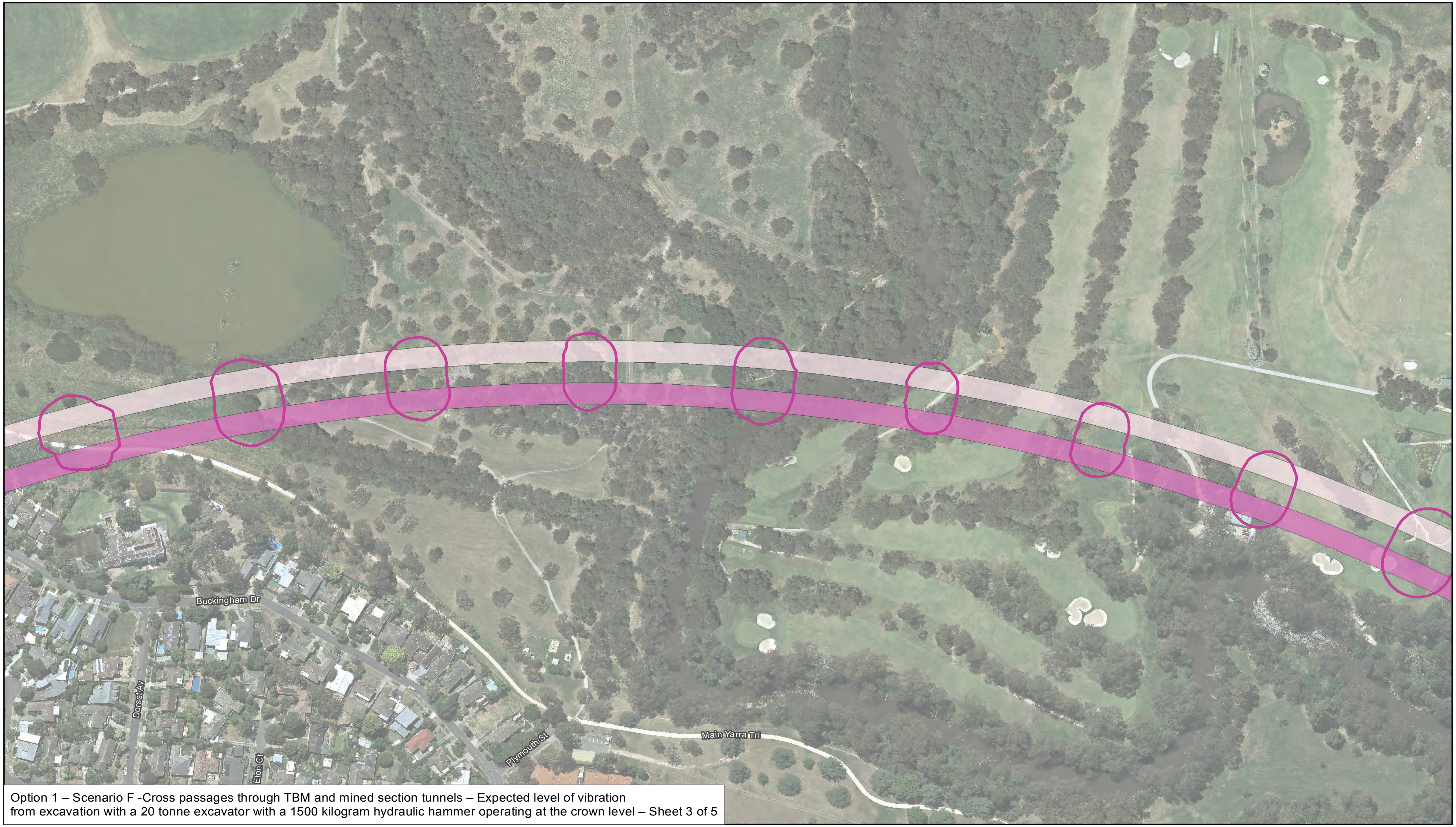

Option 1 – Scenario F -Cross passages through TBM and mined section tunnels – Expected level of vibration from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 3 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Surface Vibration Levels

0.5 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15

Tunnel Southbound

kml_id_doc_1.1.45.16

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Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of vibration from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 4 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour

Tunnel Northbound

kml_id_doc_1.1.45.15

Tunnel Southbound

kml_id_doc_1.1.45.16

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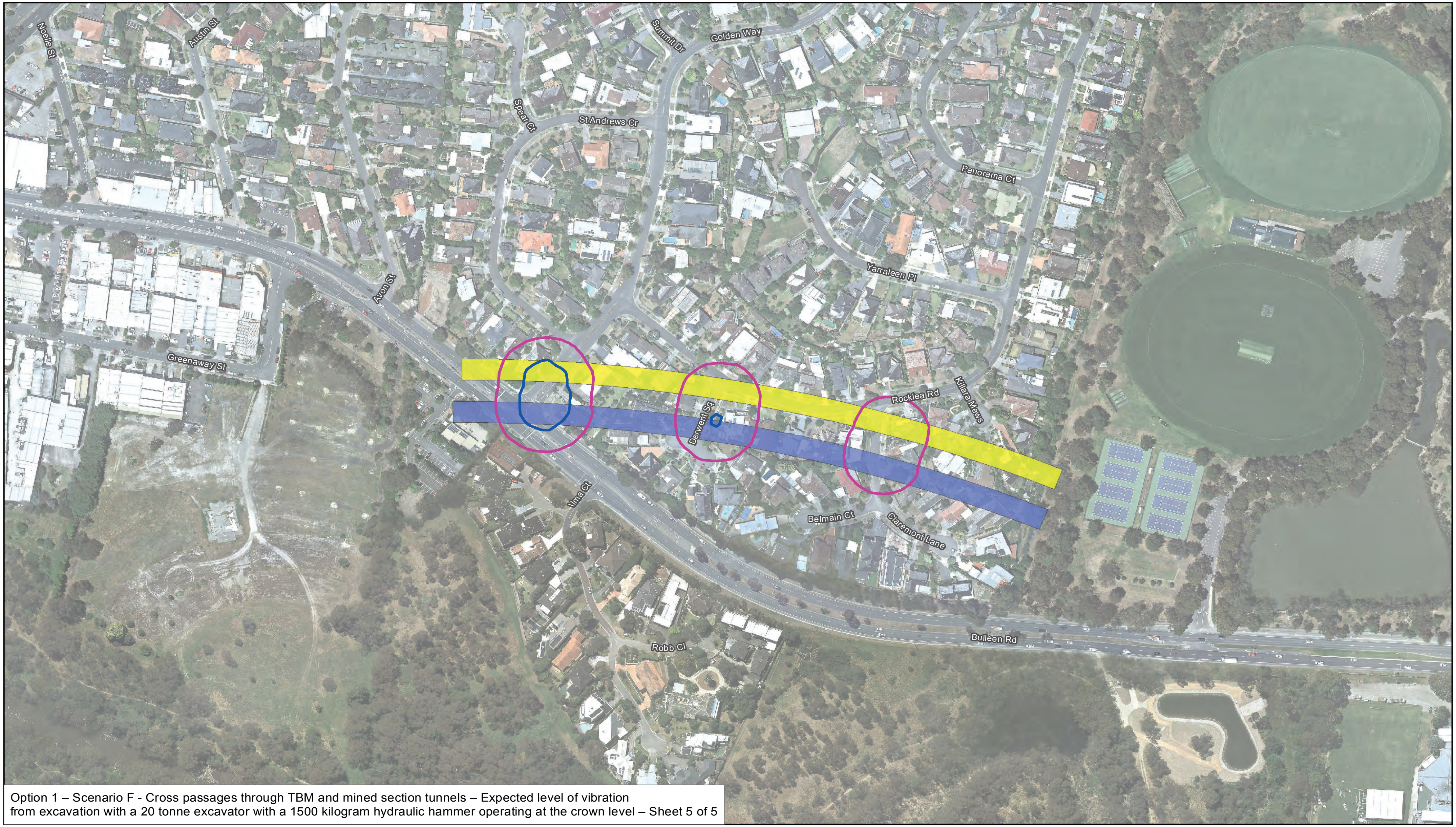

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of vibration from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 5 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels
- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour

Tunnel Northbound
- kml_id_doc_1.1.45.15_N

Tunnel Southbound
- kml_id_doc_1.1.45.16_N

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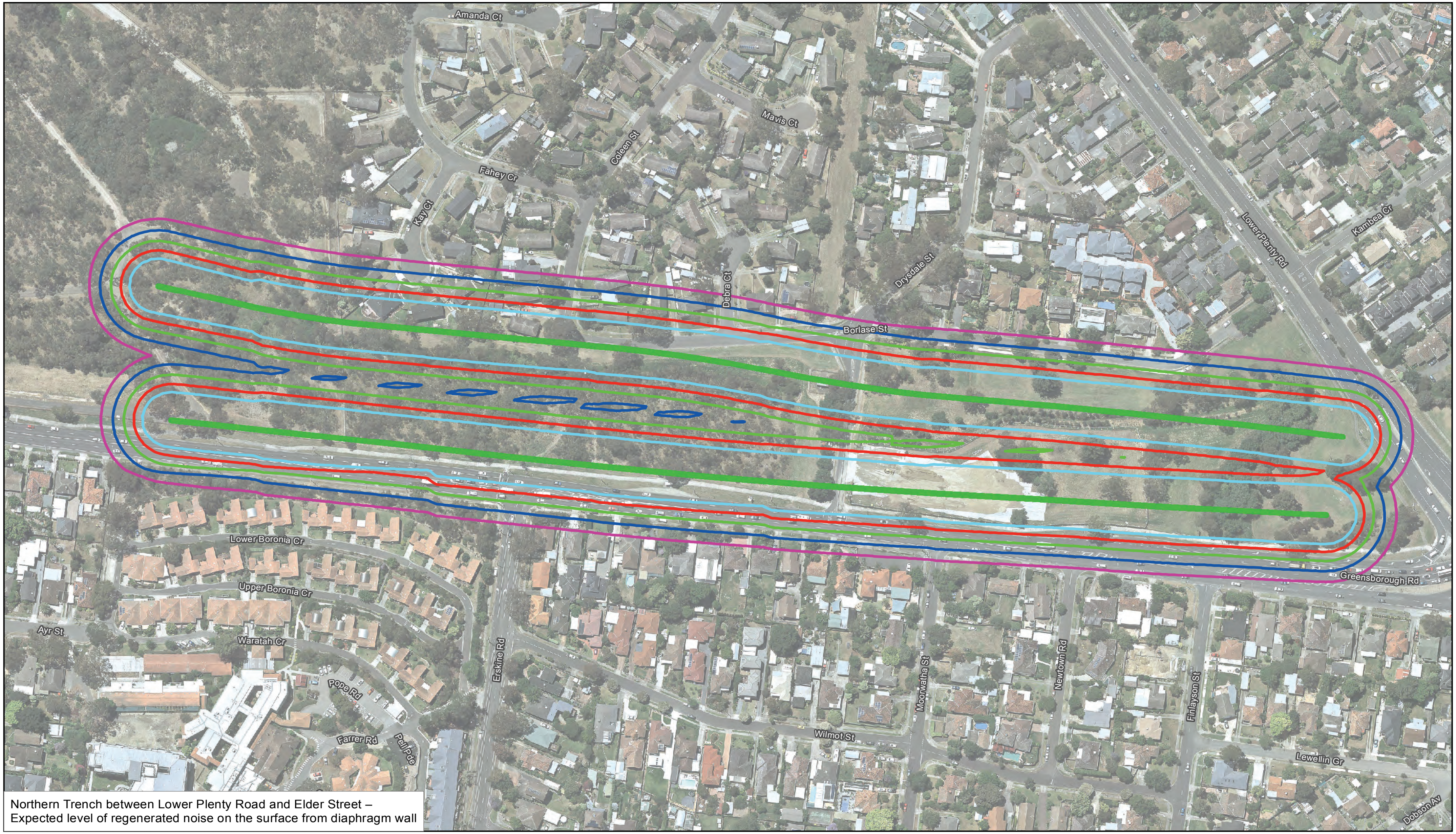
Data source: Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Appendix D Predicted regenerated noise contours for option 1 (reference project)



Northern Trench between Lower Plenty Road and Elder Street –
Expected level of regenerated noise on the surface from diaphragm wall

Paper Size A3

0 20 40 60 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Diaphragm Wall
- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

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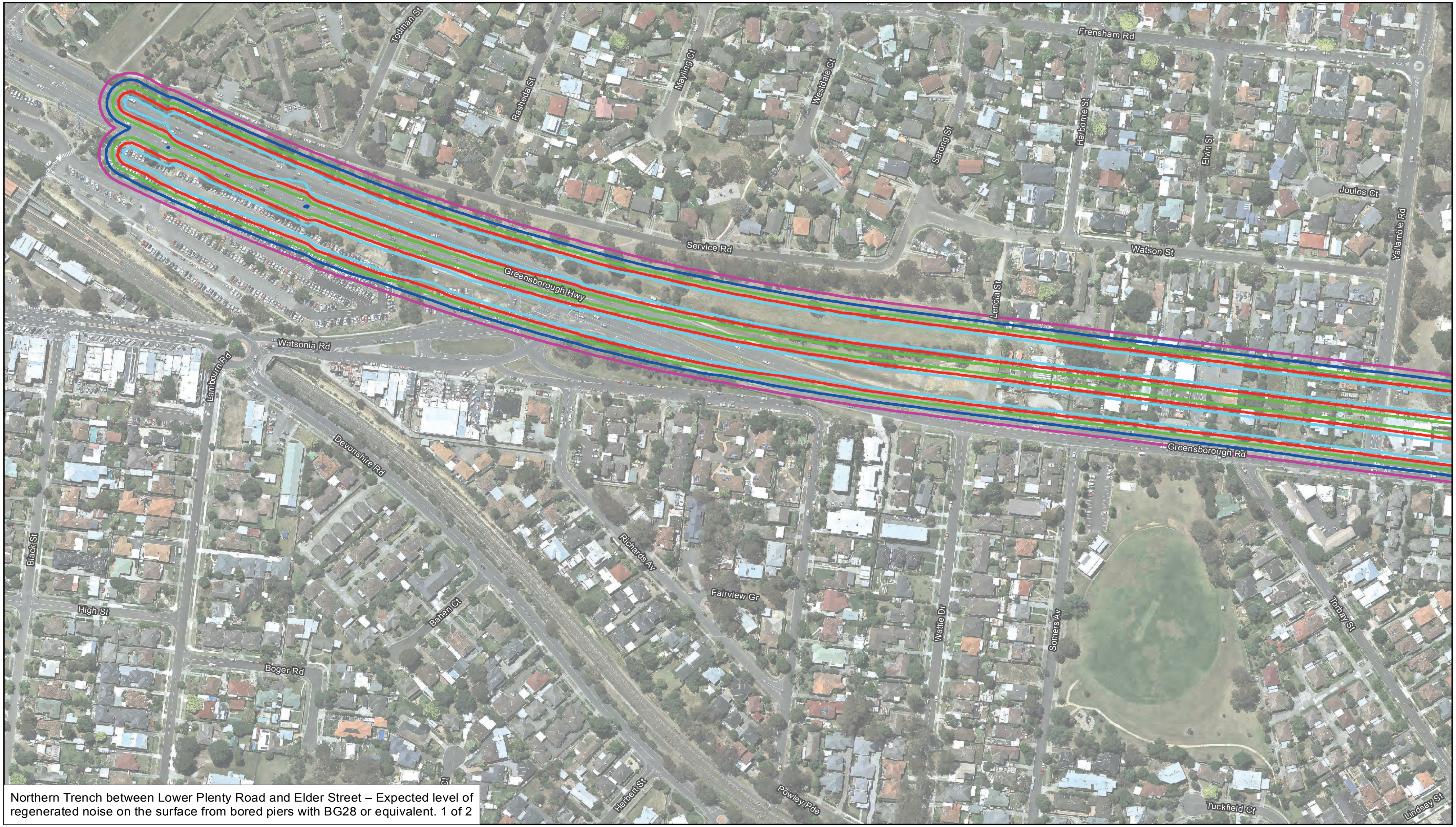
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of regenerated noise on the surface from bored piers with BG28 or equivalent. 1 of 2

Paper Size A3

0 25 50 75 100

Metres

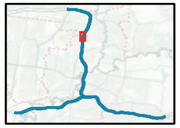
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour



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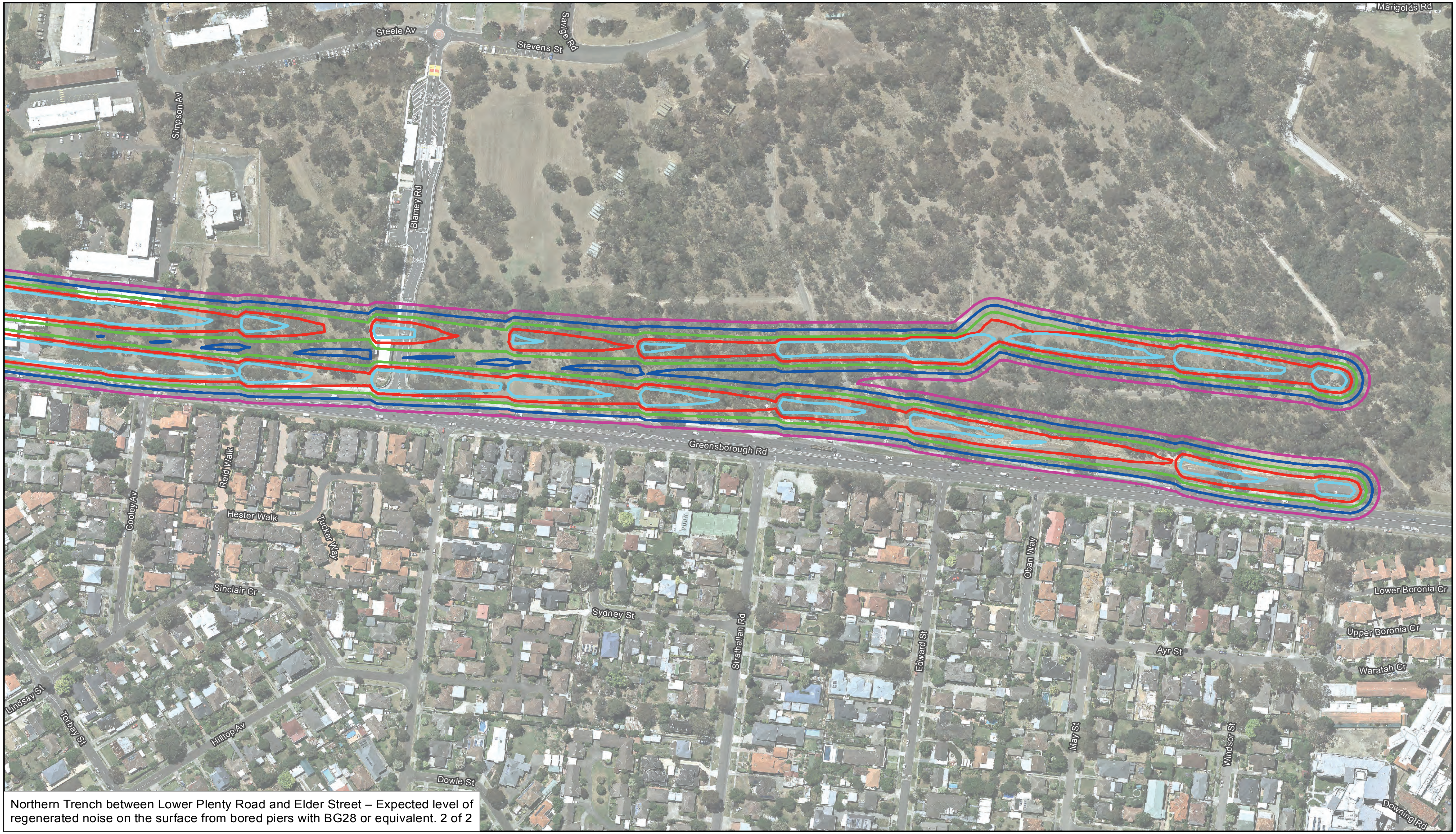
Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of regenerated noise on the surface from bored piers with BG28 or equivalent. 2 of 2

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

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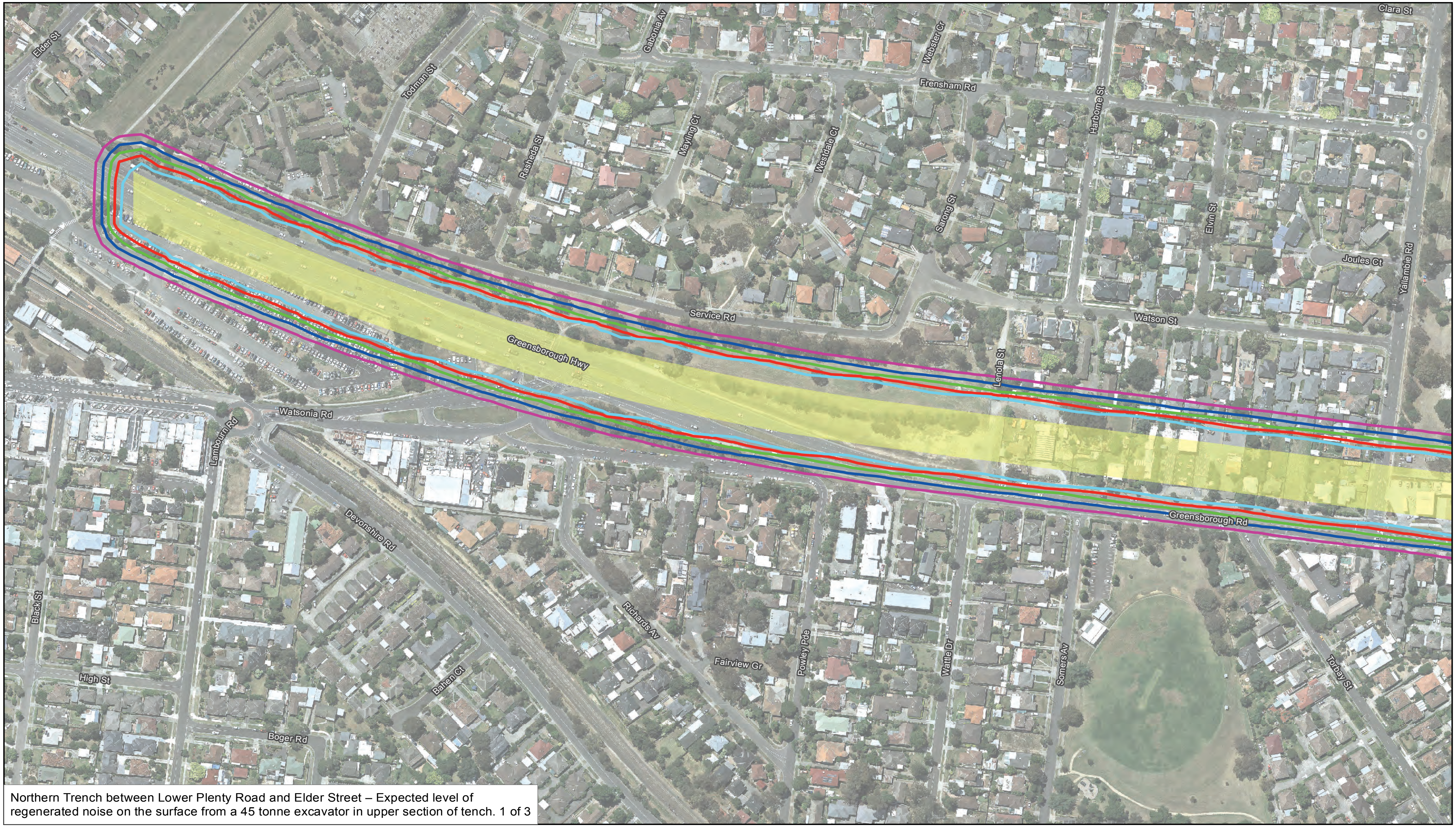
Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of regenerated noise on the surface from a 45 tonne excavator in upper section of tench. 1 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Trench

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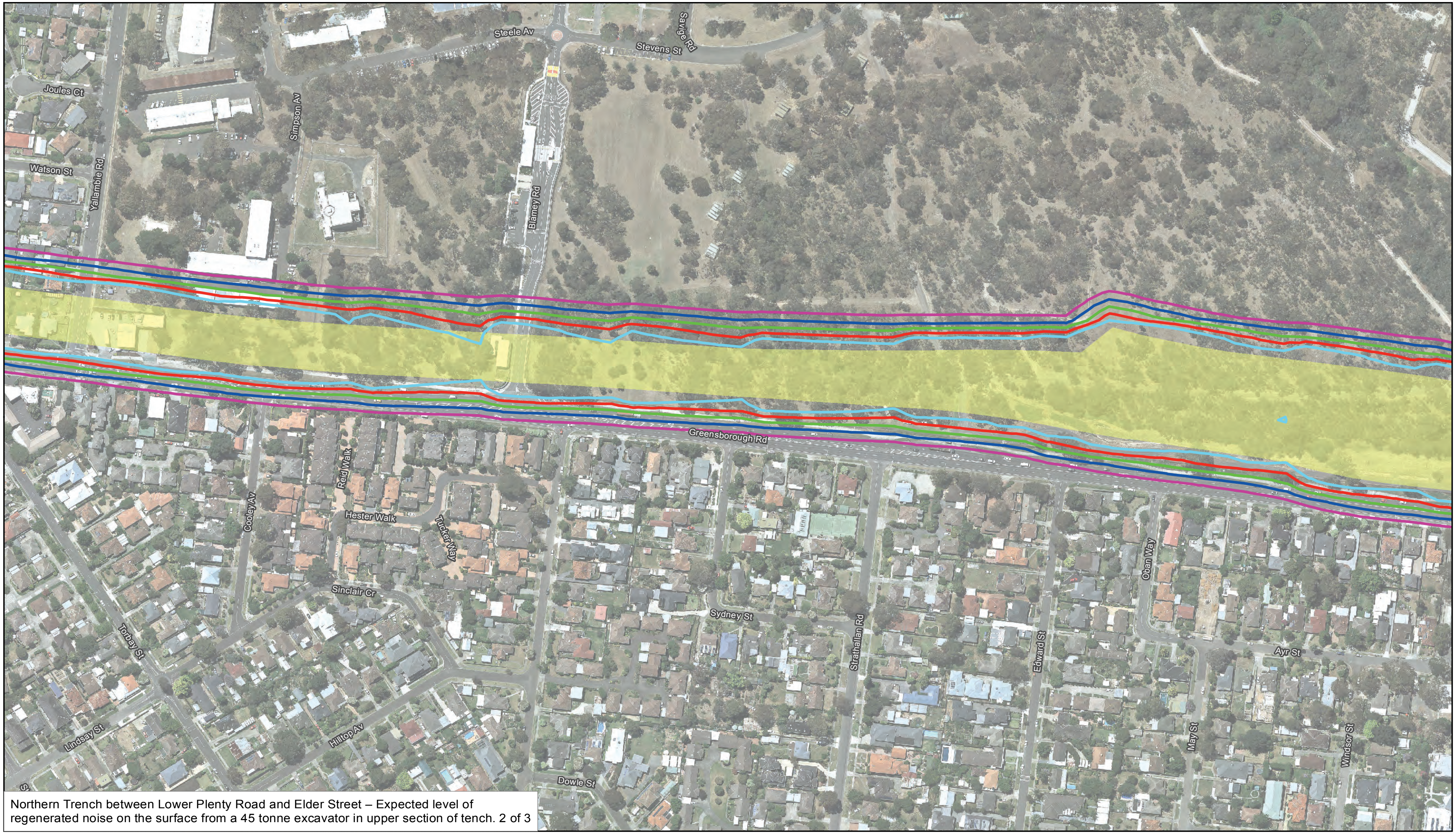
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of regenerated noise on the surface from a 45 tonne excavator in upper section of tench. 2 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Trench
- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

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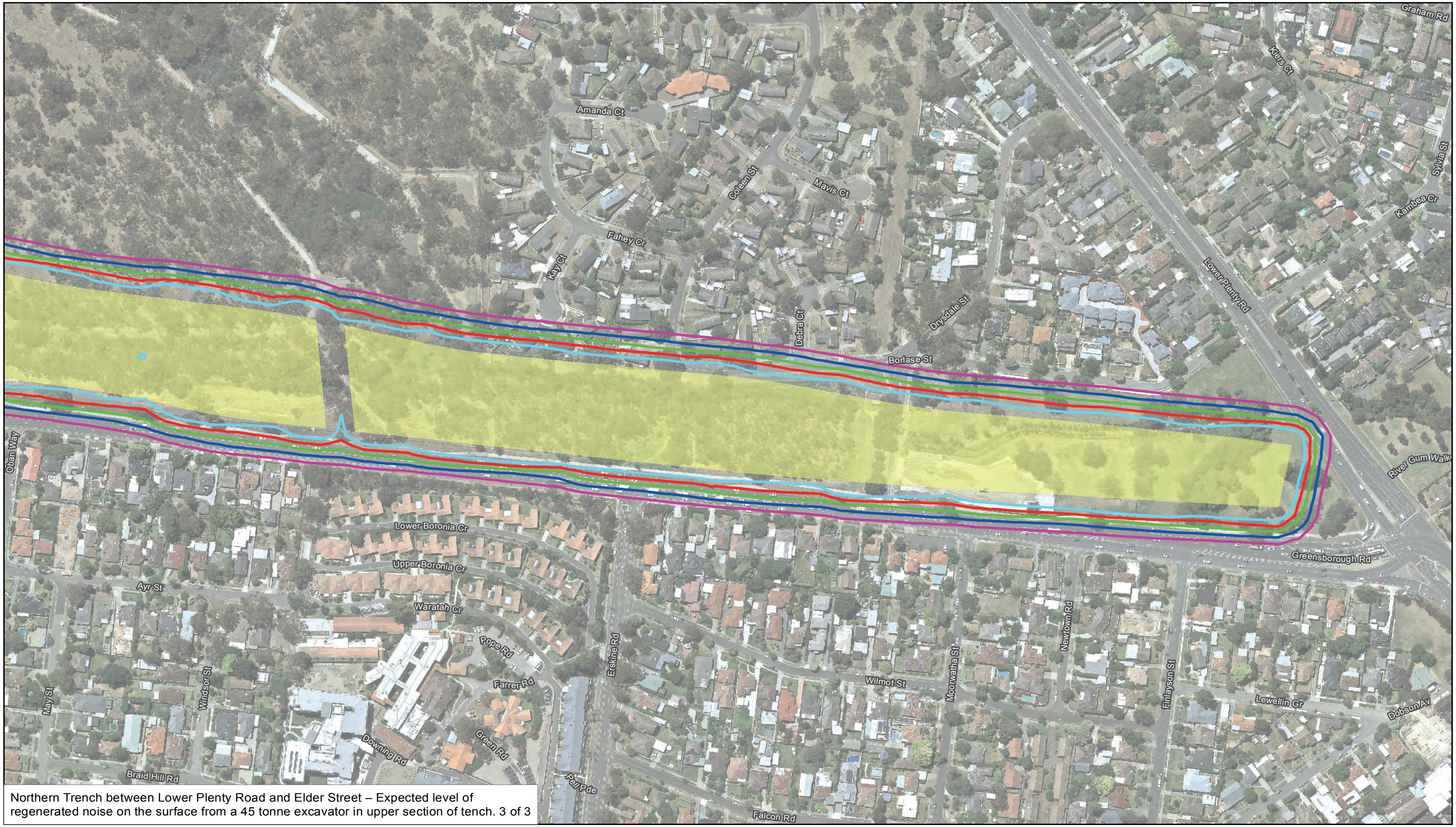
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Expected level of regenerated noise on the surface from a 45 tonne excavator in upper section of tench. 3 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Trench
- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

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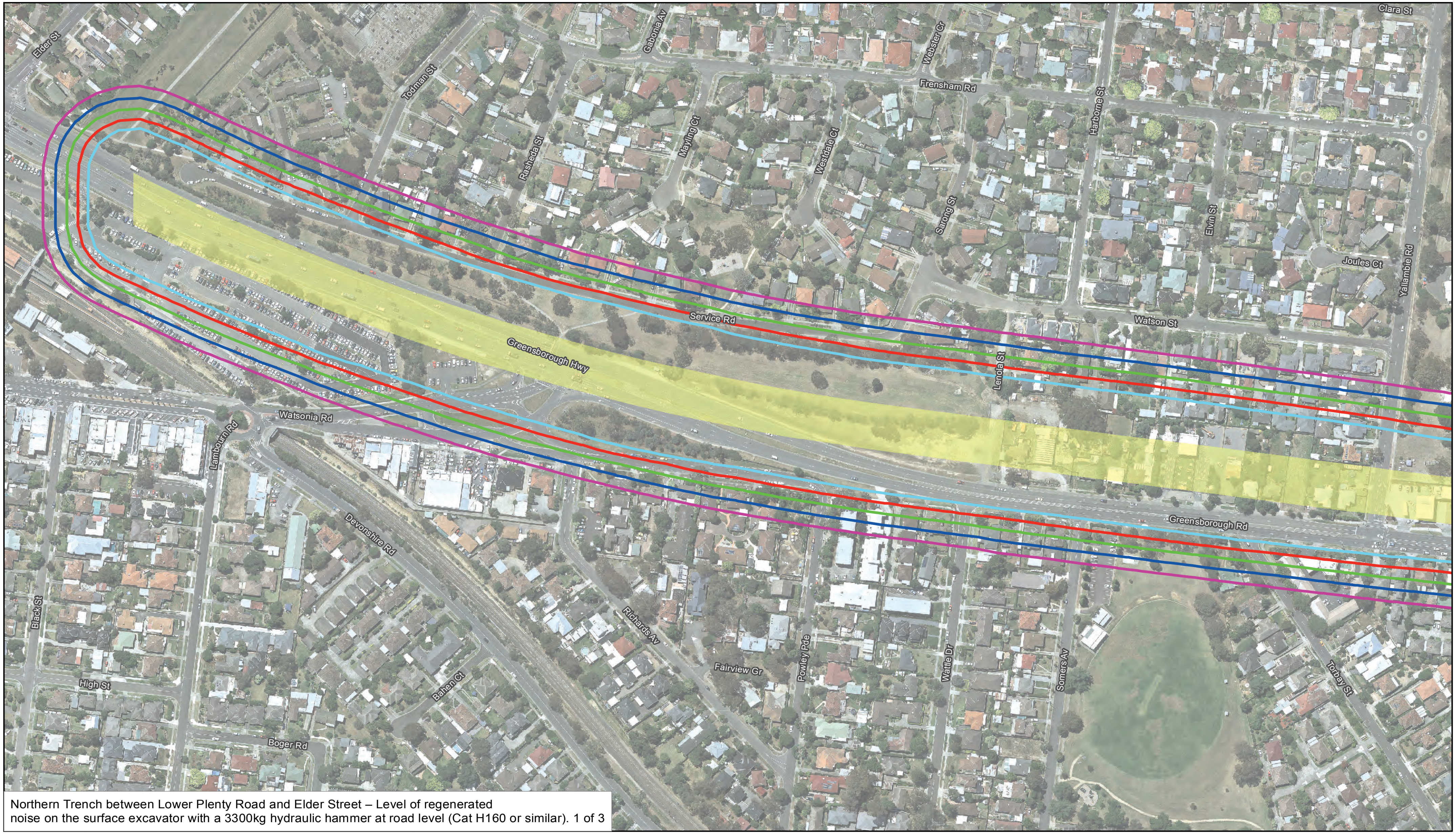

Northern Trench between Lower Plenty Road and Elder Street – Level of regenerated noise on the surface excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 1 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Trench
- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

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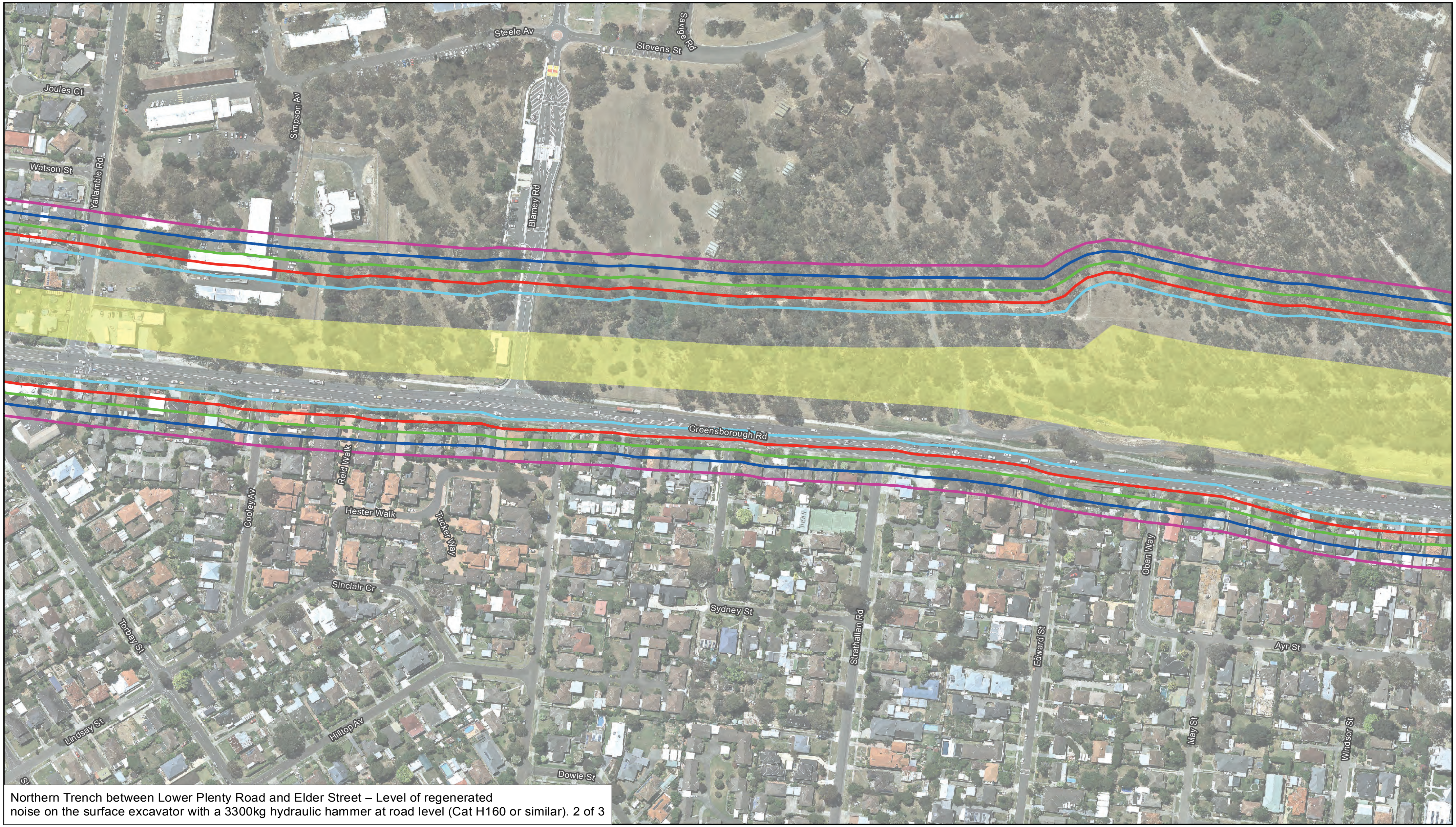

Northern Trench between Lower Plenty Road and Elder Street – Level of regenerated noise on the surface excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 2 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Trench

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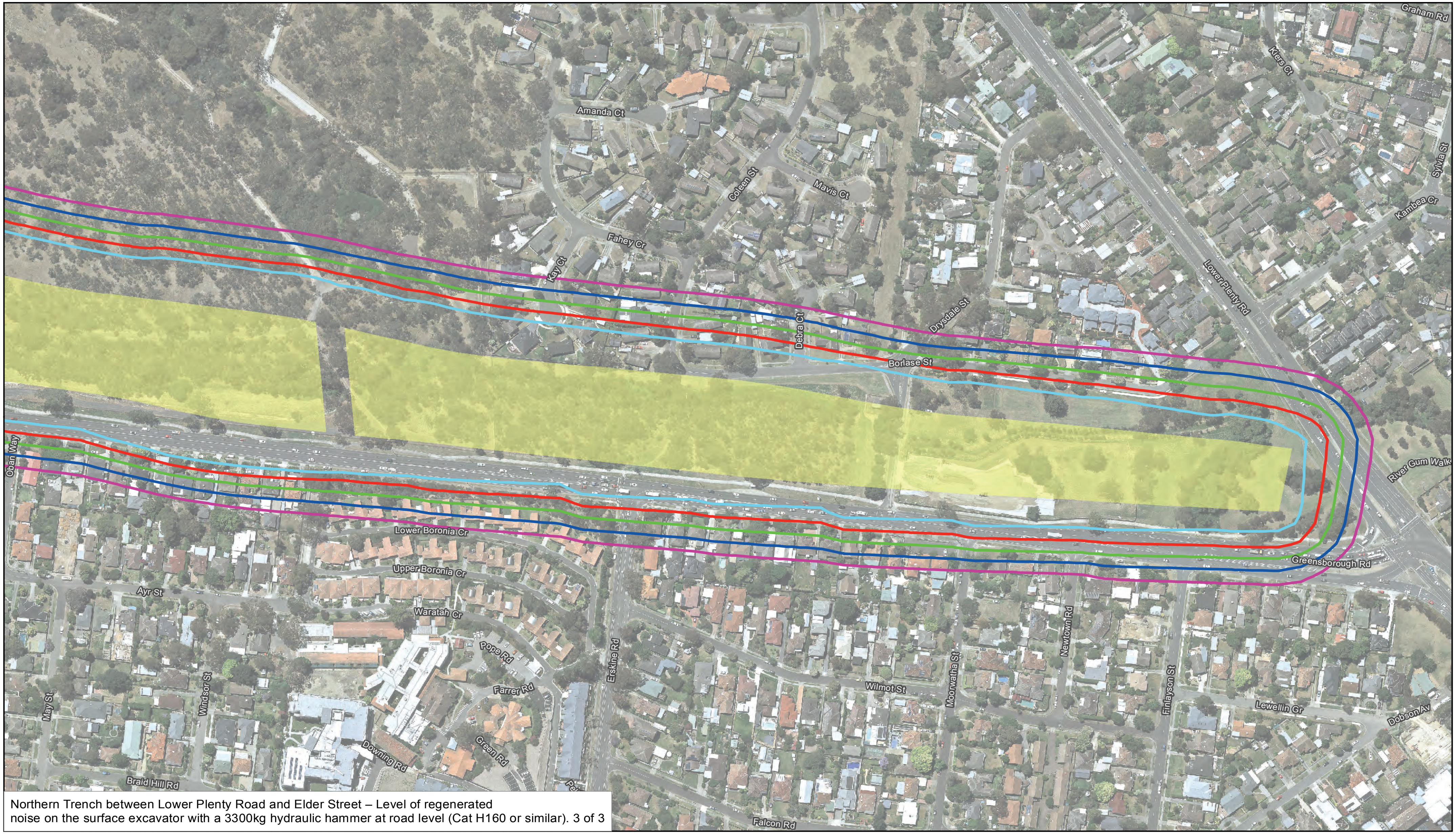
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Northern Trench between Lower Plenty Road and Elder Street – Level of regenerated noise on the surface excavator with a 3300kg hydraulic hammer at road level (Cat H160 or similar). 3 of 3

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Trench

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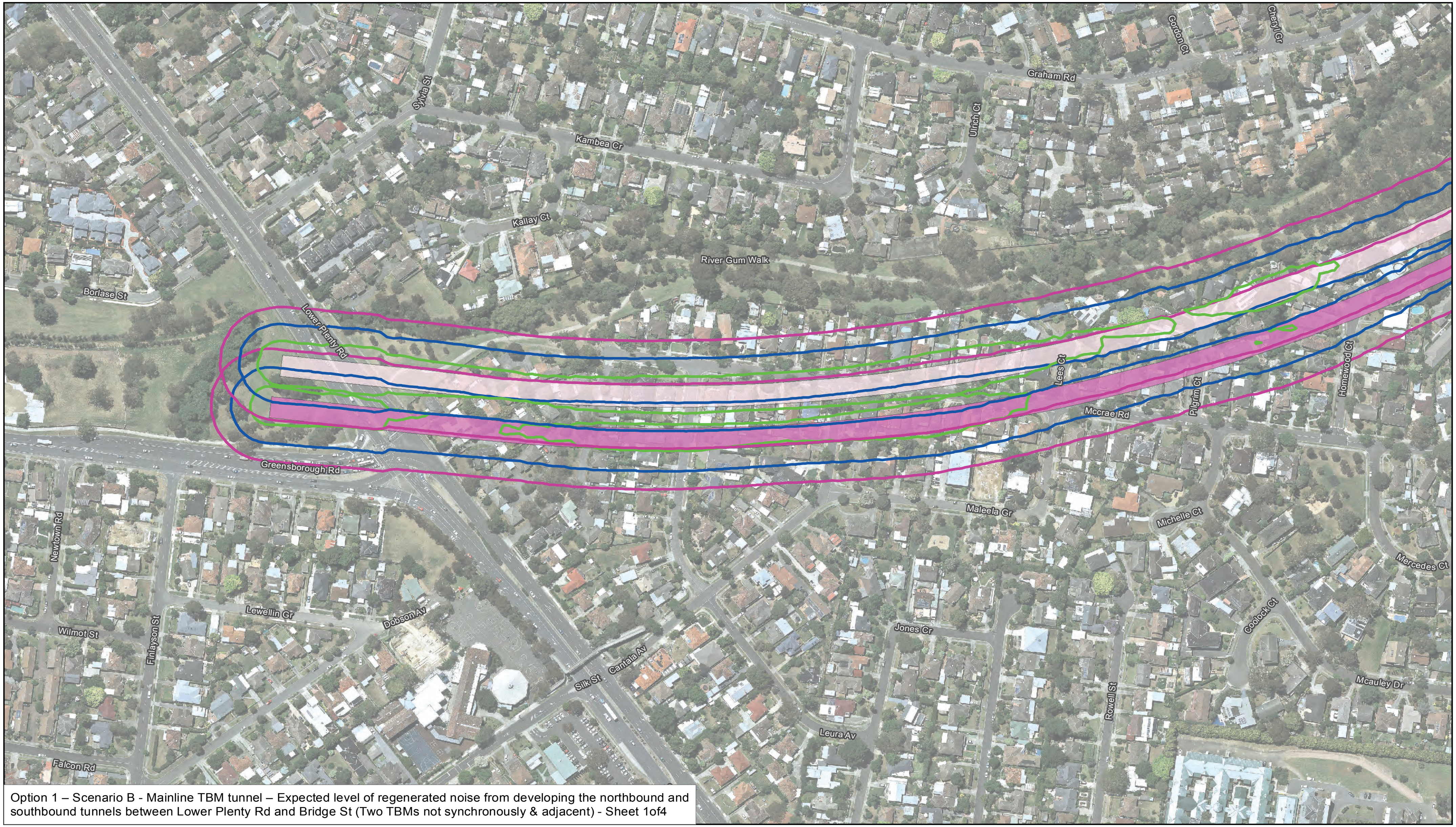
Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario B - Mainline TBM tunnel – Expected level of regenerated noise from developing the northbound and southbound tunnels between Lower Plenty Rd and Bridge St (Two TBMs not synchronously & adjacent) - Sheet 1of4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

NELA Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

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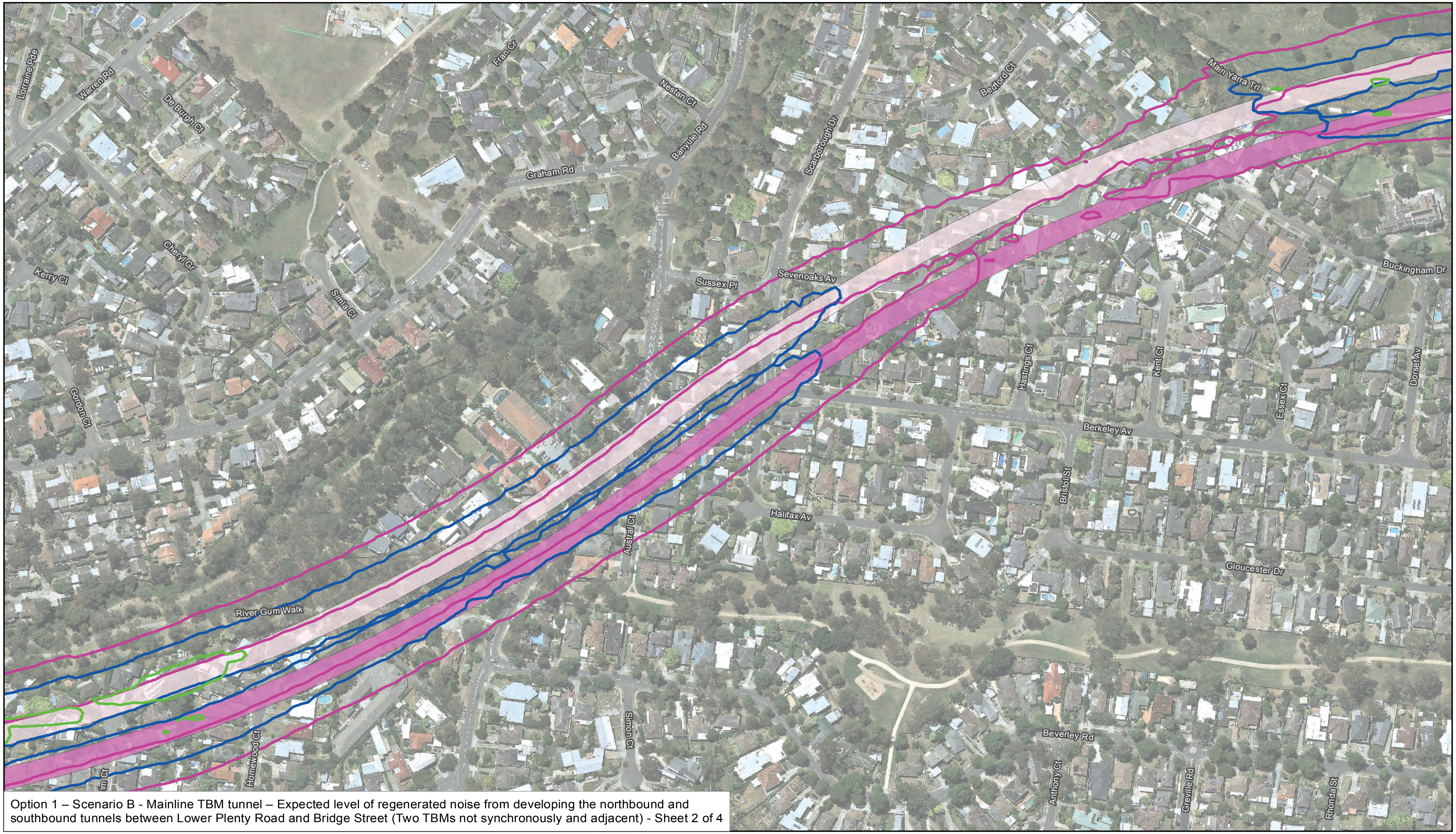
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario B - Mainline TBM tunnel – Expected level of regenerated noise from developing the northbound and southbound tunnels between Lower Plenty Road and Bridge Street (Two TBMs not synchronously and adjacent) - Sheet 2 of 4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

NELA Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

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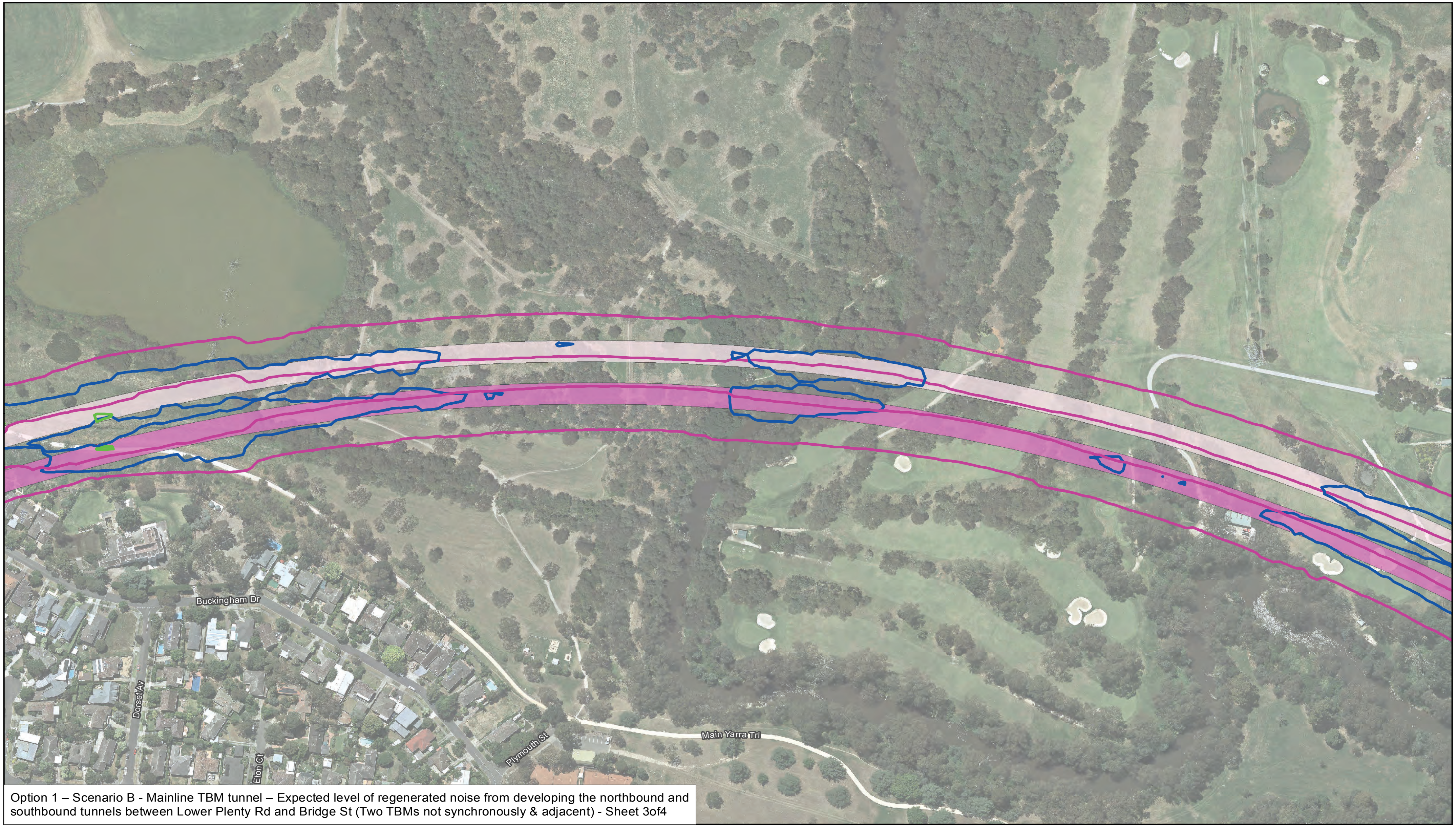
Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario B - Mainline TBM tunnel – Expected level of regenerated noise from developing the northbound and southbound tunnels between Lower Plenty Rd and Bridge St (Two TBMs not synchronously & adjacent) - Sheet 3of4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

NELA Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

- kml_id_doc_1.1.45.15

Tunnel_Southbound

- kml_id_doc_1.1.45.16

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

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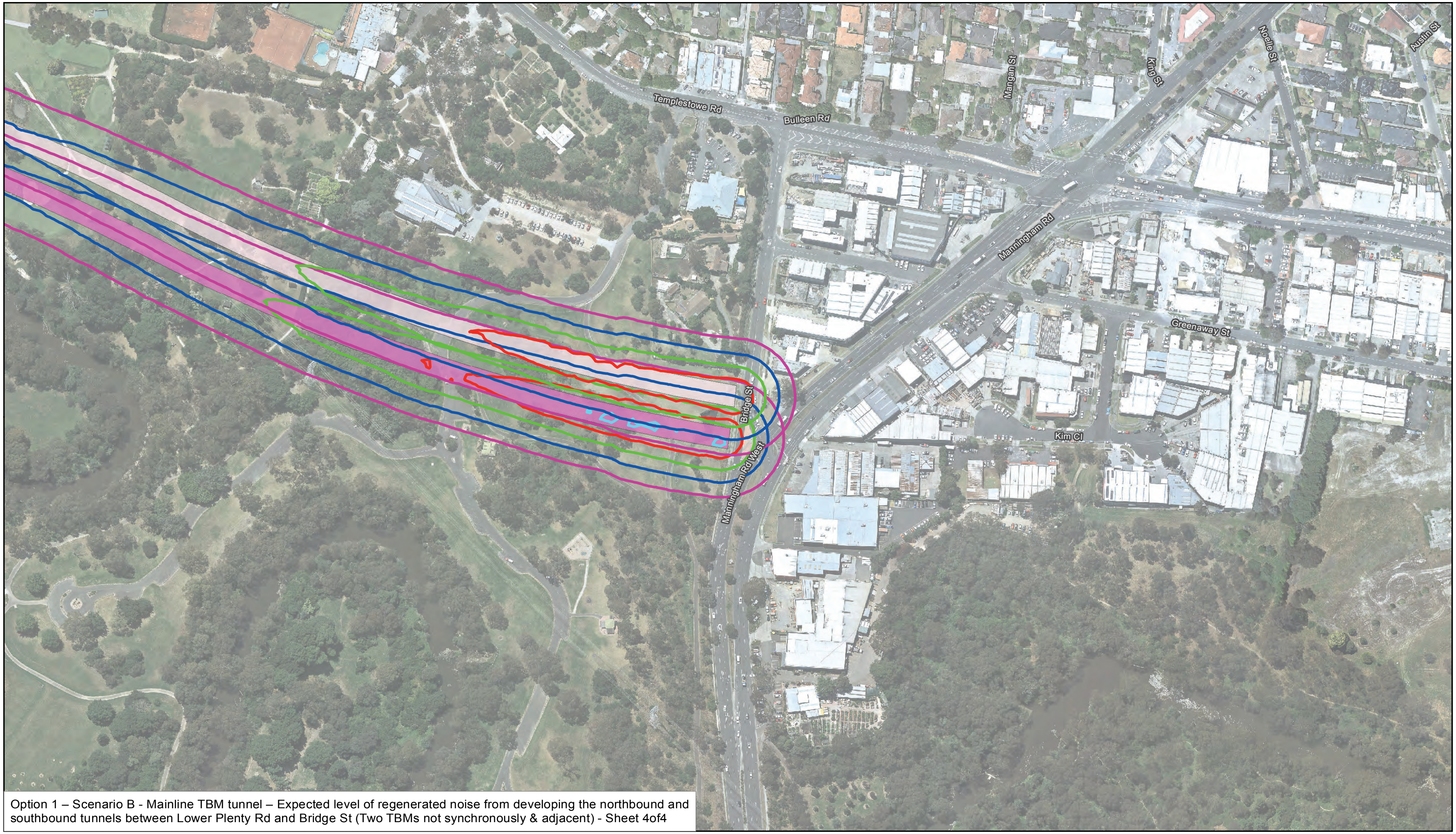

Option 1 – Scenario B - Mainline TBM tunnel – Expected level of regenerated noise from developing the northbound and southbound tunnels between Lower Plenty Rd and Bridge St (Two TBMs not synchronously & adjacent) - Sheet 4of4

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

NELA Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

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Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road – Expected level of regenerated noise from excavation with a 45 tonne excavator operating at the surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- NB Cut and Cover Floor 2 Option 1
- SB Cut and Cover Floor 2 Option 1

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road – Expected level of regenerated noise from excavation with a 45 tonne excavator with a 3300 kilogram hydraulic hammer operating at the design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- NB Cut and Cover Floor 2 Option 1
- SB Cut and Cover Floor 2 Option 1

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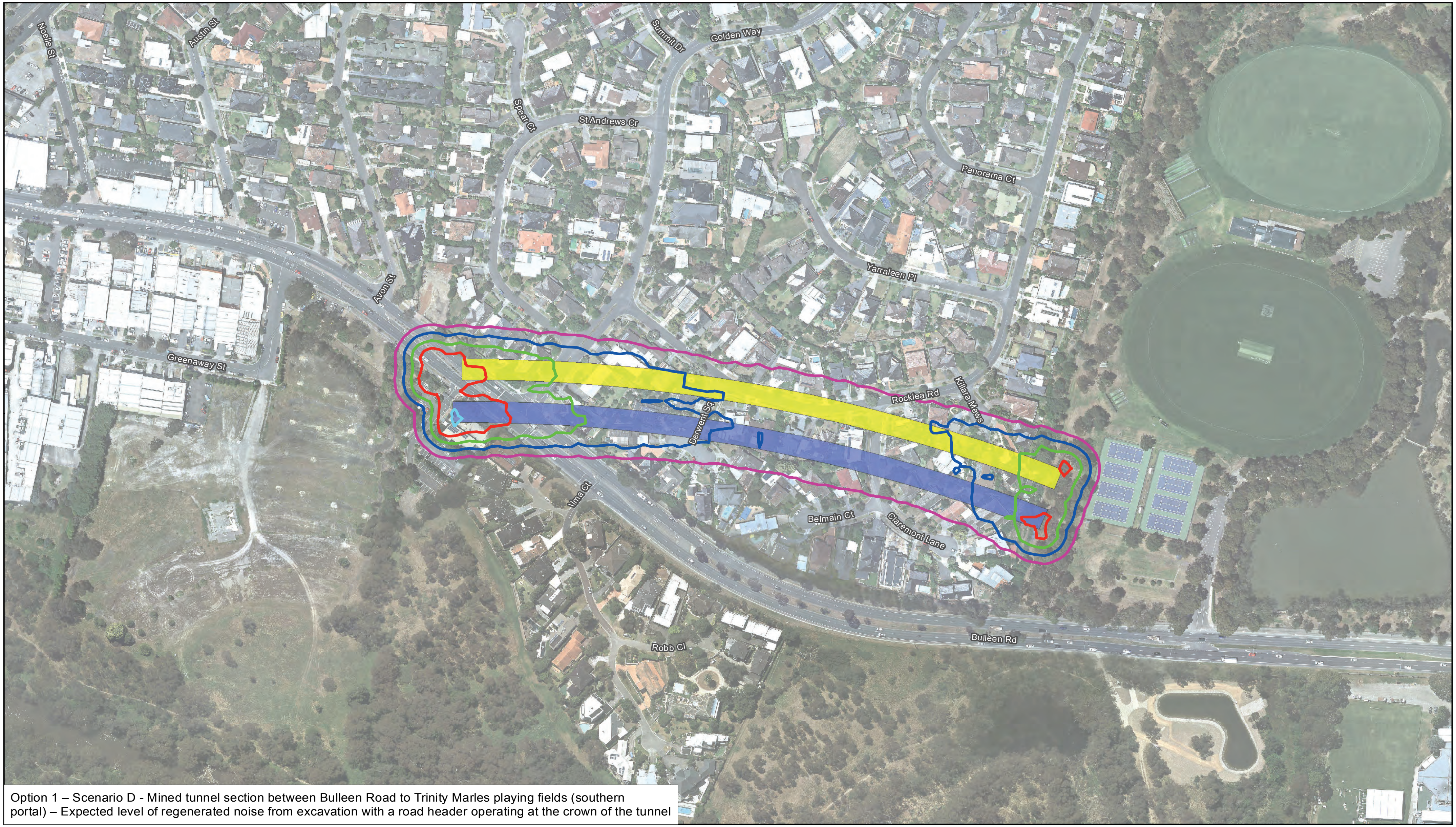
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario D - Mined tunnel section between Bulleen Road to Trinity Marles playing fields (southern portal) – Expected level of regenerated noise from excavation with a road header operating at the crown of the tunnel

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15_N

Tunnel_Southbound

kml_id_doc_1.1.45.16_N

NORTH EAST LINK PROJECT

North East Link Authority
North East Link Project

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Revision	E
Date	25 Sep 2018

Appendix D –
Regenerated Noise Contours for Option 1

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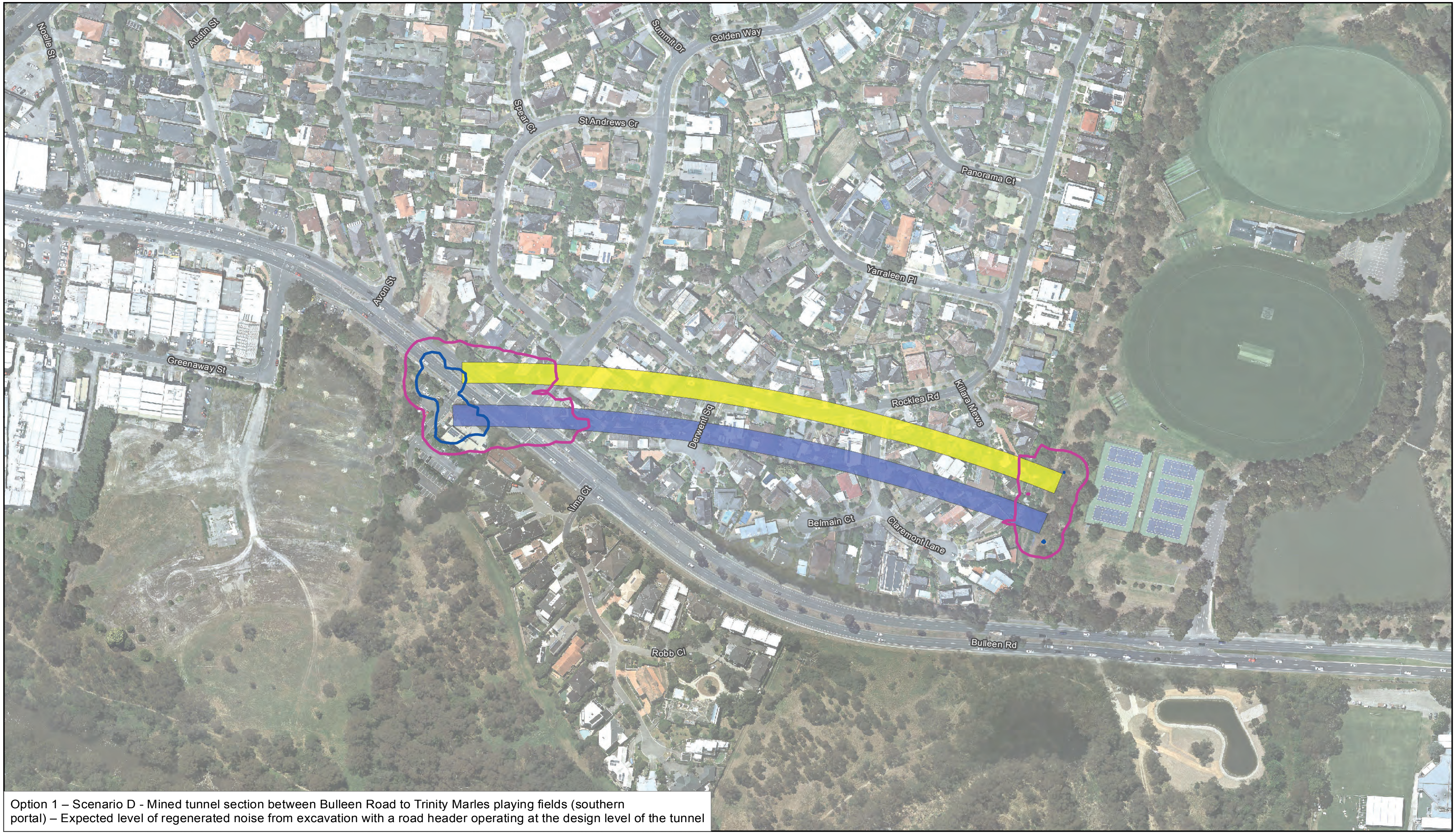
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario D - Mined tunnel section between Bulleen Road to Trinity Marles playing fields (southern portal) – Expected level of regenerated noise from excavation with a road header operating at the design level of the tunnel

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15_N

Tunnel_Southbound

kml_id_doc_1.1.45.16_N

NORTH EAST LINK PROJECT

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Appendix D – Regenerated Noise Contours for Option 1

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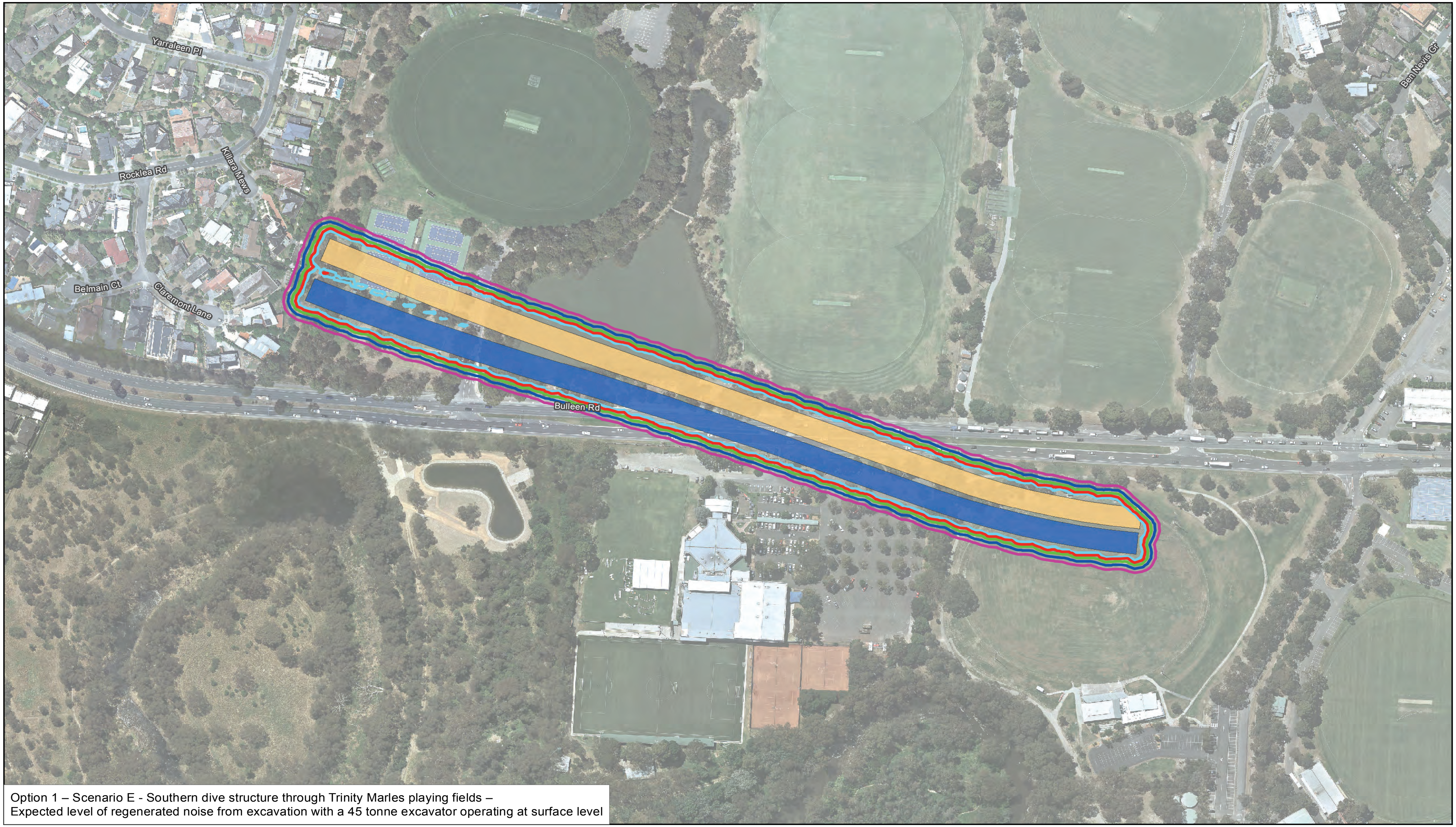
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 1 – Scenario E - Southern dive structure through Trinity Marles playing fields –
Expected level of regenerated noise from excavation with a 45 tonne excavator operating at surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- NB Cut and Cover Floor 3 Option 1
- SB Cut and Cover Floor 3 Option 1

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Appendix D – Regenerated Noise Contours for Option 1

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Air Noise and Wireless\Tunnel_Vibration\3135006_AppD_Noise_Contours_A3L_figs10to24_revE.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario E - Southern dive structure through Trinity Marles playing fields –
Expected level of regenerated noise from excavation with a 45 tonne excavator operating at design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- NB Cut and Cover Floor 3 Option 1
- SB Cut and Cover Floor 3 Option 1

NORTH EAST LINK PROJECT

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Appendix D –
Regenerated Noise Contours for Option 1

Job Number	31-35006
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G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Air Noise and Wireless\Tunnel_Vibration\3135006_AppD_Noise_Contours_A3L_figs10to24_revE.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of regenerated noise from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 1 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

NORTH EAST LINK PROJECT

North East Link Authority
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Appendix D –
Regenerated Noise Contours for Option 1

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of regenerated noise from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 2 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

North East Link Authority
North East Link Project

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Appendix D –
Regenerated Noise Contours for Option 1

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Air Noise and Wireless\Tunnel_Vibration\3135006_AppD_Noise_Contours_A3L_figs10to24_revE.mxd

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Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario F -Cross passages through TBM and mined section tunnels – Expected level of regenerated noise from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 3 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

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Appendix D –
Regenerated Noise Contours for Option 1

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of regenerated noise from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 4 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

kml_id_doc_1.1.45.15

Tunnel_Southbound

kml_id_doc_1.1.45.16

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Appendix D –
Regenerated Noise Contours for Option 1

Option 1 – Scenario F - Cross passages through TBM and mined section tunnels – Expected level of regenerated noise from excavation with a 20 tonne excavator with a 1500 kilogram hydraulic hammer operating at the crown level – Sheet 5 of 5

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour

Tunnel_Northbound

- kml_id_doc_1.1.45.15_N

Tunnel_Southbound

- kml_id_doc_1.1.45.16_N

NORTH EAST LINK PROJECT

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Appendix D –
Regenerated Noise Contours for Option 1

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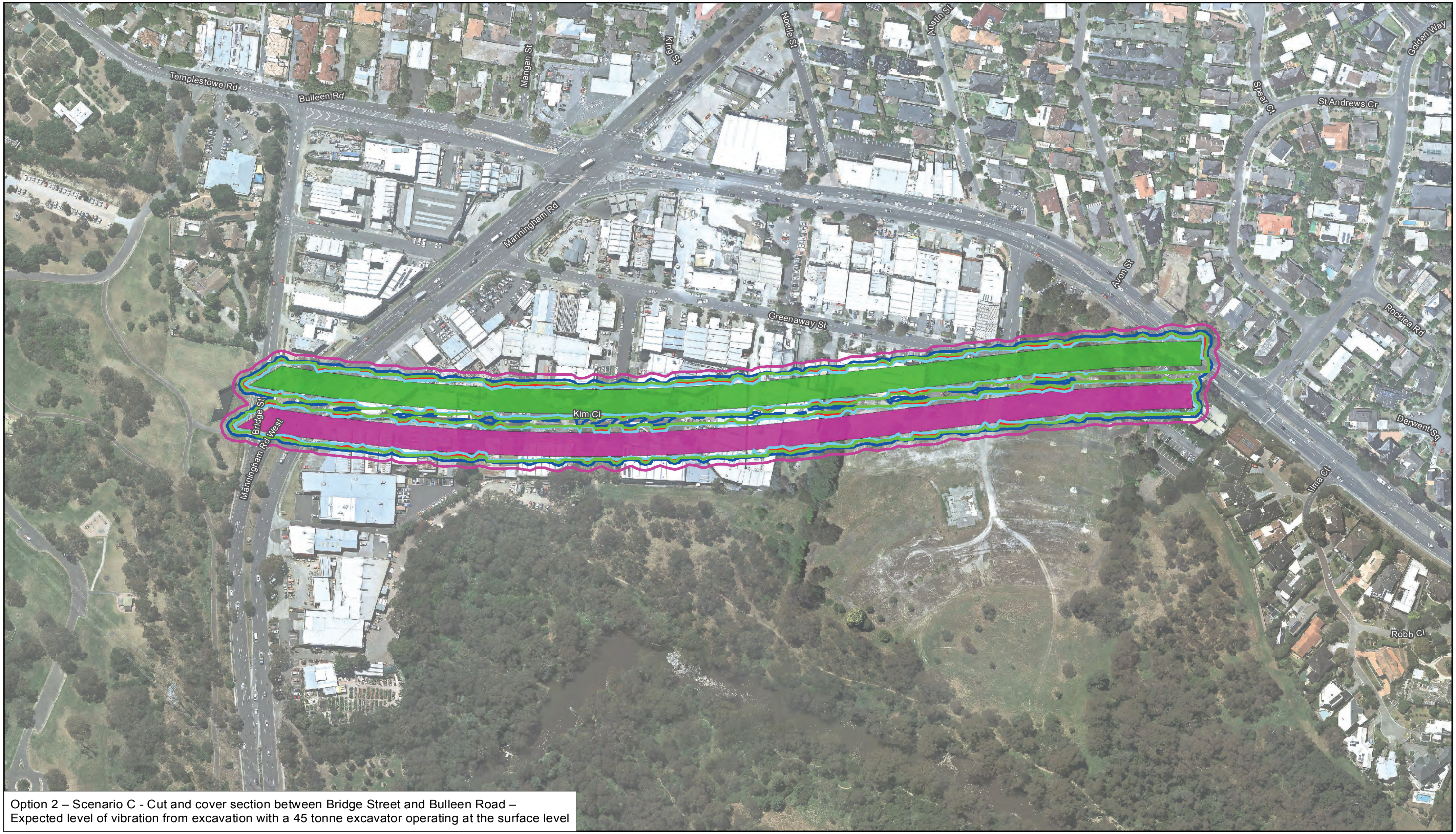
G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Air Noise and Wireless\Tunnel_Vibration\3135006_AppD_Noise_Contours_A3L_figs10to24_revE.mxd

Data source: Noise Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Appendix E Predicted vibration and regenerated noise contours for option 2 (alternative design)



Option 2 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road – Expected level of vibration from excavation with a 45 tonne excavator operating at the surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Cut and Cover Northbound
- Cut and Cover Southbound

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Appendix E – Vibration and Regenerated Noise Contours for Option 2

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise/Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 2 - Scenario C - Cut and cover section between Bridge Street and Bulleen Road –
Expected level of vibration from excavation with a 45 tonne excavator with a 3300 kilogram hydraulic hammer operating at the design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- Cut and Cover Northbound
- Cut and Cover Southbound

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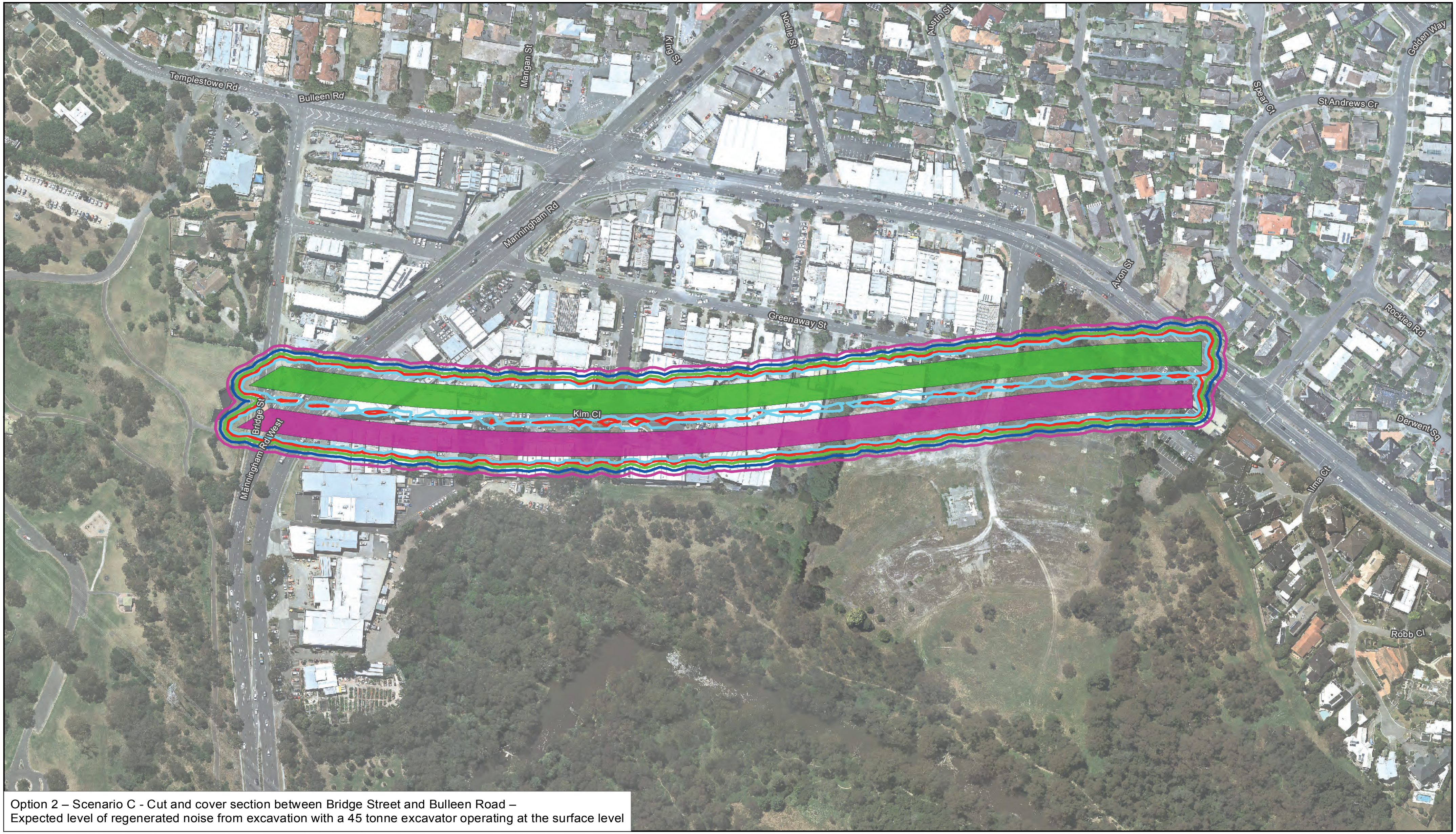
Appendix E – Vibration and Regenerated Noise Contours for Option 2

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Air Noise and Wireless\Tunnel_Vibration\3135006_AppE_Noise_Vibration_Contours_A3L_RevB.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Noise/Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives



Option 2 – Scenario C - Cut and cover section between Bridge Street and Bulleen Road –
Expected level of regenerated noise from excavation with a 45 tonne excavator operating at the surface level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Cut and Cover Northbound
- Cut and Cover Southbound

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North East Link Project

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Date	26 Sep 2018

Appendix E – Vibration and Regenerated Noise Contours for Option 2

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Data source: Noise/Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

Option 2 - Scenario C - Cut and cover section between Bridge Street and Bulleen Road –
Expected level of regenerated noise from excavation with a 45 tonne excavator with a 3300 kilogram hydraulic hammer operating at the design level

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Cut and Cover Northbound
- Cut and Cover Southbound

NORTH EAST LINK PROJECT

North East Link Authority
North East Link Project

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Date	26 Sep 2018

Appendix E – Vibration and Regenerated Noise Contours for Option 2

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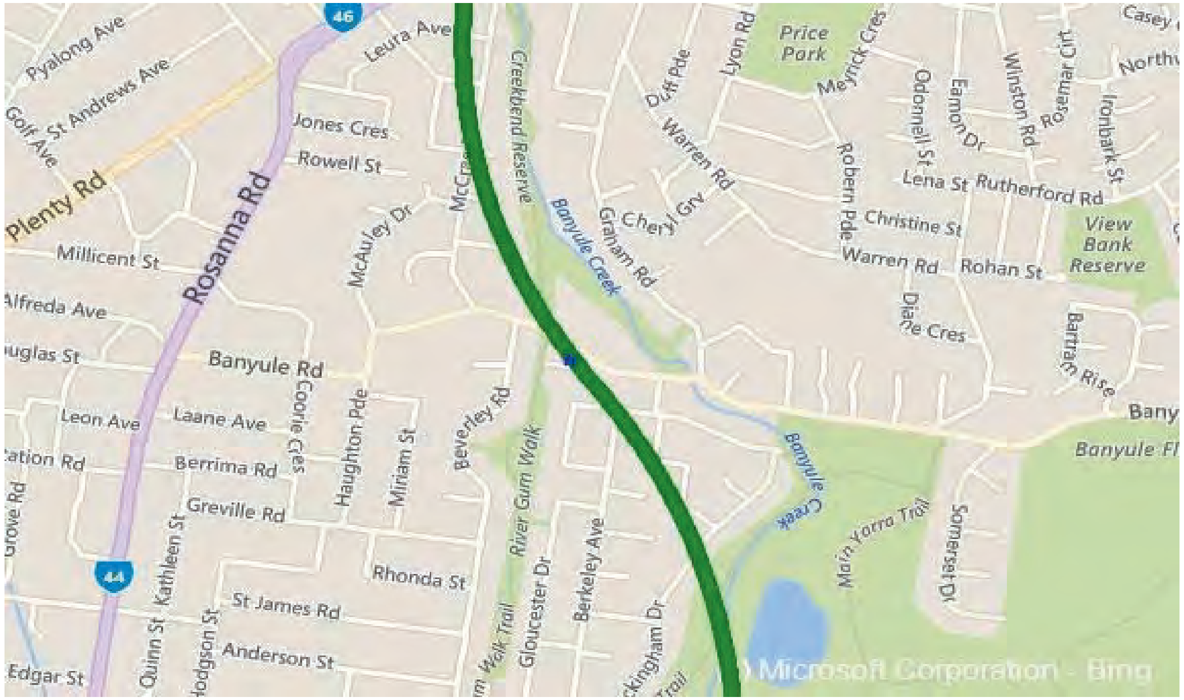
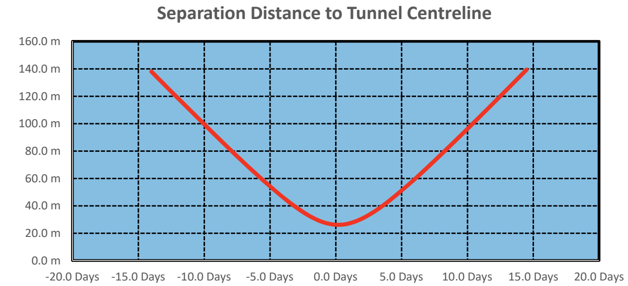
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

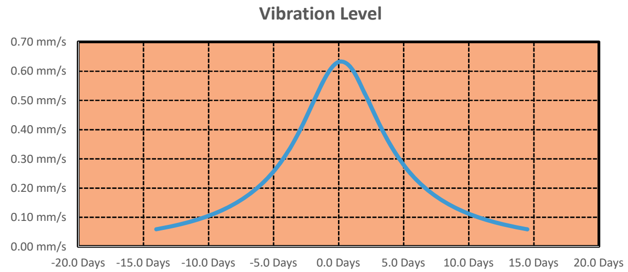
Data source: Noise/Vibration Contours, Heilig & Partners, 2018; CIP Imagery, DELWP, 2018; Roads/POI/Cadastre, Vicmap, 2018; Inset Basemap, CARTO, 2018 . Created by:mjshrives

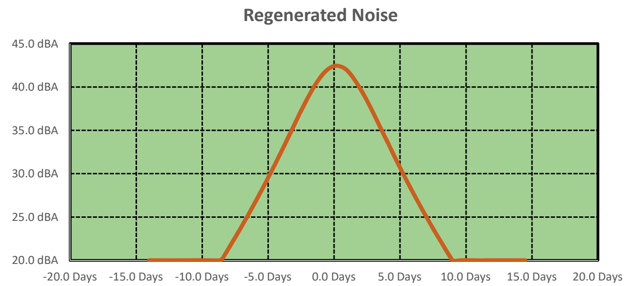
Appendix F Disturbance envelopes for northbound tunnel

Assessment Location: Austral Court - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.7 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	26.1 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.55 mm/s
95% Vibration Level	0.61 mm/s
Maximum Vibration Level	0.63 mm/s
Average Regenerated Noise level	27.2 dBA
90% Regenerated Noise Level	40.3 dBA
95% Regenerated Noise Level	41.9 dBA
Maximum Regenerated Noise Level	42.4 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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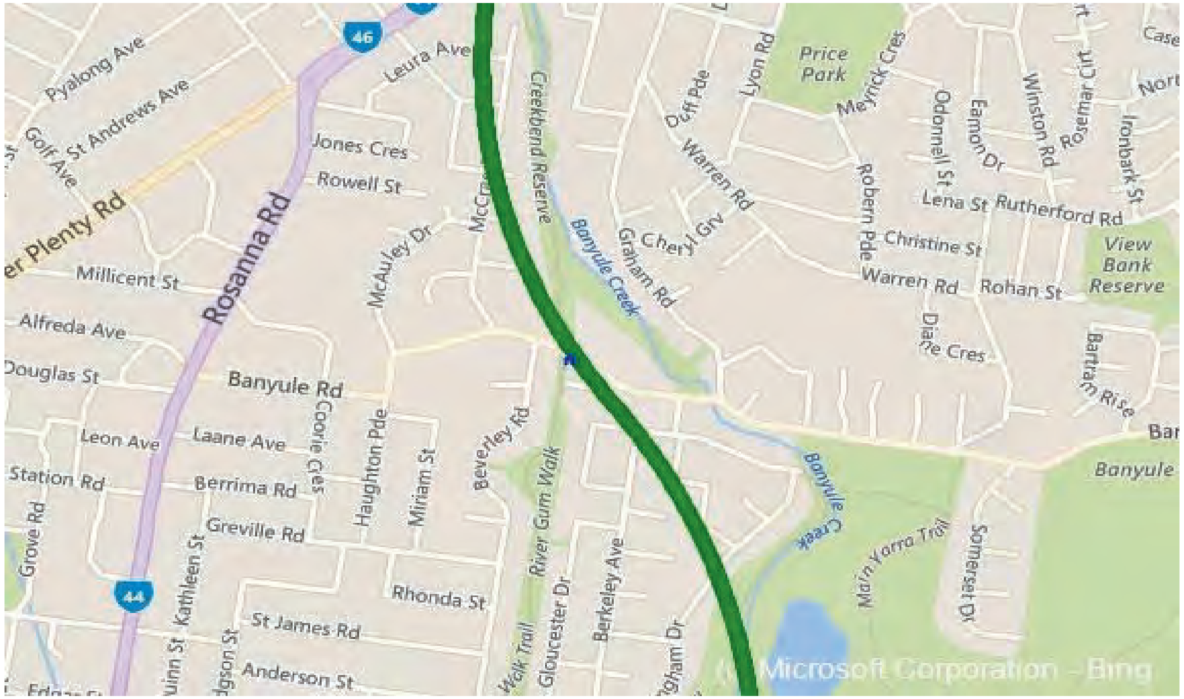
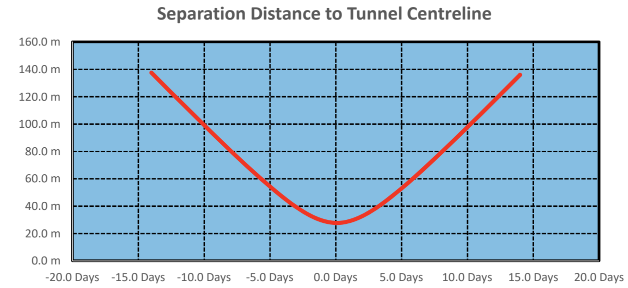
heiligandpartners.com.au
Web Address:
www.heiligandpartners.com.au

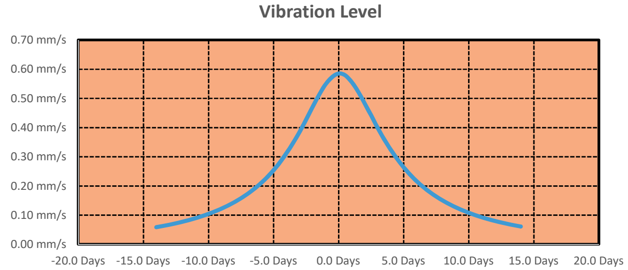
NORTH EAST LINK PROJECT

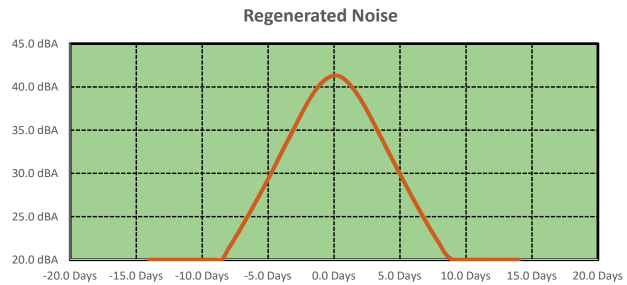
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Austral Court - 8









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.7 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.5 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	27.7 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.52 mm/s
95% Vibration Level	0.56 mm/s
Maximum Vibration Level	0.59 mm/s
Average Regenerated Noise level	27.0 dBA
90% Regenerated Noise Level	39.5 dBA
95% Regenerated Noise Level	40.7 dBA
Maximum Regenerated Noise Level	41.3 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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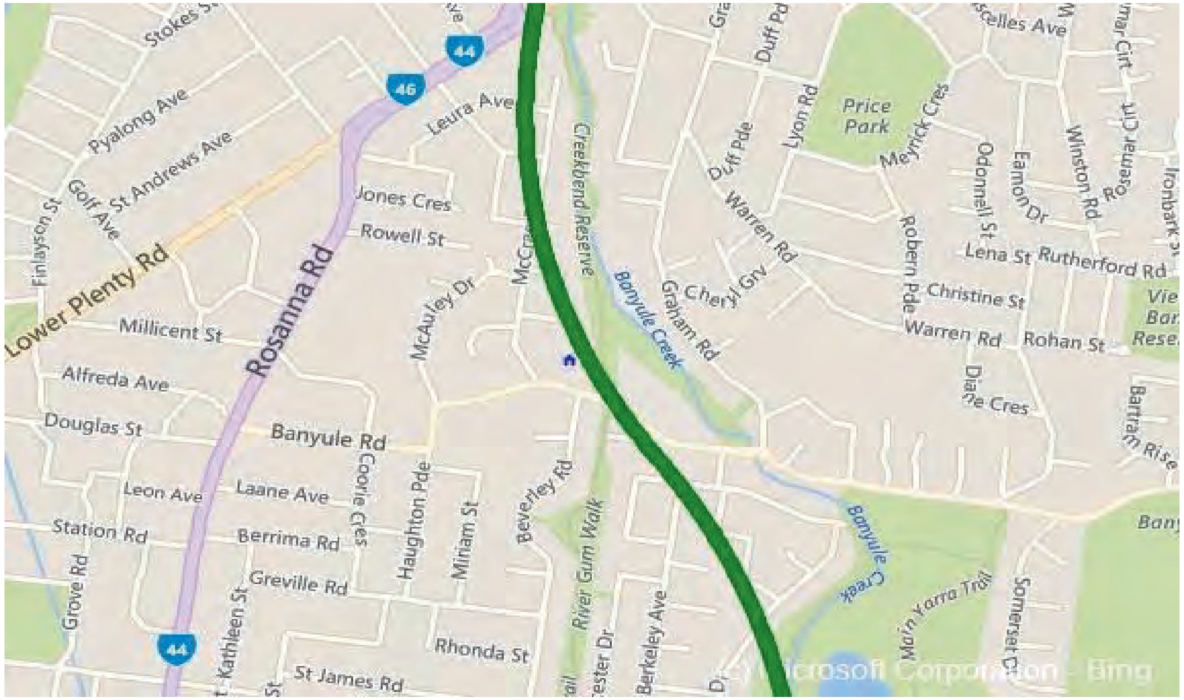
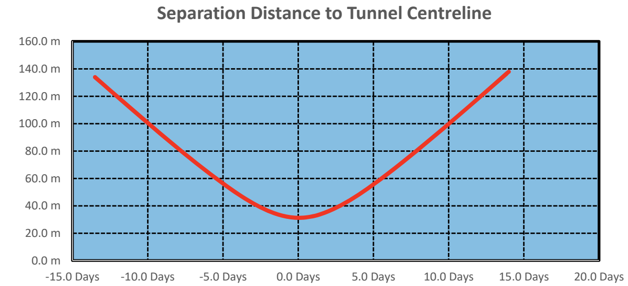
Web Address: www.heiligandpartners.com.au

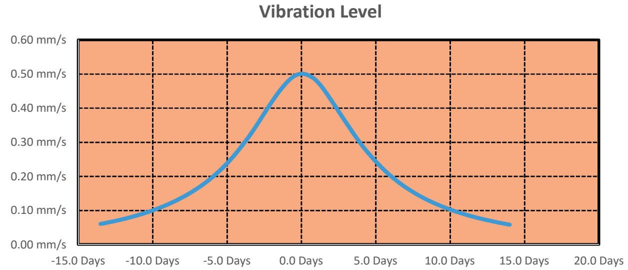
NORTH EAST LINK PROJECT

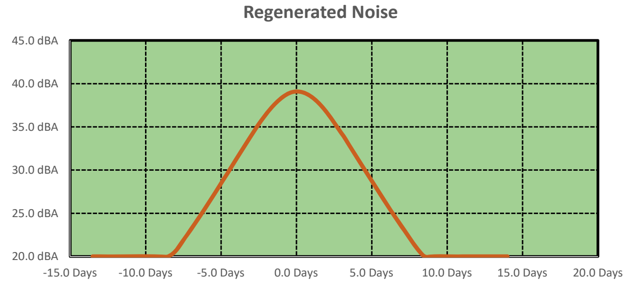
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Banyule Road - 71









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.1 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.1 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.2 m
Average Vibration Level	0.22 mm/s
90% Vibration Level	0.45 mm/s
95% Vibration Level	0.48 mm/s
Maximum Vibration Level	0.50 mm/s
Average Regenerated Noise level	26.3 dBA
90% Regenerated Noise Level	37.6 dBA
95% Regenerated Noise Level	38.6 dBA
Maximum Regenerated Noise Level	39.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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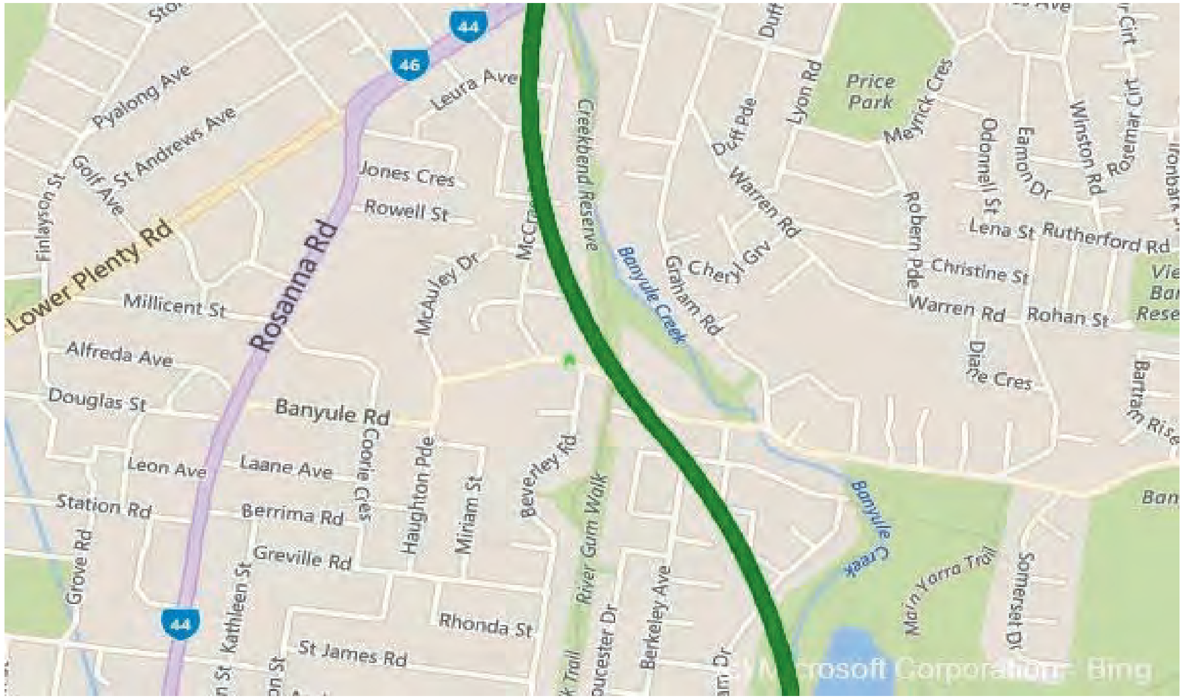
NORTH EAST LINK PROJECT

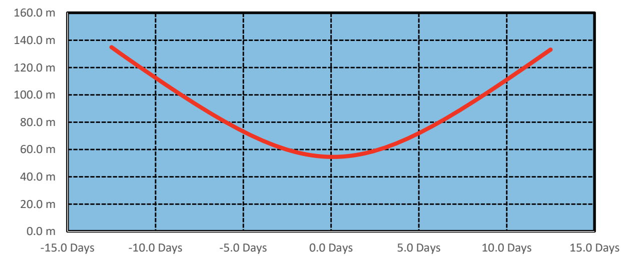
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

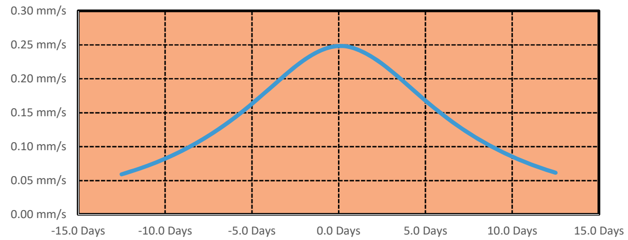
Assessment Location: Banyule Road - 76



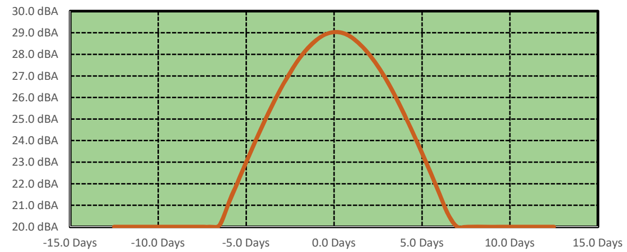
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	54.4 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.25 mm/s
Maximum Vibration Level	0.25 mm/s
Average Regenerated Noise level	22.9 dBA
90% Regenerated Noise Level	28.4 dBA
95% Regenerated Noise Level	28.9 dBA
Maximum Regenerated Noise Level	29.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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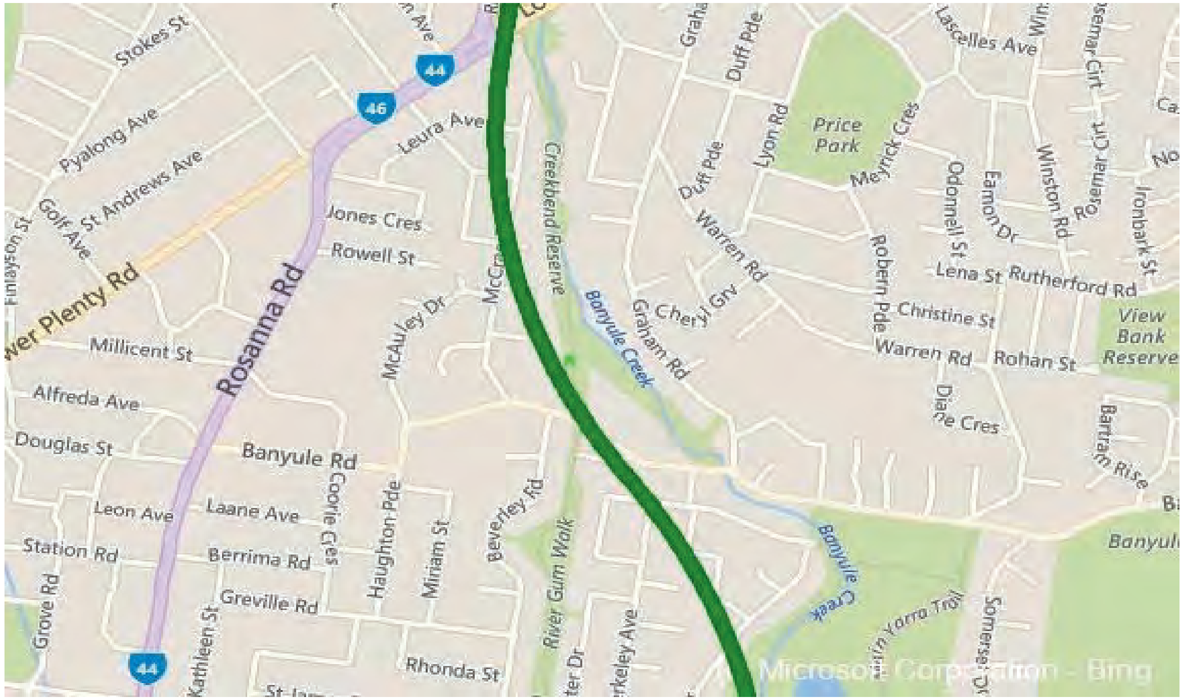
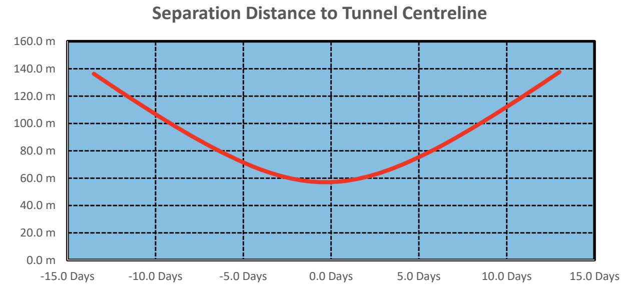
NORTH EAST LINK PROJECT

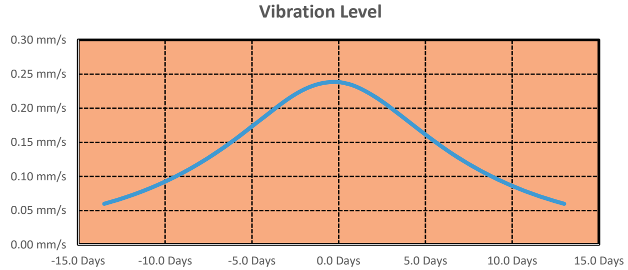
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

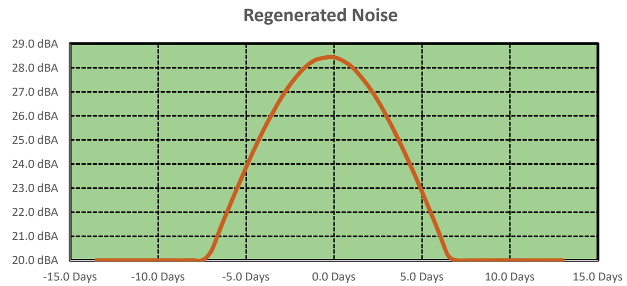
Created using TunnelTRAP Software

Assessment Location: Banyule Road - 87A









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	57.0 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.23 mm/s
95% Vibration Level	0.24 mm/s
Maximum Vibration Level	0.24 mm/s
Average Regenerated Noise level	22.7 dBA
90% Regenerated Noise Level	28.0 dBA
95% Regenerated Noise Level	28.3 dBA
Maximum Regenerated Noise Level	28.4 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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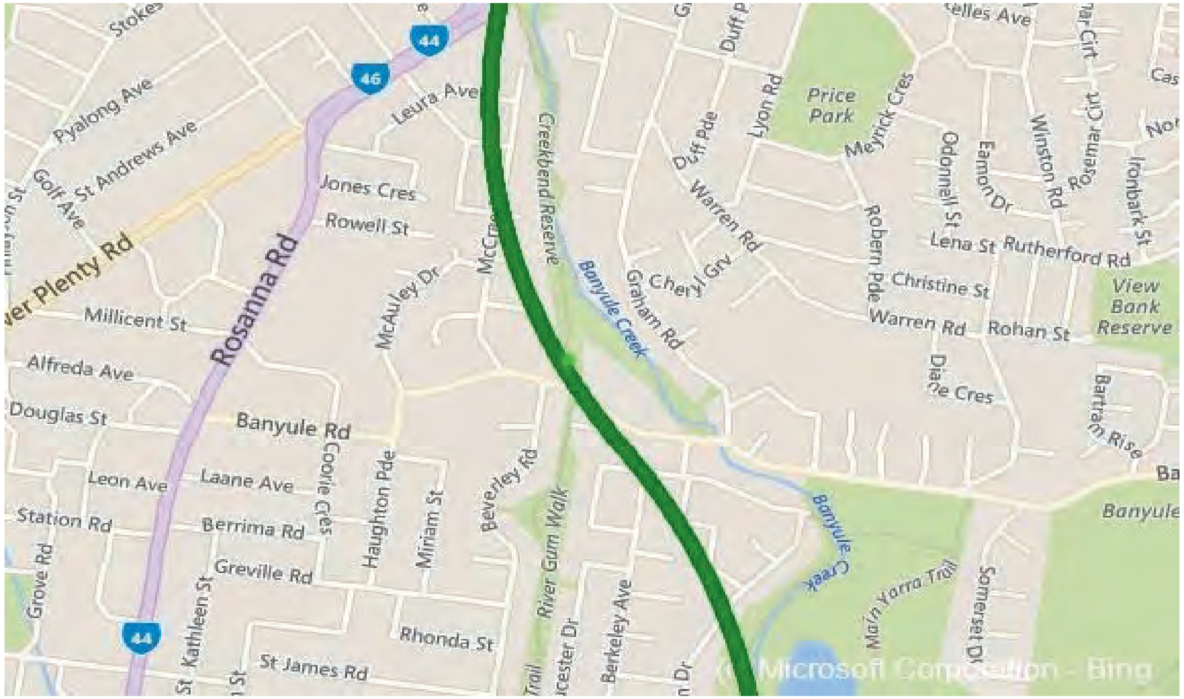
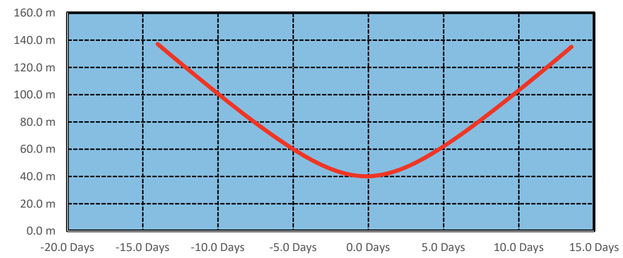
In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.

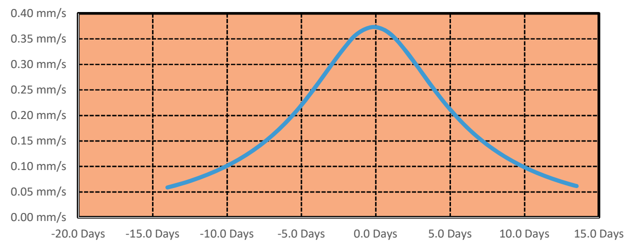
Assessment Location: Banyule Road - 87I



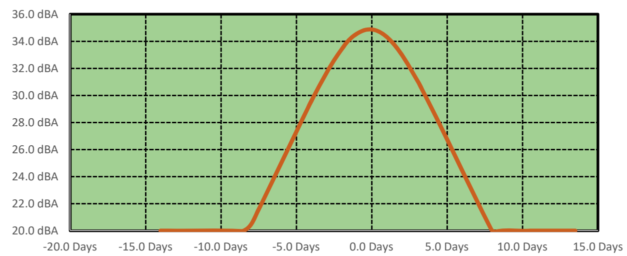
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	40.1 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.35 mm/s
95% Vibration Level	0.37 mm/s
Maximum Vibration Level	0.37 mm/s
Average Regenerated Noise level	25.0 dBA
90% Regenerated Noise Level	33.9 dBA
95% Regenerated Noise Level	34.6 dBA
Maximum Regenerated Noise Level	34.9 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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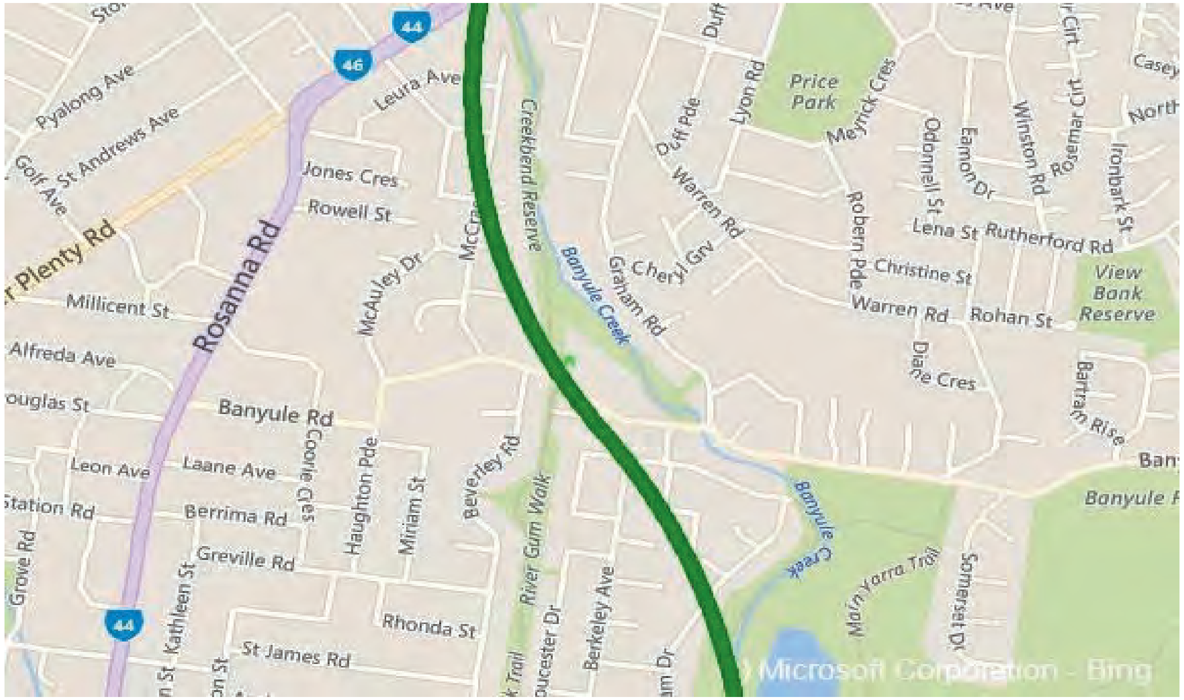
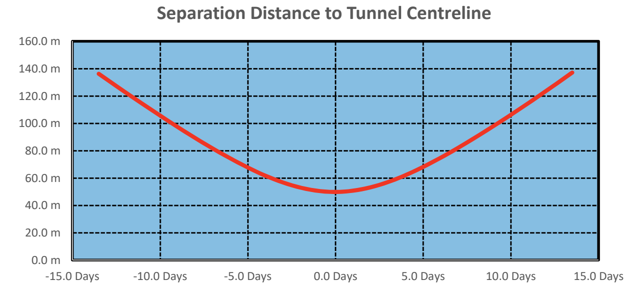
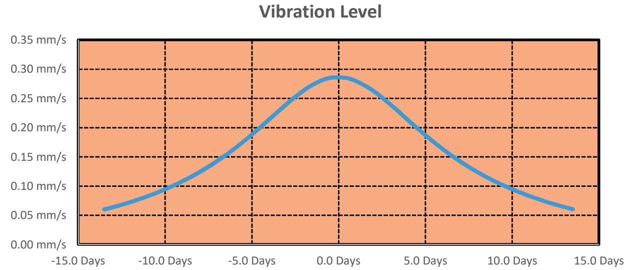
NORTH EAST LINK PROJECT

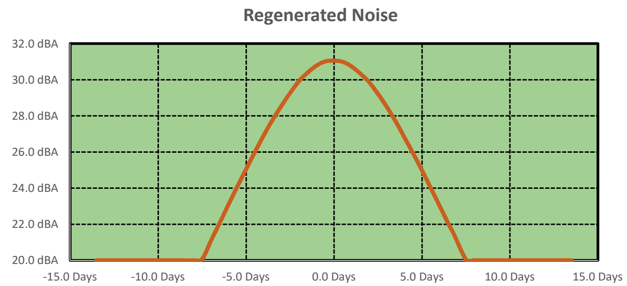
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Banyule Road - 89









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.1 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	49.8 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.27 mm/s
95% Vibration Level	0.28 mm/s
Maximum Vibration Level	0.29 mm/s
Average Regenerated Noise level	23.7 dBA
90% Regenerated Noise Level	30.4 dBA
95% Regenerated Noise Level	30.8 dBA
Maximum Regenerated Noise Level	31.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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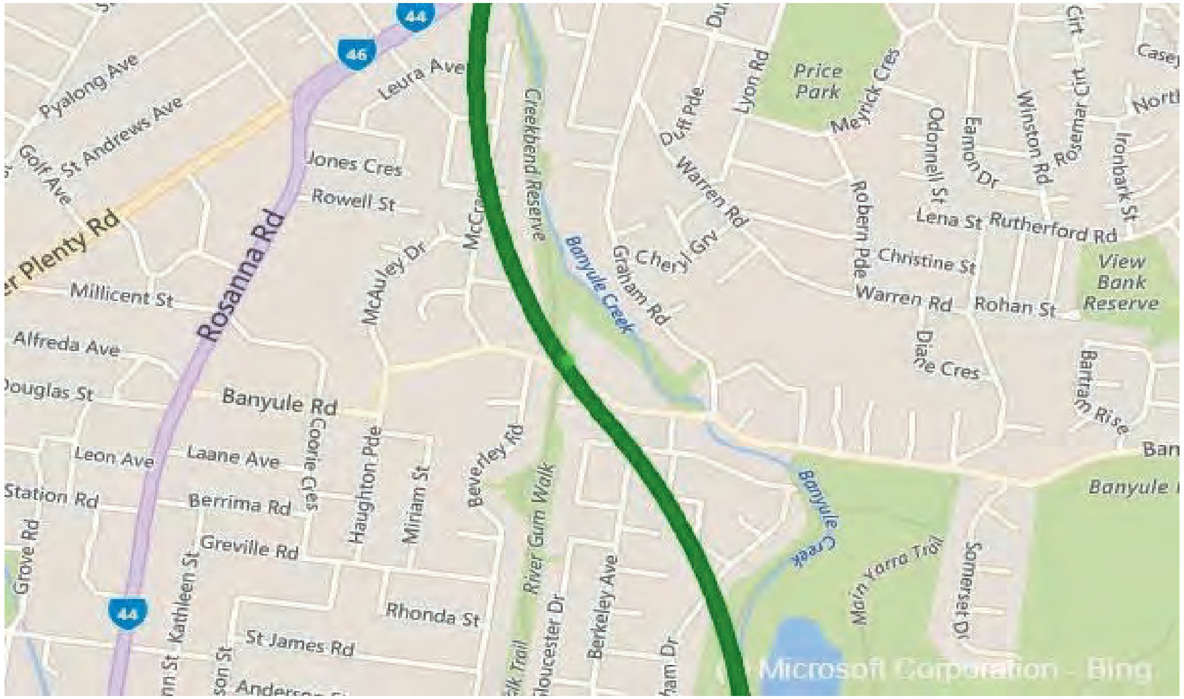
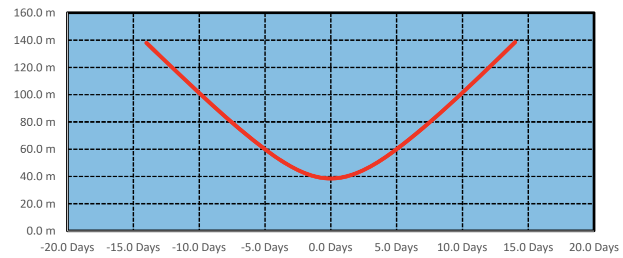
NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

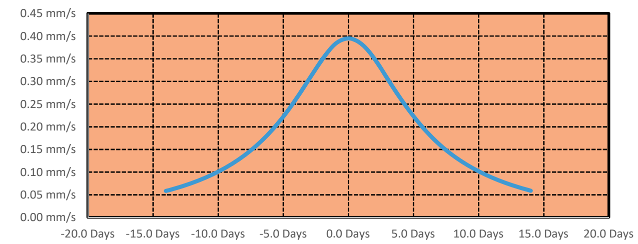
Assessment Location: Banyule Road - 91A



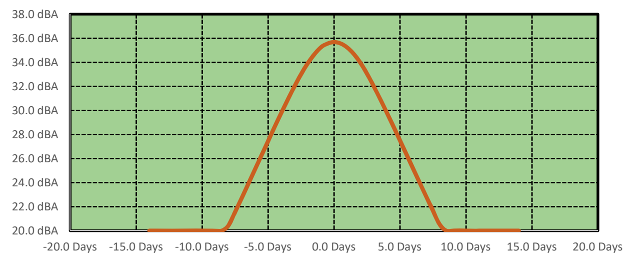
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	1.7 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.5 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	38.5 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.37 mm/s
95% Vibration Level	0.38 mm/s
Maximum Vibration Level	0.39 mm/s
Average Regenerated Noise level	25.2 dBA
90% Regenerated Noise Level	34.7 dBA
95% Regenerated Noise Level	35.3 dBA
Maximum Regenerated Noise Level	35.7 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

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Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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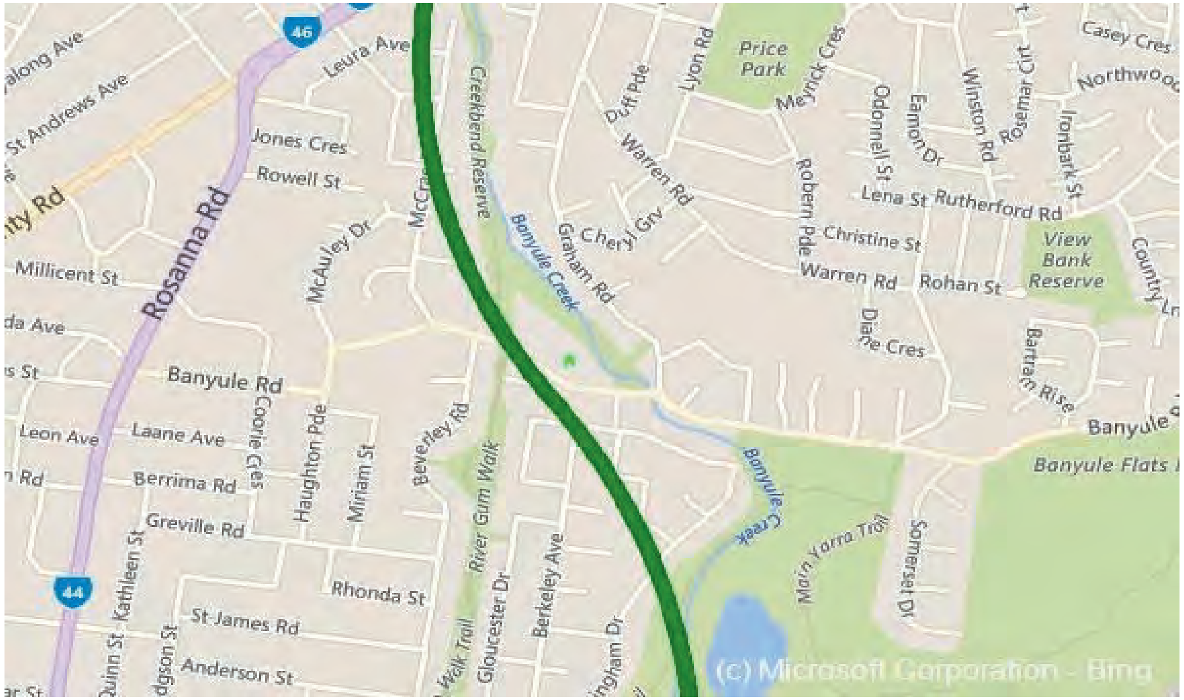
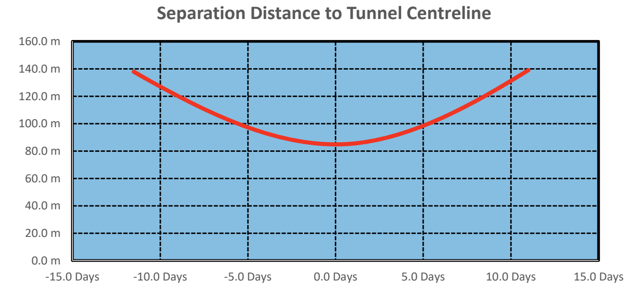
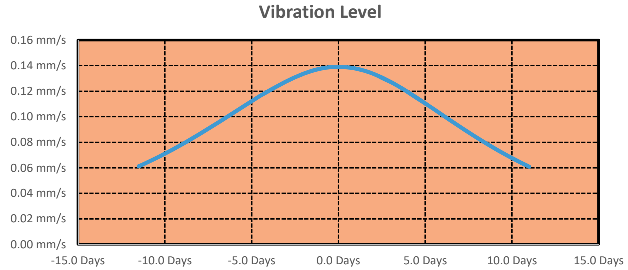
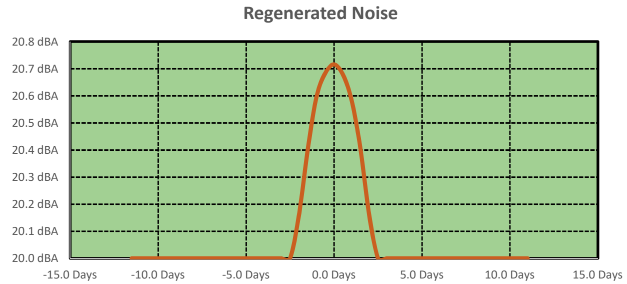
Assessment Location: Banyule Road - 107









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	84.8 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.14 mm/s
95% Vibration Level	0.14 mm/s
Maximum Vibration Level	0.14 mm/s
Average Regenerated Noise level	20.1 dBA
90% Regenerated Noise Level	20.5 dBA
95% Regenerated Noise Level	20.7 dBA
Maximum Regenerated Noise Level	20.7 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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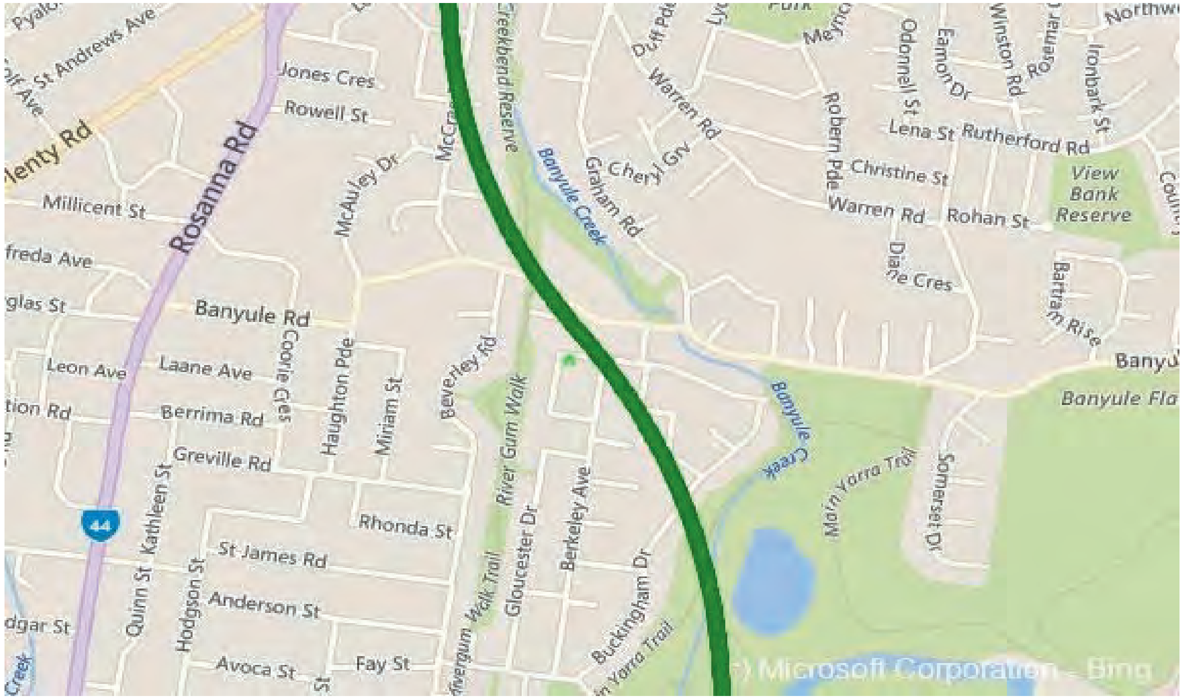
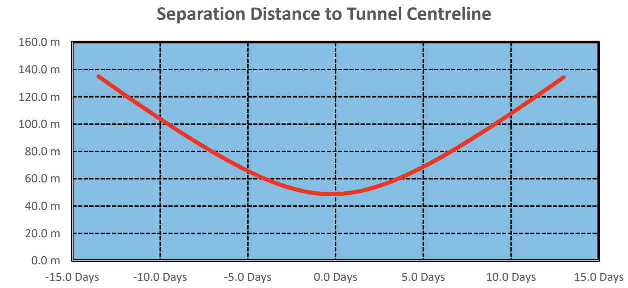
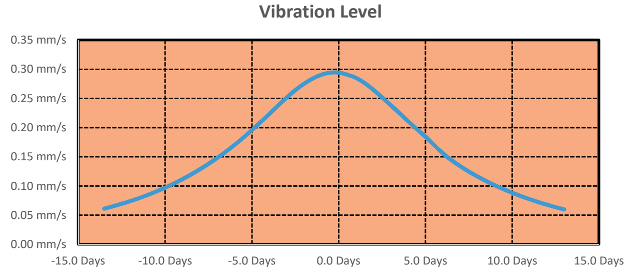
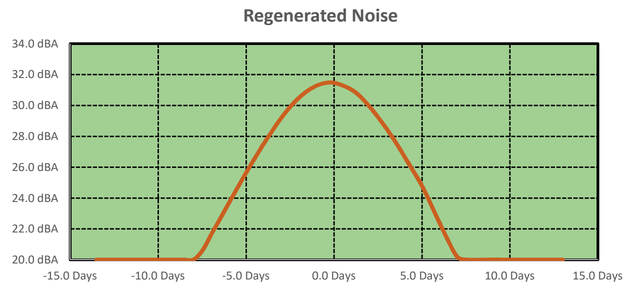
Assessment Location: Berkeley Avenue - 81









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.2 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	48.7 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.28 mm/s
95% Vibration Level	0.29 mm/s
Maximum Vibration Level	0.29 mm/s
Average Regenerated Noise level	23.9 dBA
90% Regenerated Noise Level	30.8 dBA
95% Regenerated Noise Level	31.3 dBA
Maximum Regenerated Noise Level	31.5 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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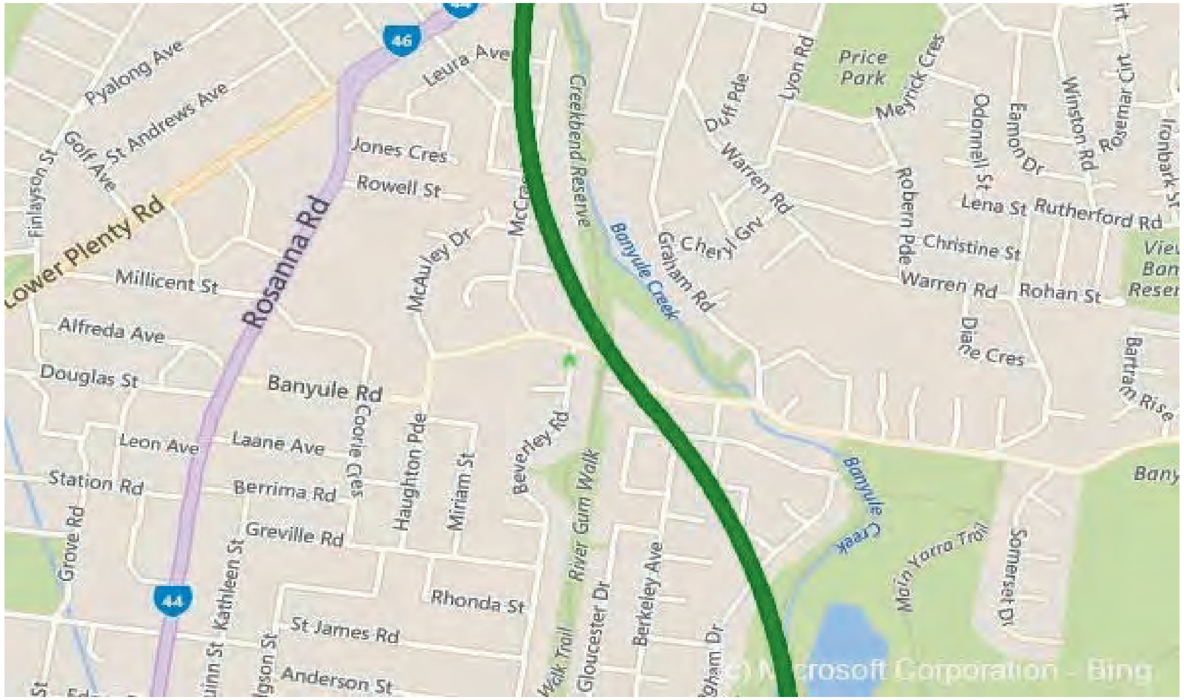
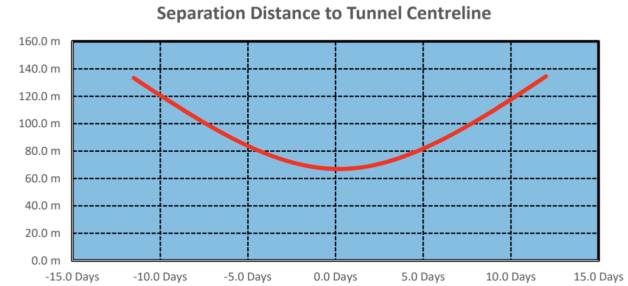
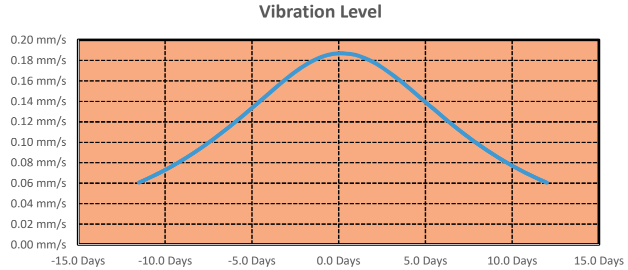
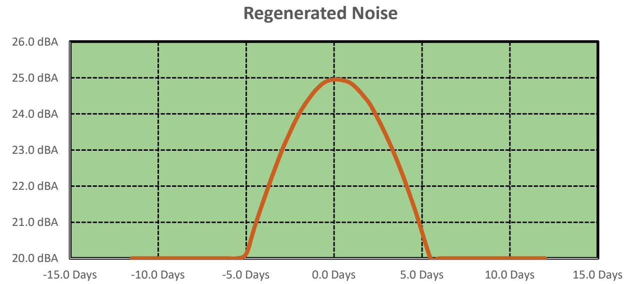
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Beverley Road - 188









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	66.8 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.19 mm/s
Maximum Vibration Level	0.19 mm/s
Average Regenerated Noise level	21.4 dBA
90% Regenerated Noise Level	24.6 dBA
95% Regenerated Noise Level	24.9 dBA
Maximum Regenerated Noise Level	25.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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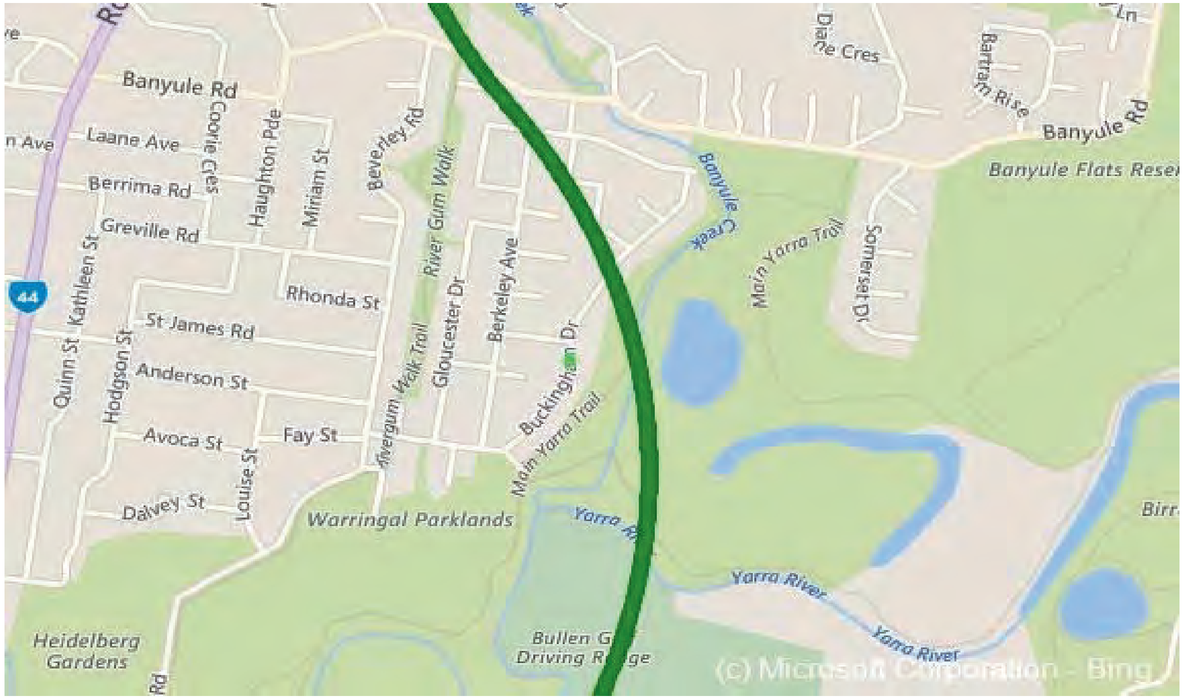
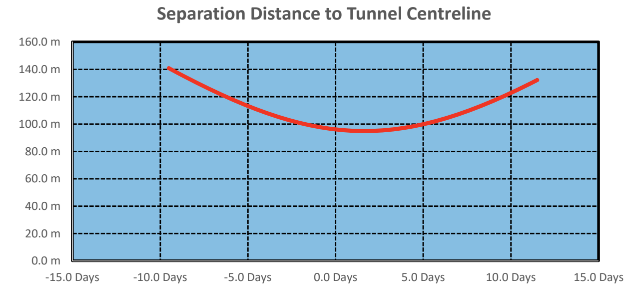
NORTH EAST LINK PROJECT

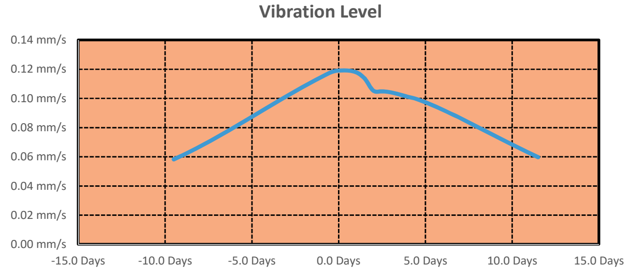
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

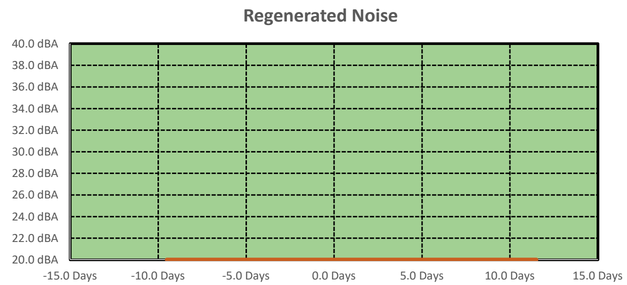
Created using TunnelTRAP Software

Assessment Location: Buckingham Drive - 58









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	94.8 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.12 mm/s
Maximum Vibration Level	0.12 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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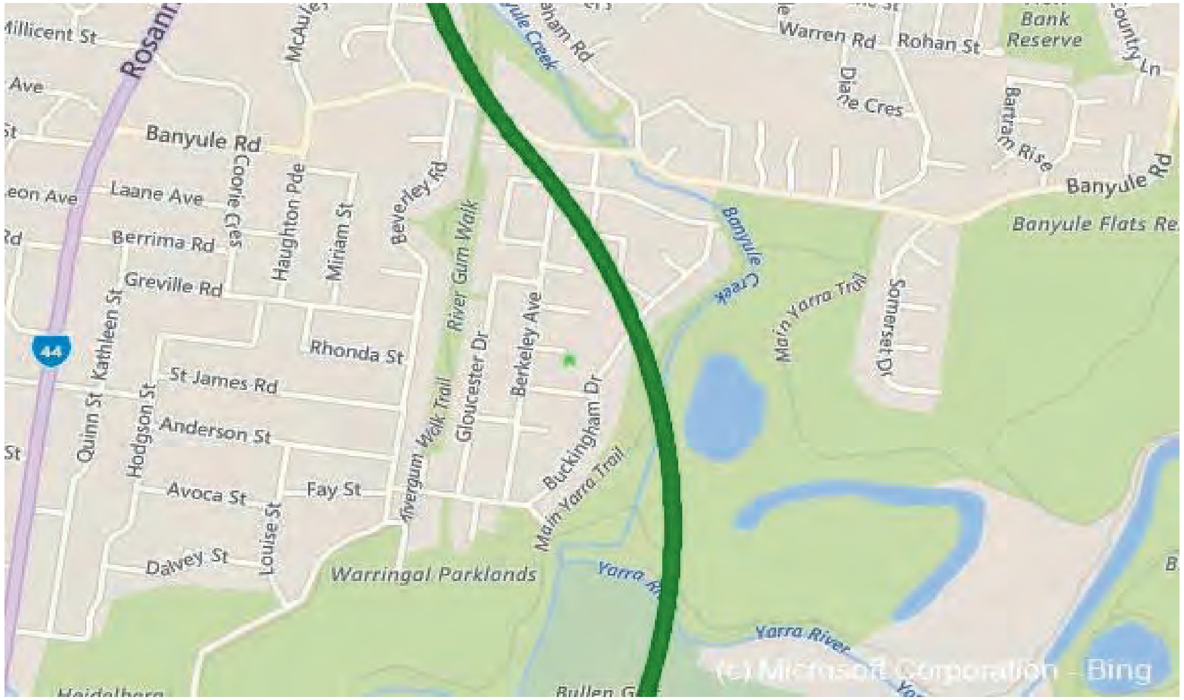
NORTH EAST LINK PROJECT

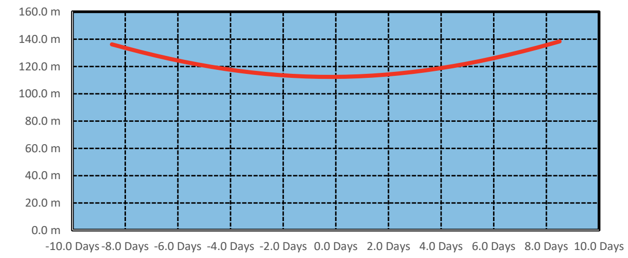
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

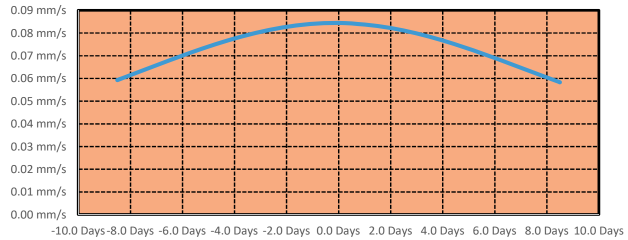
Assessment Location: Buckingham Drive - 65



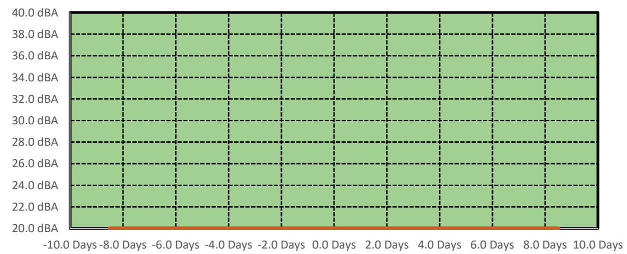
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	112.2 m
Average Vibration Level	0.07 mm/s
90% Vibration Level	0.08 mm/s
95% Vibration Level	0.08 mm/s
Maximum Vibration Level	0.08 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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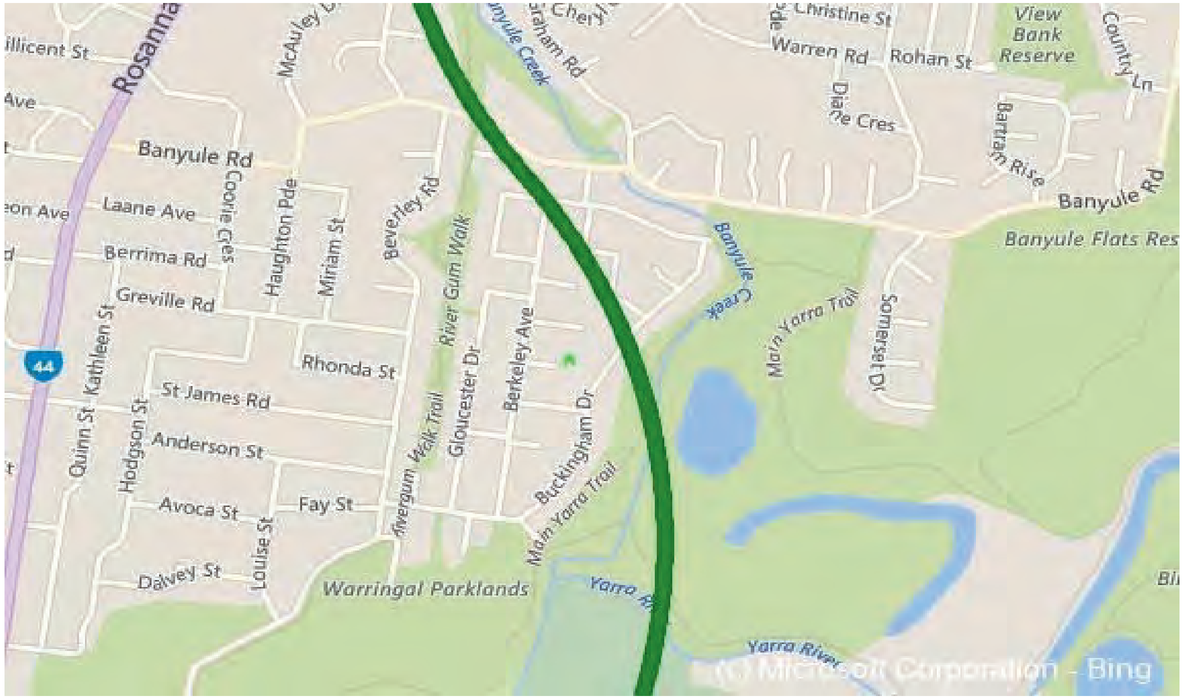
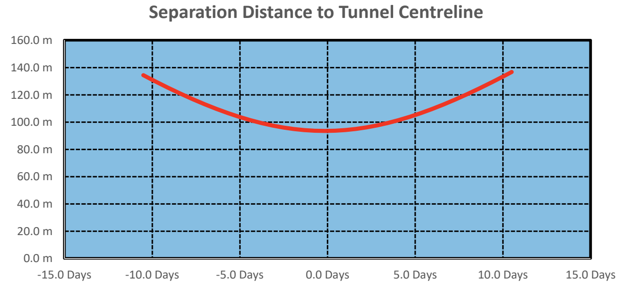
NORTH EAST LINK PROJECT

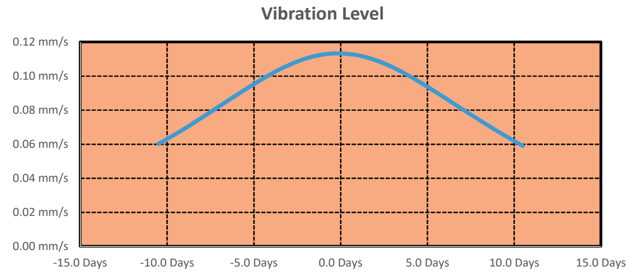
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

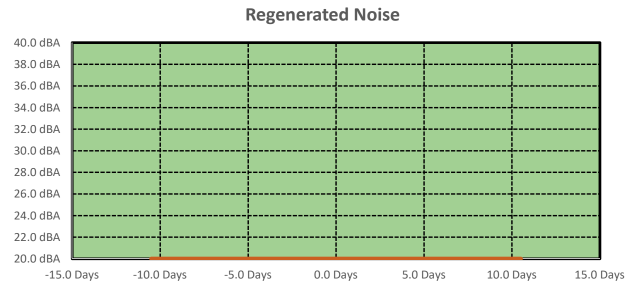
Created using TunnelTRAP Software

Assessment Location: Buckingham Drive - 69









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	93.5 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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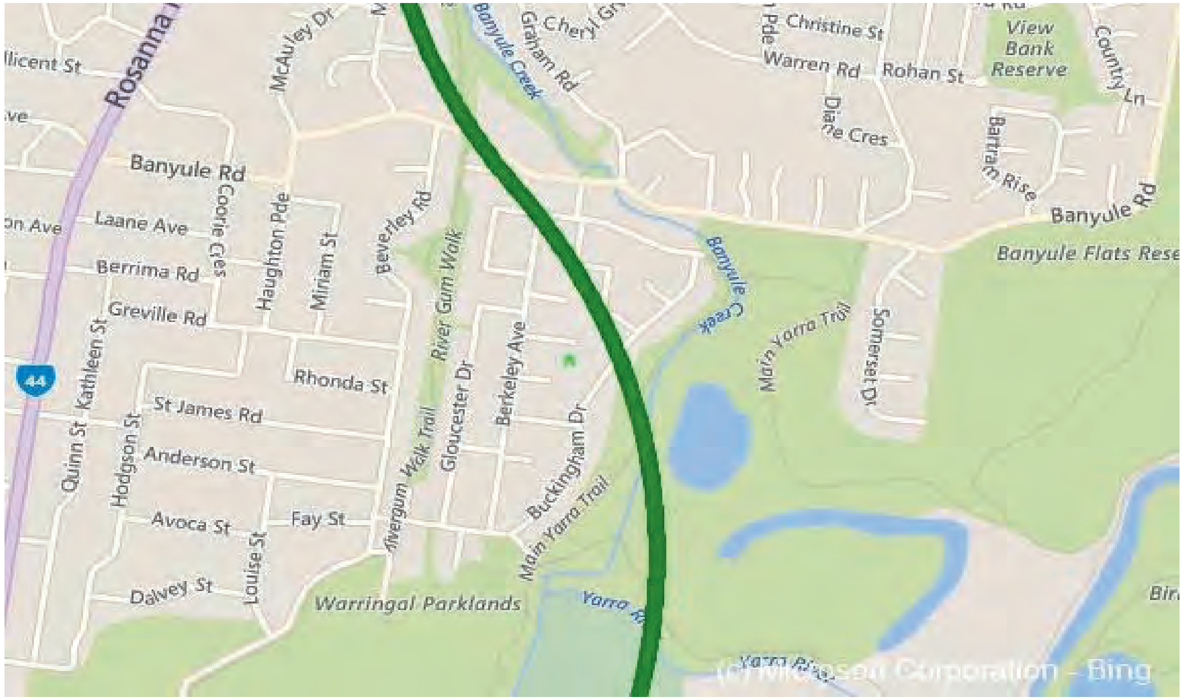
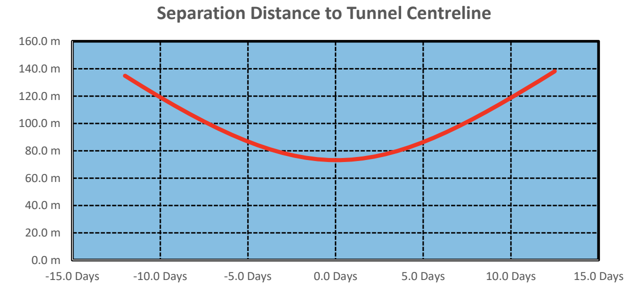
NORTH EAST LINK PROJECT

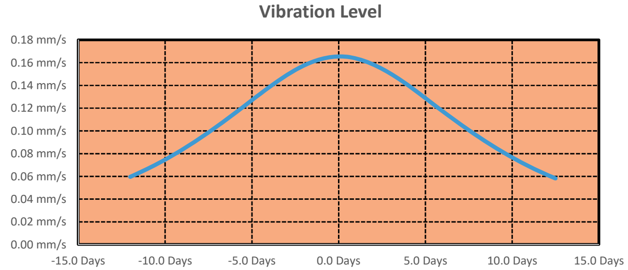
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

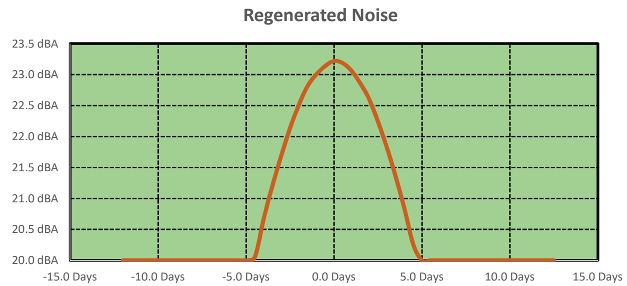
Created using TunnelTRAP Software

Assessment Location: Buckingham Drive - 73









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	73.0 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.16 mm/s
95% Vibration Level	0.16 mm/s
Maximum Vibration Level	0.17 mm/s
Average Regenerated Noise level	20.8 dBA
90% Regenerated Noise Level	22.9 dBA
95% Regenerated Noise Level	23.1 dBA
Maximum Regenerated Noise Level	23.2 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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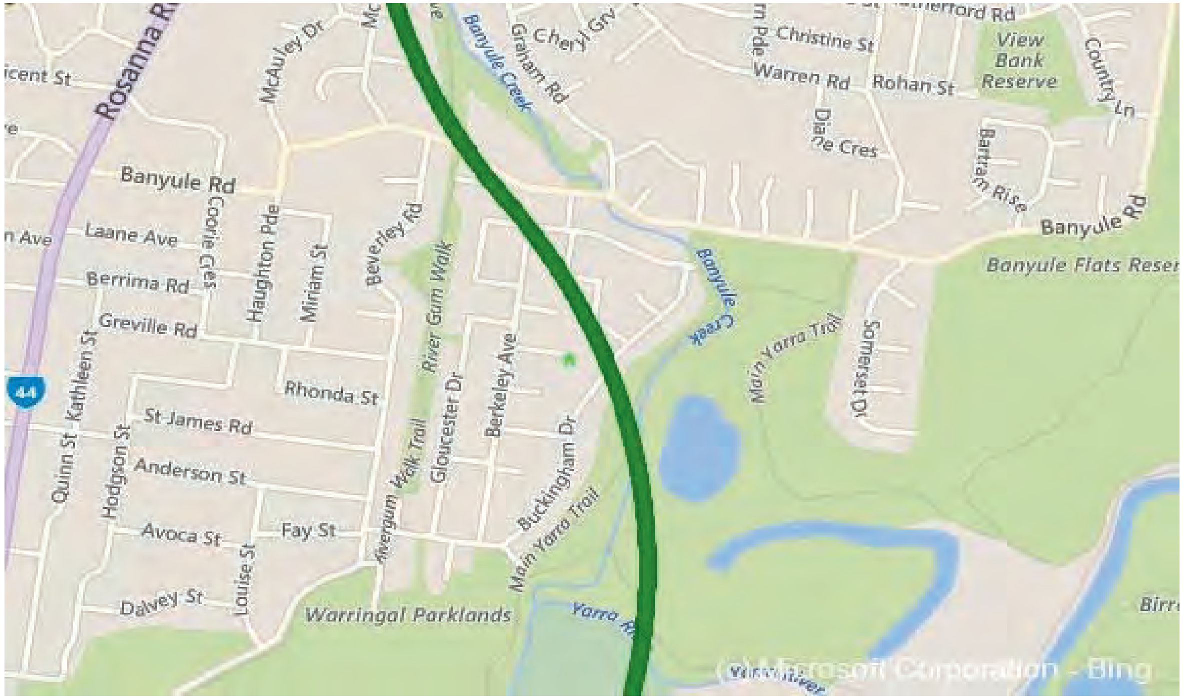
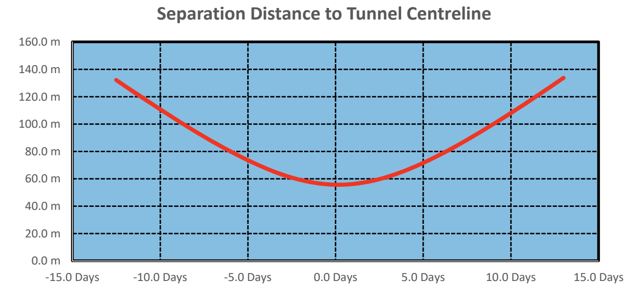
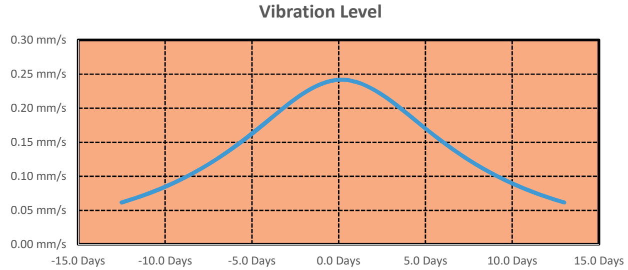
NORTH EAST LINK PROJECT

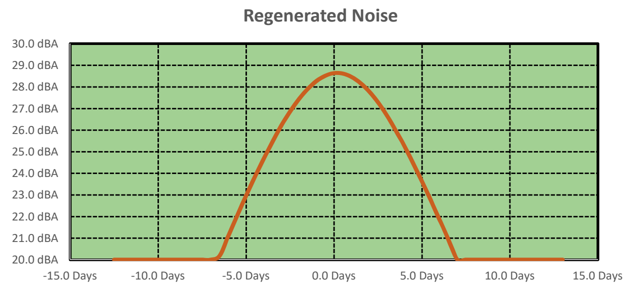
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Buckingham Drive - 77









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	55.6 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.23 mm/s
95% Vibration Level	0.24 mm/s
Maximum Vibration Level	0.24 mm/s
Average Regenerated Noise level	22.8 dBA
90% Regenerated Noise Level	28.2 dBA
95% Regenerated Noise Level	28.5 dBA
Maximum Regenerated Noise Level	28.6 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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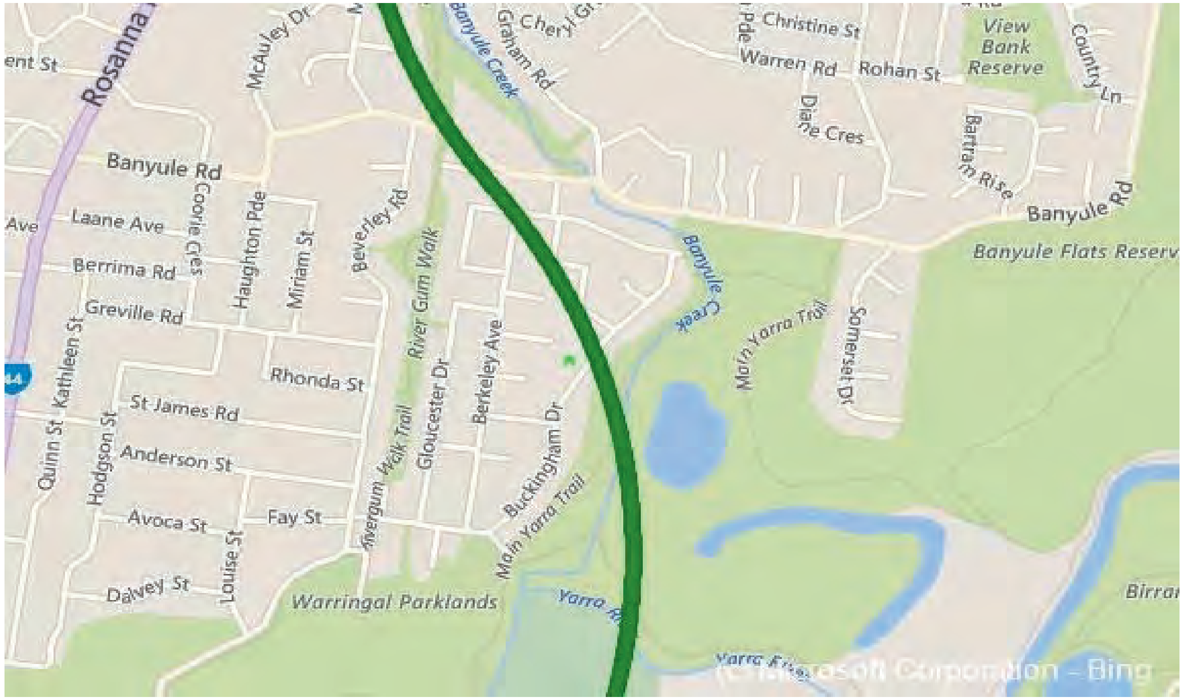
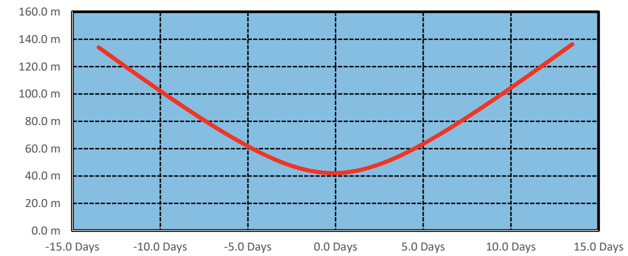
NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

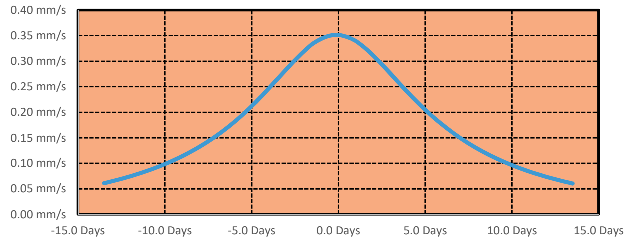
Assessment Location: Buckingham Drive - 80



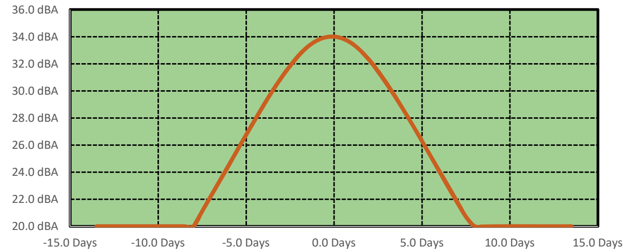
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	1.5 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	42.1 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.33 mm/s
95% Vibration Level	0.34 mm/s
Maximum Vibration Level	0.35 mm/s
Average Regenerated Noise level	24.8 dBA
90% Regenerated Noise Level	33.1 dBA
95% Regenerated Noise Level	33.7 dBA
Maximum Regenerated Noise Level	34.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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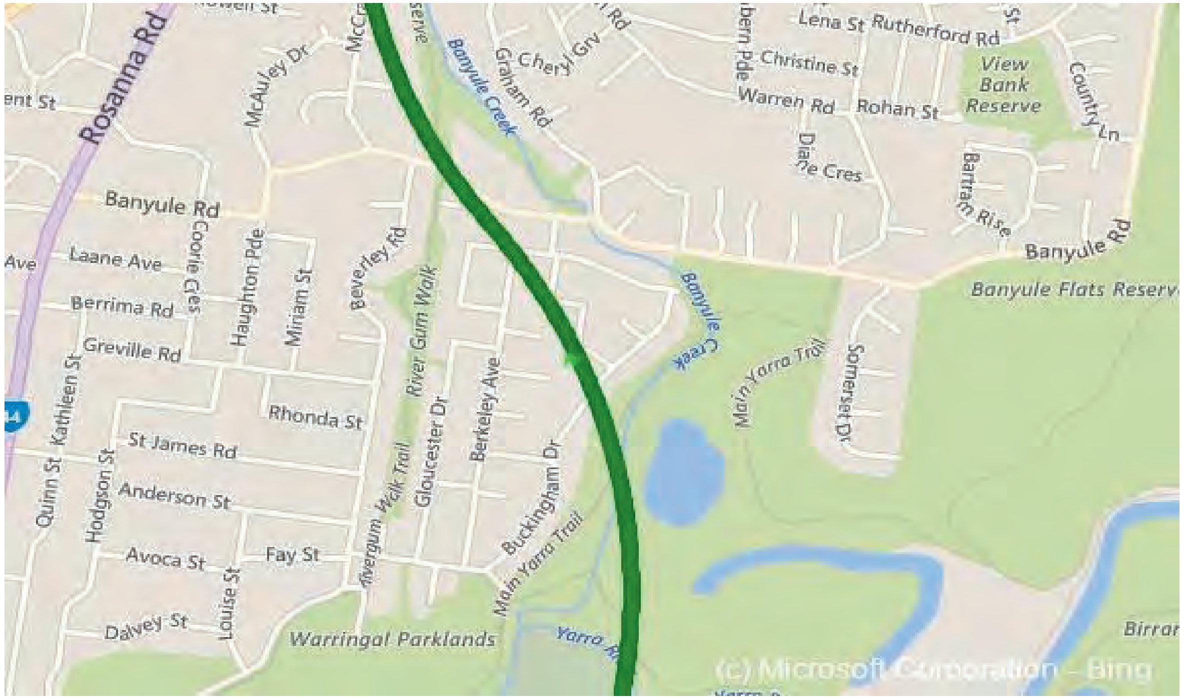
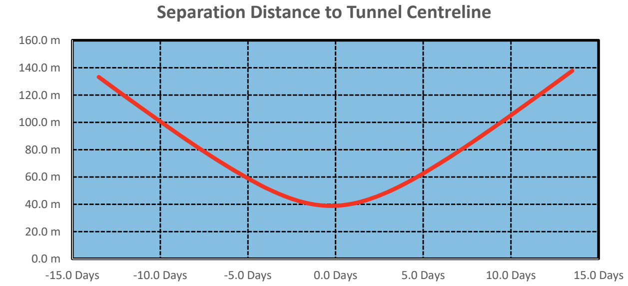
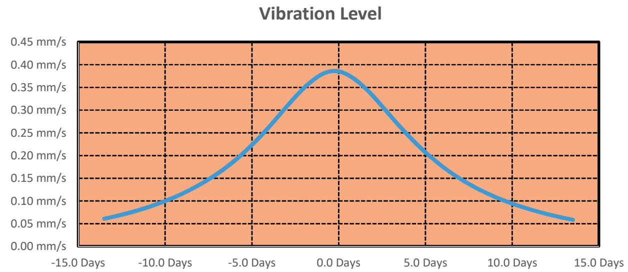
NORTH EAST LINK PROJECT

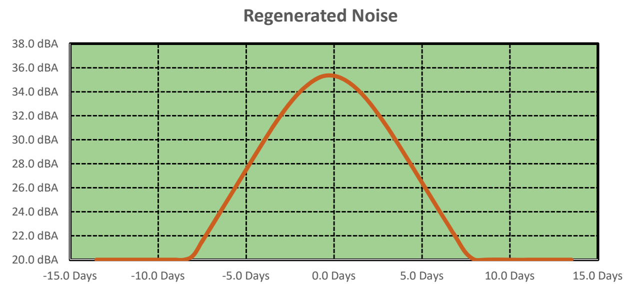
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Buckingham Drive - 83









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.4 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	38.8 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.36 mm/s
95% Vibration Level	0.38 mm/s
Maximum Vibration Level	0.39 mm/s
Average Regenerated Noise level	25.2 dBA
90% Regenerated Noise Level	34.3 dBA
95% Regenerated Noise Level	35.1 dBA
Maximum Regenerated Noise Level	35.3 dBA

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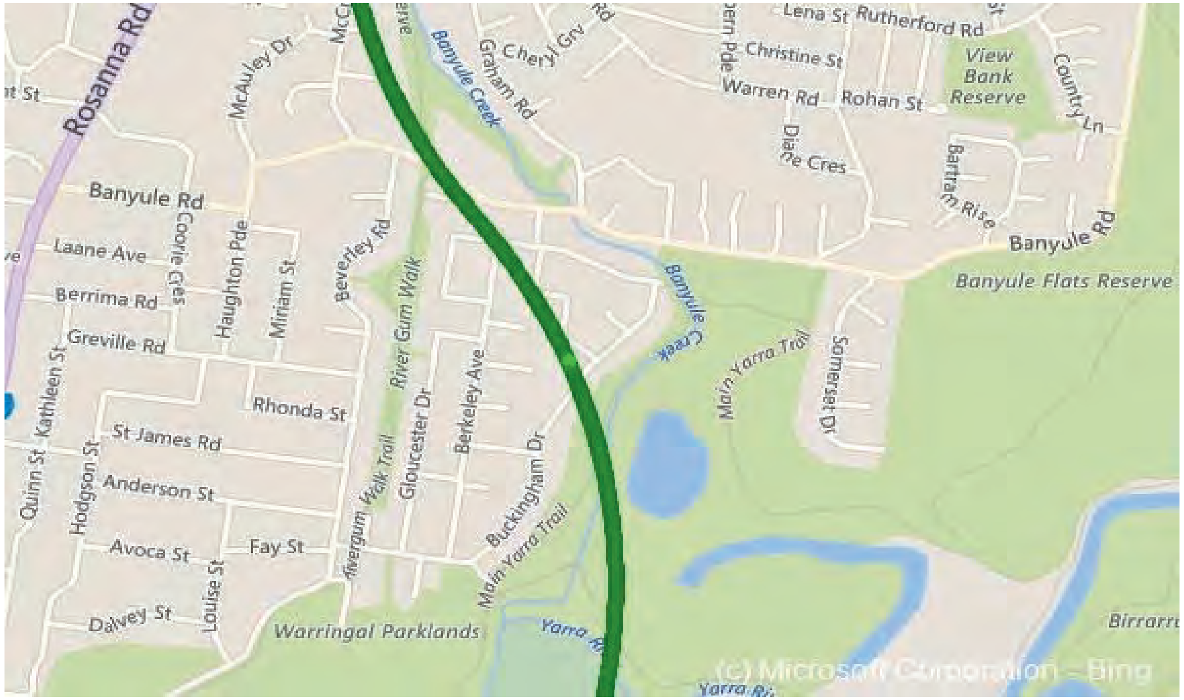
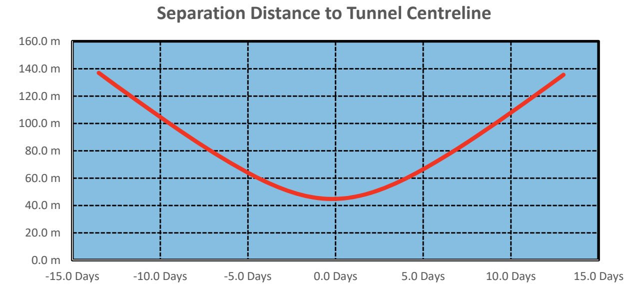
NORTH EAST LINK PROJECT

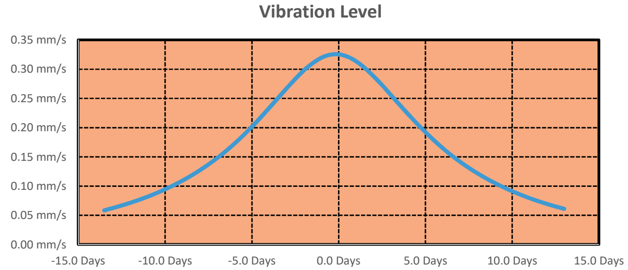
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

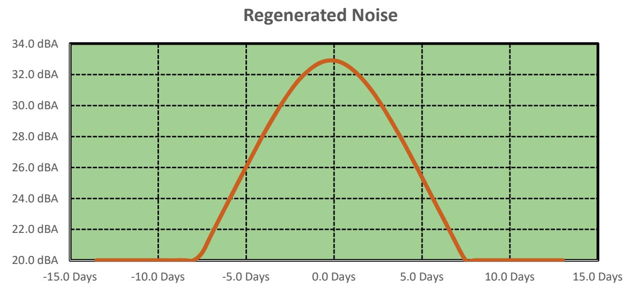
Created using TunnelTRAP Software

Assessment Location: Buckingham Drive - 90









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.4 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	44.8 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.31 mm/s
95% Vibration Level	0.32 mm/s
Maximum Vibration Level	0.33 mm/s
Average Regenerated Noise level	24.3 dBA
90% Regenerated Noise Level	32.1 dBA
95% Regenerated Noise Level	32.7 dBA
Maximum Regenerated Noise Level	32.9 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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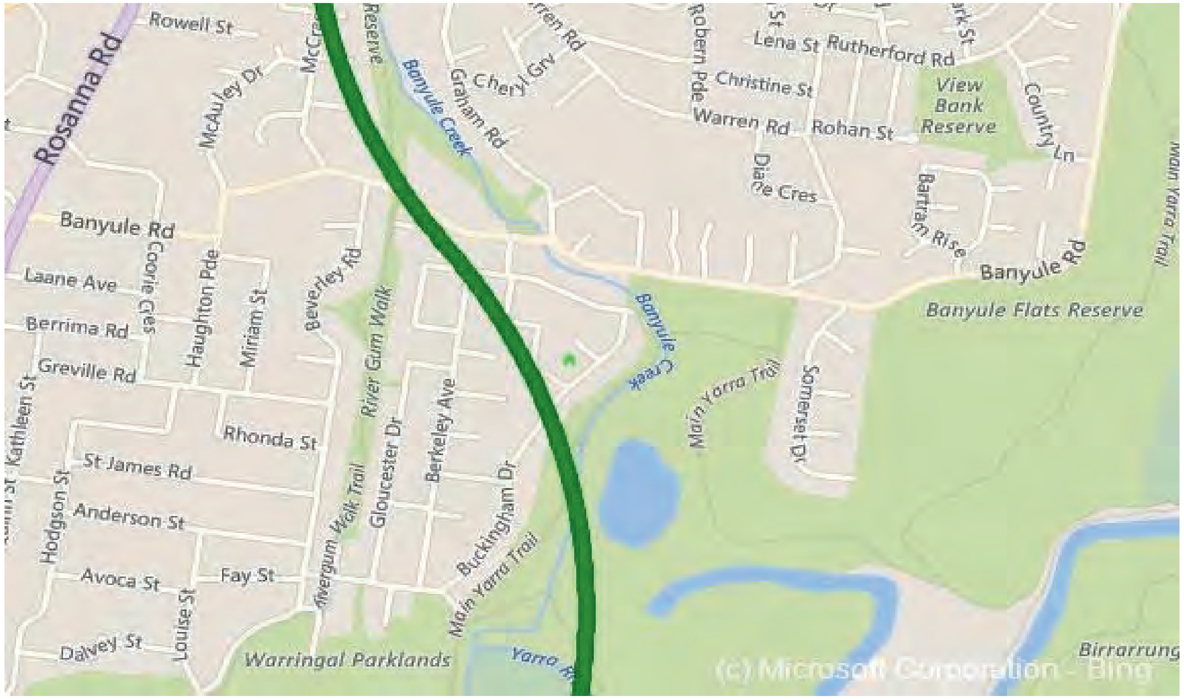
NORTH EAST LINK PROJECT

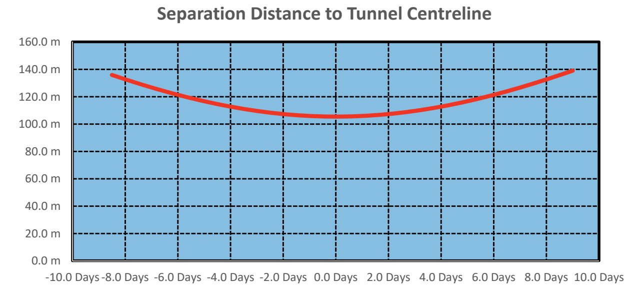
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

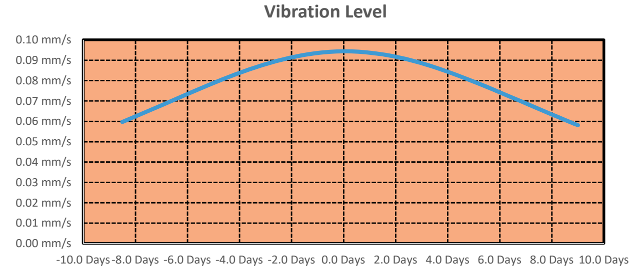
Created using TunnelTRAP Software

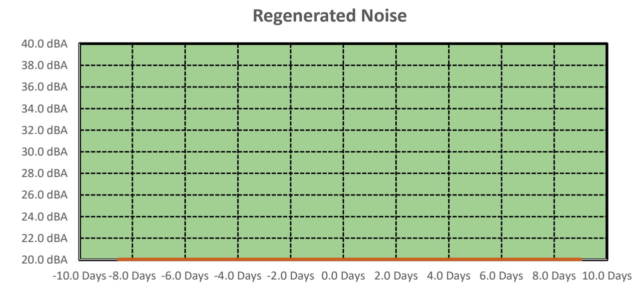
A B C D E F G H I J K L M

Assessment Location: Buckingham Drive - 100









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	105.3 m
Average Vibration Level	0.08 mm/s
90% Vibration Level	0.09 mm/s
95% Vibration Level	0.09 mm/s
Maximum Vibration Level	0.09 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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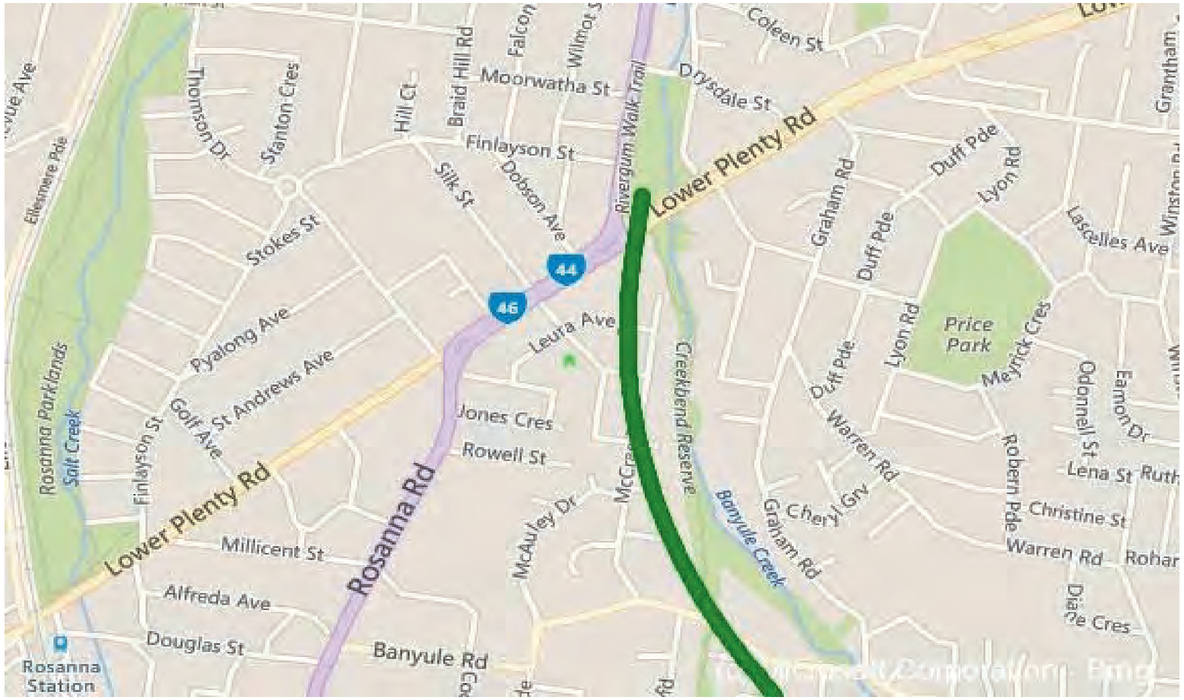
NORTH EAST LINK PROJECT

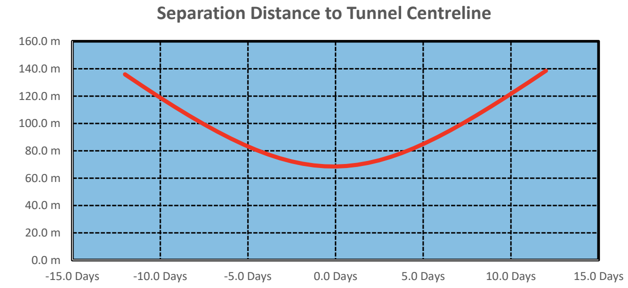
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

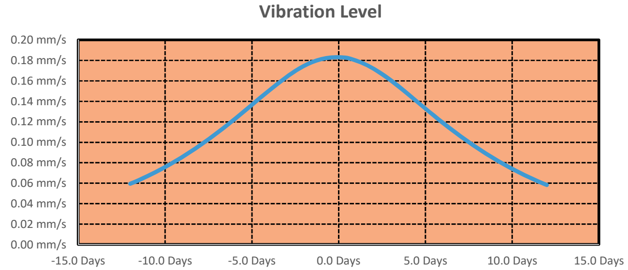
Created using TunnelTRAP Software

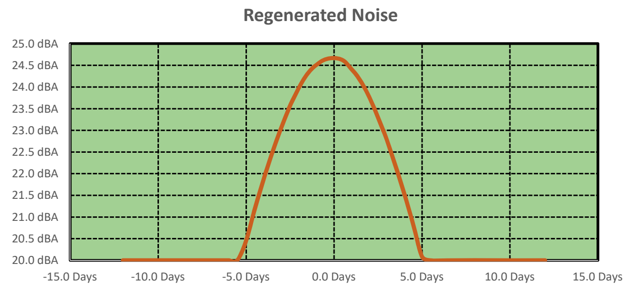
A B C D E F G H I J K L M

Assessment Location: Cantala Avenue - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	68.4 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.18 mm/s
Maximum Vibration Level	0.18 mm/s
Average Regenerated Noise level	21.3 dBA
90% Regenerated Noise Level	24.3 dBA
95% Regenerated Noise Level	24.6 dBA
Maximum Regenerated Noise Level	24.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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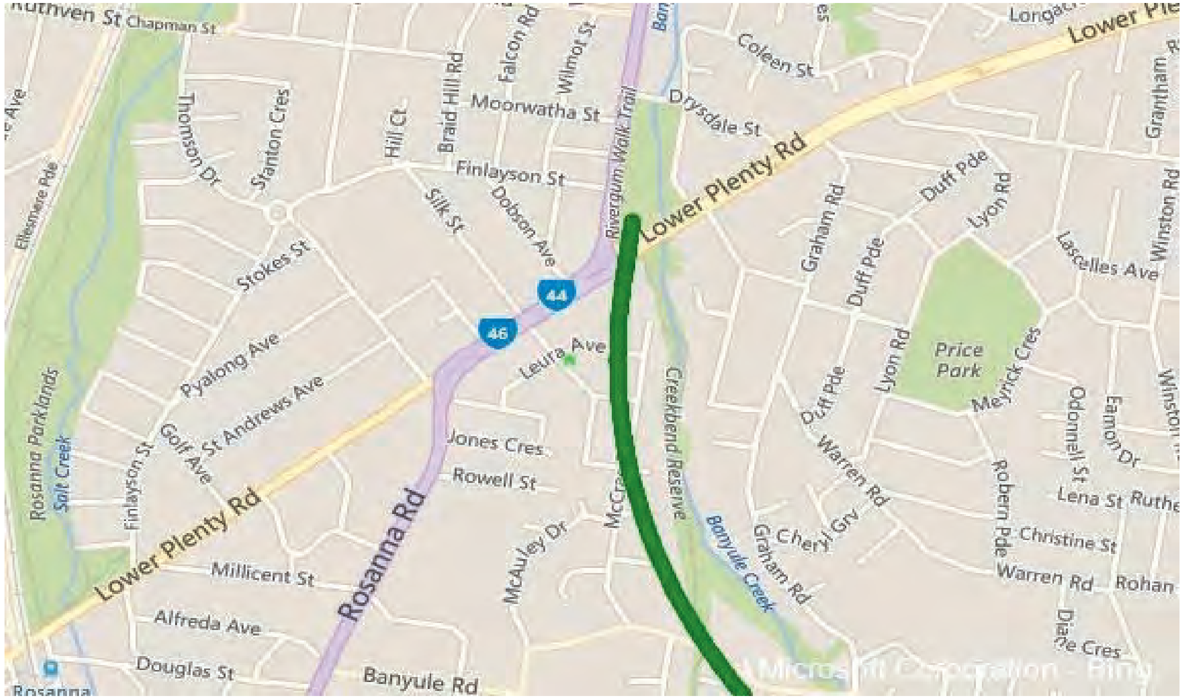
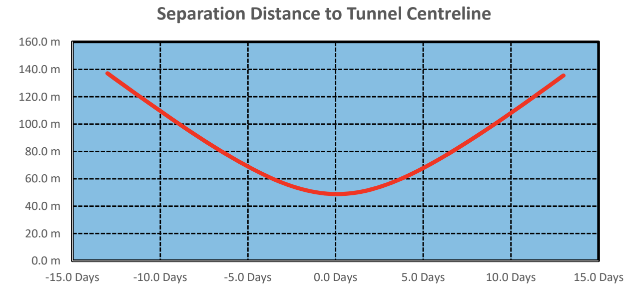
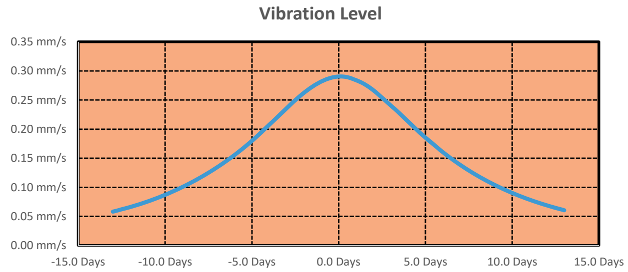
NORTH EAST LINK PROJECT

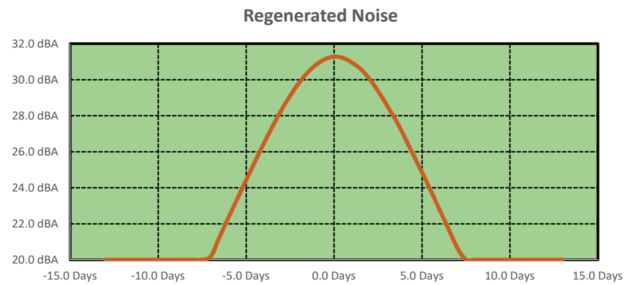
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Cantala Avenue - 10









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	48.8 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.28 mm/s
95% Vibration Level	0.29 mm/s
Maximum Vibration Level	0.29 mm/s
Average Regenerated Noise level	23.7 dBA
90% Regenerated Noise Level	30.6 dBA
95% Regenerated Noise Level	31.0 dBA
Maximum Regenerated Noise Level	31.3 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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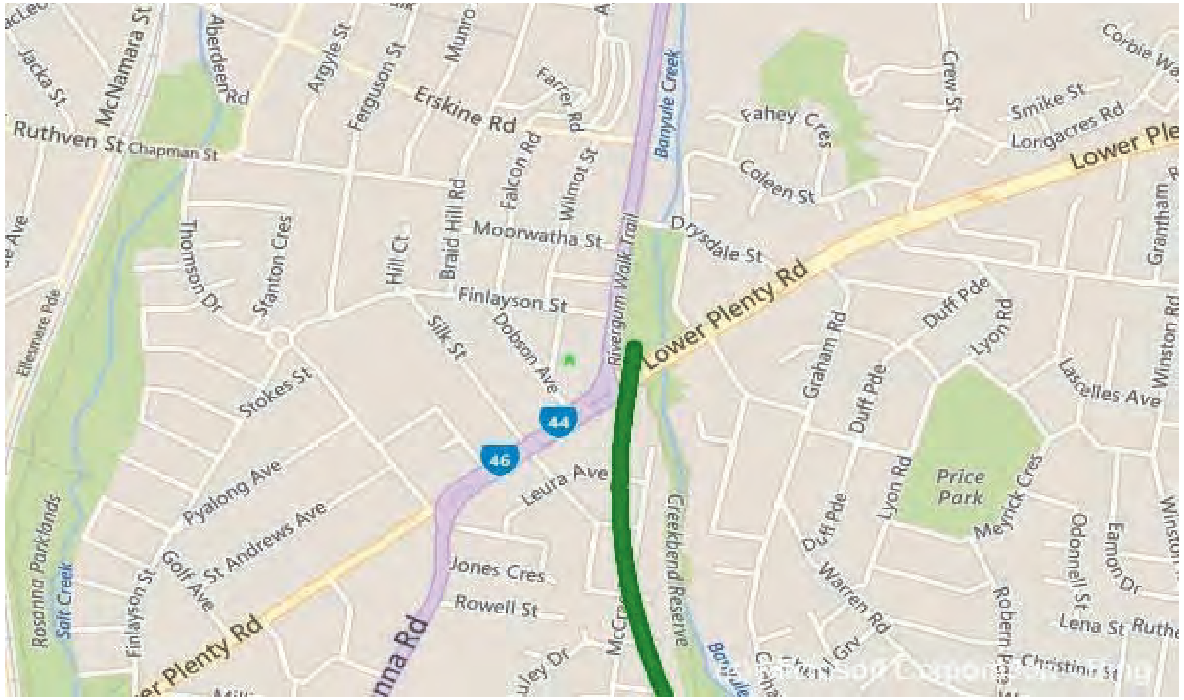
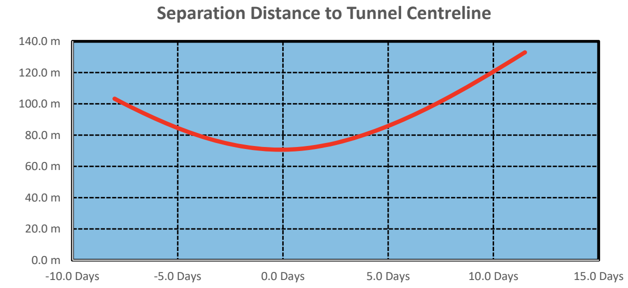
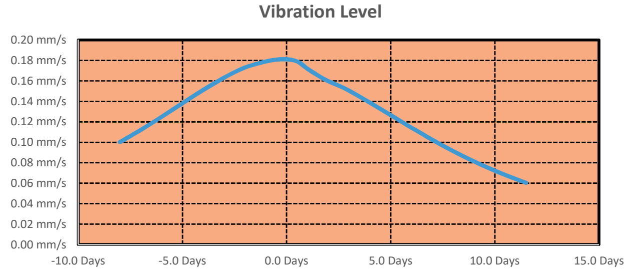
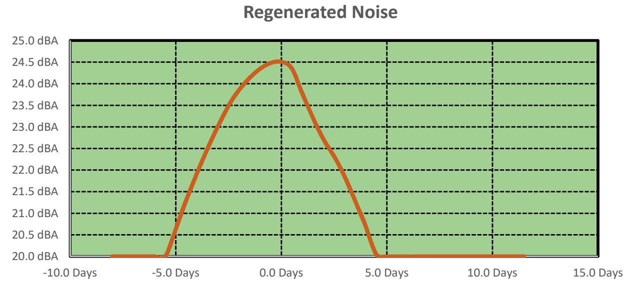
Assessment Location: Greensborough Road - 9









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	70.7 m
Average Vibration Level	0.13 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.18 mm/s
Maximum Vibration Level	0.18 mm/s
Average Regenerated Noise level	21.4 dBA
90% Regenerated Noise Level	24.2 dBA
95% Regenerated Noise Level	24.4 dBA
Maximum Regenerated Noise Level	24.5 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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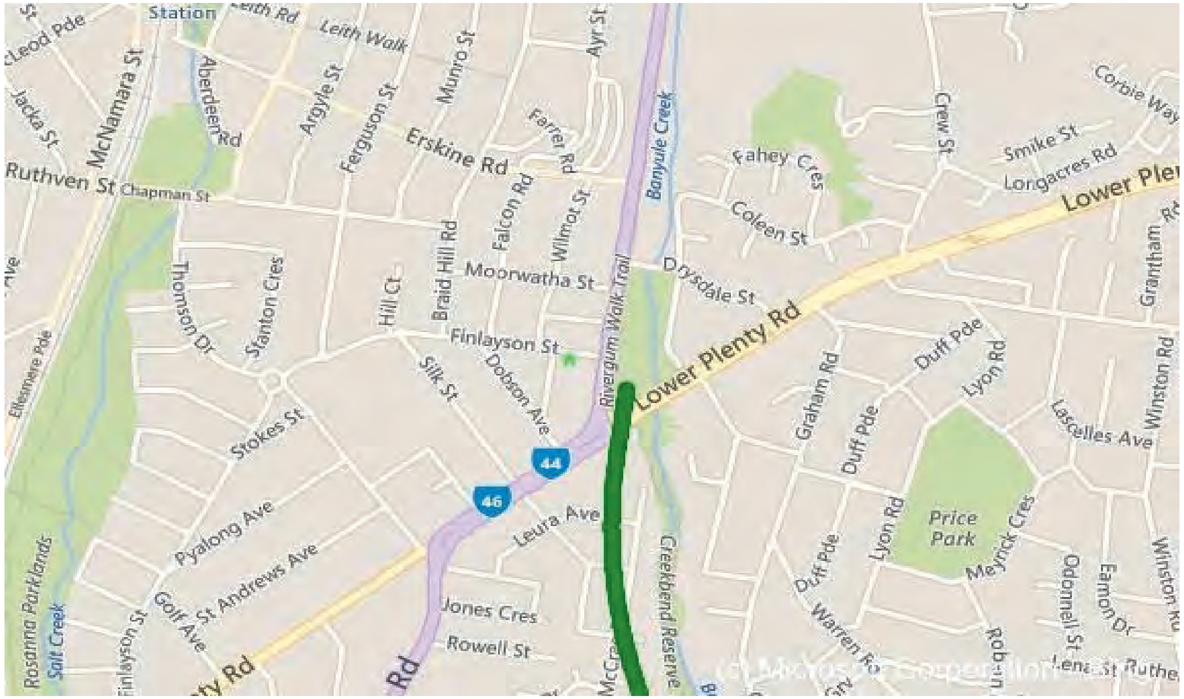
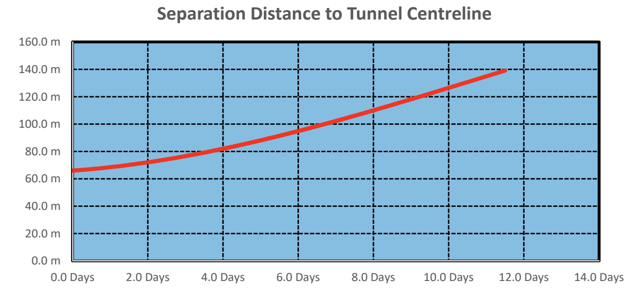
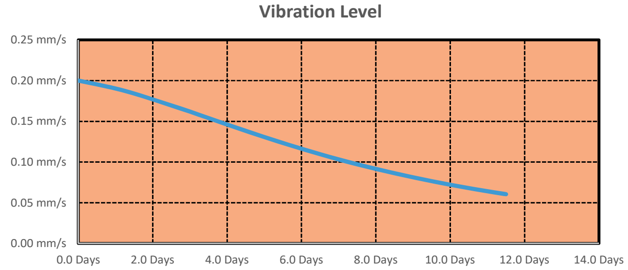
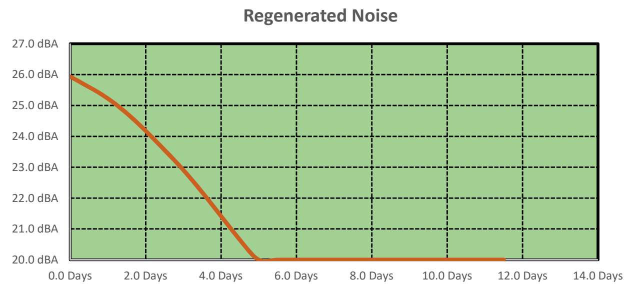
Assessment Location: Greensborough Road - 23









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	65.9 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.19 mm/s
95% Vibration Level	0.19 mm/s
Maximum Vibration Level	0.20 mm/s
Average Regenerated Noise level	21.5 dBA
90% Regenerated Noise Level	25.1 dBA
95% Regenerated Noise Level	25.5 dBA
Maximum Regenerated Noise Level	25.9 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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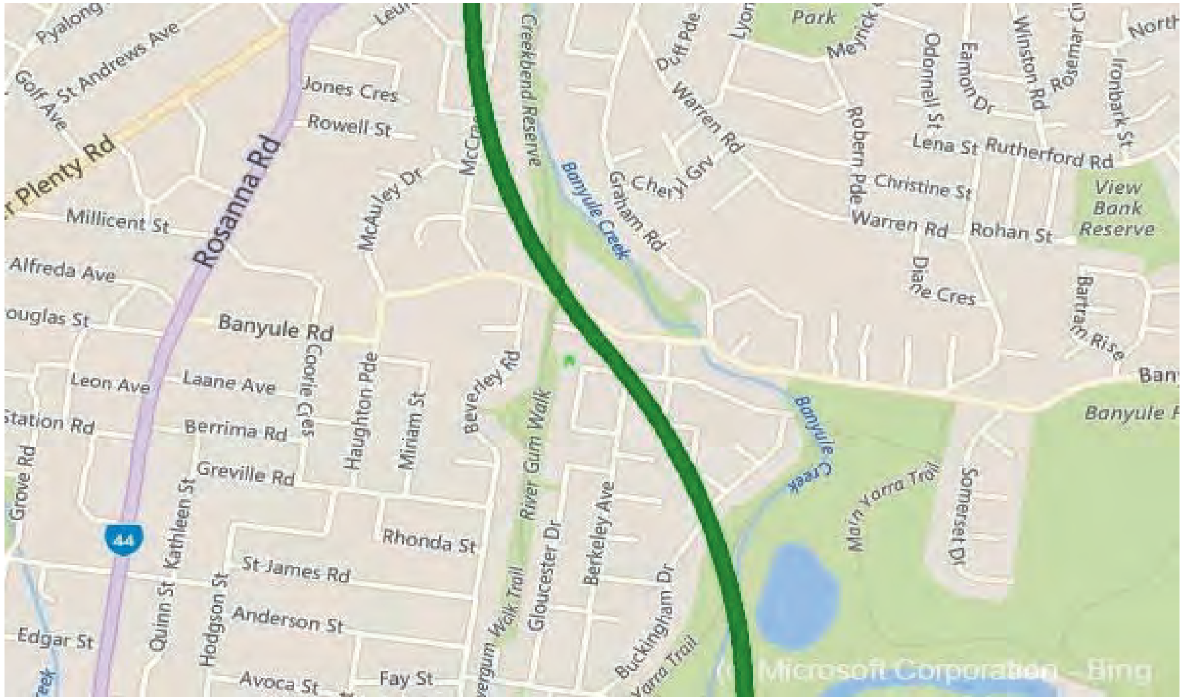
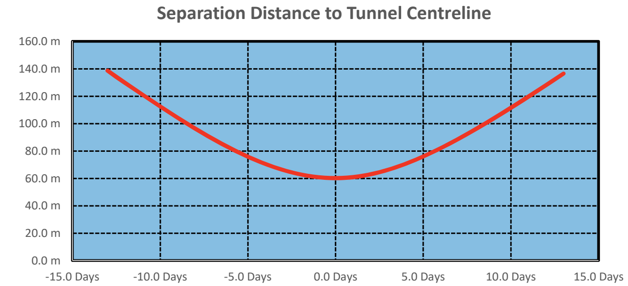
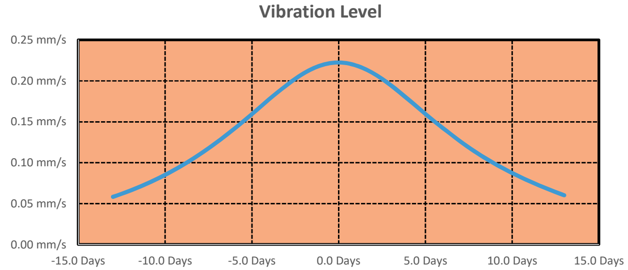
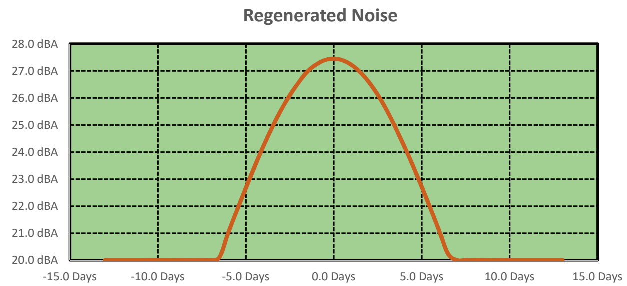
Assessment Location: Halifax Avenue - 22









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	60.2 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.22 mm/s
95% Vibration Level	0.22 mm/s
Maximum Vibration Level	0.22 mm/s
Average Regenerated Noise level	22.3 dBA
90% Regenerated Noise Level	27.0 dBA
95% Regenerated Noise Level	27.3 dBA
Maximum Regenerated Noise Level	27.4 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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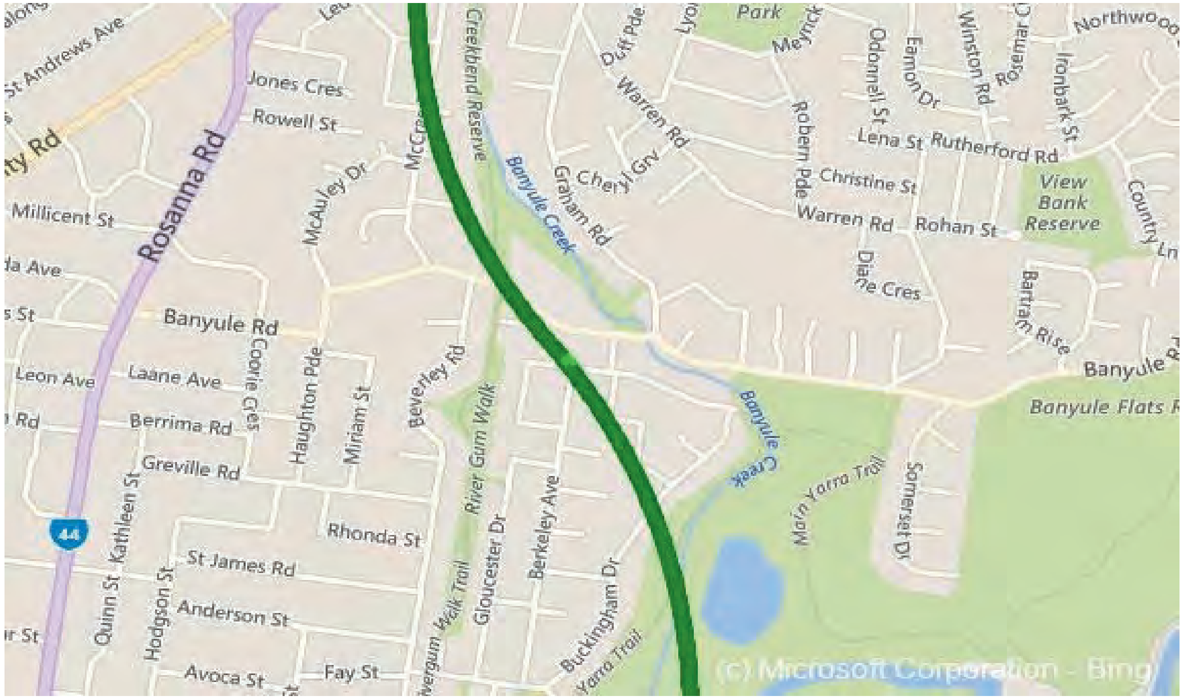
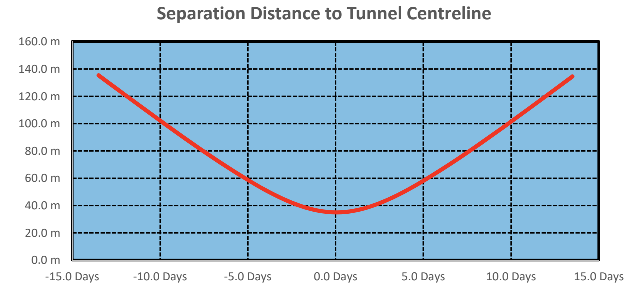
NORTH EAST LINK PROJECT

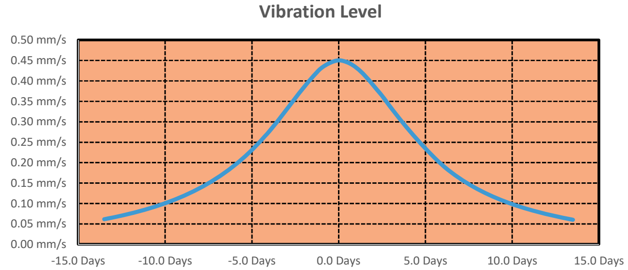
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

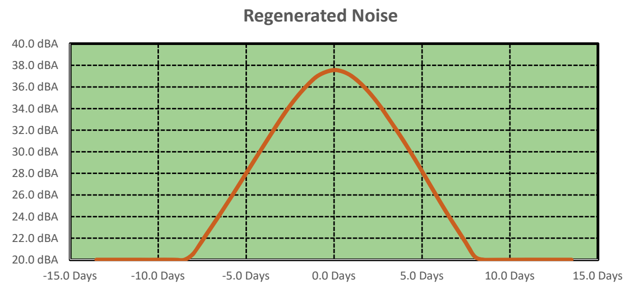
Created using TunnelTRAP Software

Assessment Location: Halifax Avenue - 34









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.9 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	34.9 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.41 mm/s
95% Vibration Level	0.44 mm/s
Maximum Vibration Level	0.45 mm/s
Average Regenerated Noise level	26.0 dBA
90% Regenerated Noise Level	36.3 dBA
95% Regenerated Noise Level	37.1 dBA
Maximum Regenerated Noise Level	37.6 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

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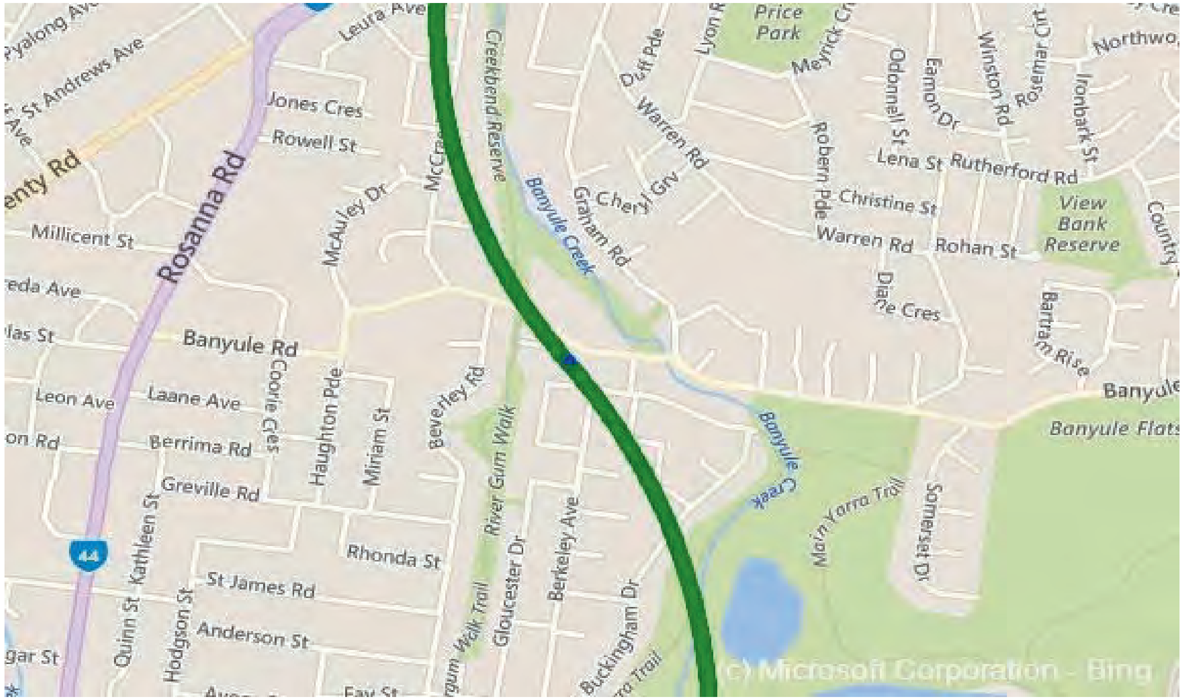
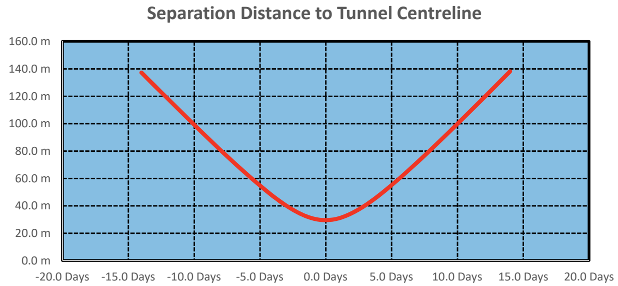
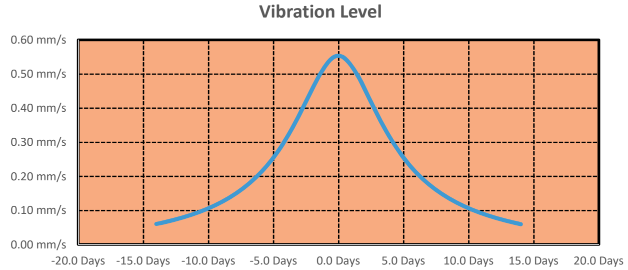
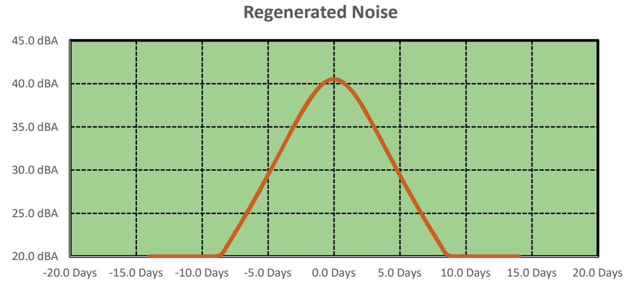
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Halifax Avenue - 51









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.5 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.3 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	29.5 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.49 mm/s
95% Vibration Level	0.53 mm/s
Maximum Vibration Level	0.55 mm/s
Average Regenerated Noise level	26.8 dBA
90% Regenerated Noise Level	38.9 dBA
95% Regenerated Noise Level	39.9 dBA
Maximum Regenerated Noise Level	40.5 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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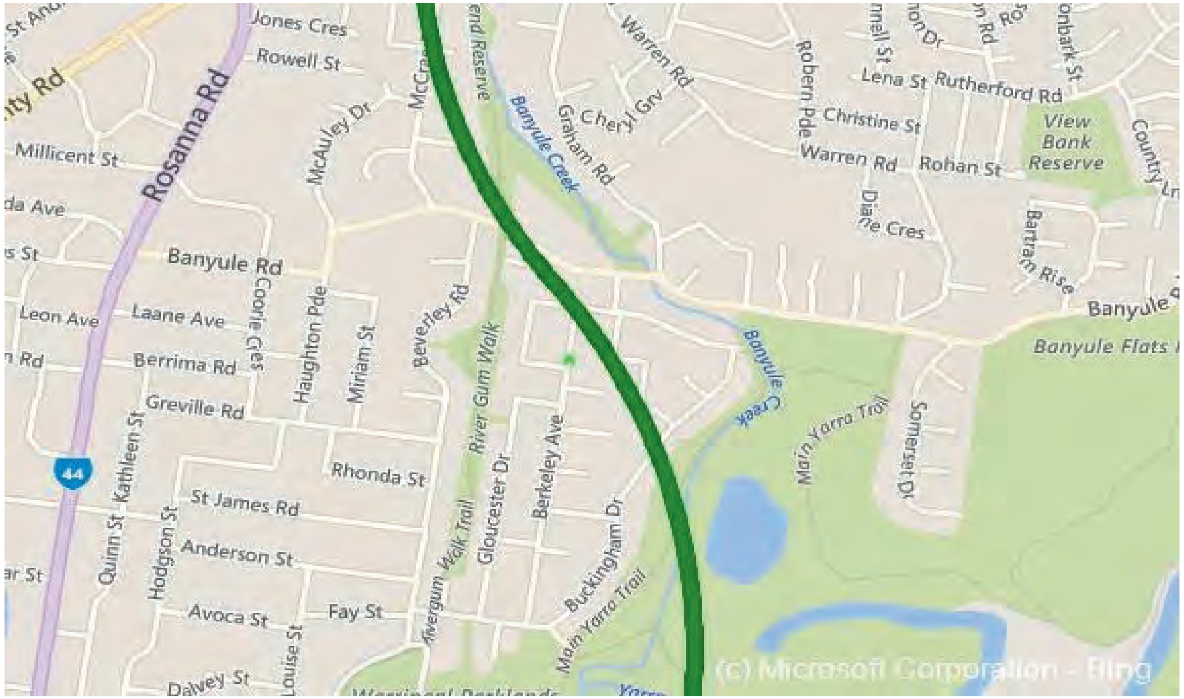
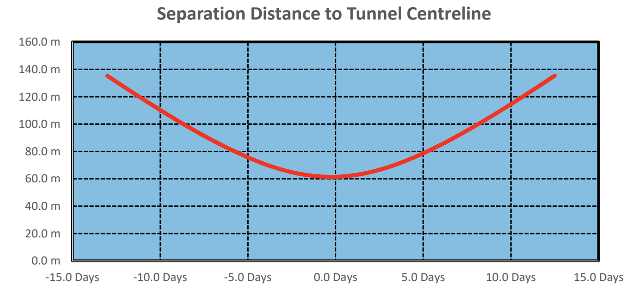
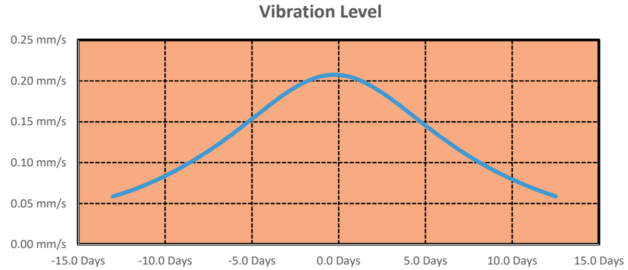
NORTH EAST LINK PROJECT

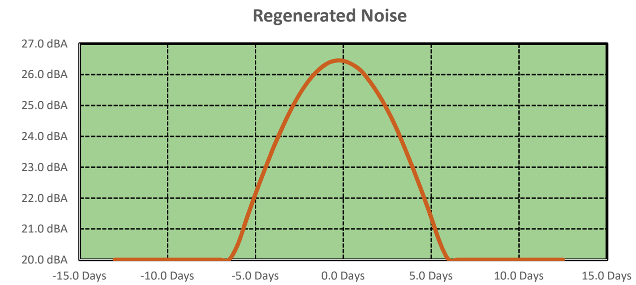
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Hastings Court - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	61.4 m
Average Vibration Level	0.13 mm/s
90% Vibration Level	0.20 mm/s
95% Vibration Level	0.21 mm/s
Maximum Vibration Level	0.21 mm/s
Average Regenerated Noise level	21.9 dBA
90% Regenerated Noise Level	26.1 dBA
95% Regenerated Noise Level	26.3 dBA
Maximum Regenerated Noise Level	26.4 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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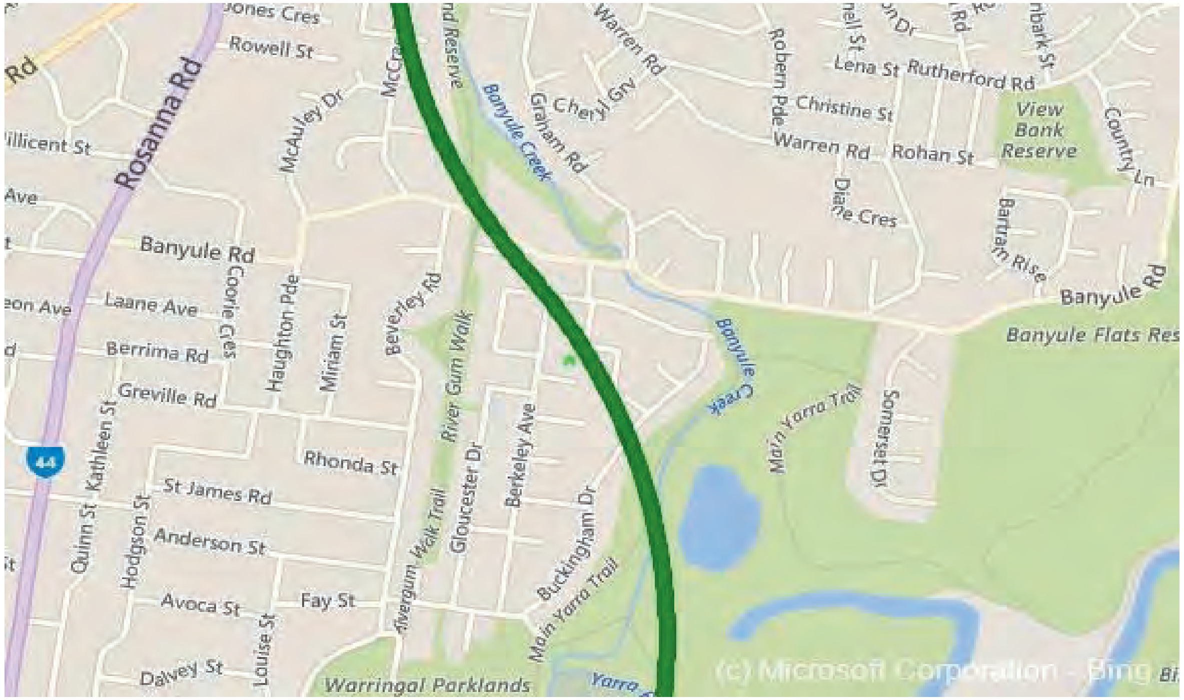
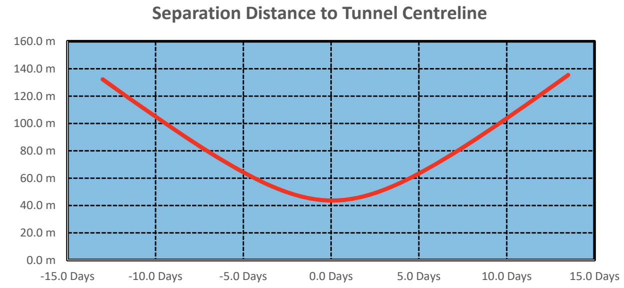
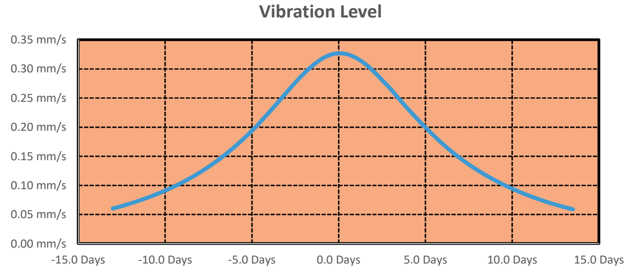
NORTH EAST LINK PROJECT

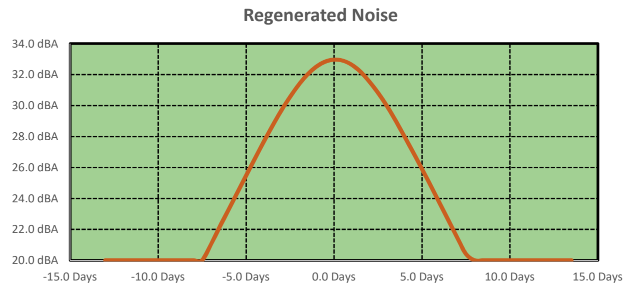
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Hastings Court - 11









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.3 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	43.6 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.31 mm/s
95% Vibration Level	0.32 mm/s
Maximum Vibration Level	0.33 mm/s
Average Regenerated Noise level	24.3 dBA
90% Regenerated Noise Level	32.1 dBA
95% Regenerated Noise Level	32.7 dBA
Maximum Regenerated Noise Level	33.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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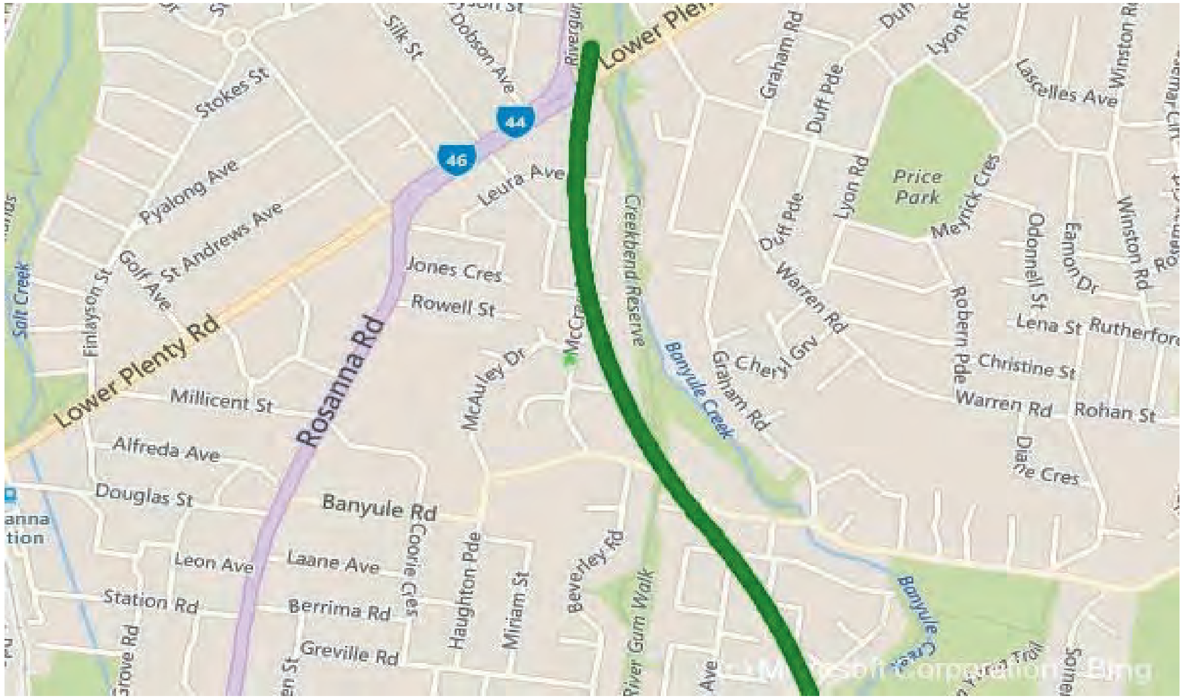
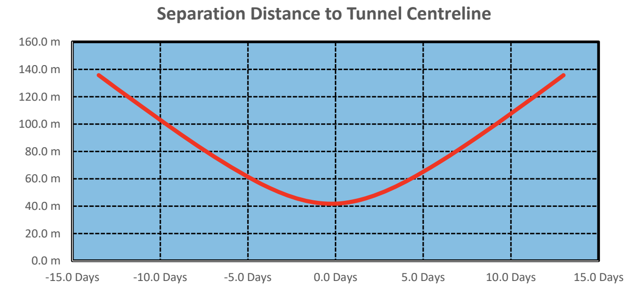
NORTH EAST LINK PROJECT

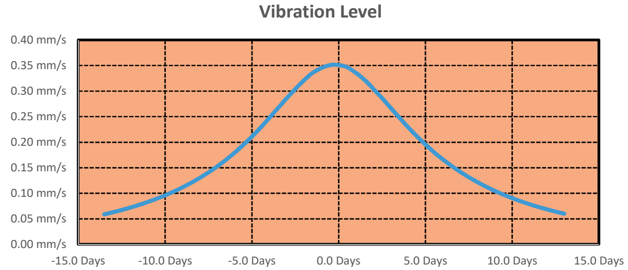
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

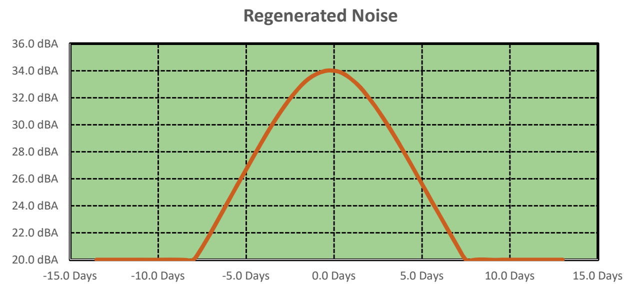
Created using TunnelTRAP Software

Assessment Location: Homewood Court - 3









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.4 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	41.8 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.33 mm/s
95% Vibration Level	0.35 mm/s
Maximum Vibration Level	0.35 mm/s
Average Regenerated Noise level	24.7 dBA
90% Regenerated Noise Level	33.2 dBA
95% Regenerated Noise Level	33.8 dBA
Maximum Regenerated Noise Level	34.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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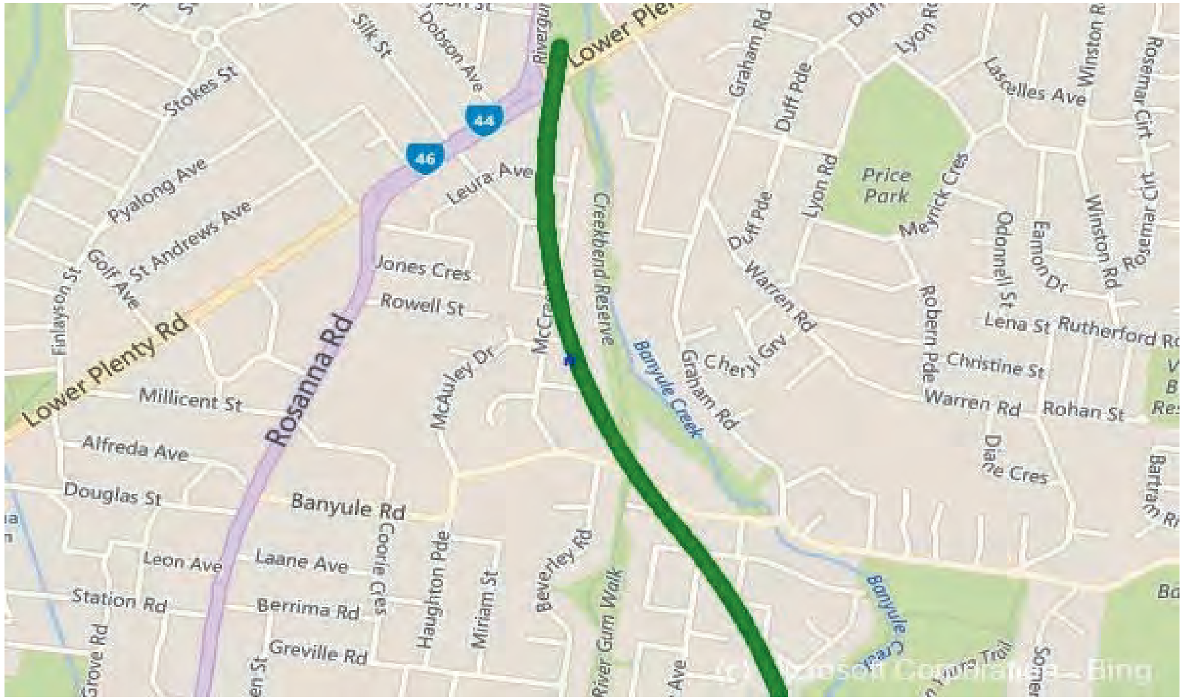
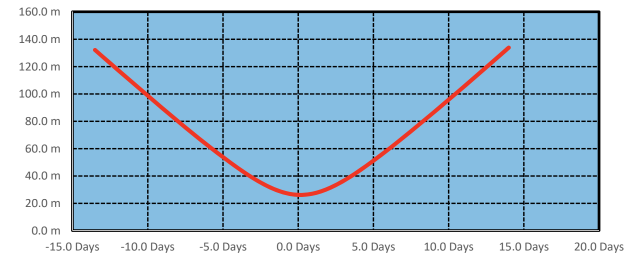
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

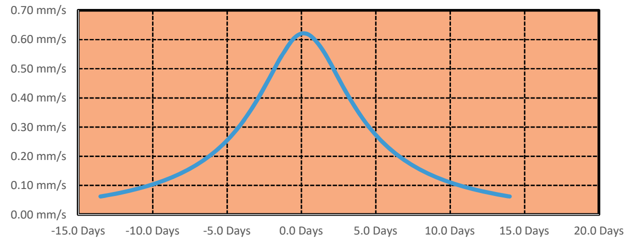
Assessment Location: Homewood Court - 11



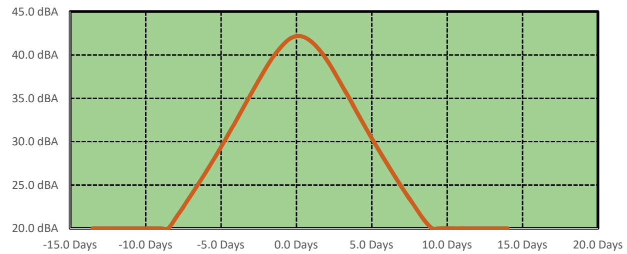
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	26.1 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.54 mm/s
95% Vibration Level	0.60 mm/s
Maximum Vibration Level	0.62 mm/s
Average Regenerated Noise level	27.4 dBA
90% Regenerated Noise Level	40.3 dBA
95% Regenerated Noise Level	41.6 dBA
Maximum Regenerated Noise Level	42.2 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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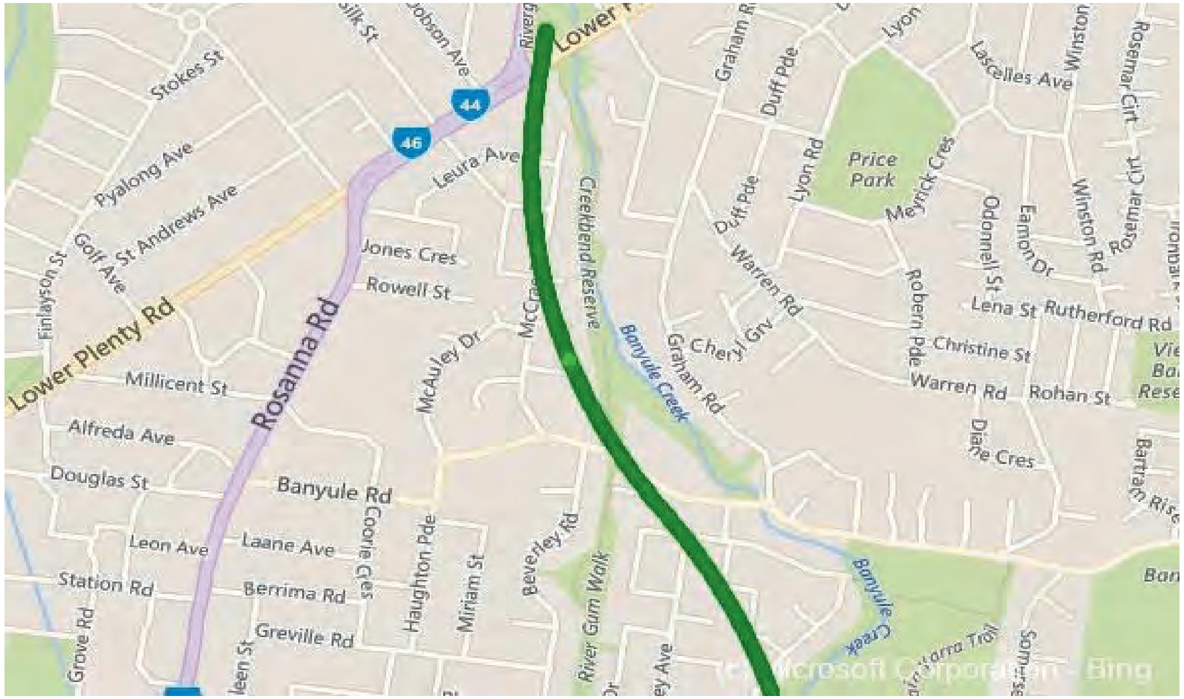
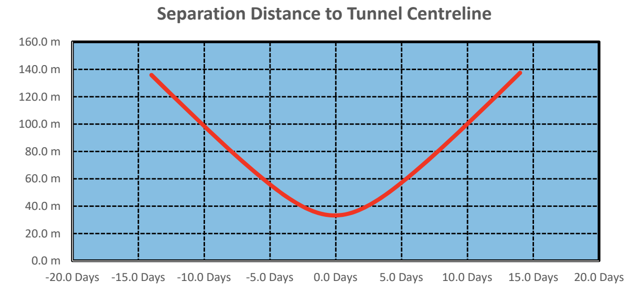
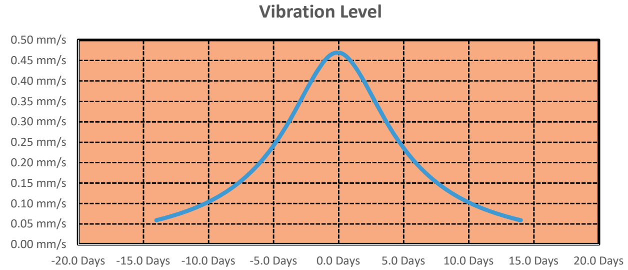
NORTH EAST LINK PROJECT

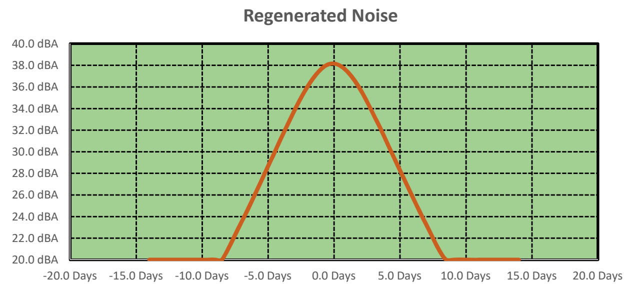
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Homewood Court - 17









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.9 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	33.2 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.43 mm/s
95% Vibration Level	0.45 mm/s
Maximum Vibration Level	0.47 mm/s
Average Regenerated Noise level	26.0 dBA
90% Regenerated Noise Level	36.8 dBA
95% Regenerated Noise Level	37.7 dBA
Maximum Regenerated Noise Level	38.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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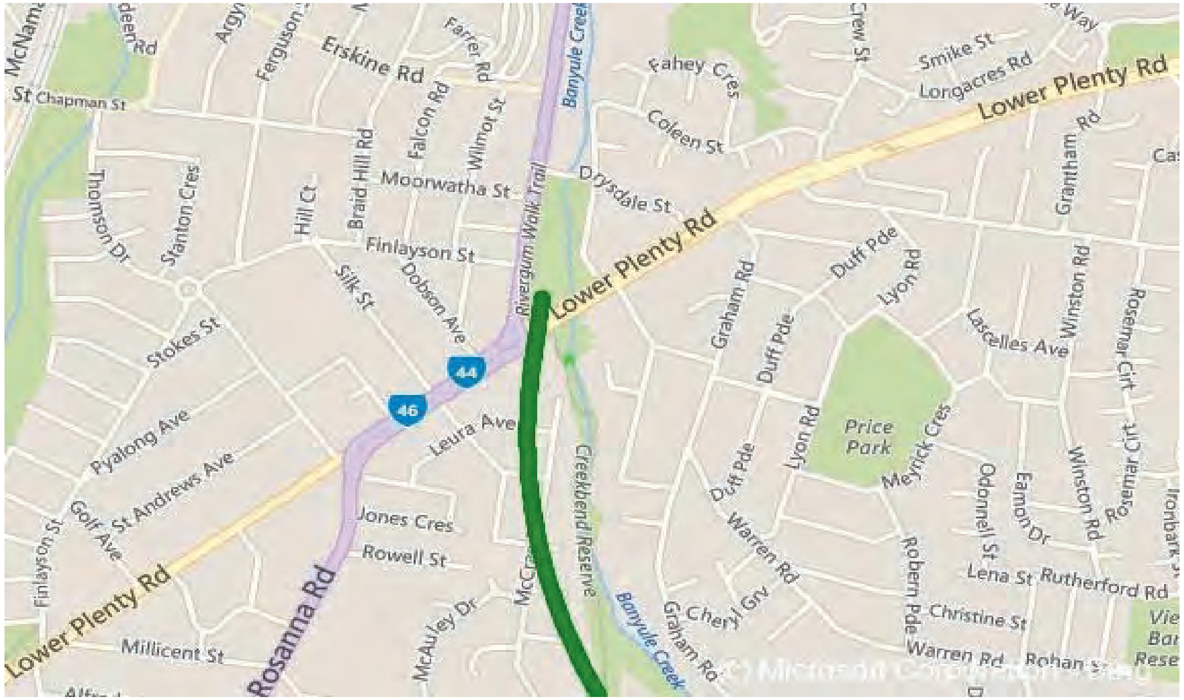
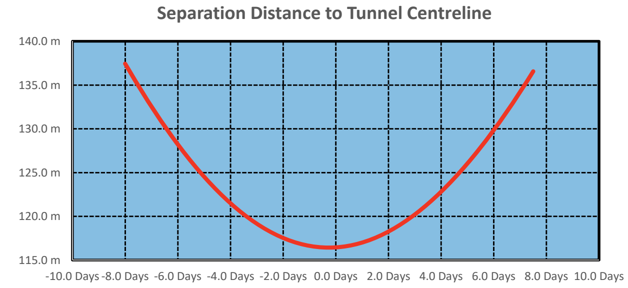
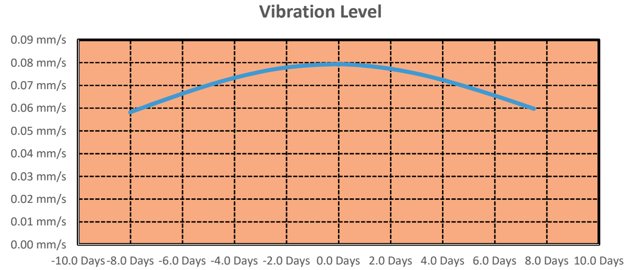
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

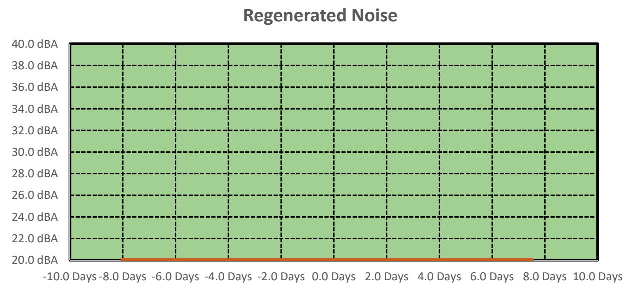
Created using TunnelTRAP Software

Assessment Location: Kallay Court - 7









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	116.4 m
Average Vibration Level	0.07 mm/s
90% Vibration Level	0.08 mm/s
95% Vibration Level	0.08 mm/s
Maximum Vibration Level	0.08 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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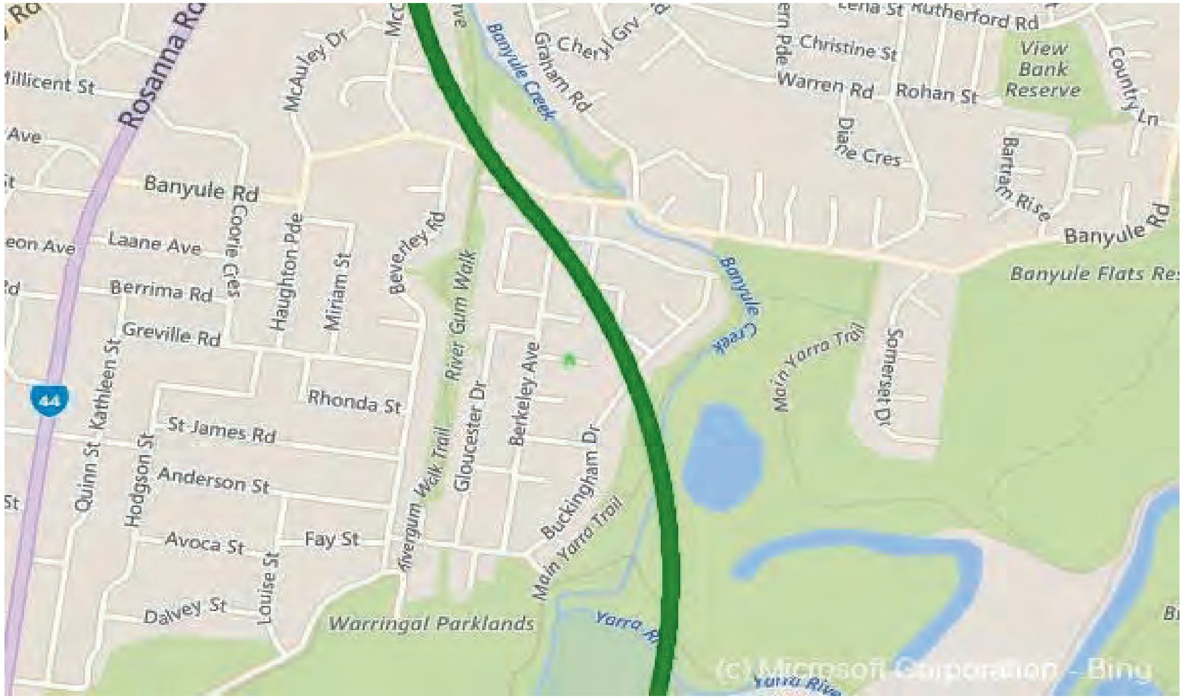
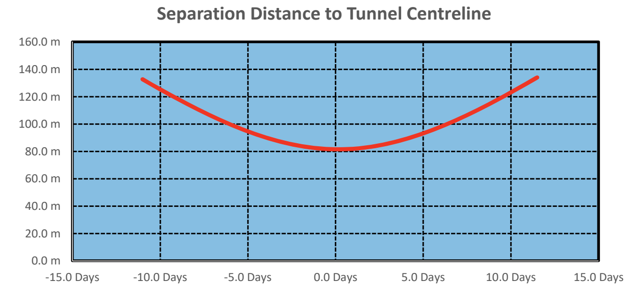
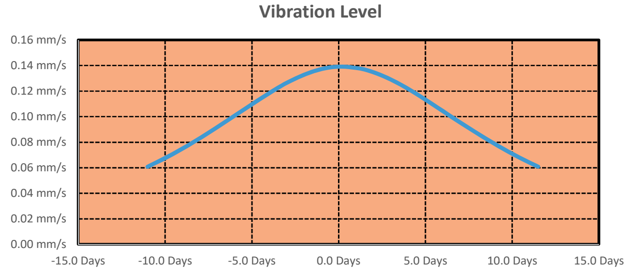
NORTH EAST LINK PROJECT

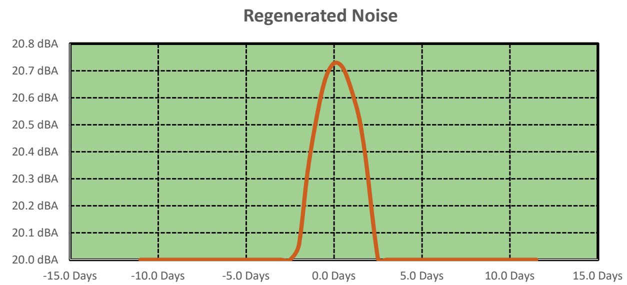
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Kent Court - 12









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	81.5 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.14 mm/s
95% Vibration Level	0.14 mm/s
Maximum Vibration Level	0.14 mm/s
Average Regenerated Noise level	20.1 dBA
90% Regenerated Noise Level	20.5 dBA
95% Regenerated Noise Level	20.7 dBA
Maximum Regenerated Noise Level	20.7 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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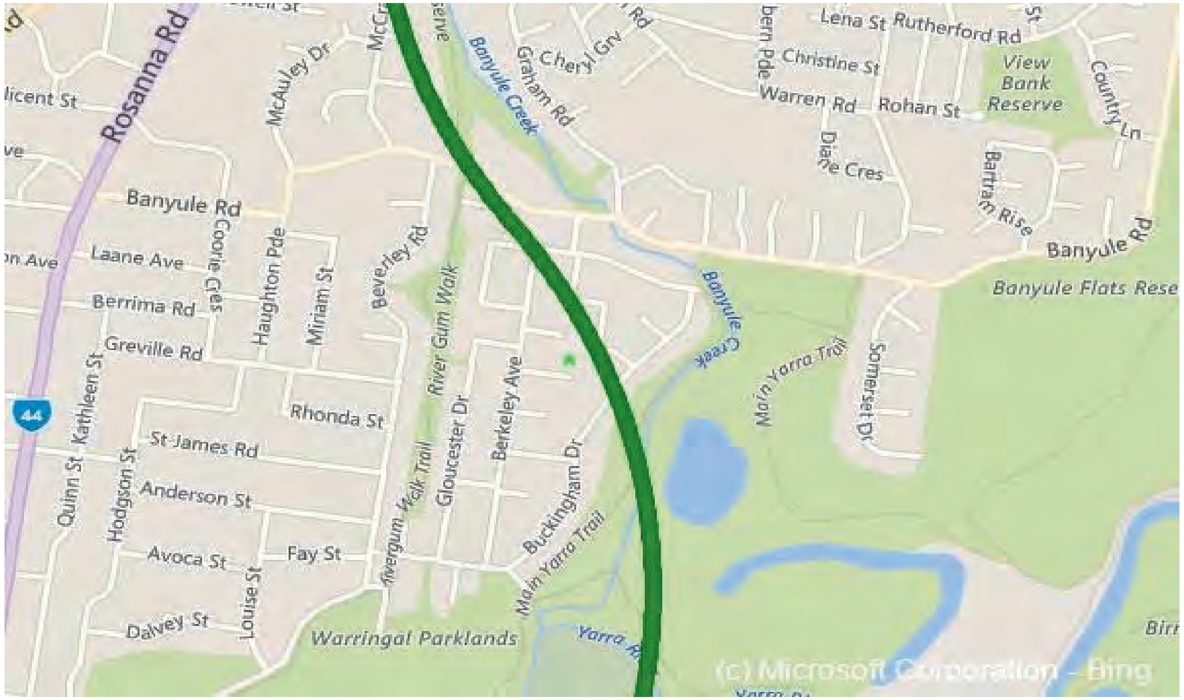
NORTH EAST LINK PROJECT

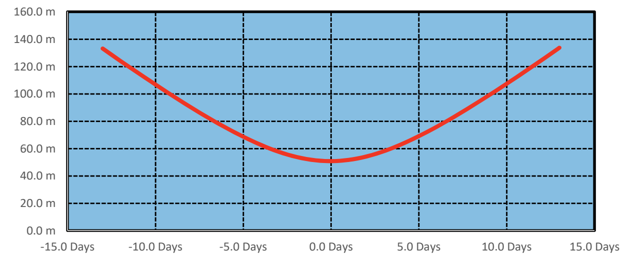
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

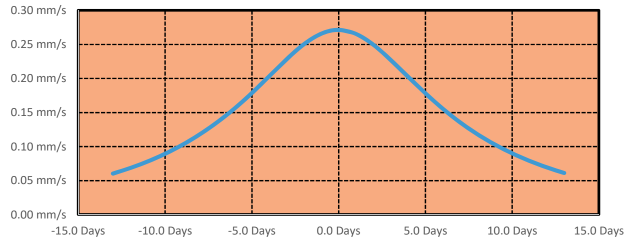
Assessment Location: Kent Court - 16



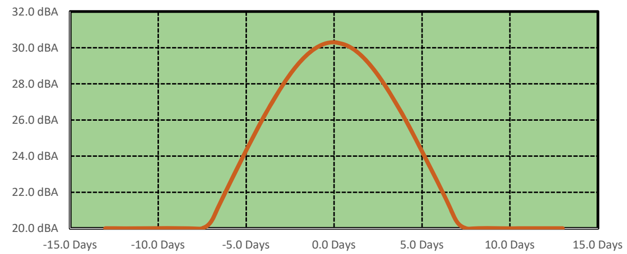
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.8 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	50.8 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.26 mm/s
95% Vibration Level	0.27 mm/s
Maximum Vibration Level	0.27 mm/s
Average Regenerated Noise level	23.4 dBA
90% Regenerated Noise Level	29.6 dBA
95% Regenerated Noise Level	30.1 dBA
Maximum Regenerated Noise Level	30.3 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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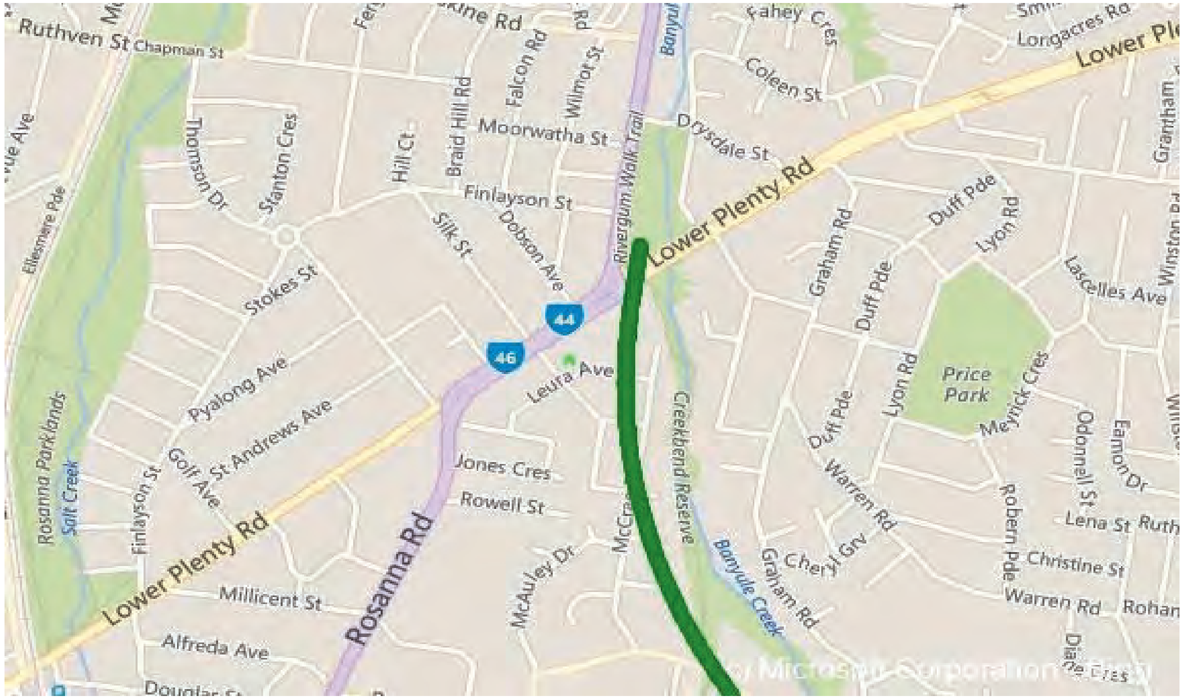
NORTH EAST LINK PROJECT

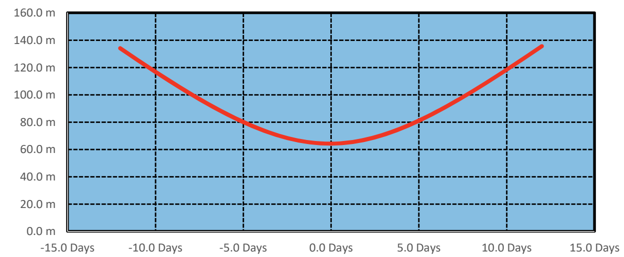
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

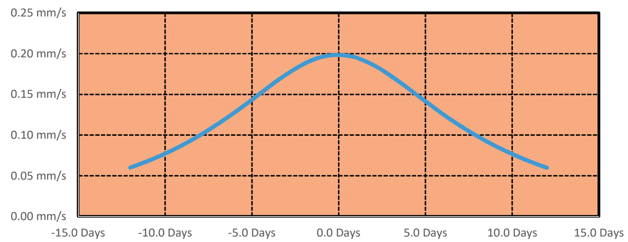
Assessment Location: Leura Avenue - 20/22



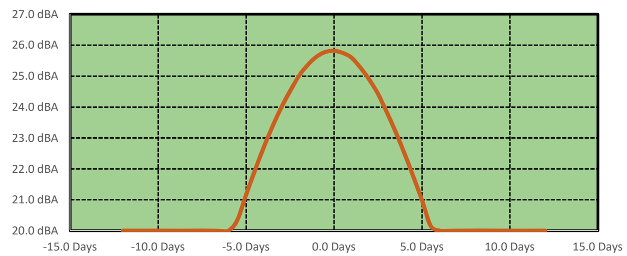
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	64.2 m
Average Vibration Level	0.13 mm/s
90% Vibration Level	0.19 mm/s
95% Vibration Level	0.20 mm/s
Maximum Vibration Level	0.20 mm/s
Average Regenerated Noise level	21.7 dBA
90% Regenerated Noise Level	25.4 dBA
95% Regenerated Noise Level	25.7 dBA
Maximum Regenerated Noise Level	25.8 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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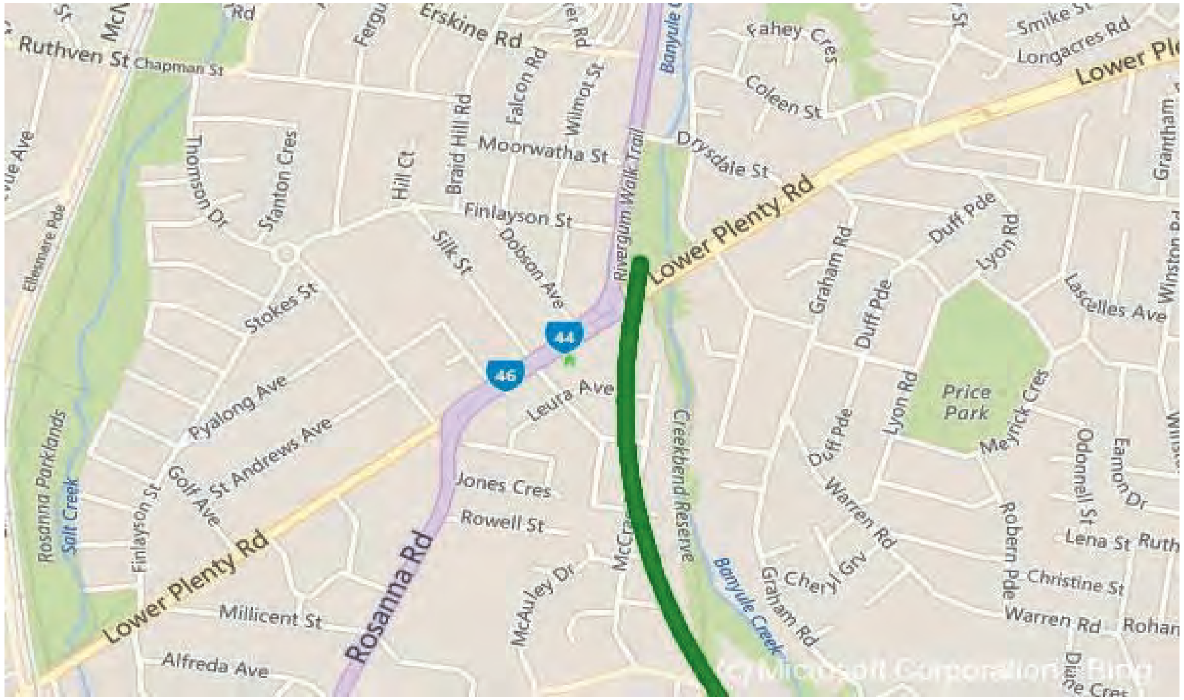
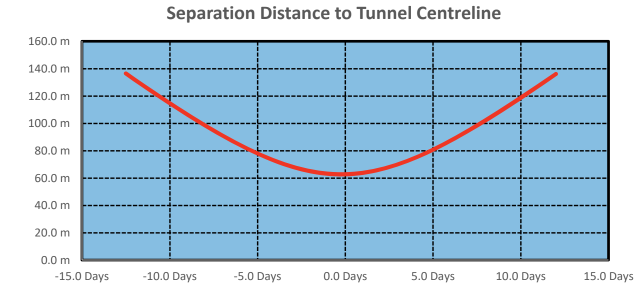
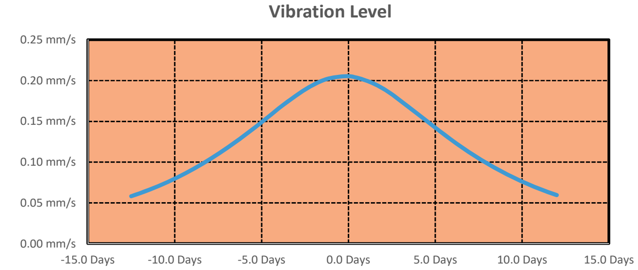
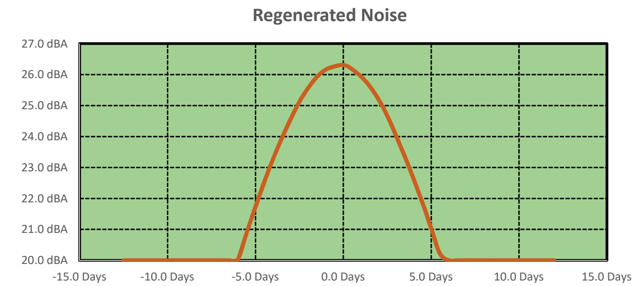
Assessment Location: Leura Avenue - 25









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	62.7 m
Average Vibration Level	0.13 mm/s
90% Vibration Level	0.20 mm/s
95% Vibration Level	0.20 mm/s
Maximum Vibration Level	0.21 mm/s
Average Regenerated Noise level	21.9 dBA
90% Regenerated Noise Level	25.9 dBA
95% Regenerated Noise Level	26.2 dBA
Maximum Regenerated Noise Level	26.3 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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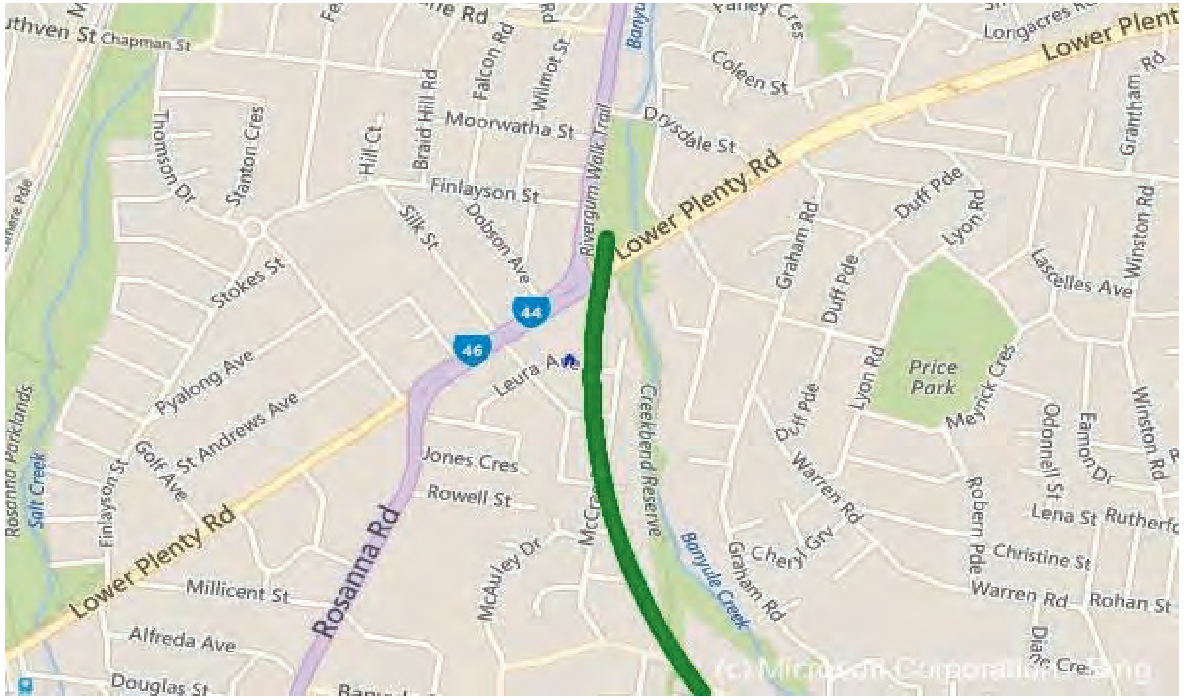
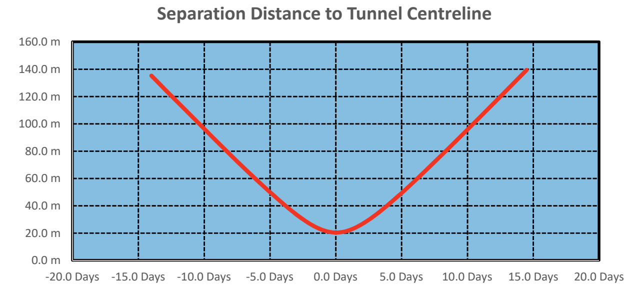
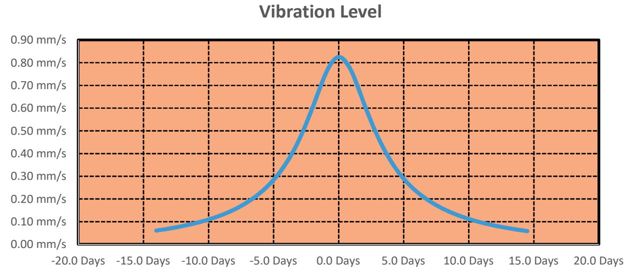
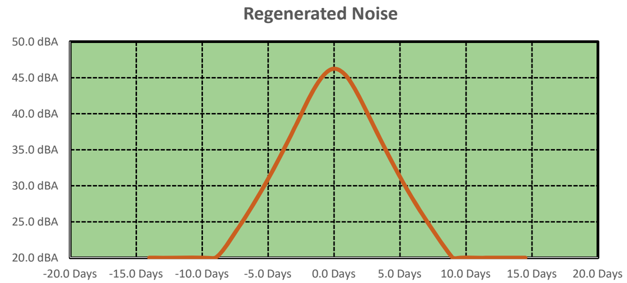
A B C D E F G H I J K L M

Assessment Location: Leura Avenue - 28









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.4 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.4 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	20.4 m
Average Vibration Level	0.28 mm/s
90% Vibration Level	0.68 mm/s
95% Vibration Level	0.77 mm/s
Maximum Vibration Level	0.83 mm/s
Average Regenerated Noise level	28.2 dBA
90% Regenerated Noise Level	43.5 dBA
95% Regenerated Noise Level	45.2 dBA
Maximum Regenerated Noise Level	46.2 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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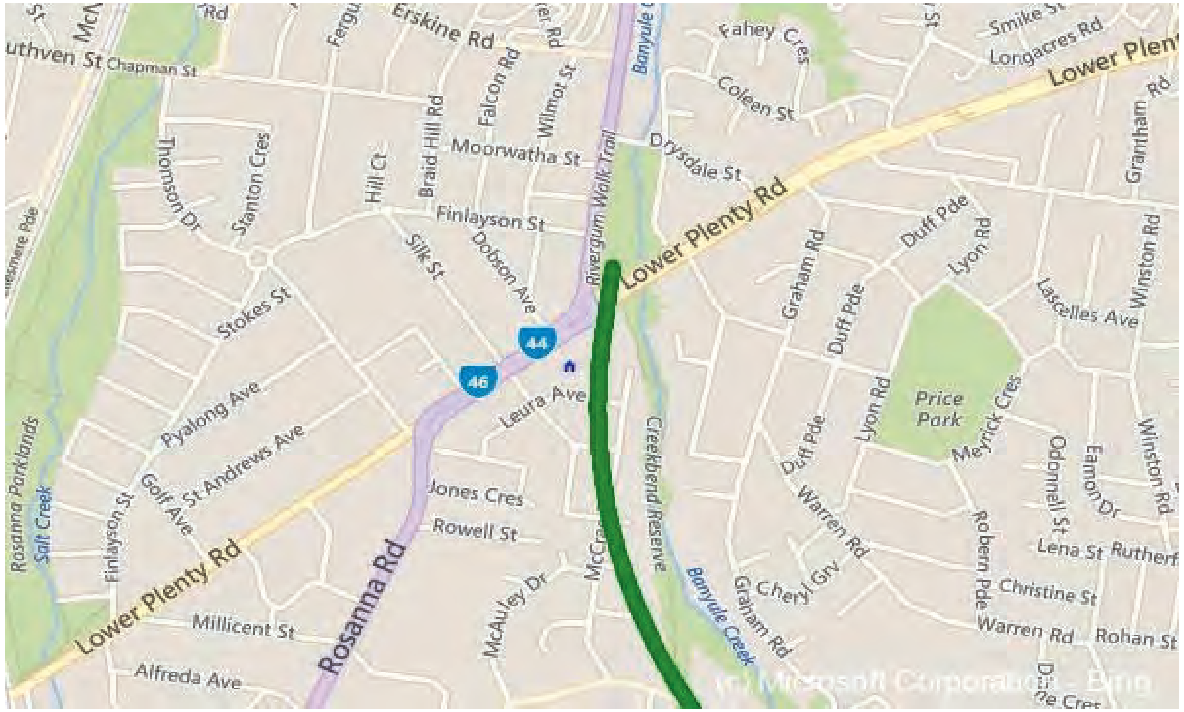
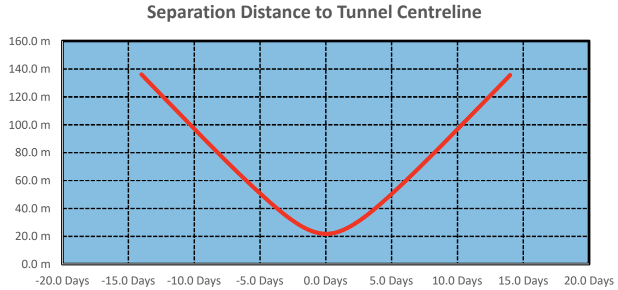
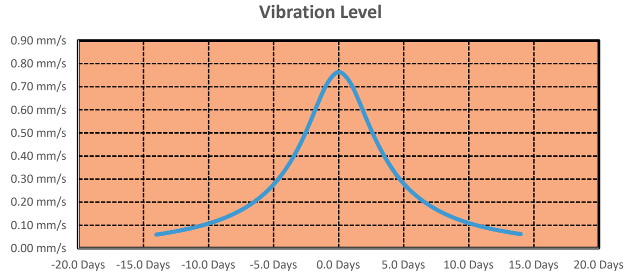
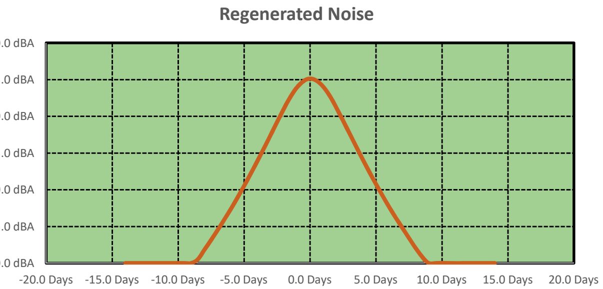
A B C D E F G H I J K L M

Assessment Location: Leura Avenue - 31









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.1 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	0.9 days
Number of days above 45dBA	0.1 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.7 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.64 mm/s
95% Vibration Level	0.71 mm/s
Maximum Vibration Level	0.76 mm/s
Average Regenerated Noise level	28.0 dBA
90% Regenerated Noise Level	42.7 dBA
95% Regenerated Noise Level	44.2 dBA
Maximum Regenerated Noise Level	45.1 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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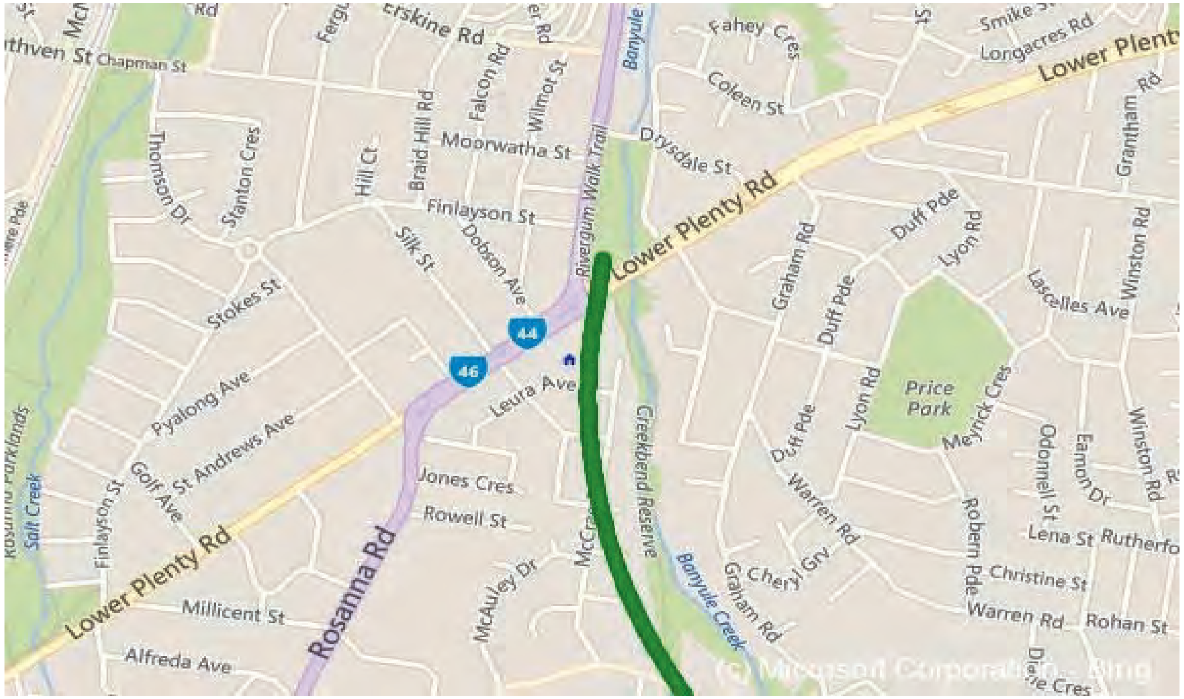
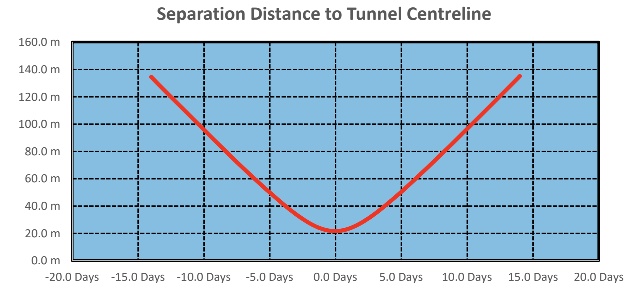
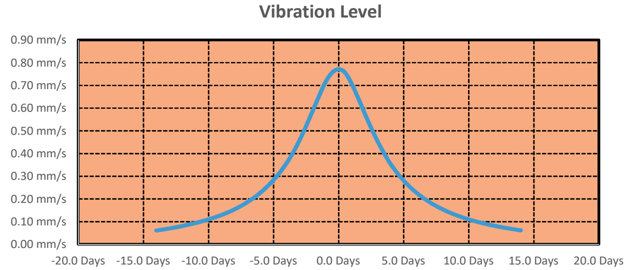
NORTH EAST LINK PROJECT

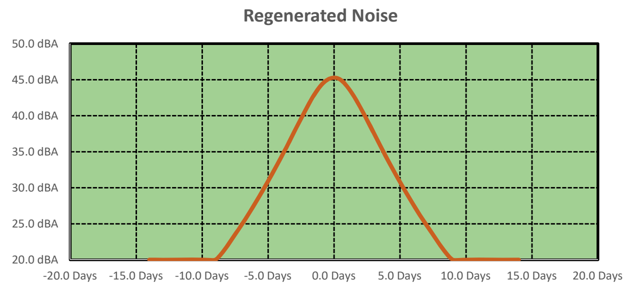
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Leura Avenue - 33









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.3 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	0.9 days
Number of days above 45dBA	0.1 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.6 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.65 mm/s
95% Vibration Level	0.72 mm/s
Maximum Vibration Level	0.77 mm/s
Average Regenerated Noise level	28.1 dBA
90% Regenerated Noise Level	42.8 dBA
95% Regenerated Noise Level	44.3 dBA
Maximum Regenerated Noise Level	45.3 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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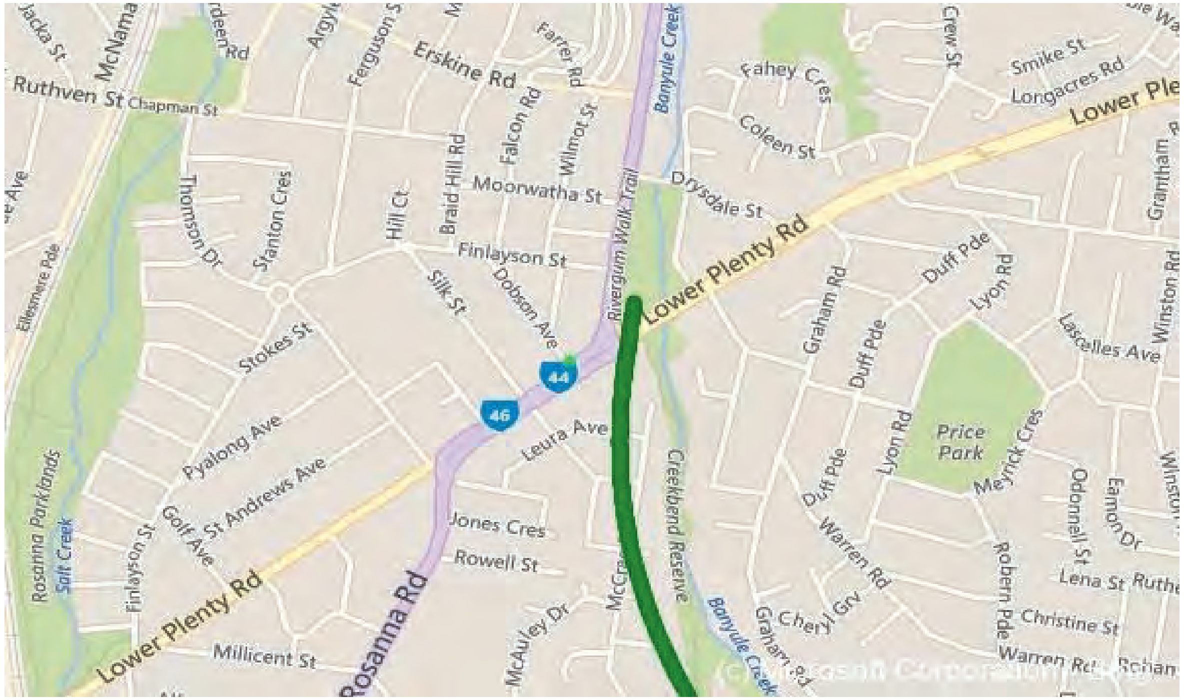
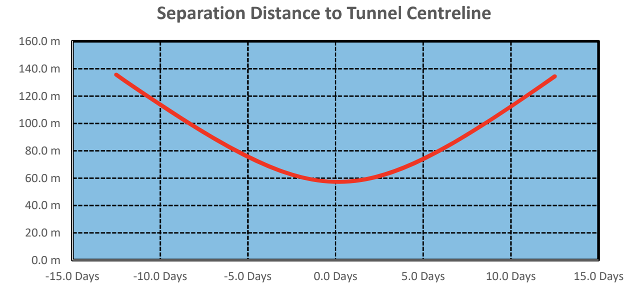
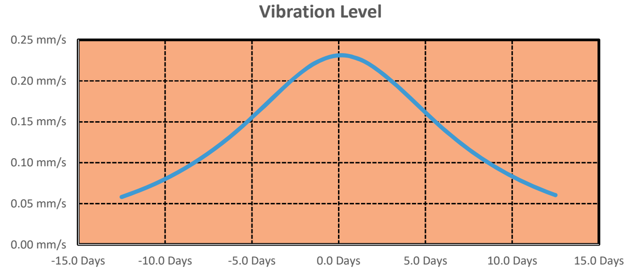
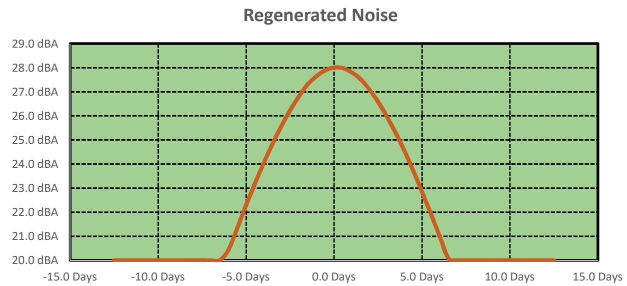
Assessment Location: Lower Plenty Road - 302A









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	57.2 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.22 mm/s
95% Vibration Level	0.23 mm/s
Maximum Vibration Level	0.23 mm/s
Average Regenerated Noise level	22.5 dBA
90% Regenerated Noise Level	27.5 dBA
95% Regenerated Noise Level	27.8 dBA
Maximum Regenerated Noise Level	28.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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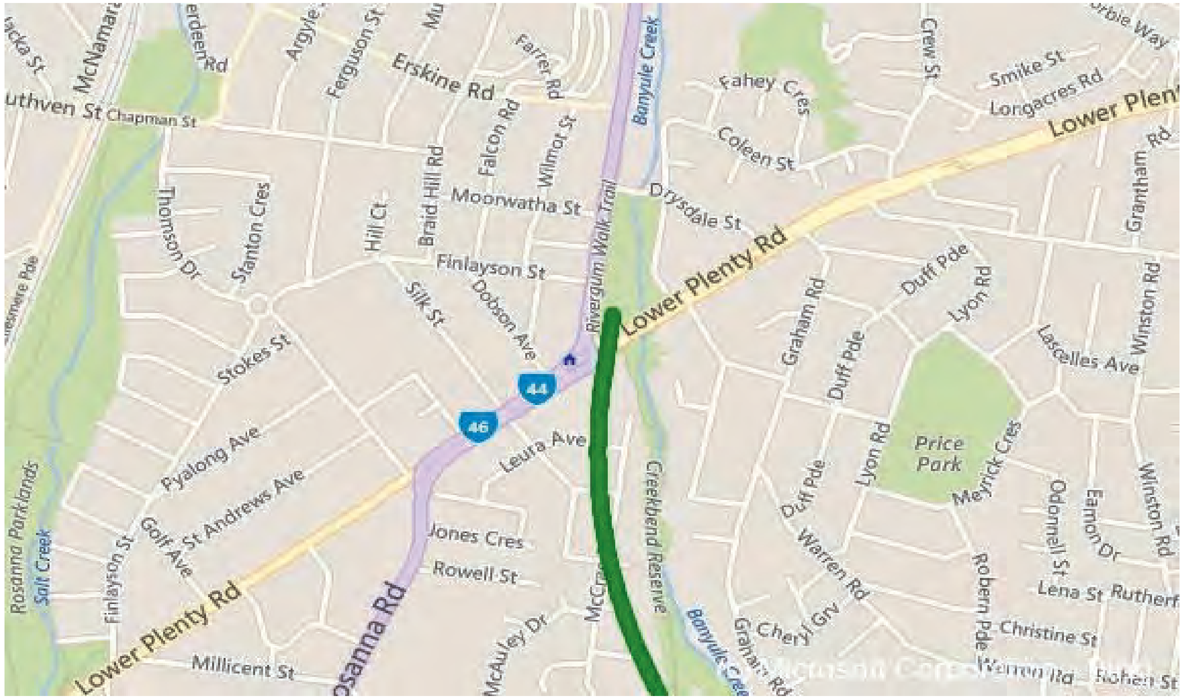
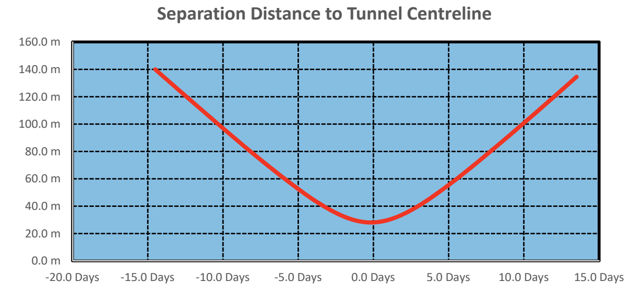
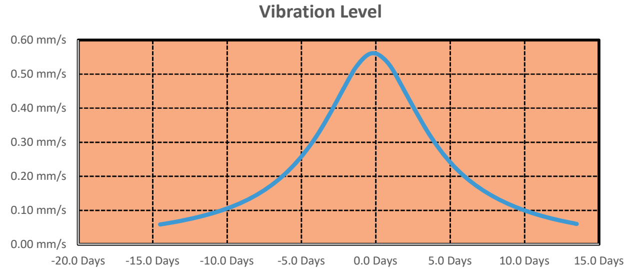
NORTH EAST LINK PROJECT

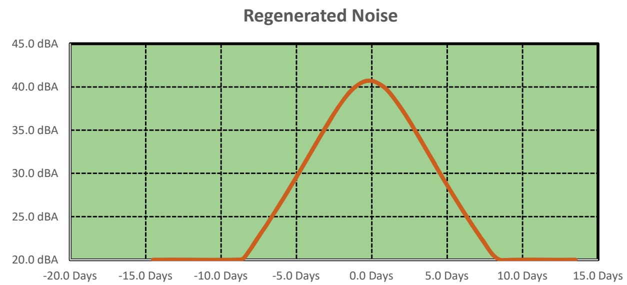
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Lower Plenty Road - 302D









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.6 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.2 days
Number of days above 40dBA	0.4 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	28.1 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.49 mm/s
95% Vibration Level	0.54 mm/s
Maximum Vibration Level	0.56 mm/s
Average Regenerated Noise level	26.7 dBA
90% Regenerated Noise Level	38.9 dBA
95% Regenerated Noise Level	40.2 dBA
Maximum Regenerated Noise Level	40.7 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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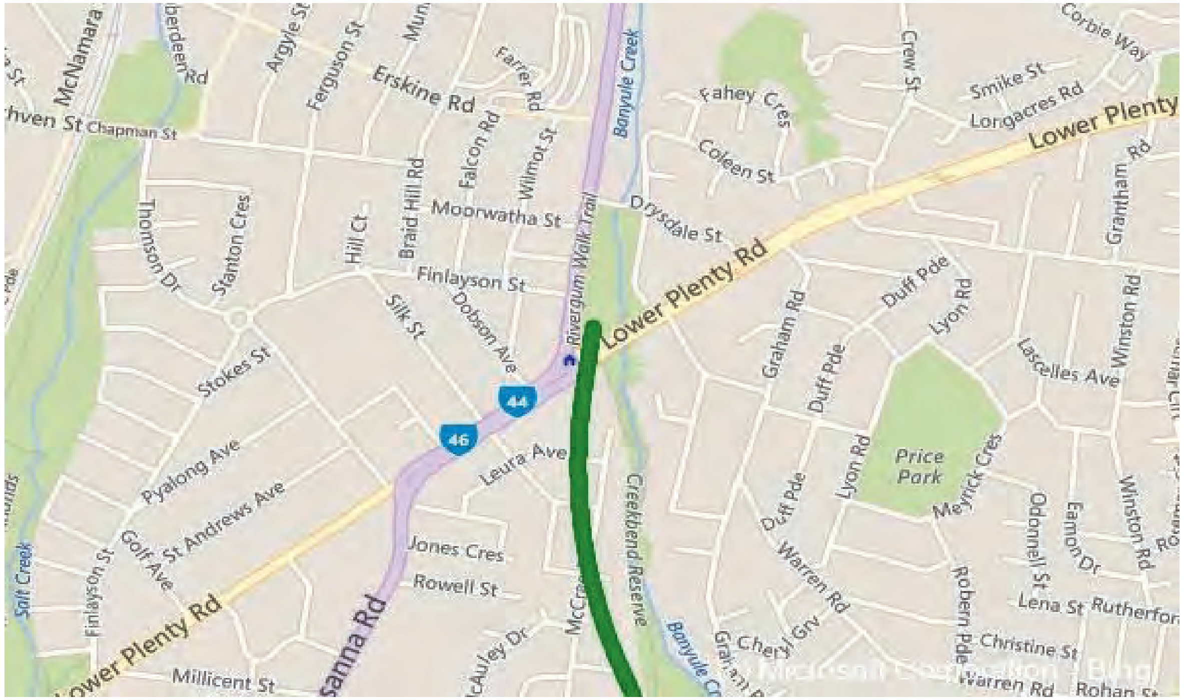
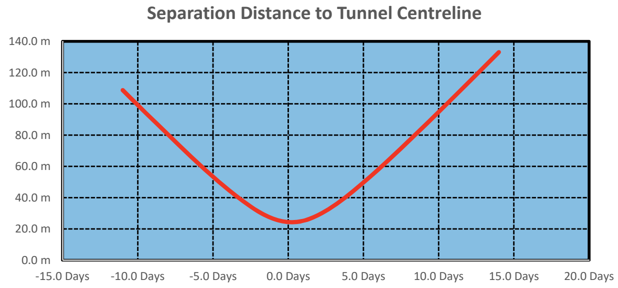
NORTH EAST LINK PROJECT

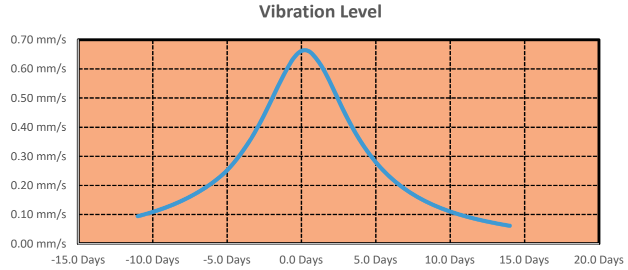
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

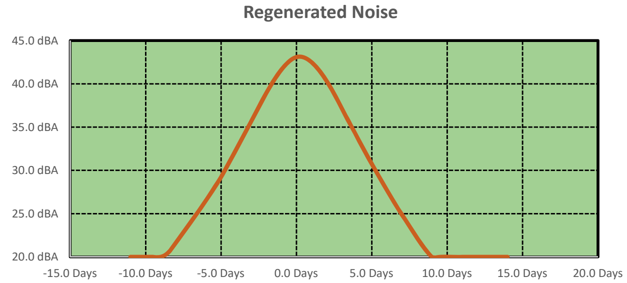
Created using TunnelTRAP Software

Assessment Location: Lower Plenty Road - 314









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.8 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	24.4 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.60 mm/s
95% Vibration Level	0.64 mm/s
Maximum Vibration Level	0.66 mm/s
Average Regenerated Noise level	28.3 dBA
90% Regenerated Noise Level	41.6 dBA
95% Regenerated Noise Level	42.5 dBA
Maximum Regenerated Noise Level	43.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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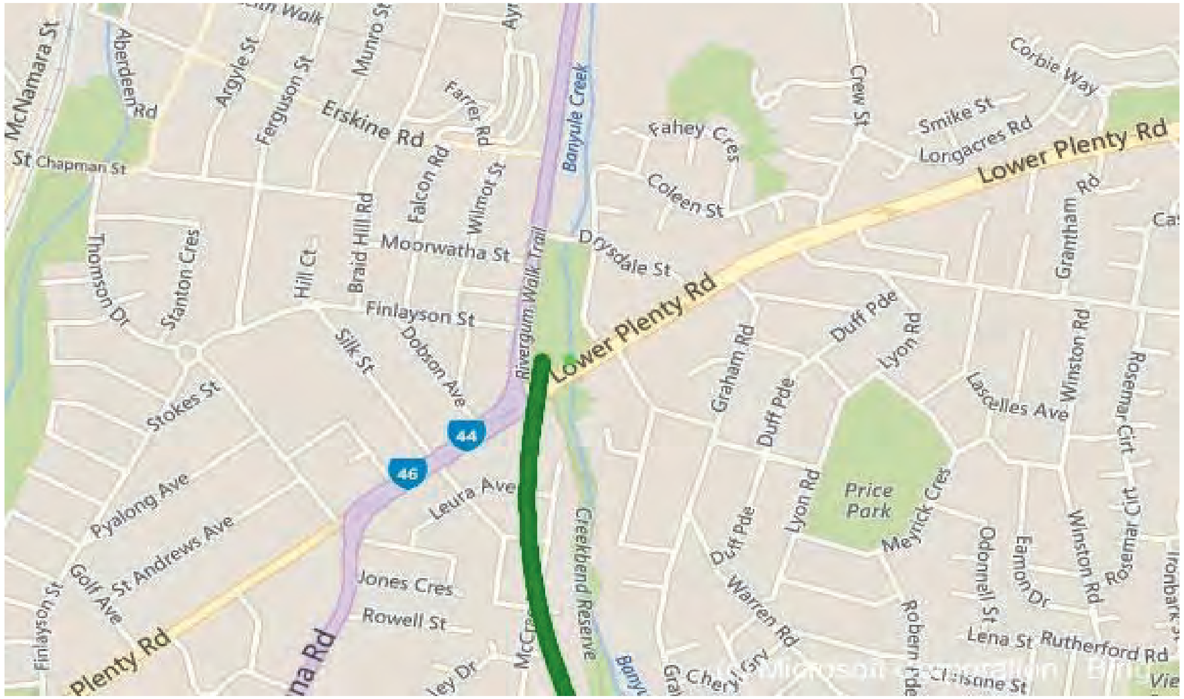
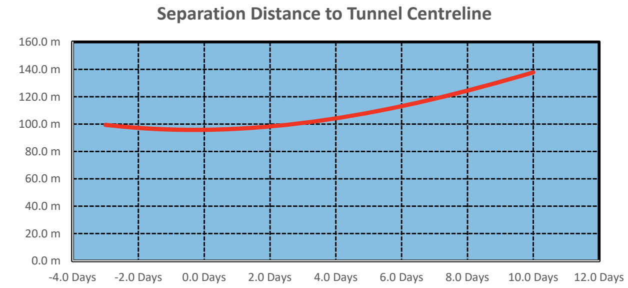
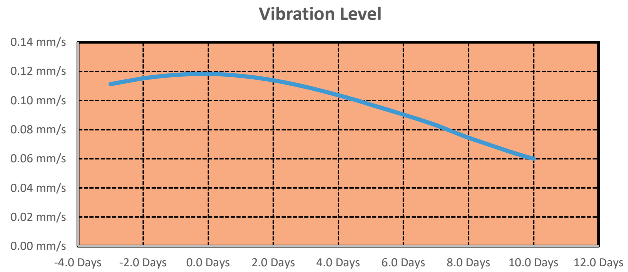
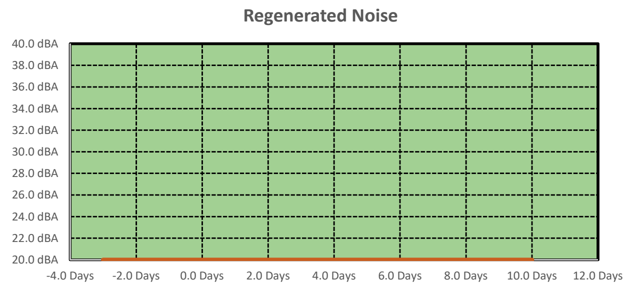
Assessment Location: Lower Plenty Road - 328A









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	95.8 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.12 mm/s
95% Vibration Level	0.12 mm/s
Maximum Vibration Level	0.12 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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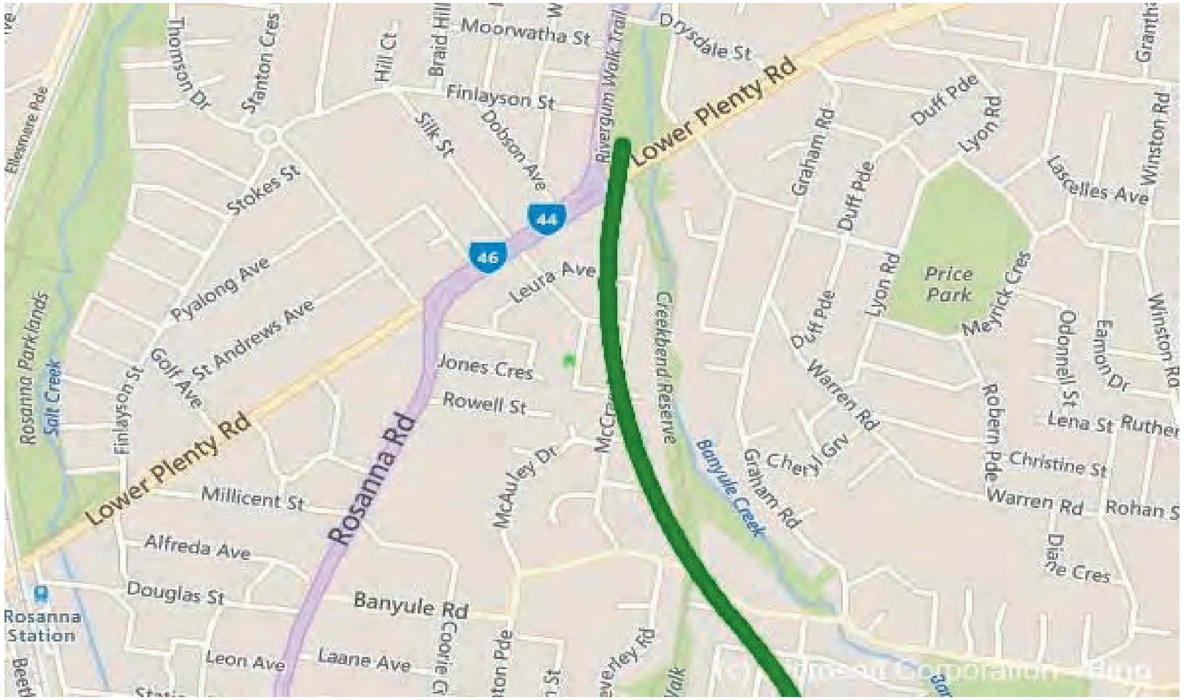
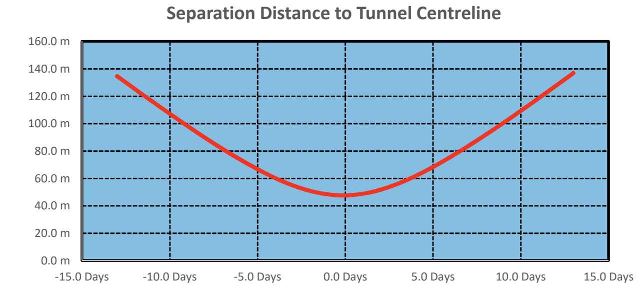
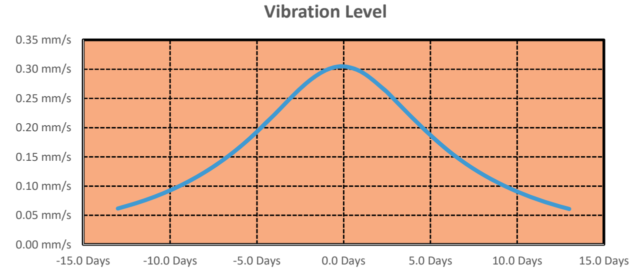
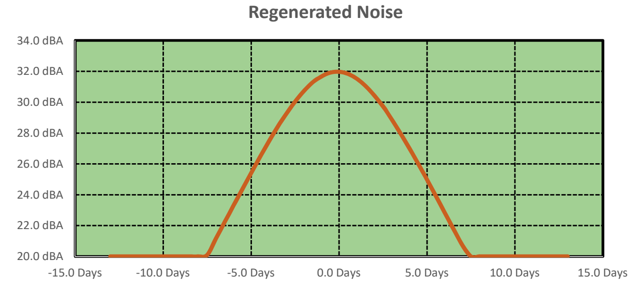
Assessment Location: Maleela Grove - 6









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.2 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	47.6 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.29 mm/s
95% Vibration Level	0.30 mm/s
Maximum Vibration Level	0.30 mm/s
Average Regenerated Noise level	24.0 dBA
90% Regenerated Noise Level	31.2 dBA
95% Regenerated Noise Level	31.7 dBA
Maximum Regenerated Noise Level	32.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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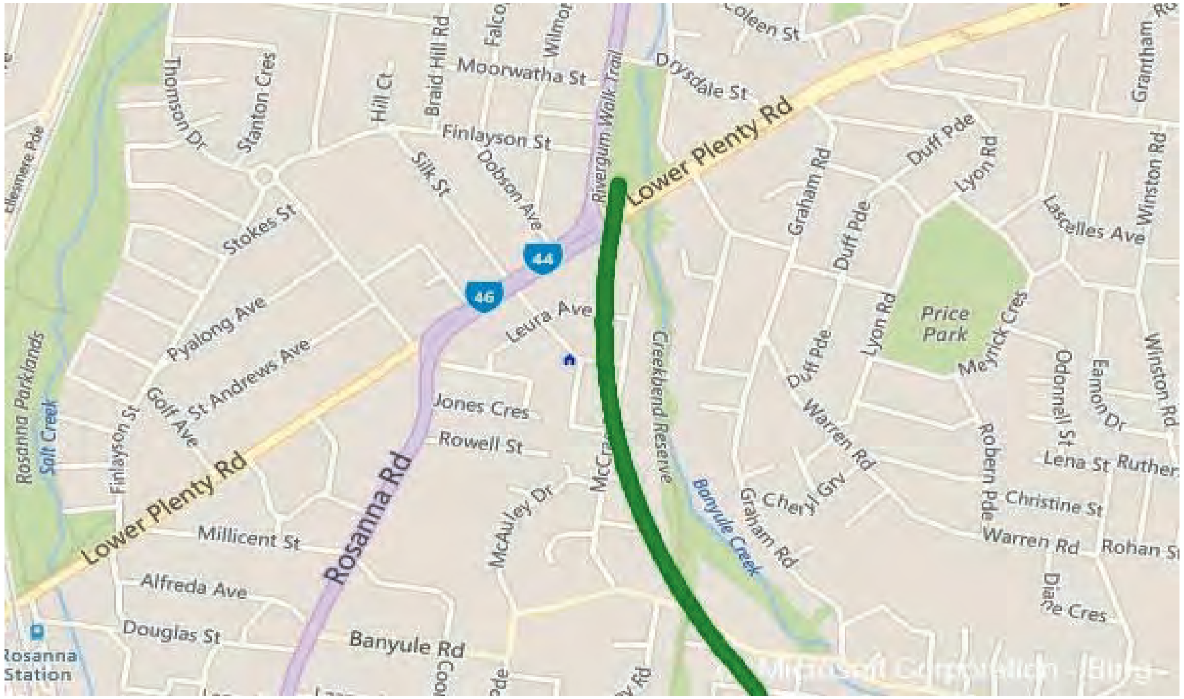
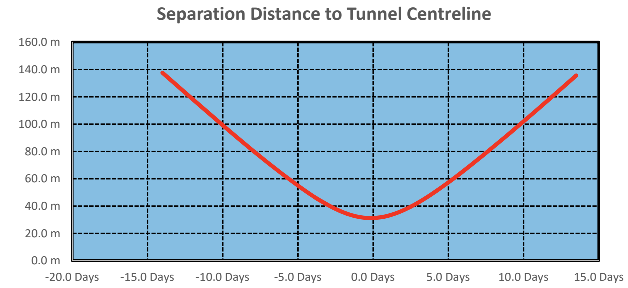
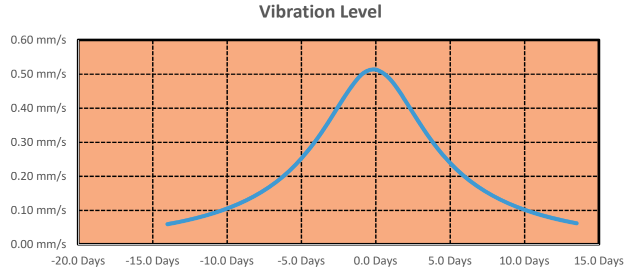
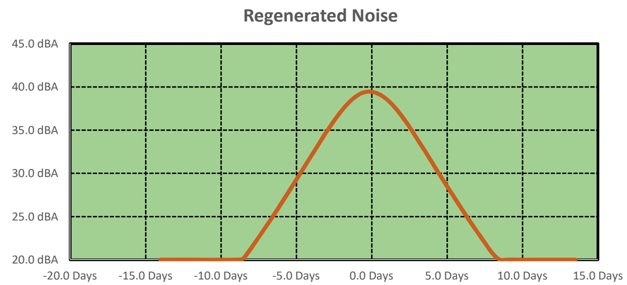
Assessment Location: Maleela Grove - 16









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.3 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.1 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.2 m
Average Vibration Level	0.22 mm/s
90% Vibration Level	0.46 mm/s
95% Vibration Level	0.50 mm/s
Maximum Vibration Level	0.51 mm/s
Average Regenerated Noise level	26.5 dBA
90% Regenerated Noise Level	37.9 dBA
95% Regenerated Noise Level	39.0 dBA
Maximum Regenerated Noise Level	39.4 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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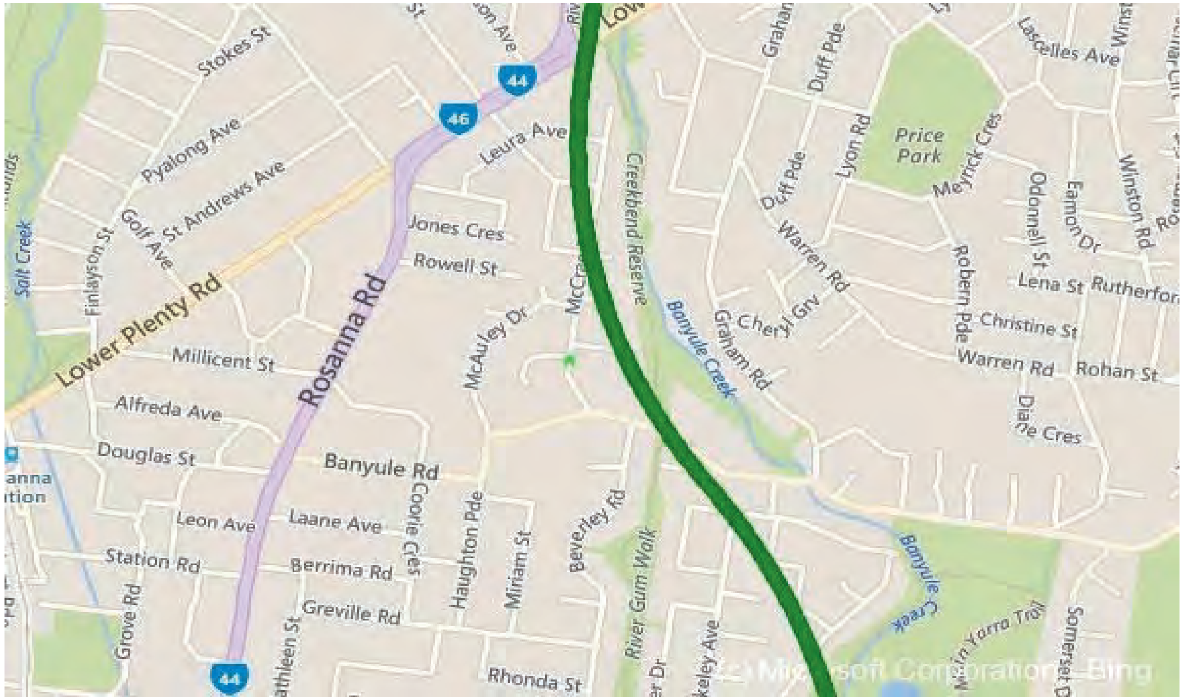
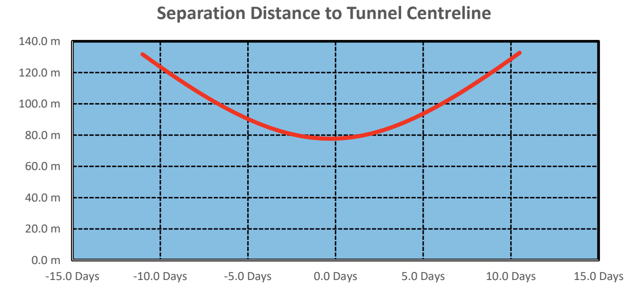
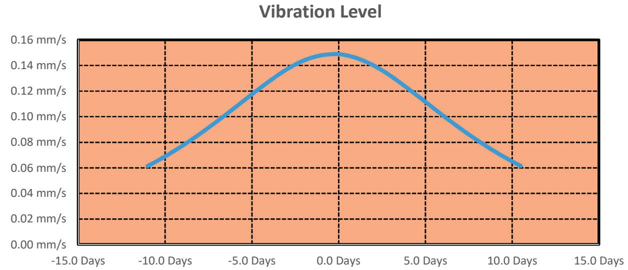
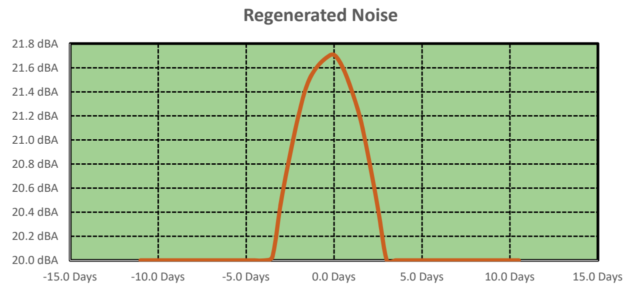
Assessment Location: McCrae Road - 8









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	77.7 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.15 mm/s
95% Vibration Level	0.15 mm/s
Maximum Vibration Level	0.15 mm/s
Average Regenerated Noise level	20.3 dBA
90% Regenerated Noise Level	21.5 dBA
95% Regenerated Noise Level	21.6 dBA
Maximum Regenerated Noise Level	21.7 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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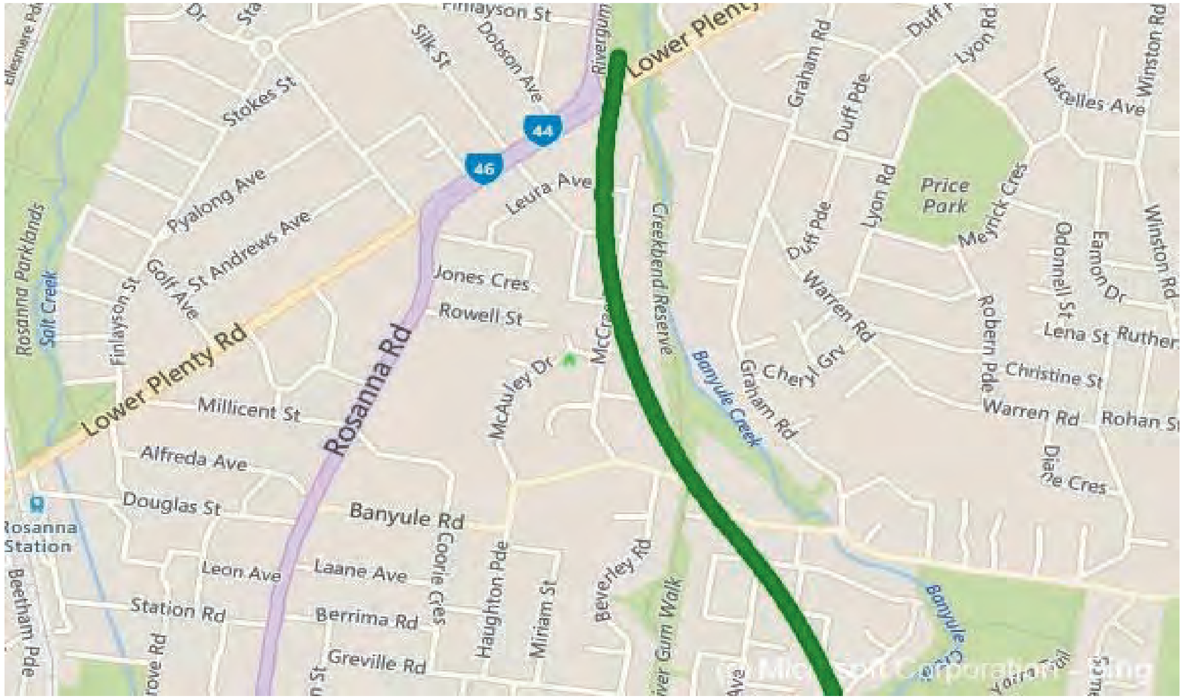
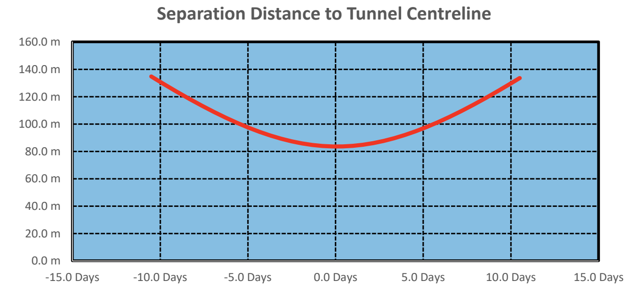
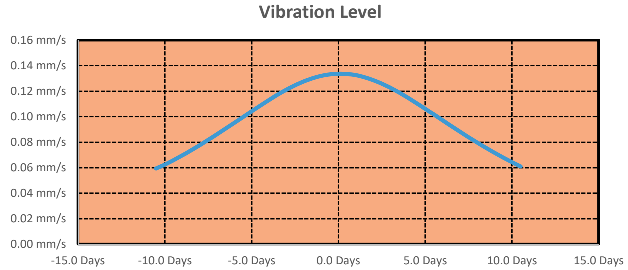
NORTH EAST LINK PROJECT

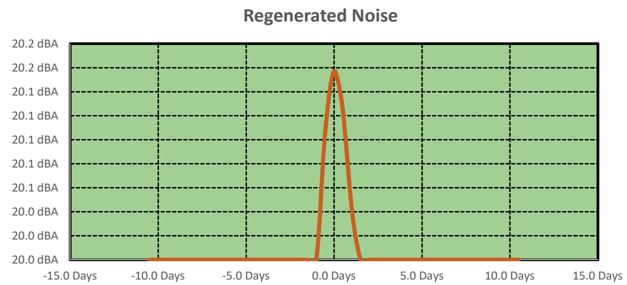
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 17









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	83.5 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.13 mm/s
95% Vibration Level	0.13 mm/s
Maximum Vibration Level	0.13 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.1 dBA
Maximum Regenerated Noise Level	20.2 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

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Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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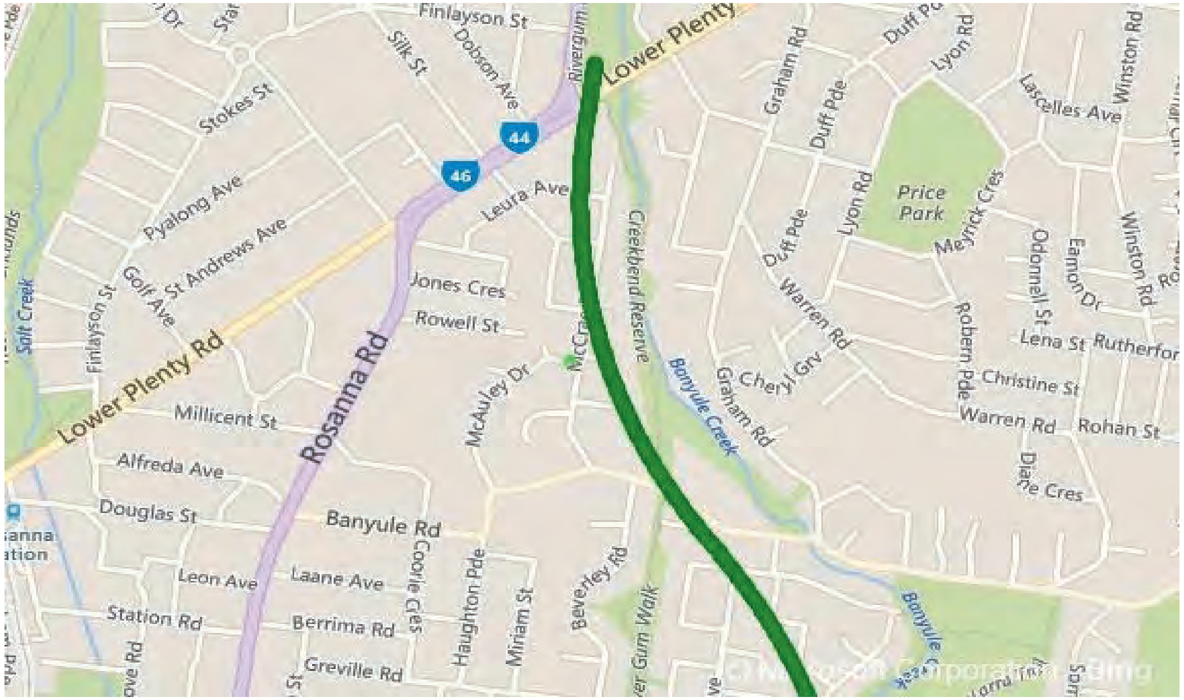
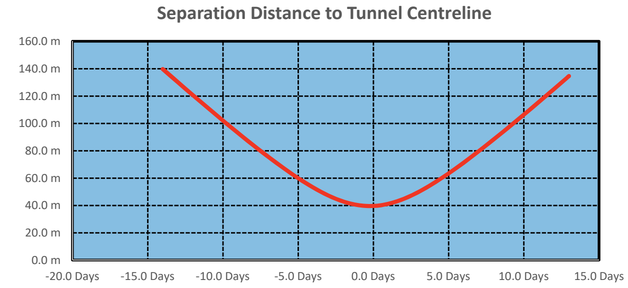
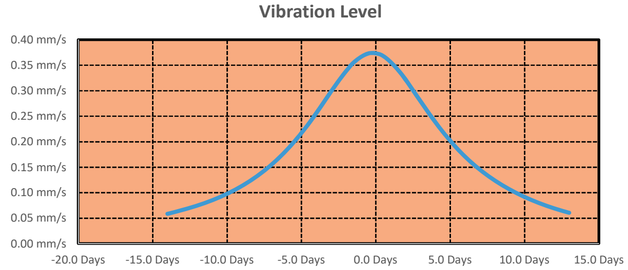
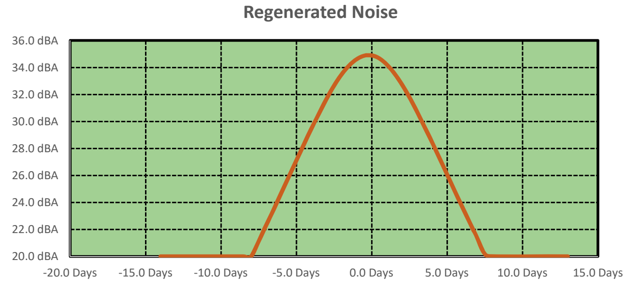
A B C D E F G H I J K L M

Assessment Location: McCrae Road - 20









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	39.6 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.35 mm/s
95% Vibration Level	0.37 mm/s
Maximum Vibration Level	0.37 mm/s
Average Regenerated Noise level	24.9 dBA
90% Regenerated Noise Level	33.9 dBA
95% Regenerated Noise Level	34.6 dBA
Maximum Regenerated Noise Level	34.9 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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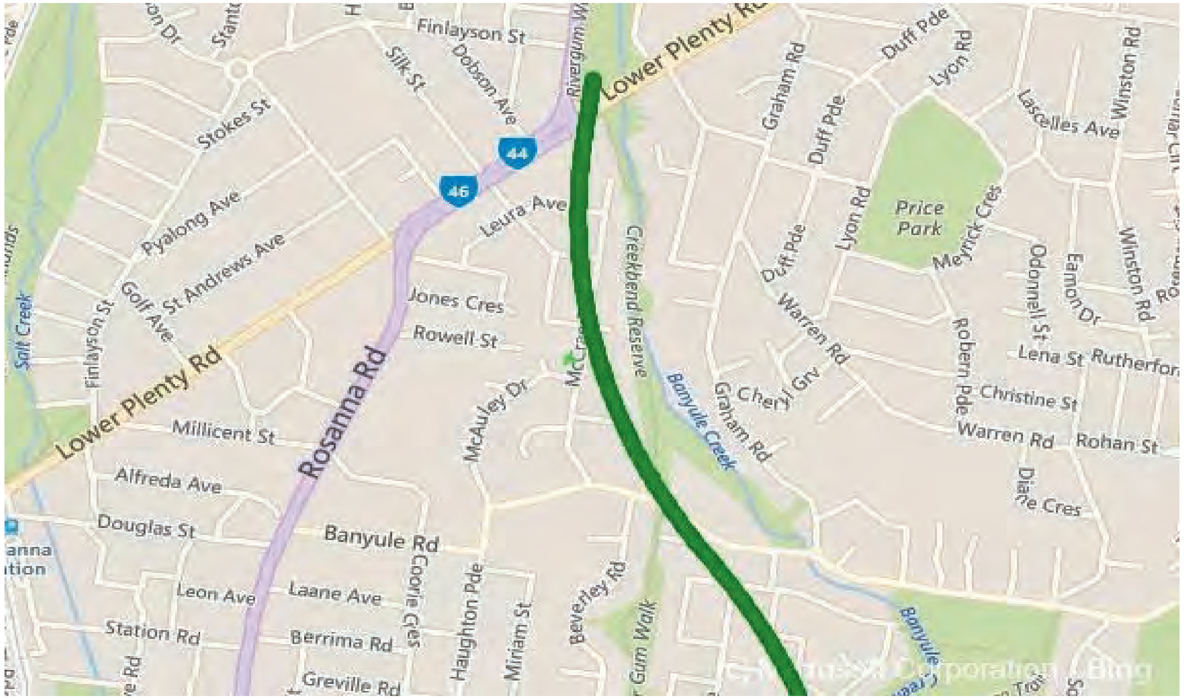
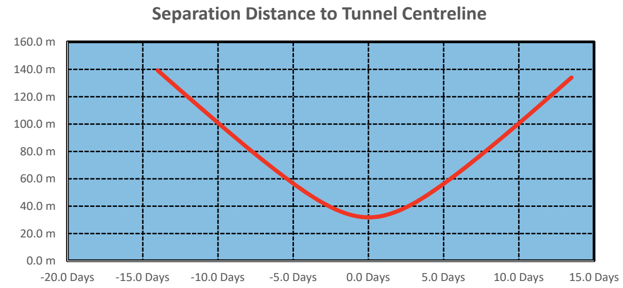
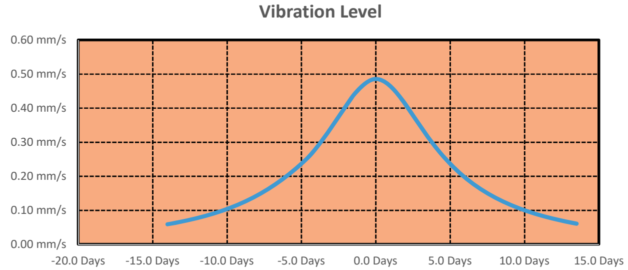
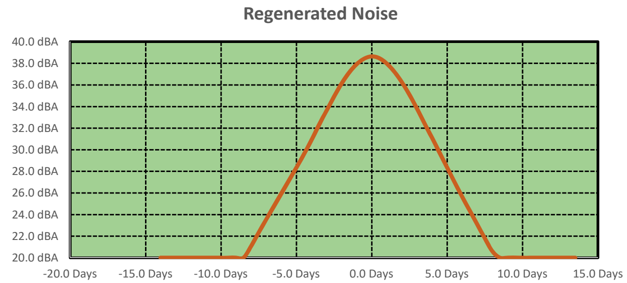
A B C D E F G H I J K L M

Assessment Location: McCrae Road - 24









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.8 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.44 mm/s
95% Vibration Level	0.47 mm/s
Maximum Vibration Level	0.49 mm/s
Average Regenerated Noise level	26.2 dBA
90% Regenerated Noise Level	37.2 dBA
95% Regenerated Noise Level	38.1 dBA
Maximum Regenerated Noise Level	38.6 dBA

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V1 - Original		Job Number	HP1704-1
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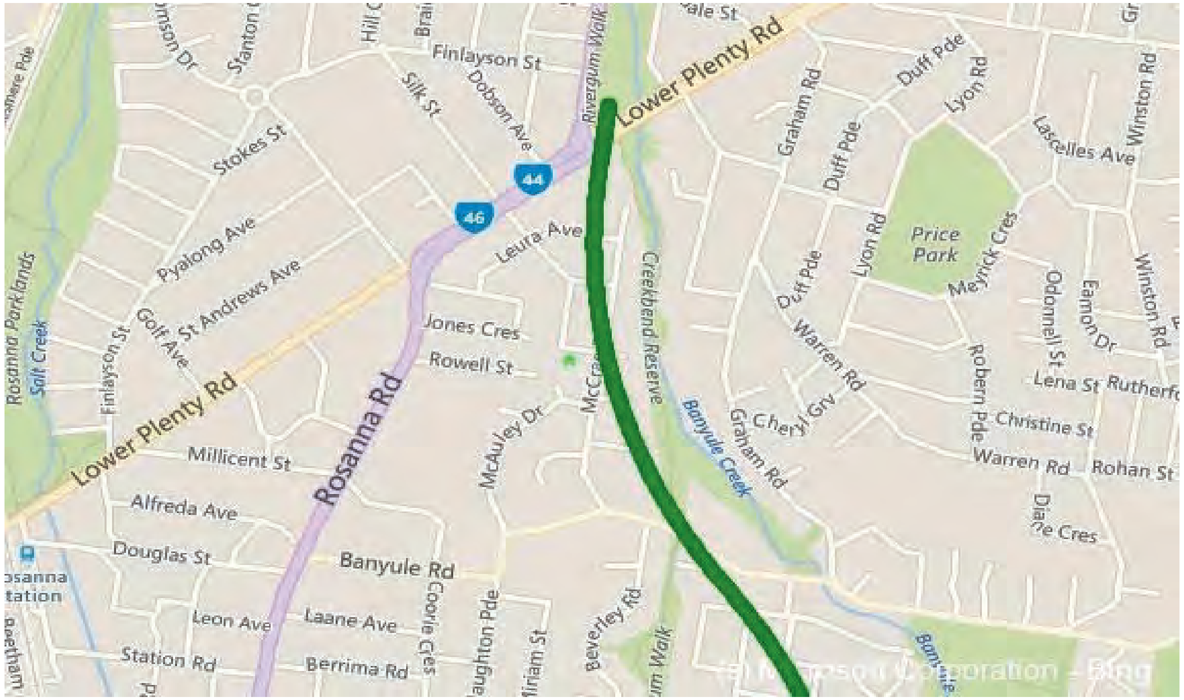
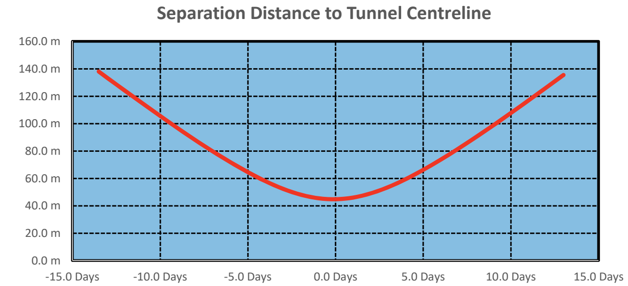
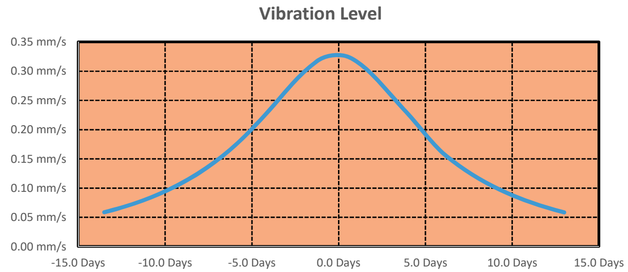
		File	

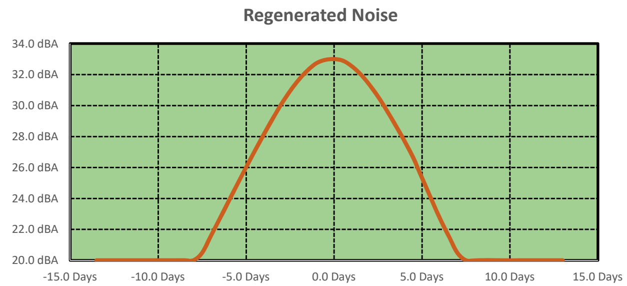
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 31









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.3 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	44.8 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.31 mm/s
95% Vibration Level	0.32 mm/s
Maximum Vibration Level	0.33 mm/s
Average Regenerated Noise level	24.3 dBA
90% Regenerated Noise Level	32.2 dBA
95% Regenerated Noise Level	32.8 dBA
Maximum Regenerated Noise Level	33.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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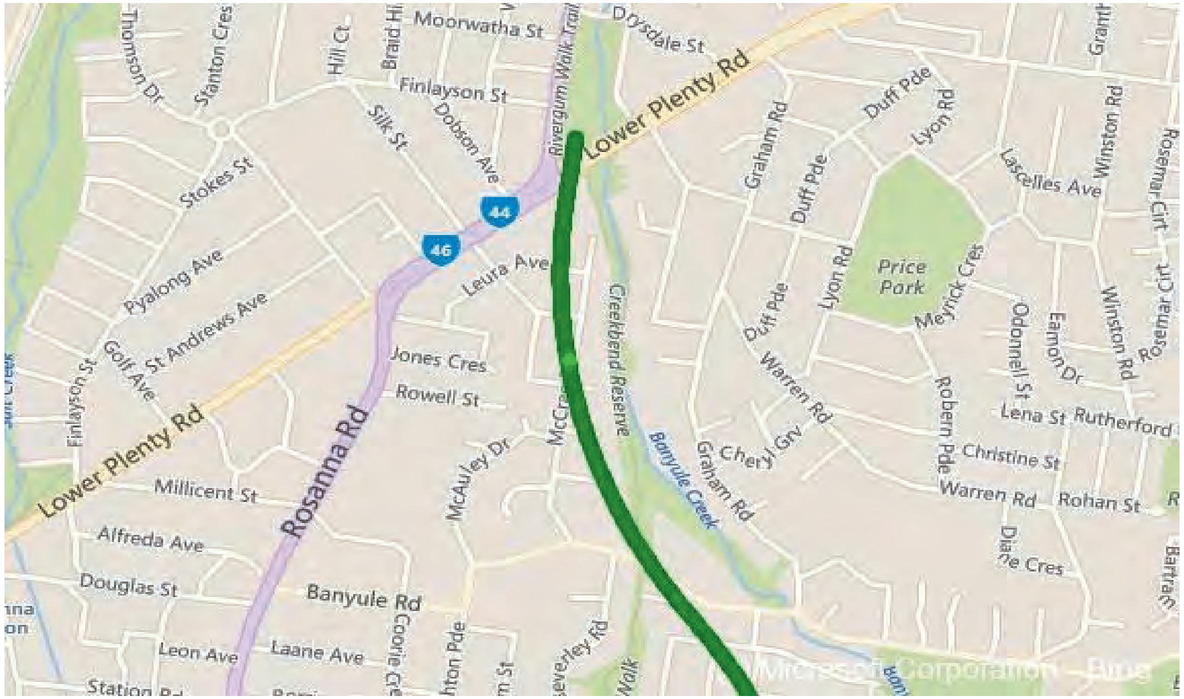
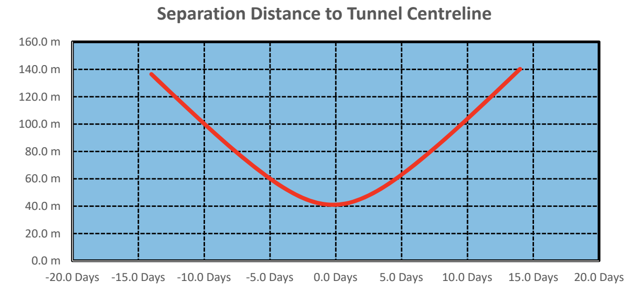
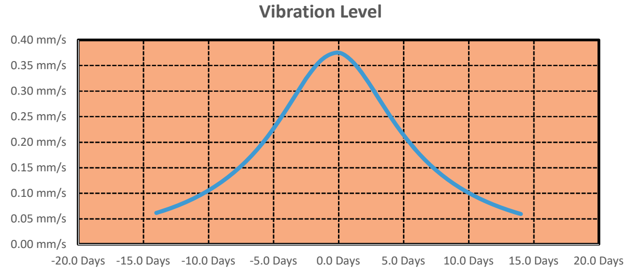
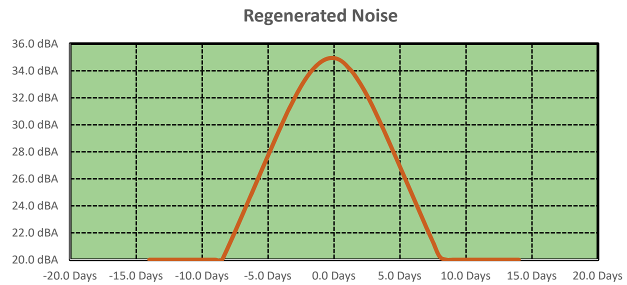
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 40









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	41.0 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.35 mm/s
95% Vibration Level	0.37 mm/s
Maximum Vibration Level	0.38 mm/s
Average Regenerated Noise level	25.1 dBA
90% Regenerated Noise Level	33.9 dBA
95% Regenerated Noise Level	34.7 dBA
Maximum Regenerated Noise Level	34.9 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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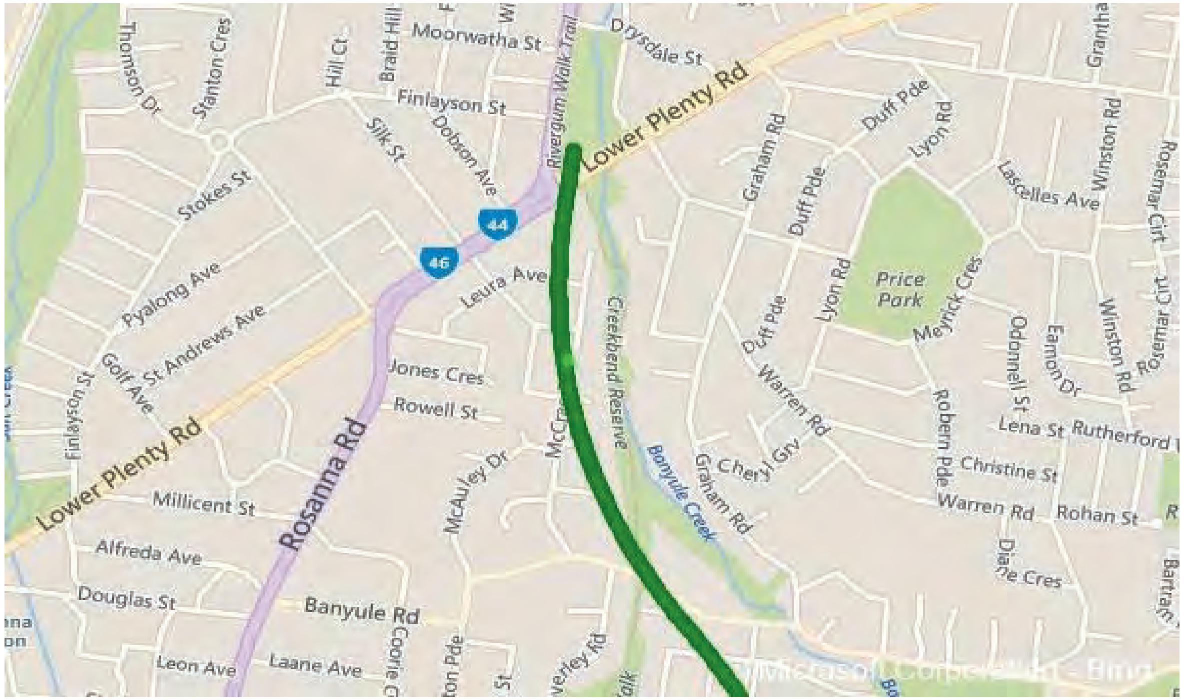
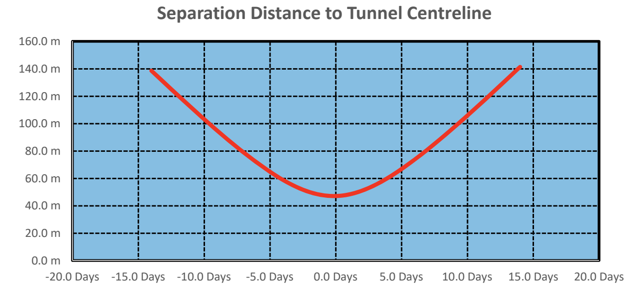
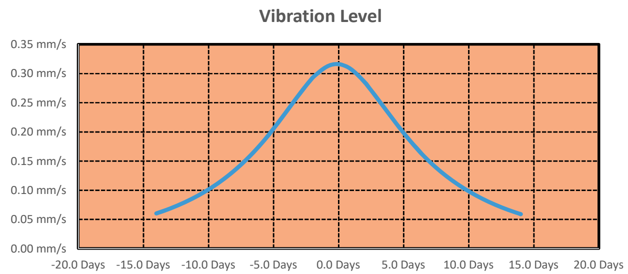
NORTH EAST LINK PROJECT

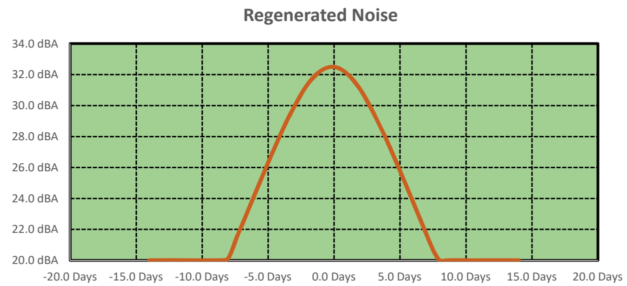
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 44









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.4 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	47.1 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.30 mm/s
95% Vibration Level	0.31 mm/s
Maximum Vibration Level	0.32 mm/s
Average Regenerated Noise level	24.2 dBA
90% Regenerated Noise Level	31.7 dBA
95% Regenerated Noise Level	32.3 dBA
Maximum Regenerated Noise Level	32.5 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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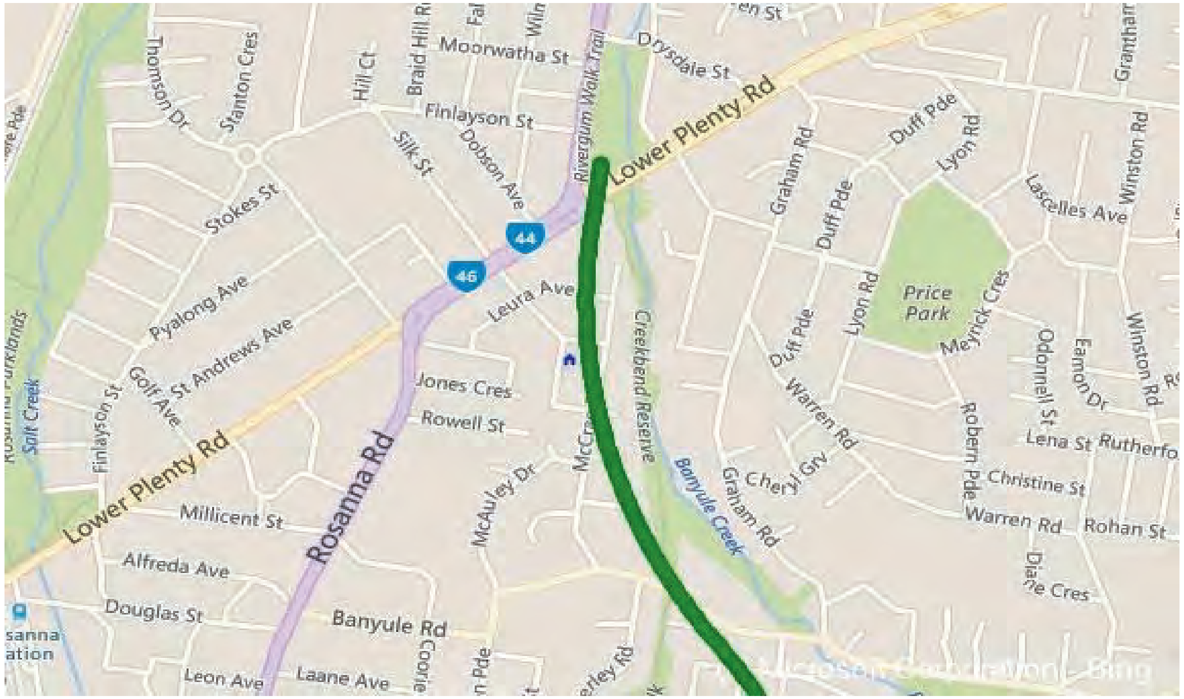
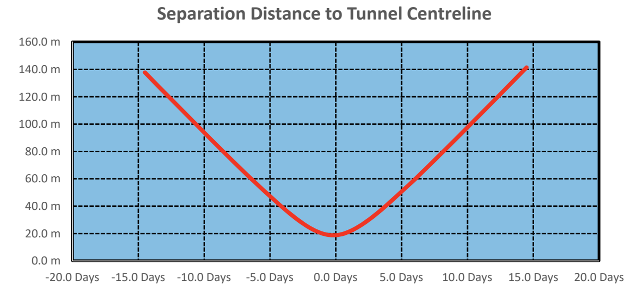
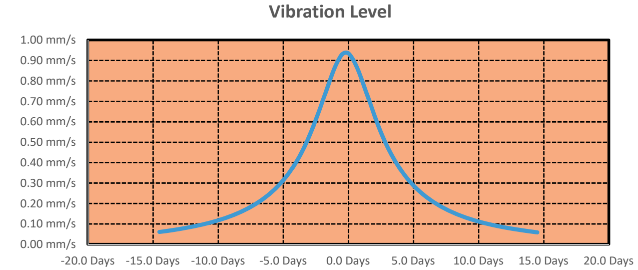
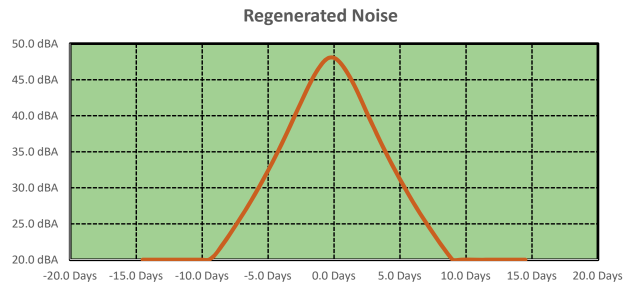
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 47









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.2 days
Number of days above 0.75mm/s	0.6 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.6 days
Number of days above 40dBA	1.1 days
Number of days above 45dBA	0.6 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	18.7 m
Average Vibration Level	0.29 mm/s
90% Vibration Level	0.74 mm/s
95% Vibration Level	0.87 mm/s
Maximum Vibration Level	0.93 mm/s
Average Regenerated Noise level	28.6 dBA
90% Regenerated Noise Level	44.6 dBA
95% Regenerated Noise Level	47.0 dBA
Maximum Regenerated Noise Level	48.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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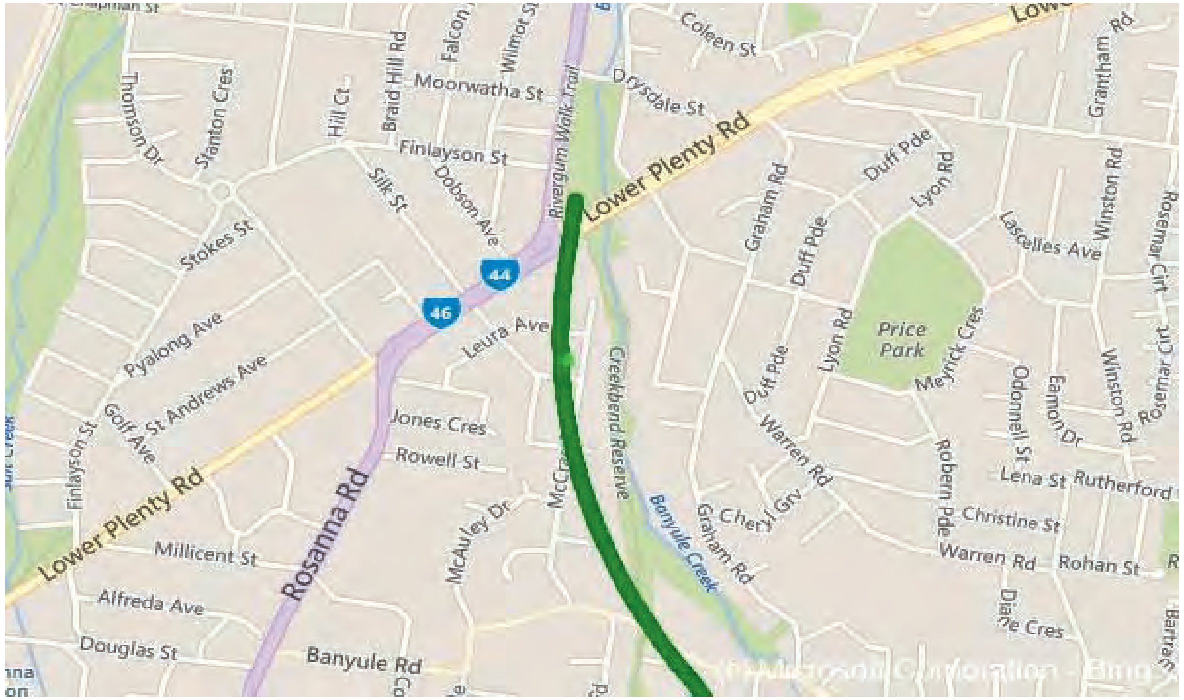
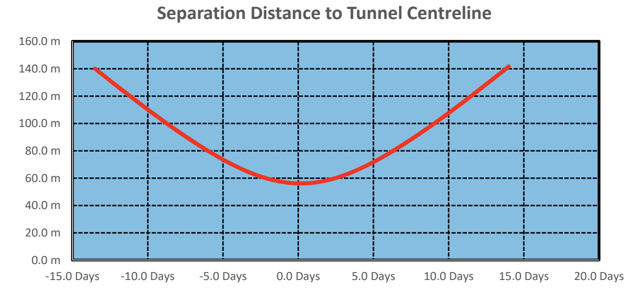
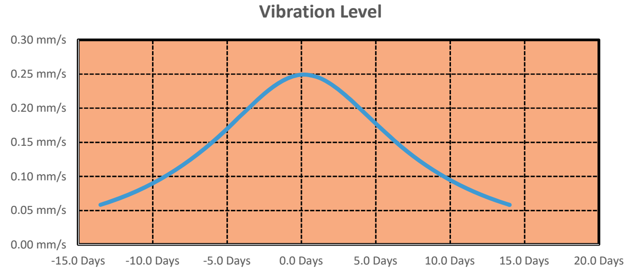
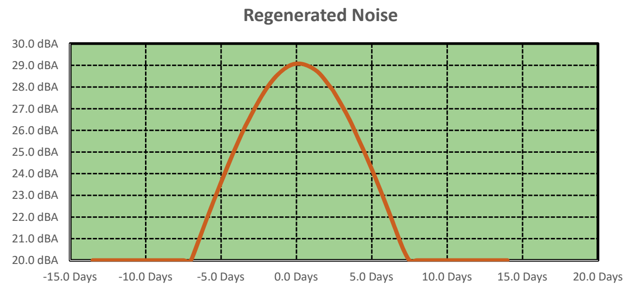
Assessment Location: McCrae Road - 58









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	56.1 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.25 mm/s
Maximum Vibration Level	0.25 mm/s
Average Regenerated Noise level	22.9 dBA
90% Regenerated Noise Level	28.5 dBA
95% Regenerated Noise Level	28.9 dBA
Maximum Regenerated Noise Level	29.1 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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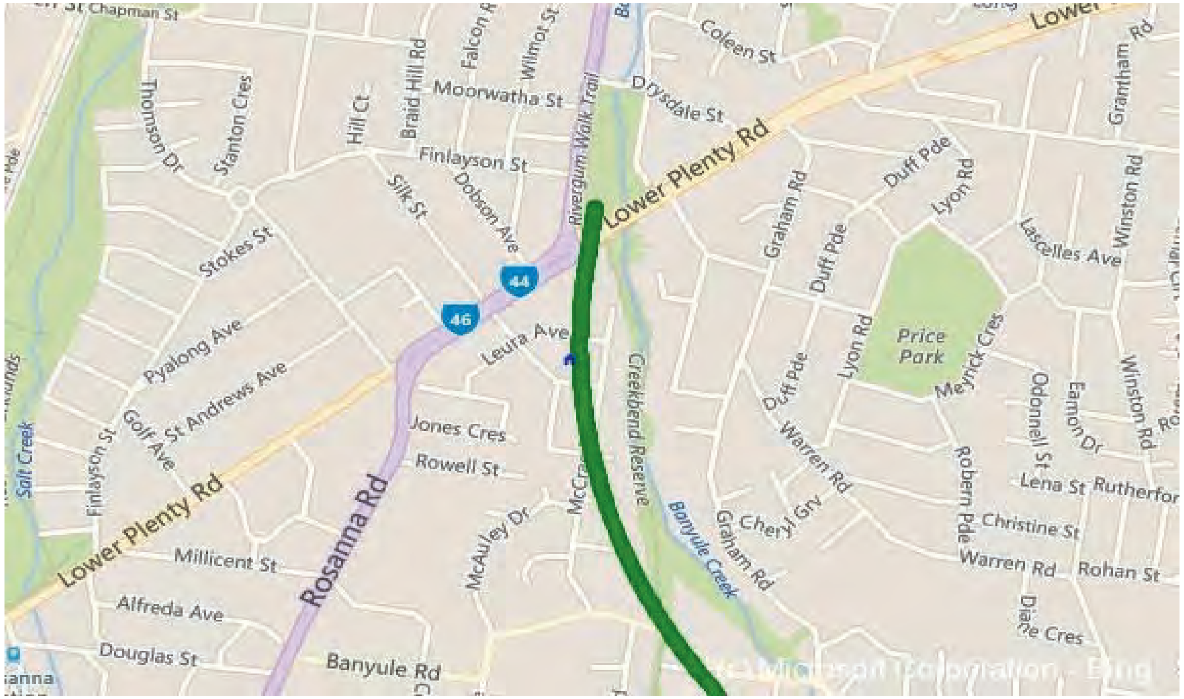
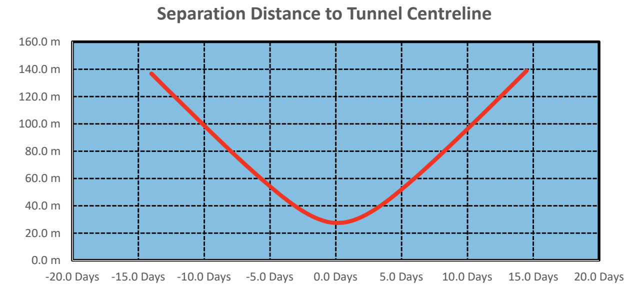
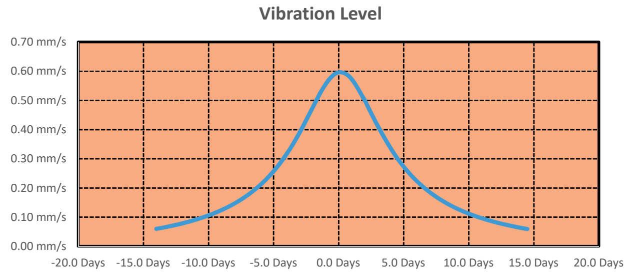
NORTH EAST LINK PROJECT

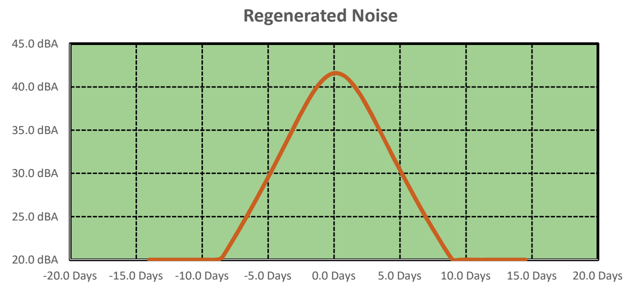
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 61









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	27.4 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.52 mm/s
95% Vibration Level	0.57 mm/s
Maximum Vibration Level	0.60 mm/s
Average Regenerated Noise level	27.1 dBA
90% Regenerated Noise Level	39.7 dBA
95% Regenerated Noise Level	41.1 dBA
Maximum Regenerated Noise Level	41.6 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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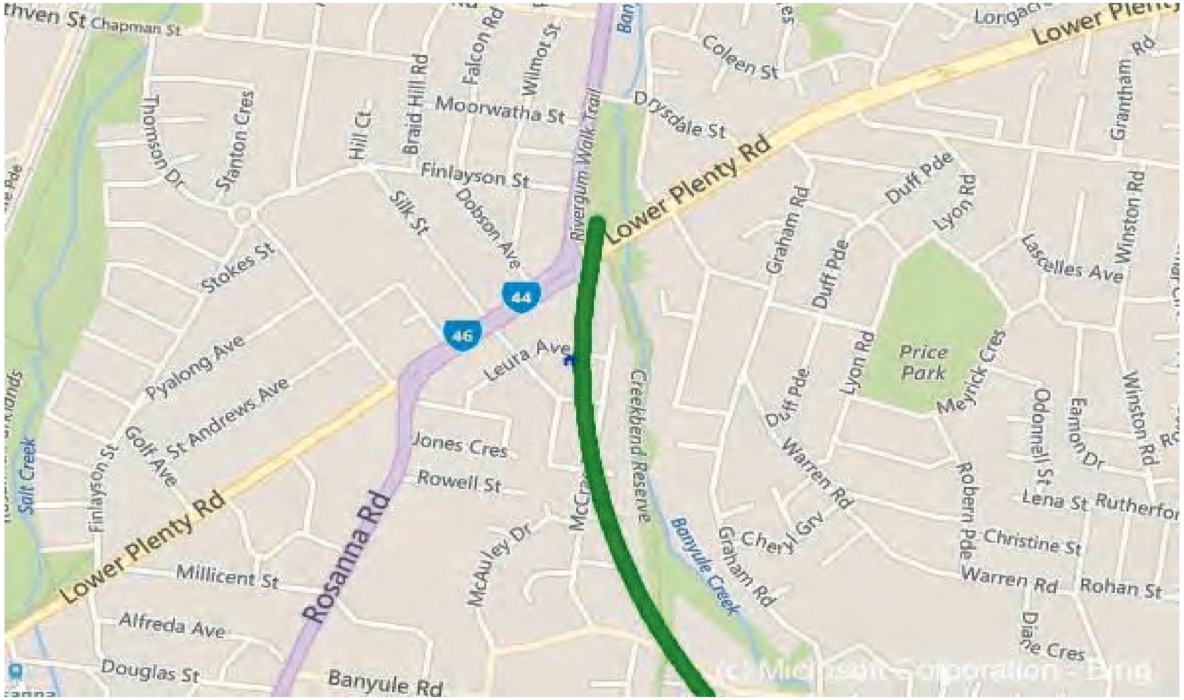
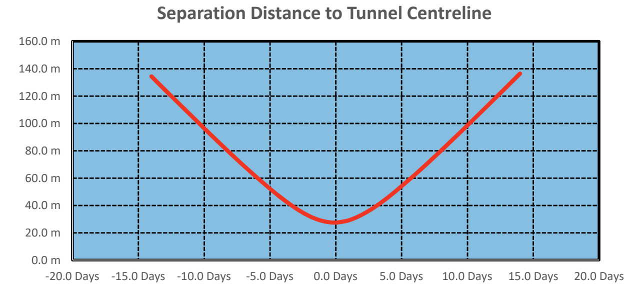
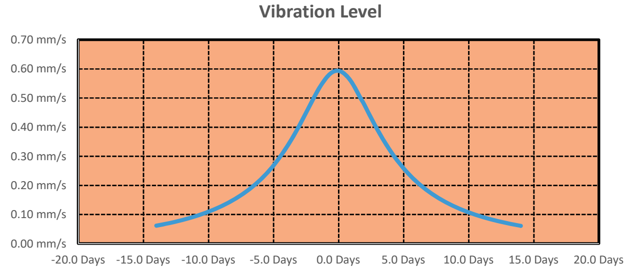
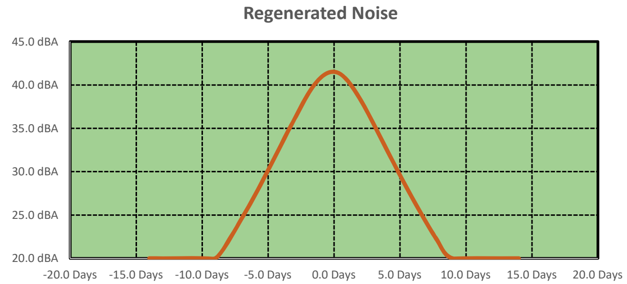
Assessment Location: McCrae Road - 65









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.7 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.5 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	27.5 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.52 mm/s
95% Vibration Level	0.57 mm/s
Maximum Vibration Level	0.59 mm/s
Average Regenerated Noise level	27.1 dBA
90% Regenerated Noise Level	39.7 dBA
95% Regenerated Noise Level	40.9 dBA
Maximum Regenerated Noise Level	41.5 dBA

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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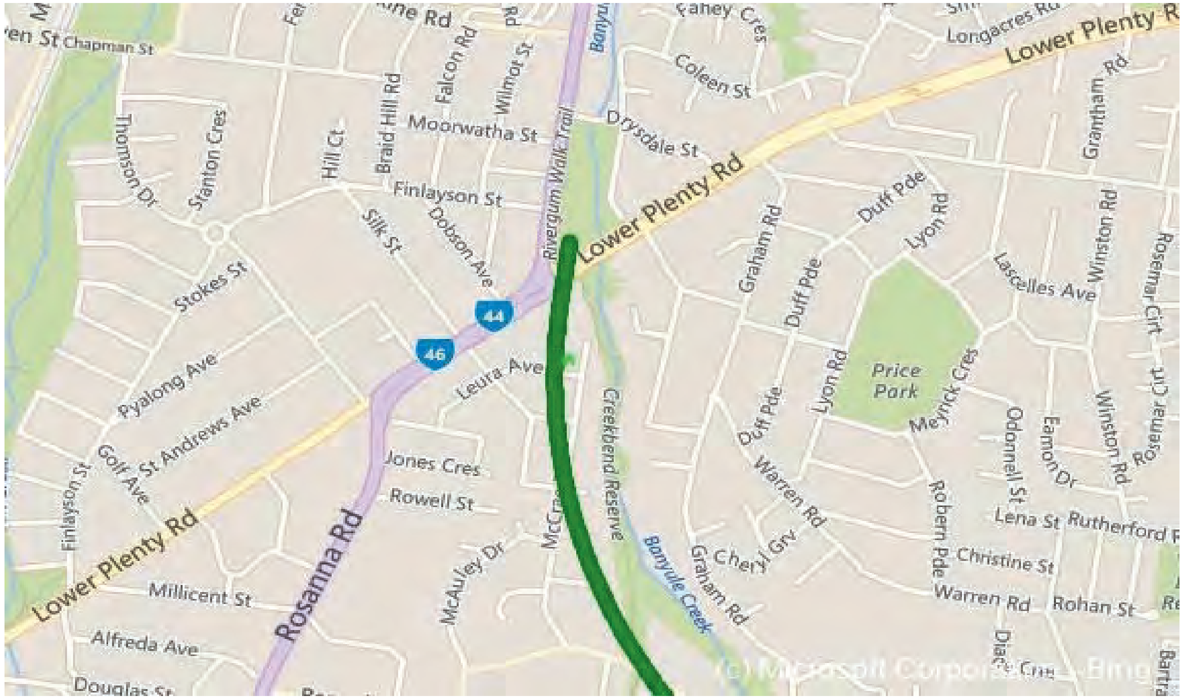
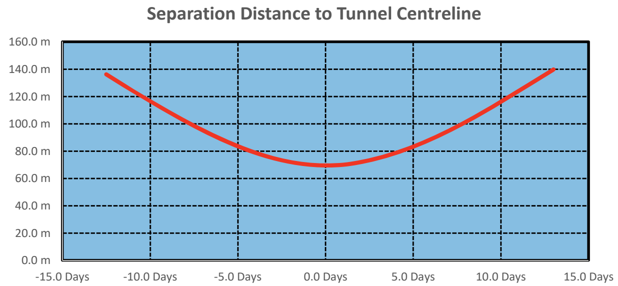
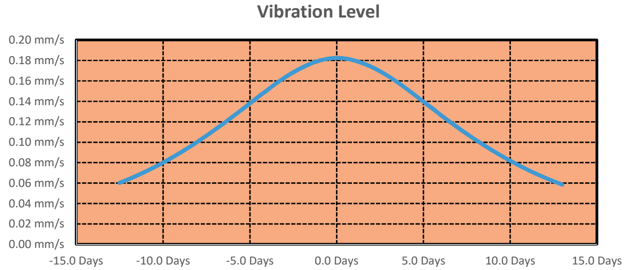
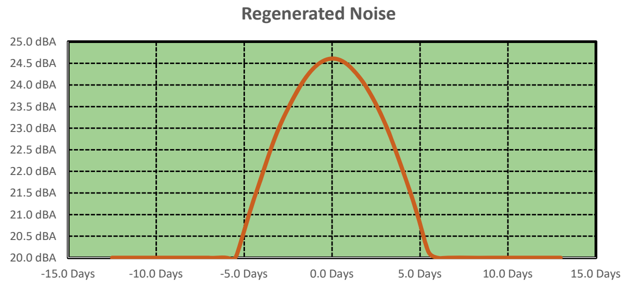
Assessment Location: McCrae Road - 70









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	69.5 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.18 mm/s
Maximum Vibration Level	0.18 mm/s
Average Regenerated Noise level	21.3 dBA
90% Regenerated Noise Level	24.2 dBA
95% Regenerated Noise Level	24.5 dBA
Maximum Regenerated Noise Level	24.6 dBA

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NORTH EAST LINK PROJECT

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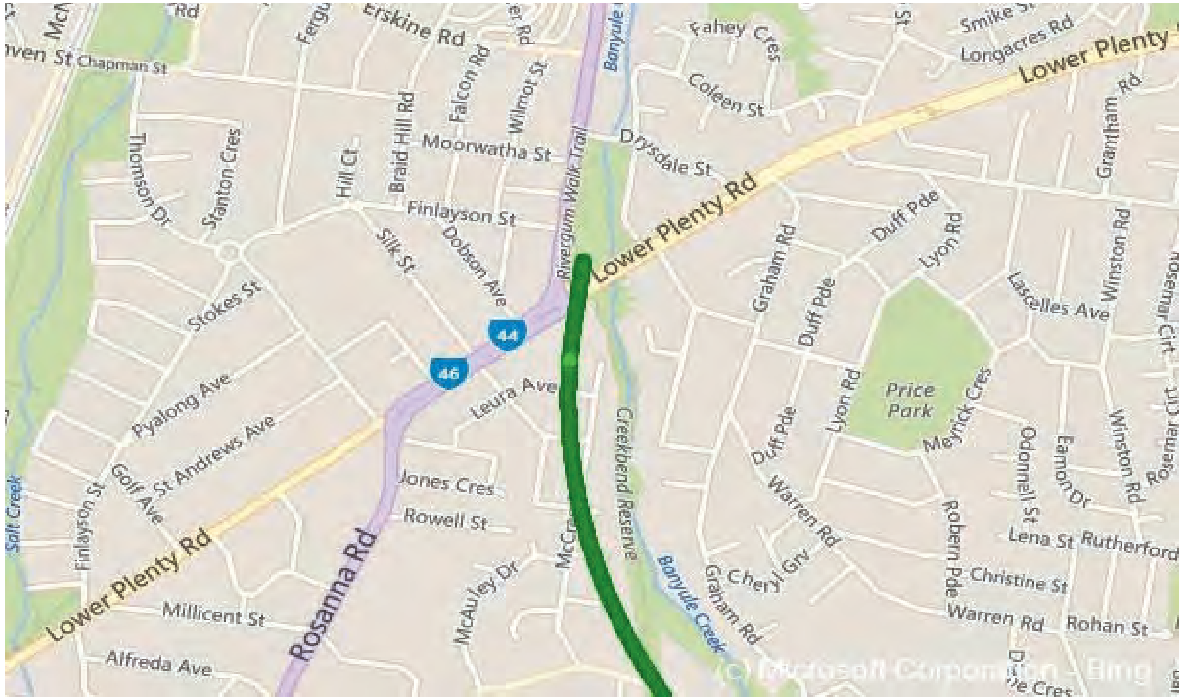
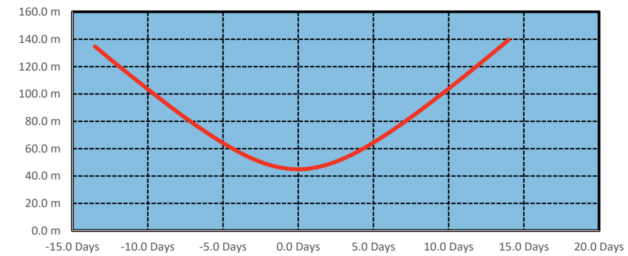
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

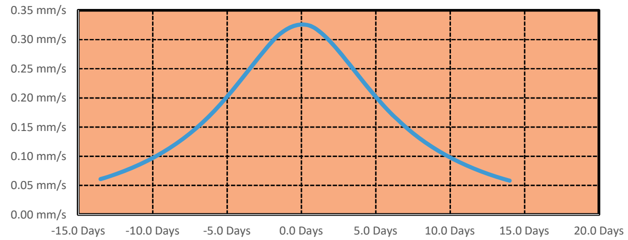
Assessment Location: McCrae Road - 75



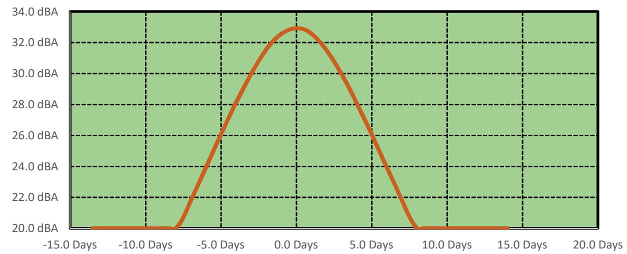
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	1.3 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	44.9 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.31 mm/s
95% Vibration Level	0.32 mm/s
Maximum Vibration Level	0.33 mm/s
Average Regenerated Noise level	24.3 dBA
90% Regenerated Noise Level	32.1 dBA
95% Regenerated Noise Level	32.6 dBA
Maximum Regenerated Noise Level	32.9 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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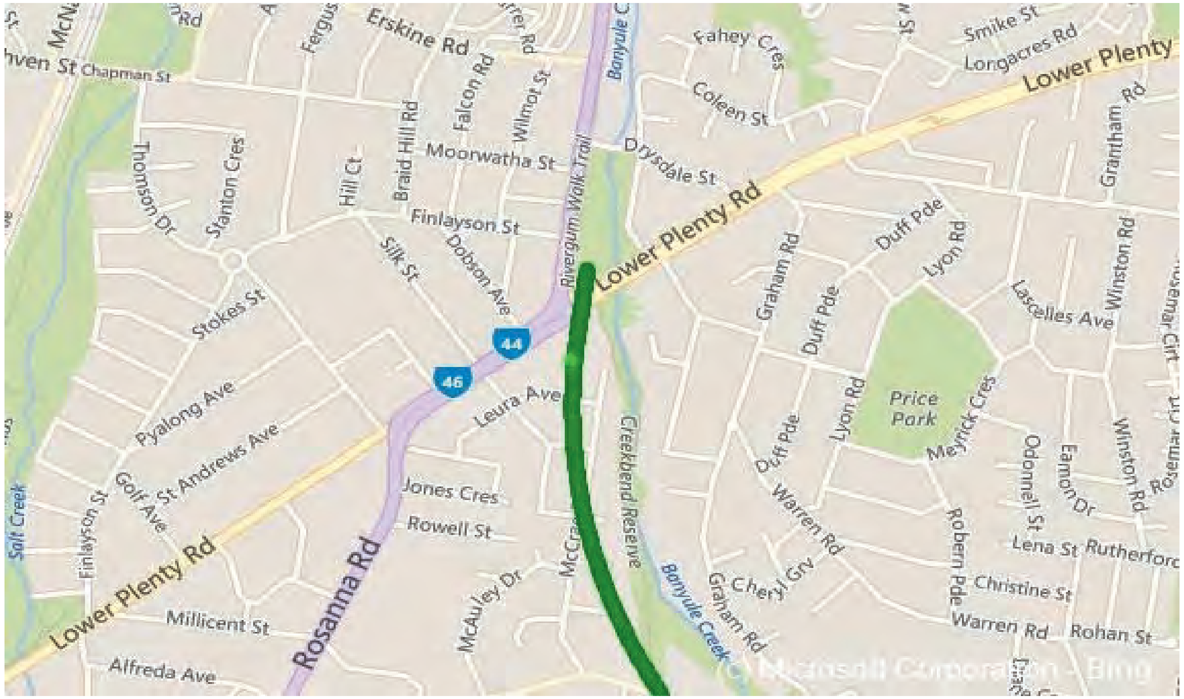
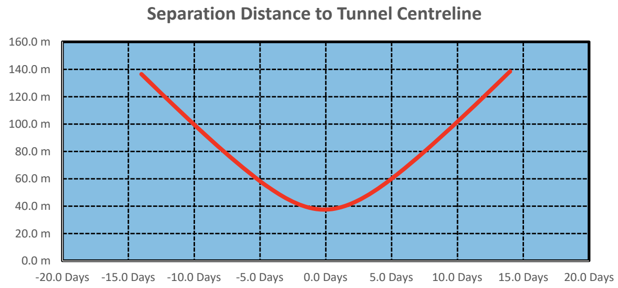
NORTH EAST LINK PROJECT

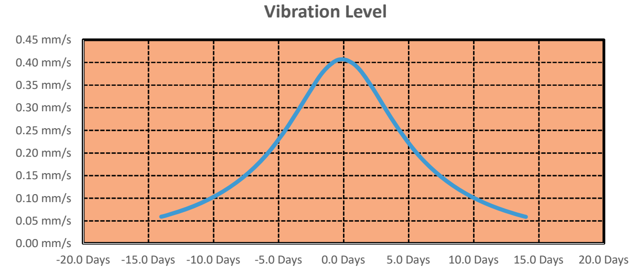
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

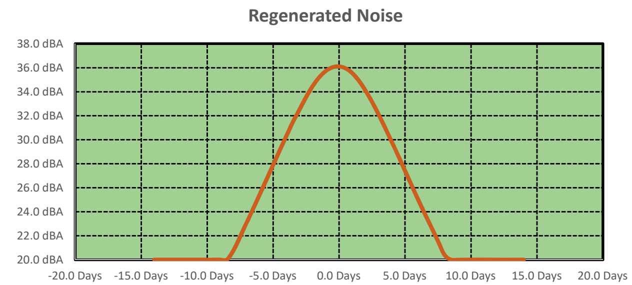
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 77A









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.7 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.6 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	37.5 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.38 mm/s
95% Vibration Level	0.40 mm/s
Maximum Vibration Level	0.41 mm/s
Average Regenerated Noise level	25.4 dBA
90% Regenerated Noise Level	35.0 dBA
95% Regenerated Noise Level	35.8 dBA
Maximum Regenerated Noise Level	36.1 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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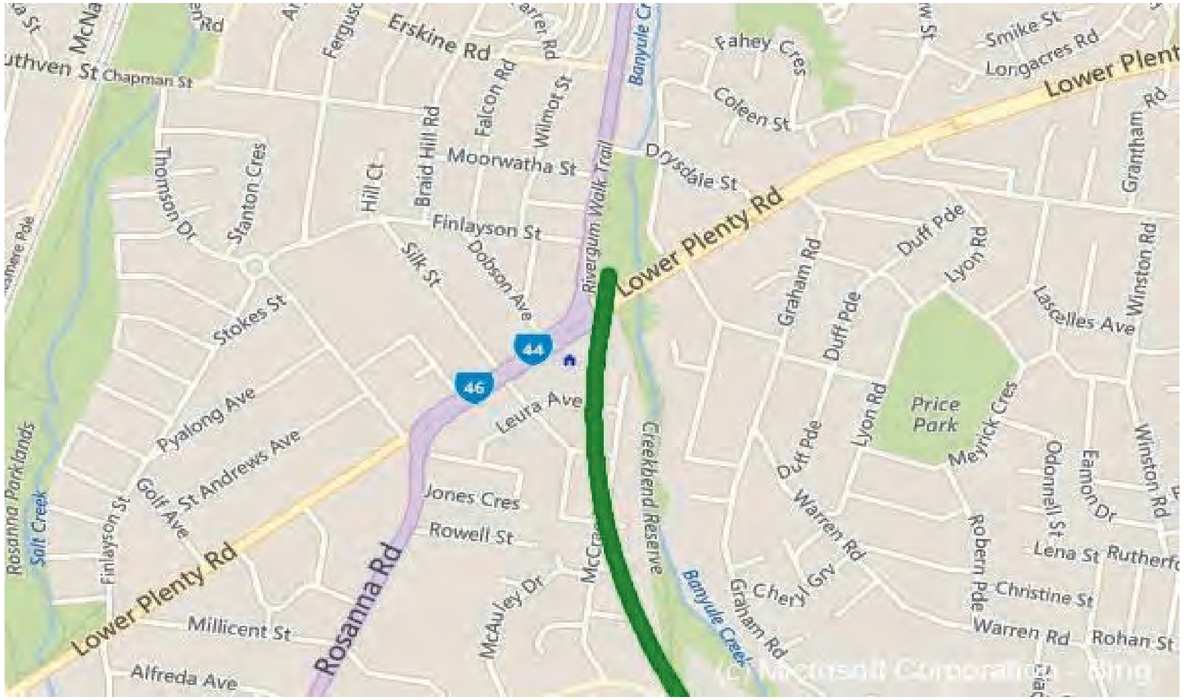
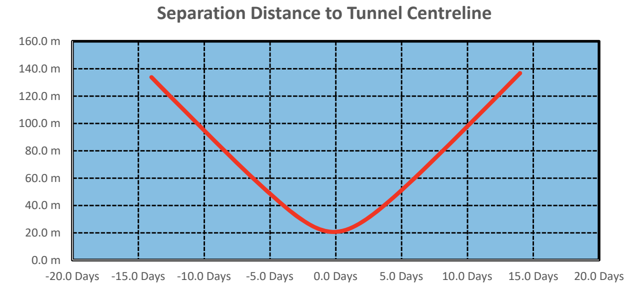
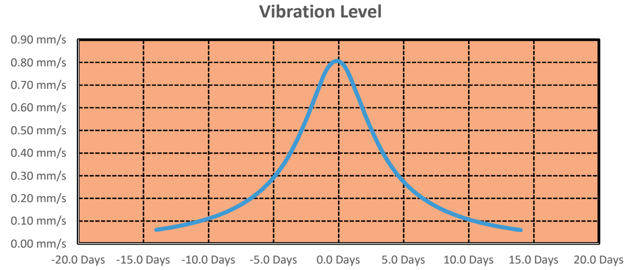
NORTH EAST LINK PROJECT

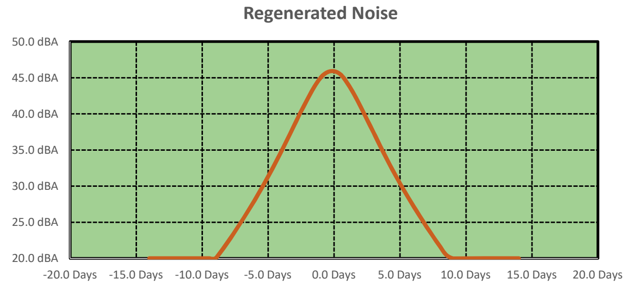
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 77D









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.4 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.4 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	20.6 m
Average Vibration Level	0.28 mm/s
90% Vibration Level	0.66 mm/s
95% Vibration Level	0.76 mm/s
Maximum Vibration Level	0.81 mm/s
Average Regenerated Noise level	28.2 dBA
90% Regenerated Noise Level	43.1 dBA
95% Regenerated Noise Level	45.1 dBA
Maximum Regenerated Noise Level	45.9 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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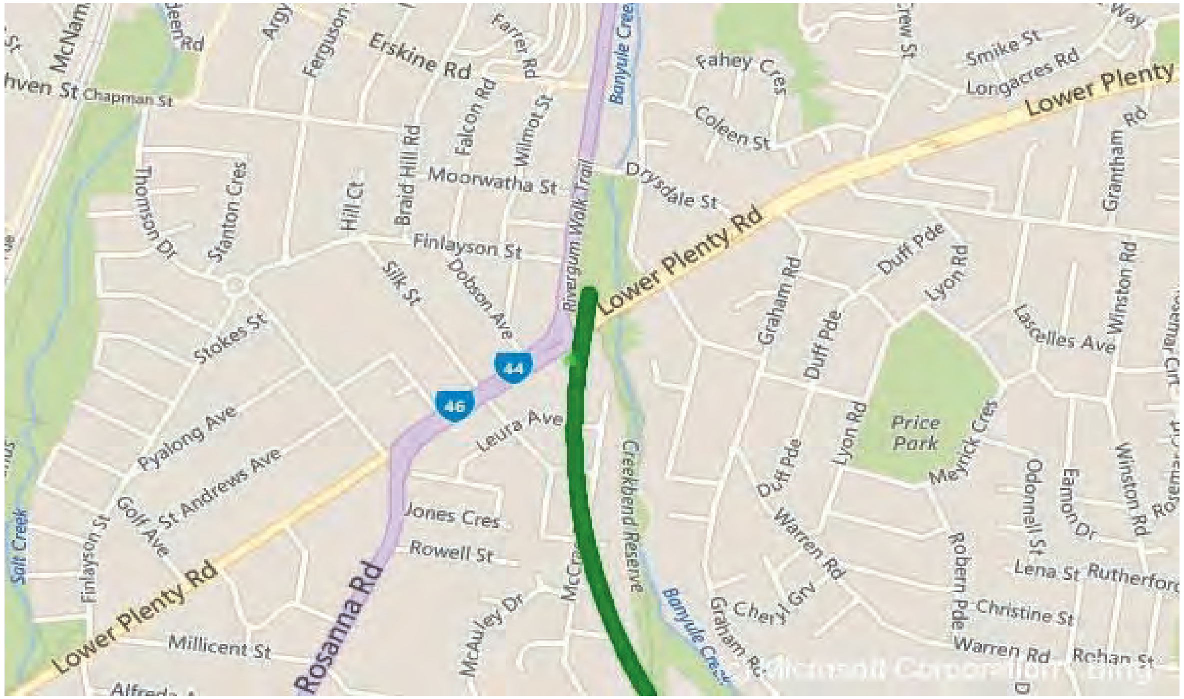
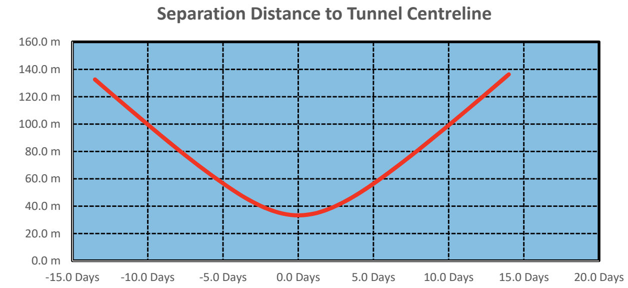
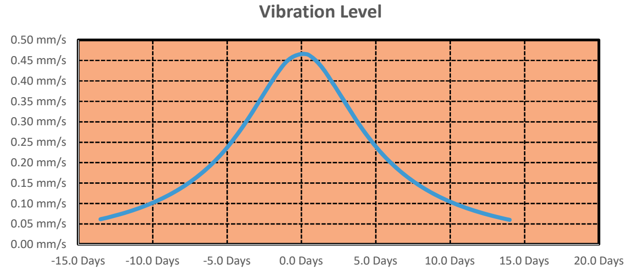
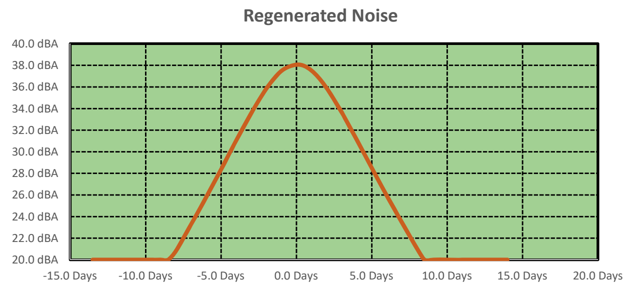
Assessment Location: McCrae Road - 77L









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.9 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	33.2 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.43 mm/s
95% Vibration Level	0.45 mm/s
Maximum Vibration Level	0.47 mm/s
Average Regenerated Noise level	26.1 dBA
90% Regenerated Noise Level	36.8 dBA
95% Regenerated Noise Level	37.6 dBA
Maximum Regenerated Noise Level	38.0 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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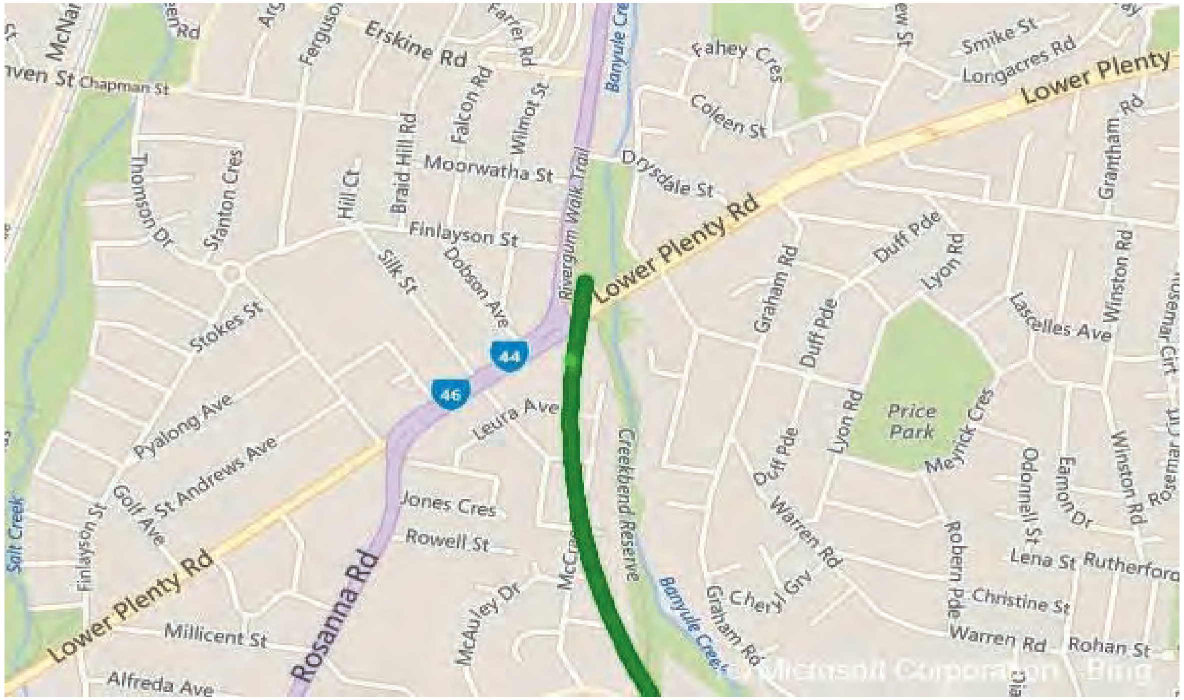
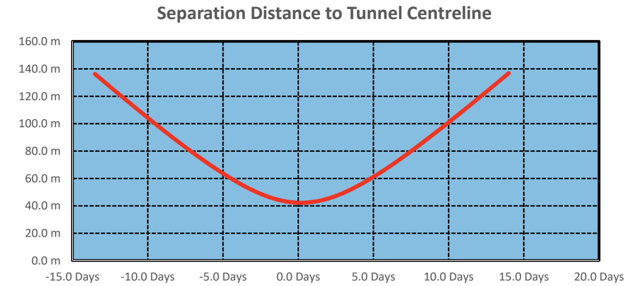
NORTH EAST LINK PROJECT

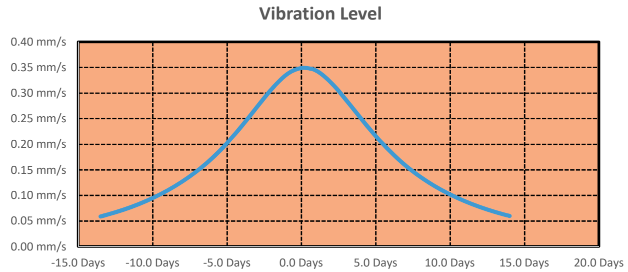
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

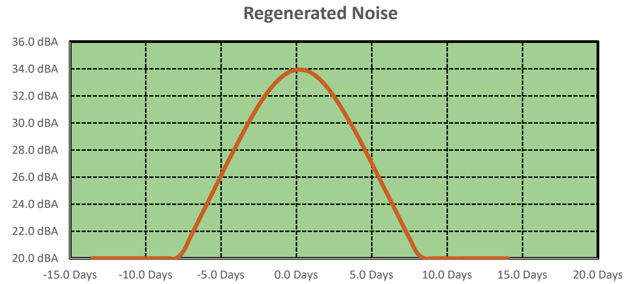
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 77N









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	42.2 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.33 mm/s
95% Vibration Level	0.34 mm/s
Maximum Vibration Level	0.35 mm/s
Average Regenerated Noise level	24.7 dBA
90% Regenerated Noise Level	33.0 dBA
95% Regenerated Noise Level	33.7 dBA
Maximum Regenerated Noise Level	33.9 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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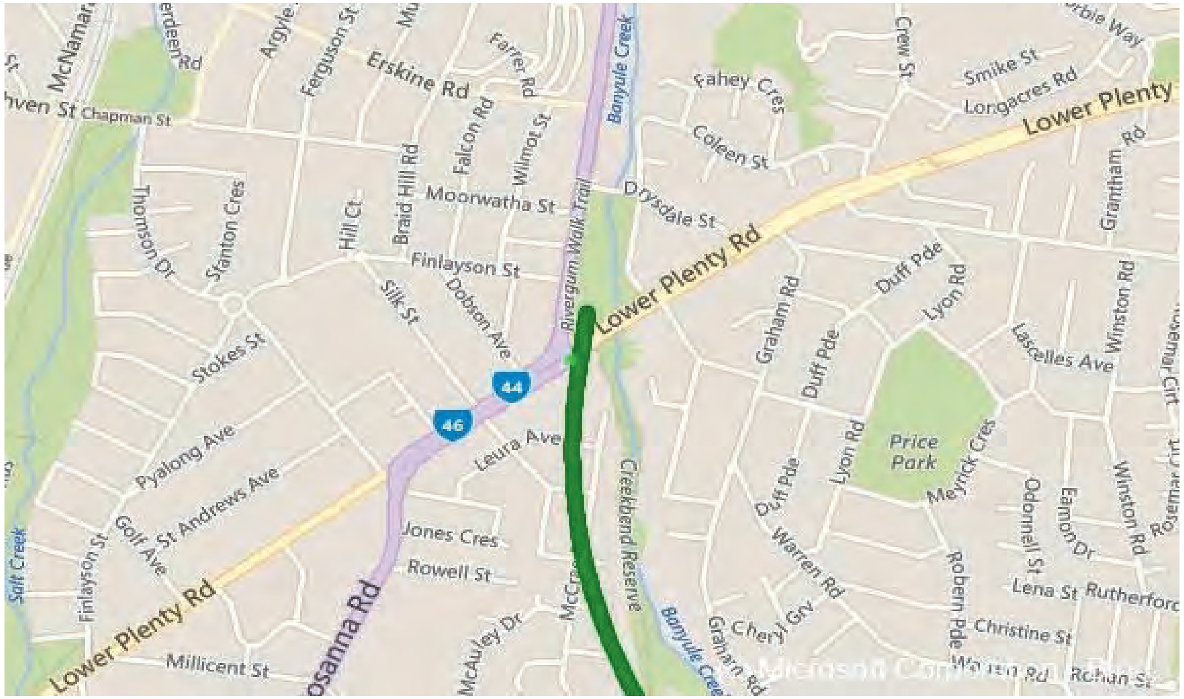
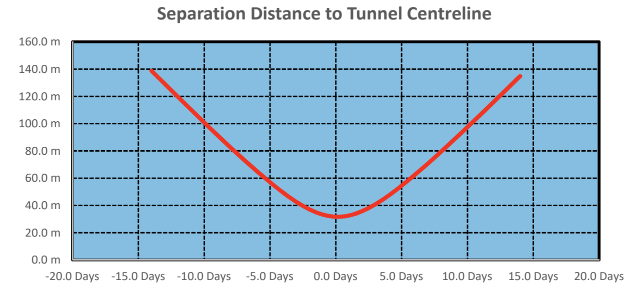
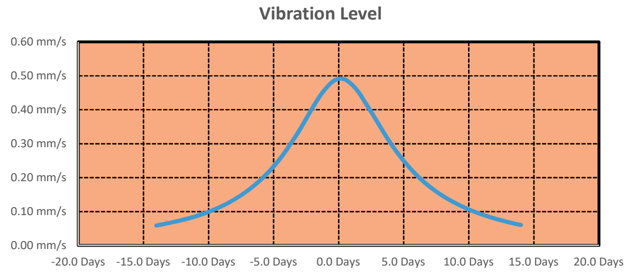
NORTH EAST LINK PROJECT

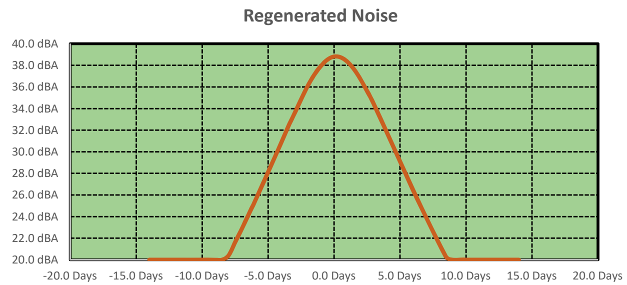
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 85E









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.7 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.44 mm/s
95% Vibration Level	0.48 mm/s
Maximum Vibration Level	0.49 mm/s
Average Regenerated Noise level	26.2 dBA
90% Regenerated Noise Level	37.4 dBA
95% Regenerated Noise Level	38.4 dBA
Maximum Regenerated Noise Level	38.8 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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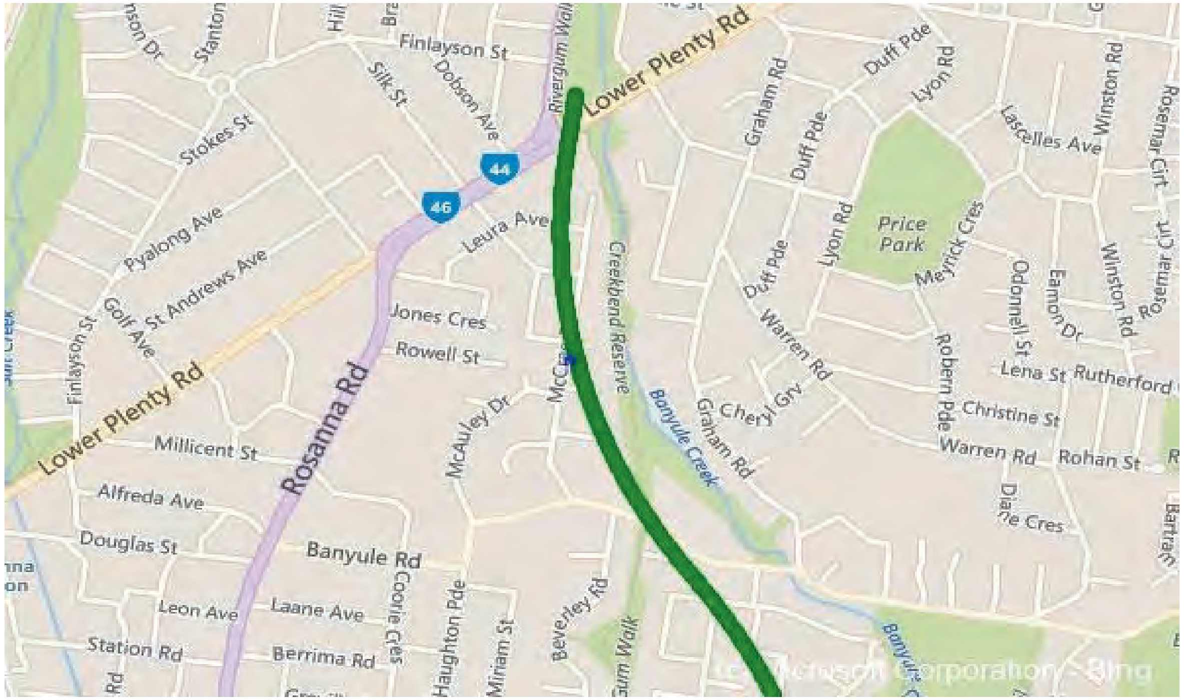
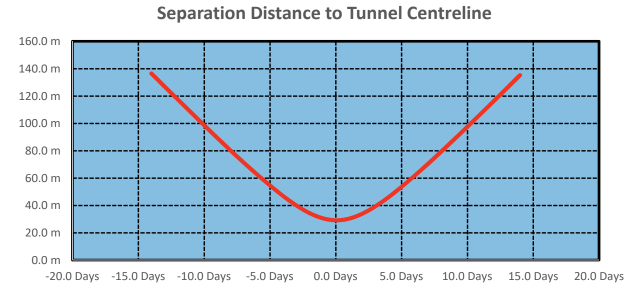
NORTH EAST LINK PROJECT

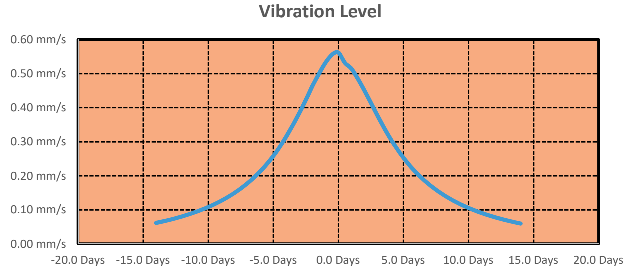
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

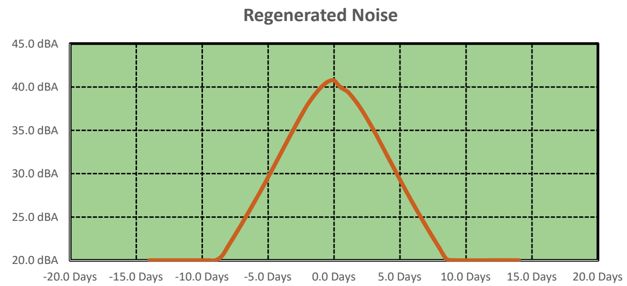
Created using TunnelTRAP Software

Assessment Location: Pilgrim Court - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.5 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.2 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	29.1 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.49 mm/s
95% Vibration Level	0.53 mm/s
Maximum Vibration Level	0.56 mm/s
Average Regenerated Noise level	26.8 dBA
90% Regenerated Noise Level	38.8 dBA
95% Regenerated Noise Level	39.9 dBA
Maximum Regenerated Noise Level	40.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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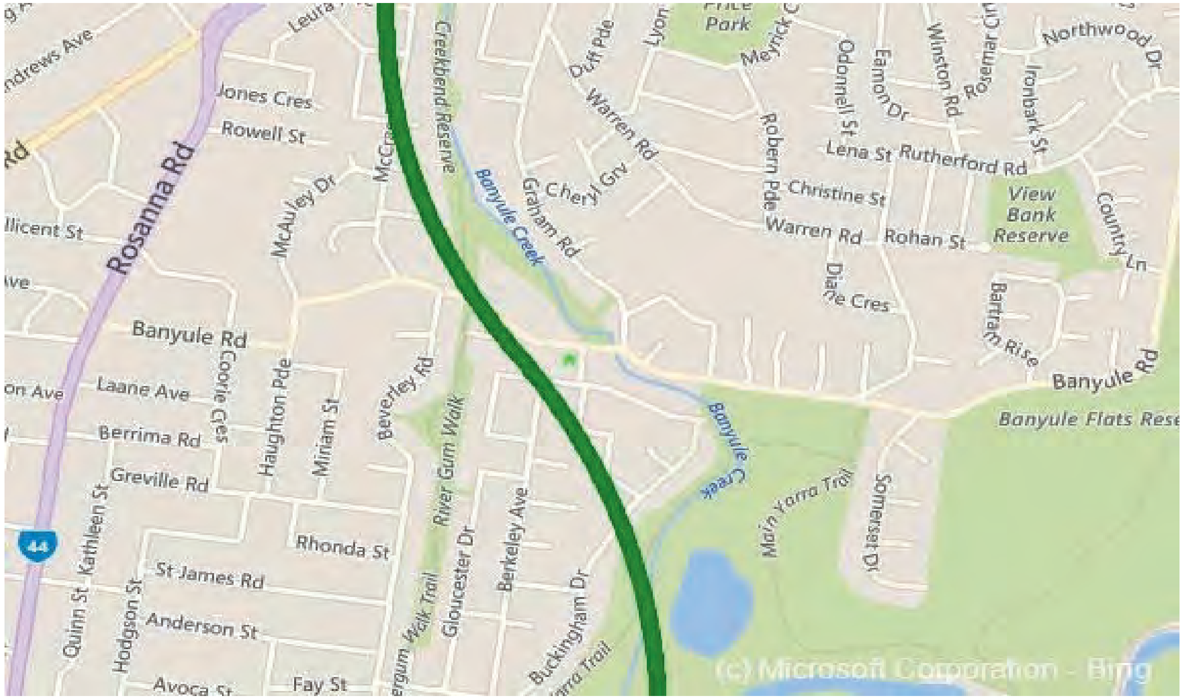
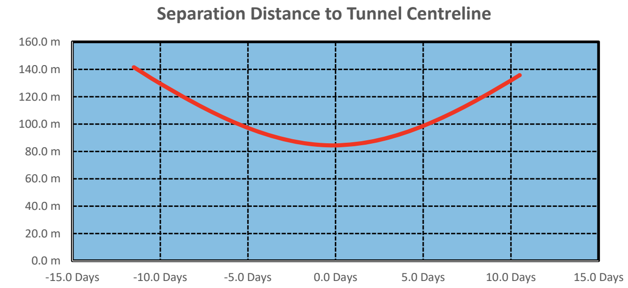
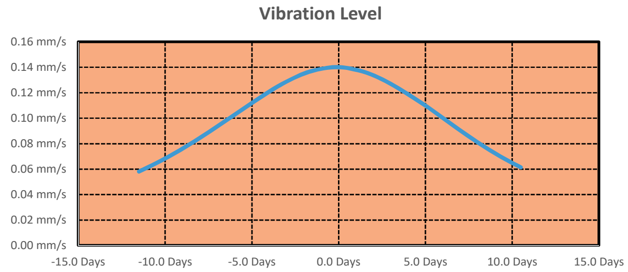
NORTH EAST LINK PROJECT

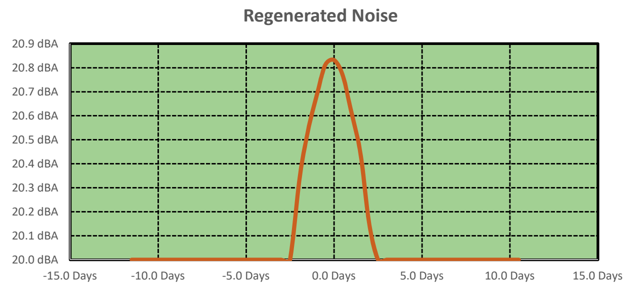
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Scarborough Drive - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	84.4 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.14 mm/s
95% Vibration Level	0.14 mm/s
Maximum Vibration Level	0.14 mm/s
Average Regenerated Noise level	20.1 dBA
90% Regenerated Noise Level	20.6 dBA
95% Regenerated Noise Level	20.7 dBA
Maximum Regenerated Noise Level	20.8 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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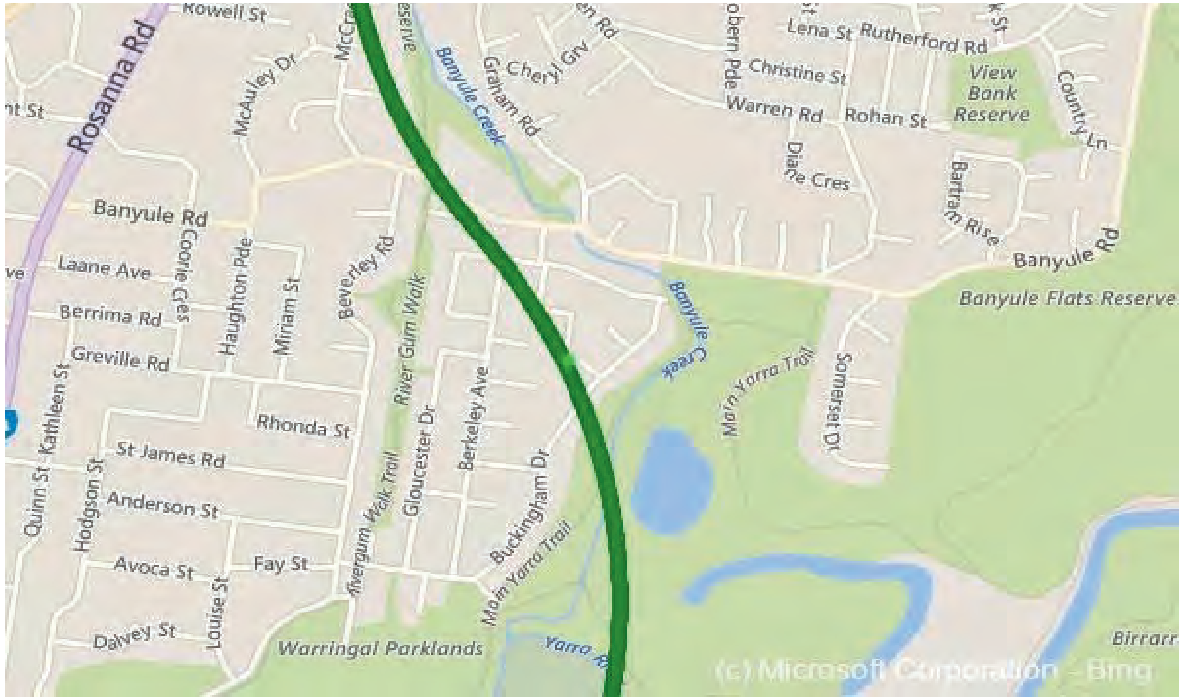
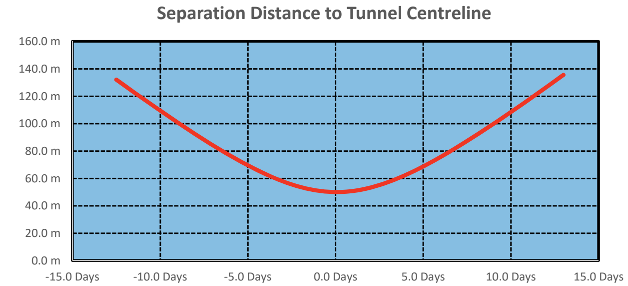
NORTH EAST LINK PROJECT

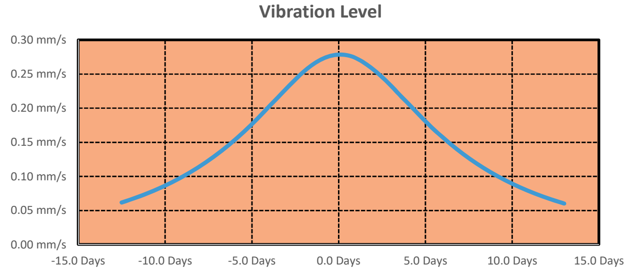
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

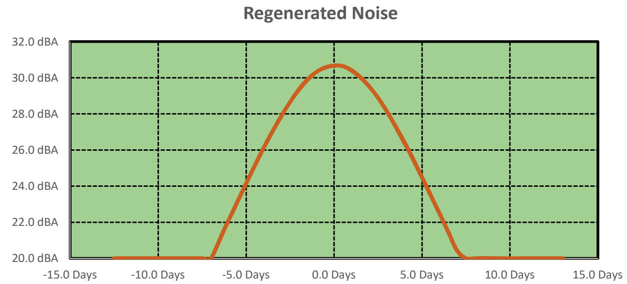
Created using TunnelTRAP Software

Assessment Location: Sevenoaks Avenue - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	50.0 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.27 mm/s
95% Vibration Level	0.27 mm/s
Maximum Vibration Level	0.28 mm/s
Average Regenerated Noise level	23.6 dBA
90% Regenerated Noise Level	30.0 dBA
95% Regenerated Noise Level	30.5 dBA
Maximum Regenerated Noise Level	30.7 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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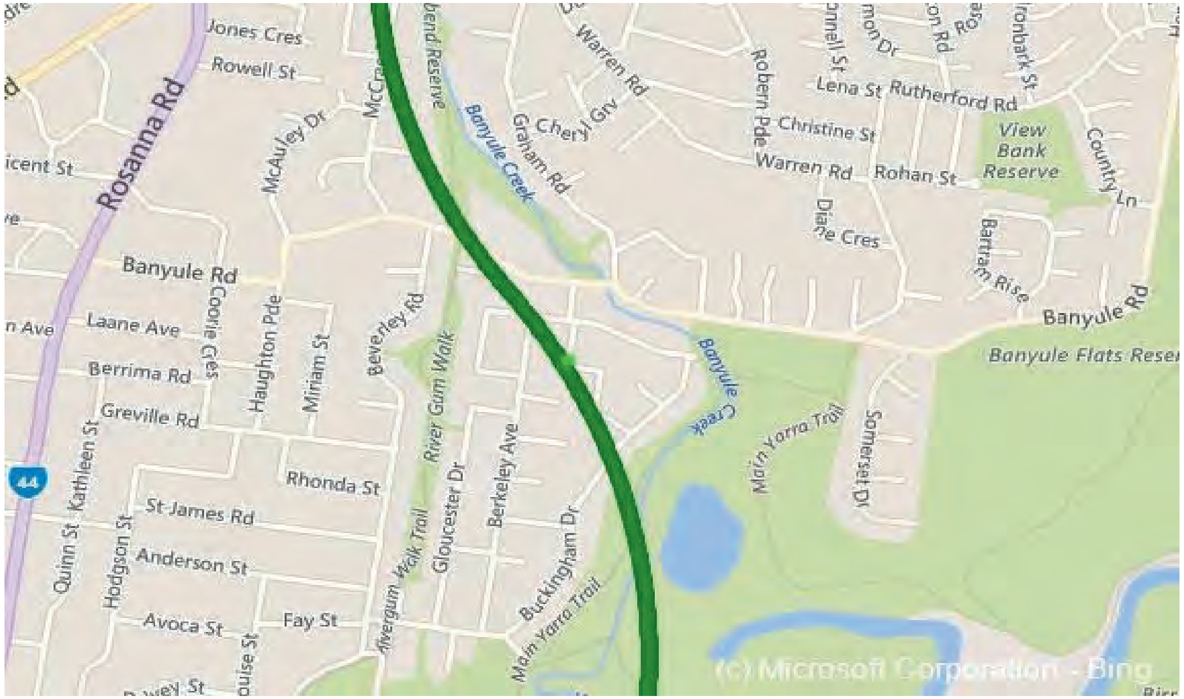
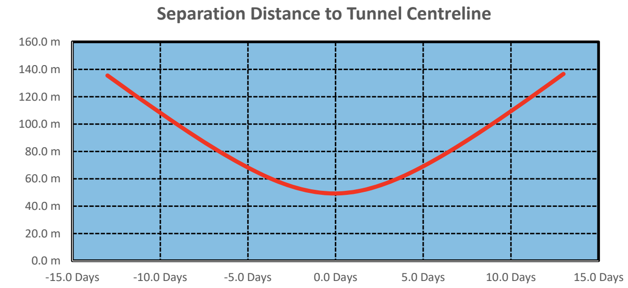
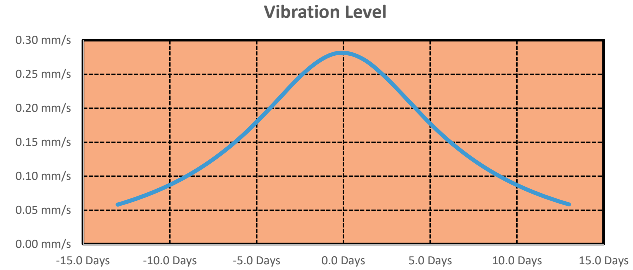
NORTH EAST LINK PROJECT

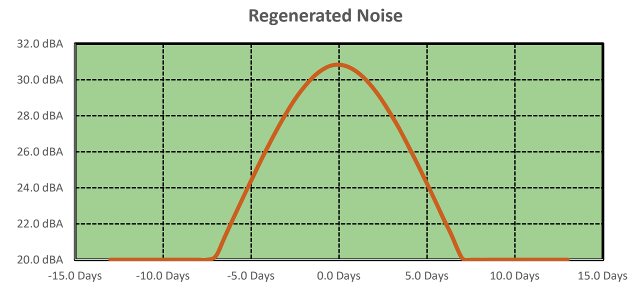
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Sevenoaks Avenue - 23









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	49.2 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.27 mm/s
95% Vibration Level	0.28 mm/s
Maximum Vibration Level	0.28 mm/s
Average Regenerated Noise level	23.5 dBA
90% Regenerated Noise Level	30.1 dBA
95% Regenerated Noise Level	30.6 dBA
Maximum Regenerated Noise Level	30.8 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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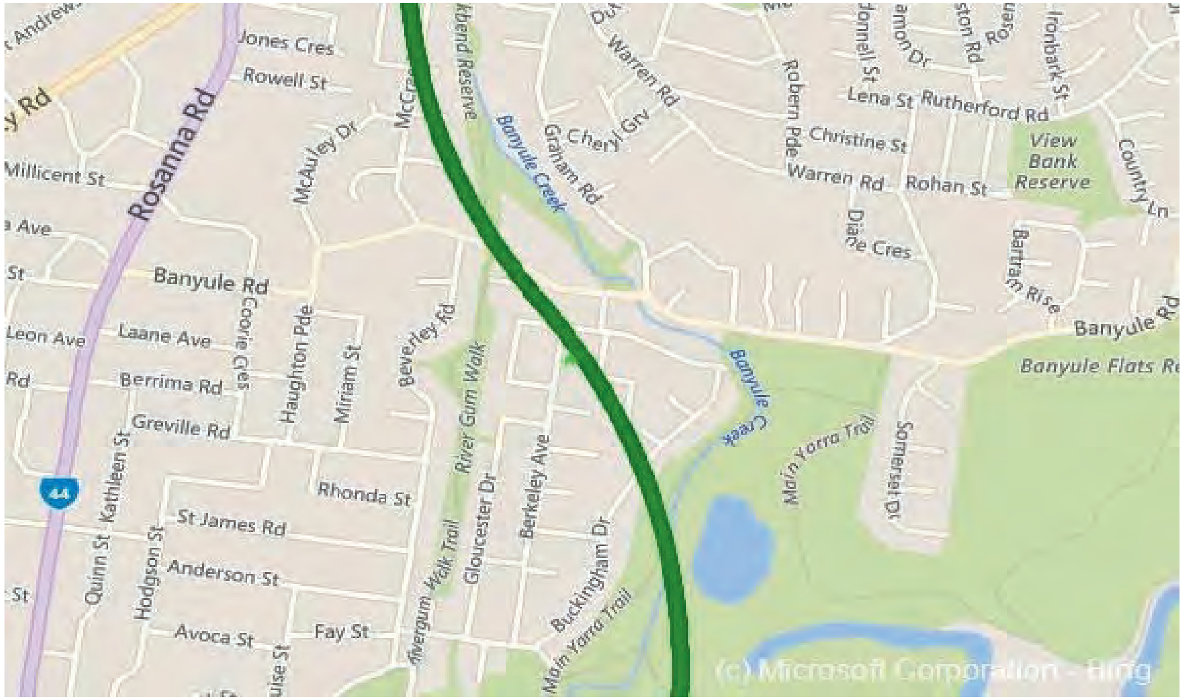
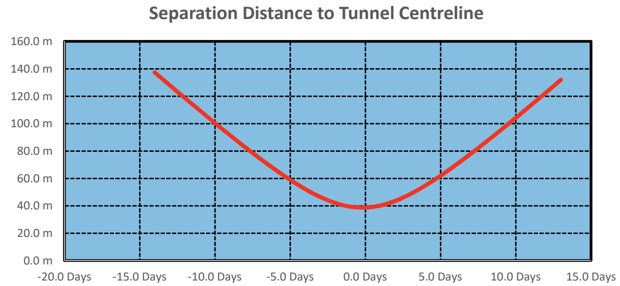
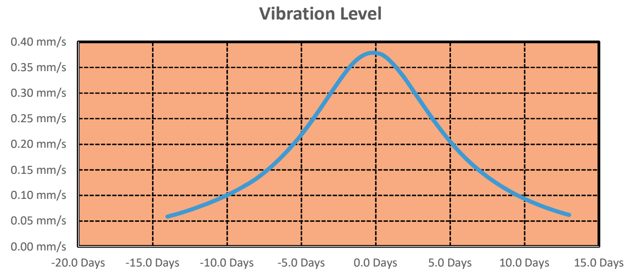
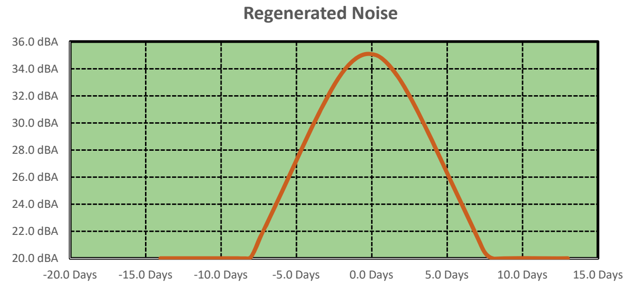
Assessment Location: Sevenoaks Avenue - 31









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.2 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	38.7 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.35 mm/s
95% Vibration Level	0.37 mm/s
Maximum Vibration Level	0.38 mm/s
Average Regenerated Noise level	25.0 dBA
90% Regenerated Noise Level	34.1 dBA
95% Regenerated Noise Level	34.8 dBA
Maximum Regenerated Noise Level	35.1 dBA

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Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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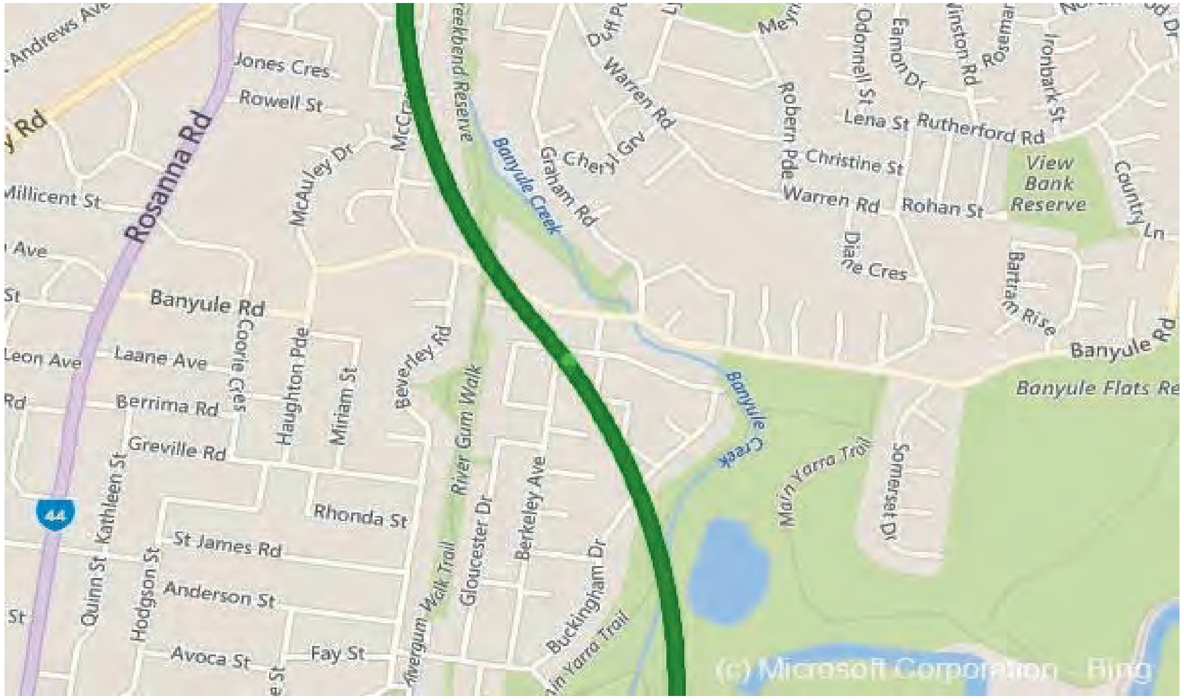
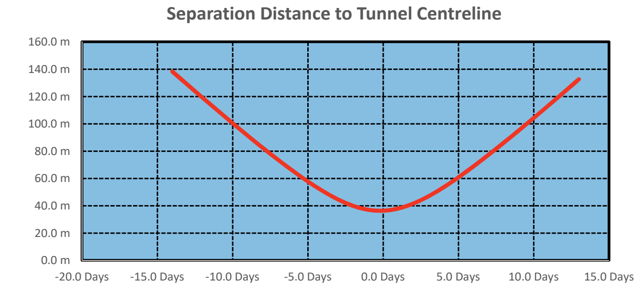
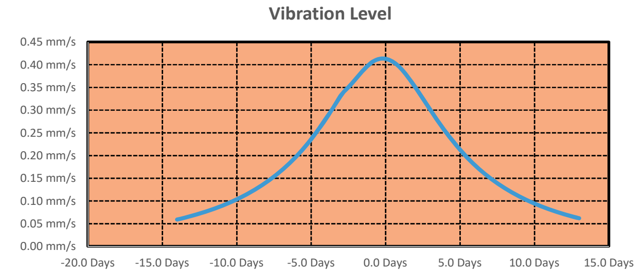
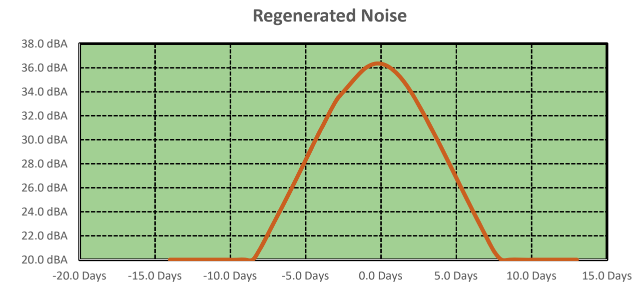
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Sevenoaks Avenue - 39









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.8 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.6 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	36.3 m
Average Vibration Level	0.20 mm/s
90% Vibration Level	0.38 mm/s
95% Vibration Level	0.40 mm/s
Maximum Vibration Level	0.41 mm/s
Average Regenerated Noise level	25.6 dBA
90% Regenerated Noise Level	35.2 dBA
95% Regenerated Noise Level	36.0 dBA
Maximum Regenerated Noise Level	36.3 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Northbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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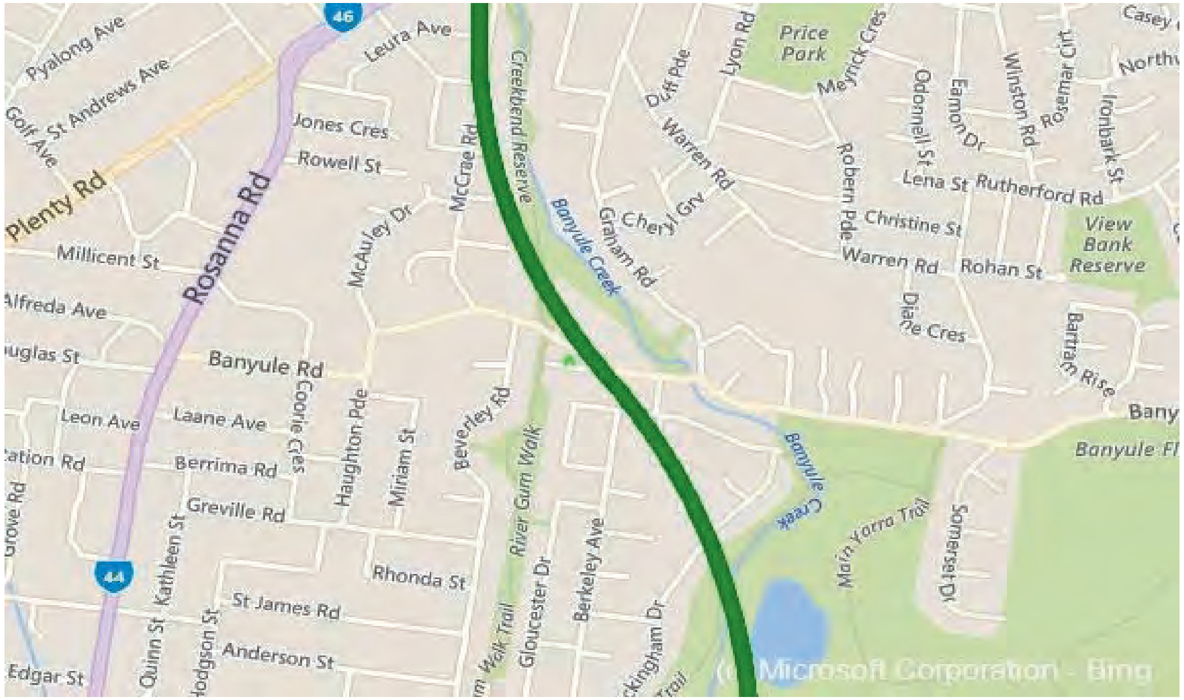
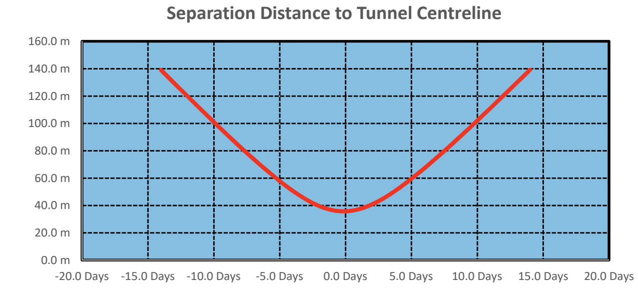
NORTH EAST LINK PROJECT

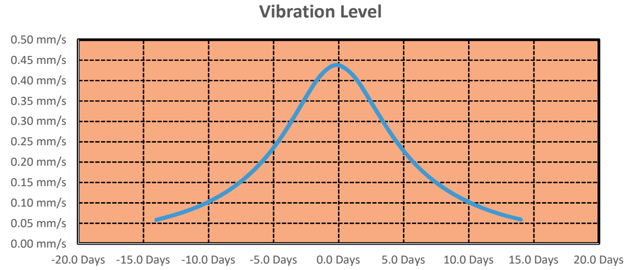
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

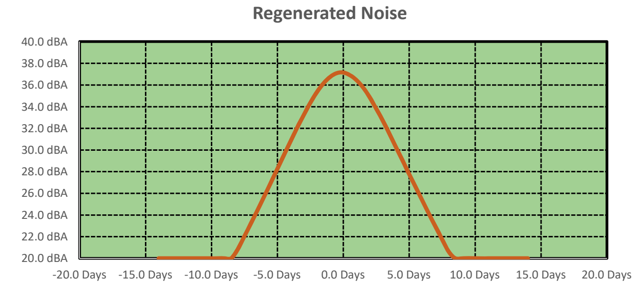
Appendix G Disturbance envelopes for southbound tunnel

Assessment Location: Austral Court - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.8 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.8 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	35.7 m
Average Vibration Level	0.20 mm/s
90% Vibration Level	0.40 mm/s
95% Vibration Level	0.43 mm/s
Maximum Vibration Level	0.44 mm/s
Average Regenerated Noise level	25.7 dBA
90% Regenerated Noise Level	35.9 dBA
95% Regenerated Noise Level	36.8 dBA
Maximum Regenerated Noise Level	37.2 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

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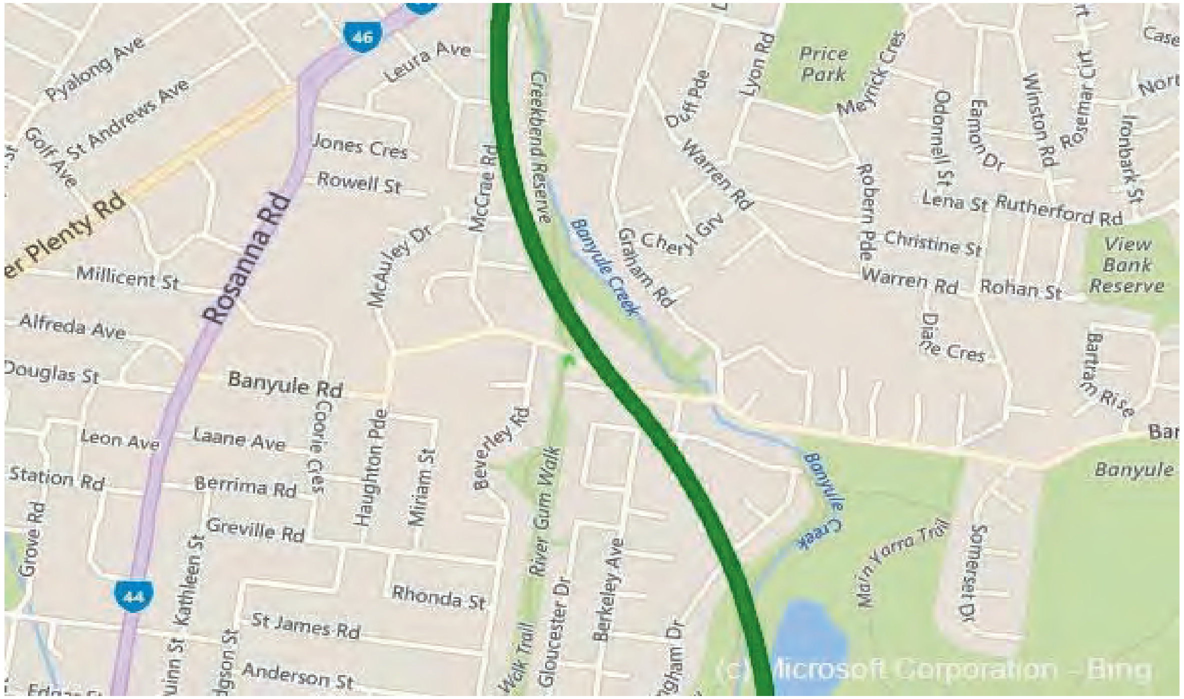
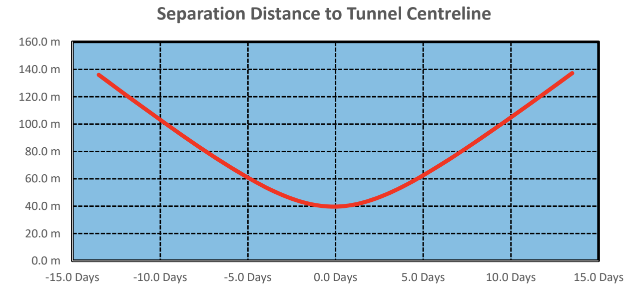
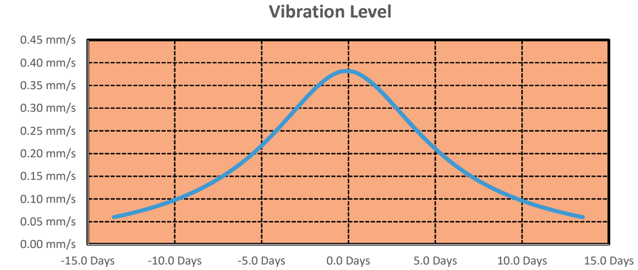
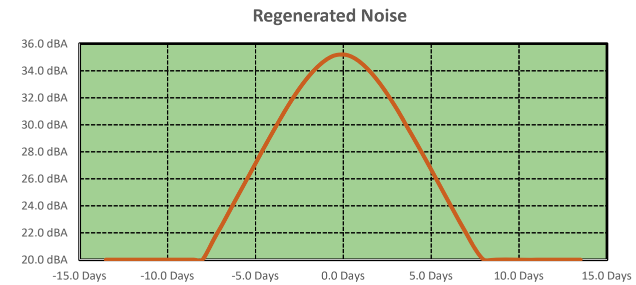
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Austral Court - 8









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.3 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	39.6 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.35 mm/s
95% Vibration Level	0.37 mm/s
Maximum Vibration Level	0.38 mm/s
Average Regenerated Noise level	25.1 dBA
90% Regenerated Noise Level	34.1 dBA
95% Regenerated Noise Level	34.9 dBA
Maximum Regenerated Noise Level	35.2 dBA

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V1 - Original		Job Number	HP1704-1
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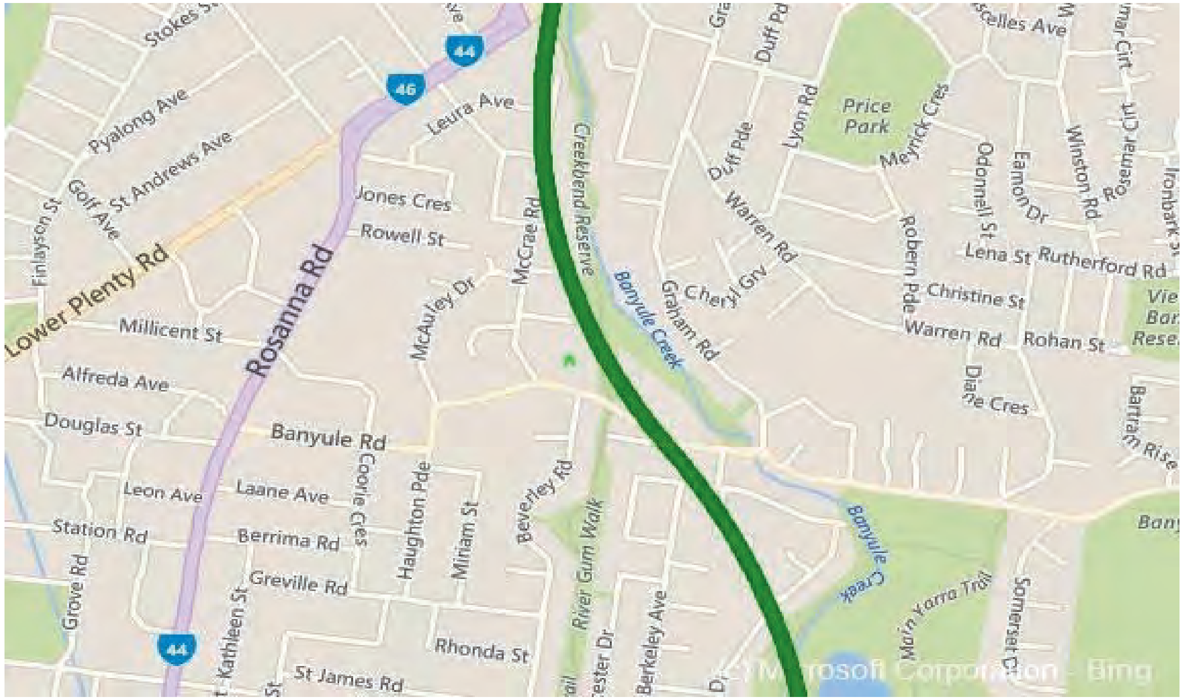
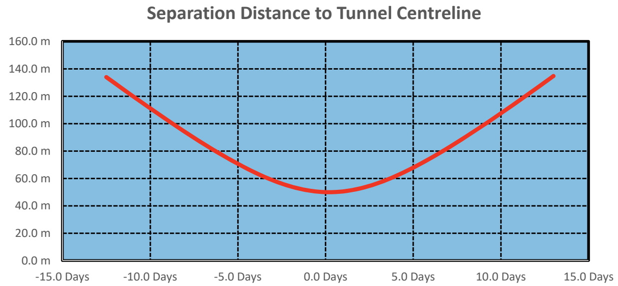
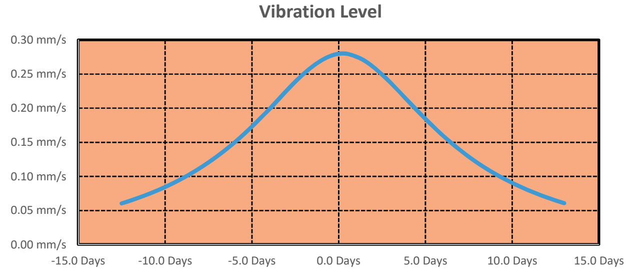
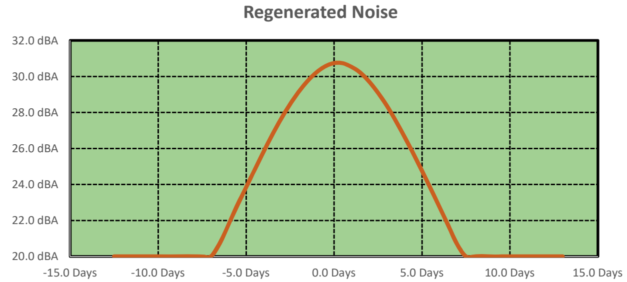
Assessment Location: Banyule Road - 71









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	50.0 m
Average Vibration Level	0.16 mm/s
90% Vibration Level	0.27 mm/s
95% Vibration Level	0.28 mm/s
Maximum Vibration Level	0.28 mm/s
Average Regenerated Noise level	23.6 dBA
90% Regenerated Noise Level	30.2 dBA
95% Regenerated Noise Level	30.5 dBA
Maximum Regenerated Noise Level	30.7 dBA

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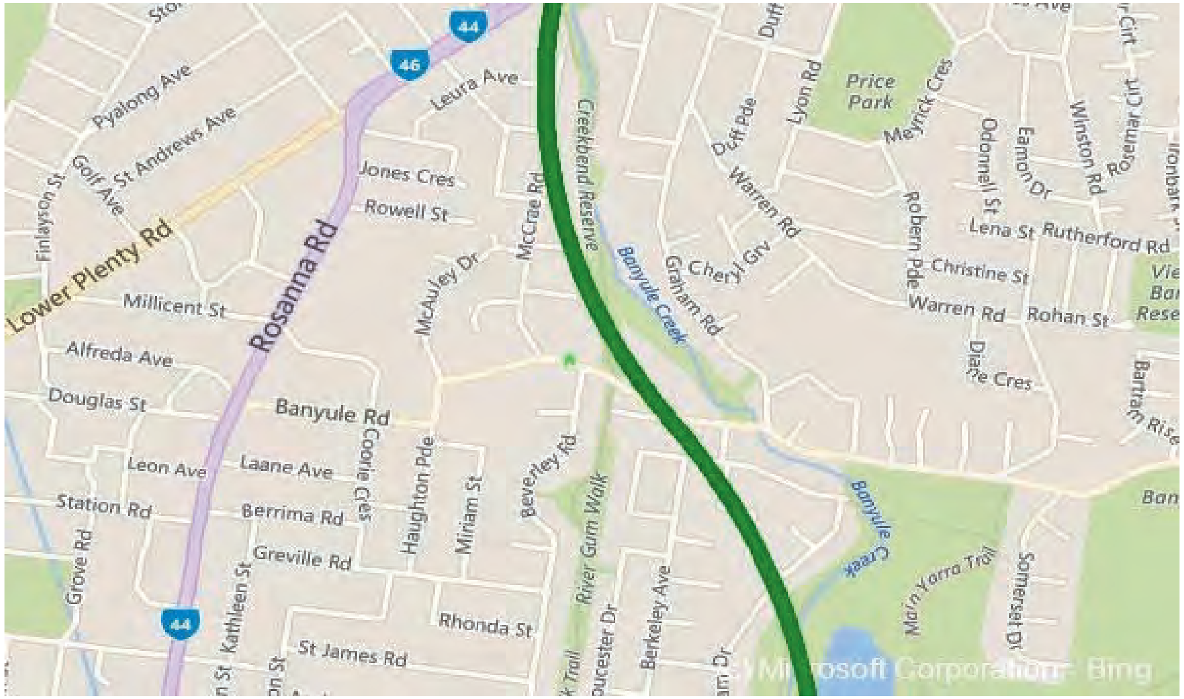
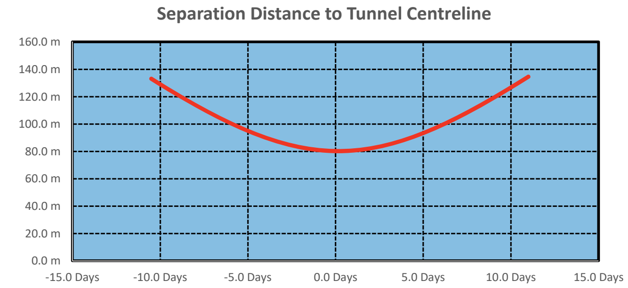
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

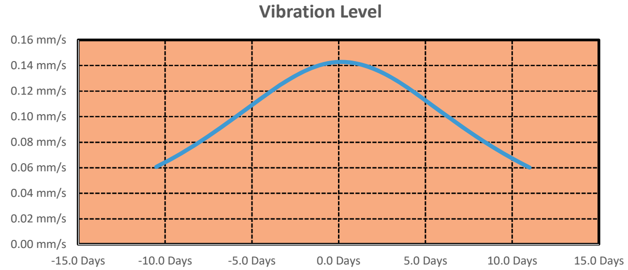
Assessment Location: Banyule Road - 76

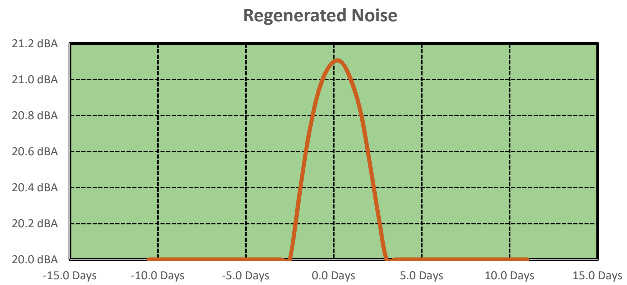


Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	80.2 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.14 mm/s
95% Vibration Level	0.14 mm/s
Maximum Vibration Level	0.14 mm/s
Average Regenerated Noise level	20.2 dBA
90% Regenerated Noise Level	20.9 dBA
95% Regenerated Noise Level	21.0 dBA
Maximum Regenerated Noise Level	21.1 dBA







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		File	

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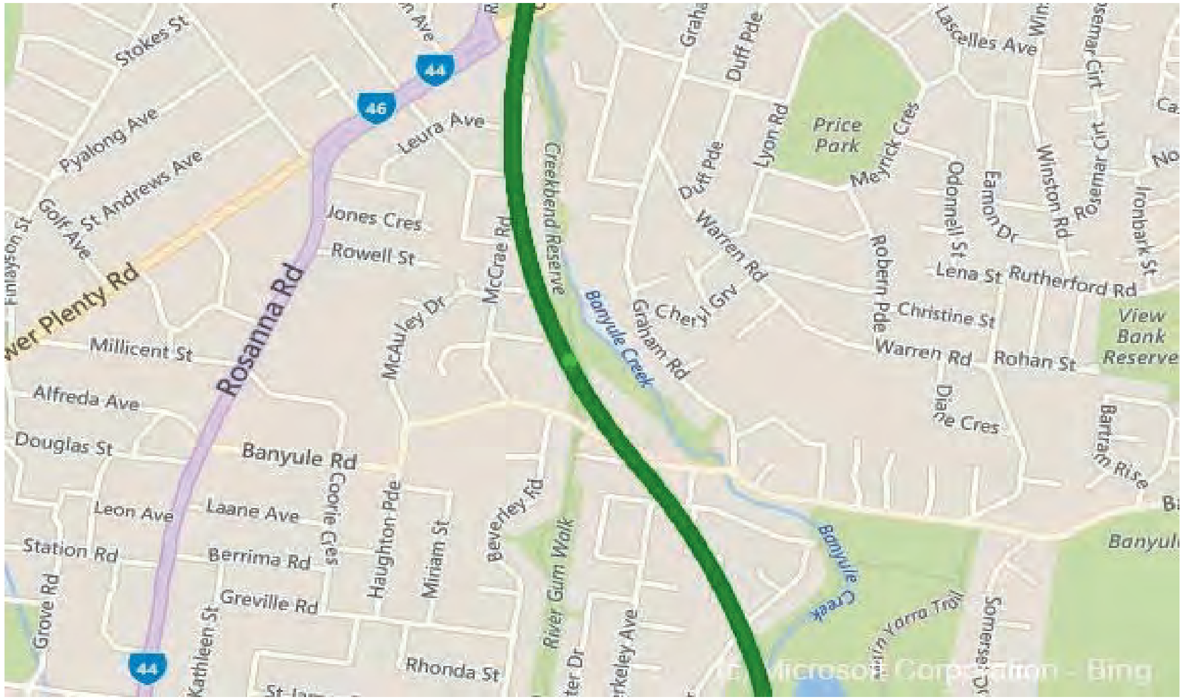
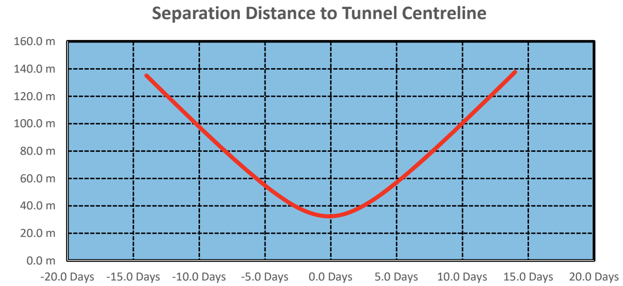
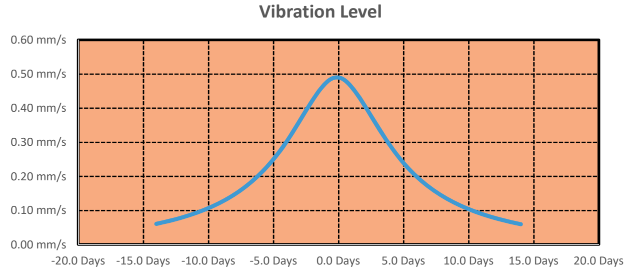
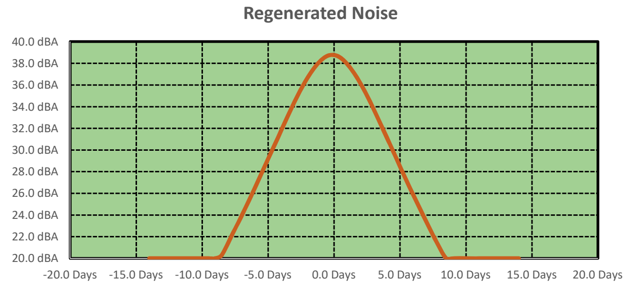
In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.

Assessment Location: Banyule Road - 87A









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.1 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	32.3 m
Average Vibration Level	0.21 mm/s
90% Vibration Level	0.44 mm/s
95% Vibration Level	0.47 mm/s
Maximum Vibration Level	0.49 mm/s
Average Regenerated Noise level	26.3 dBA
90% Regenerated Noise Level	37.3 dBA
95% Regenerated Noise Level	38.3 dBA
Maximum Regenerated Noise Level	38.8 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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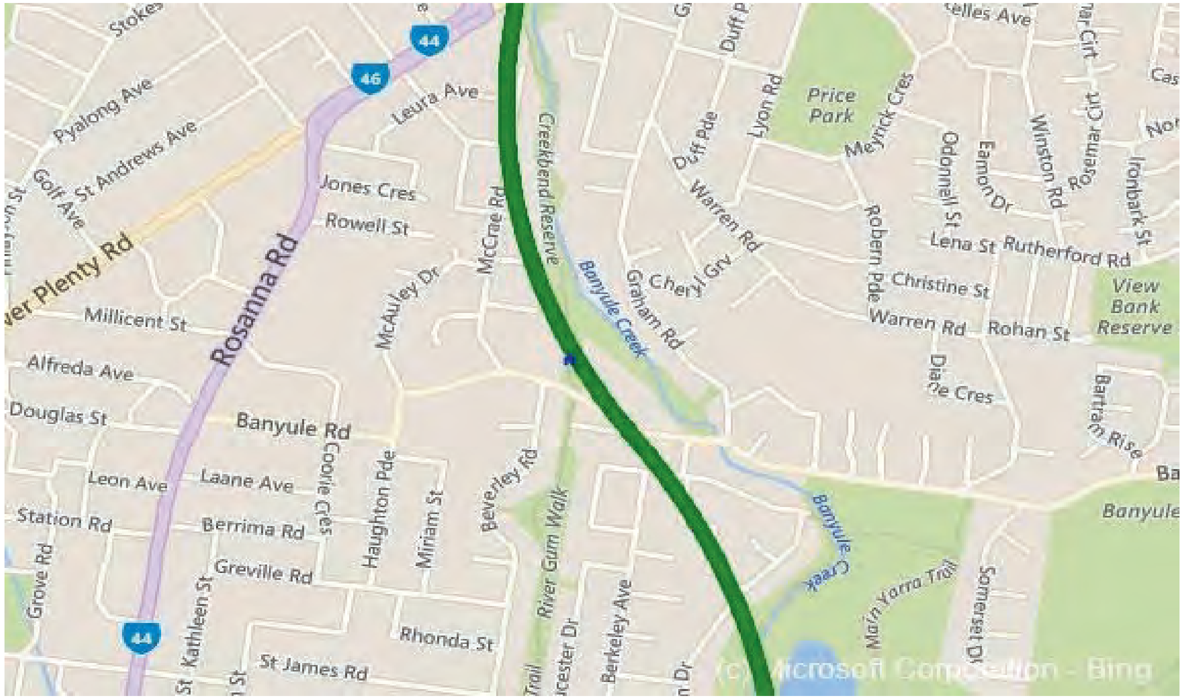
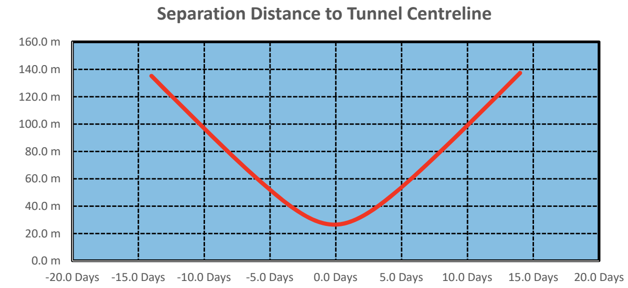
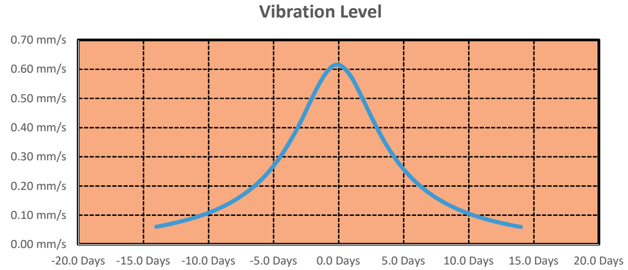
NORTH EAST LINK PROJECT

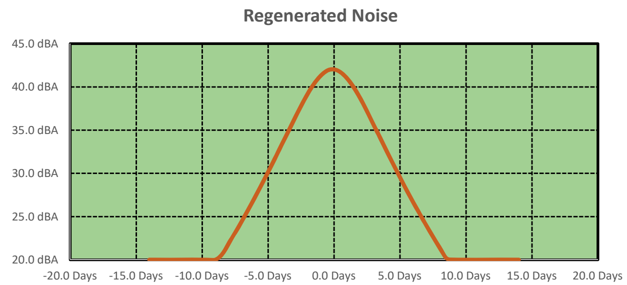
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Banyule Road - 87I









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	26.5 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.54 mm/s
95% Vibration Level	0.59 mm/s
Maximum Vibration Level	0.61 mm/s
Average Regenerated Noise level	27.2 dBA
90% Regenerated Noise Level	40.1 dBA
95% Regenerated Noise Level	41.4 dBA
Maximum Regenerated Noise Level	42.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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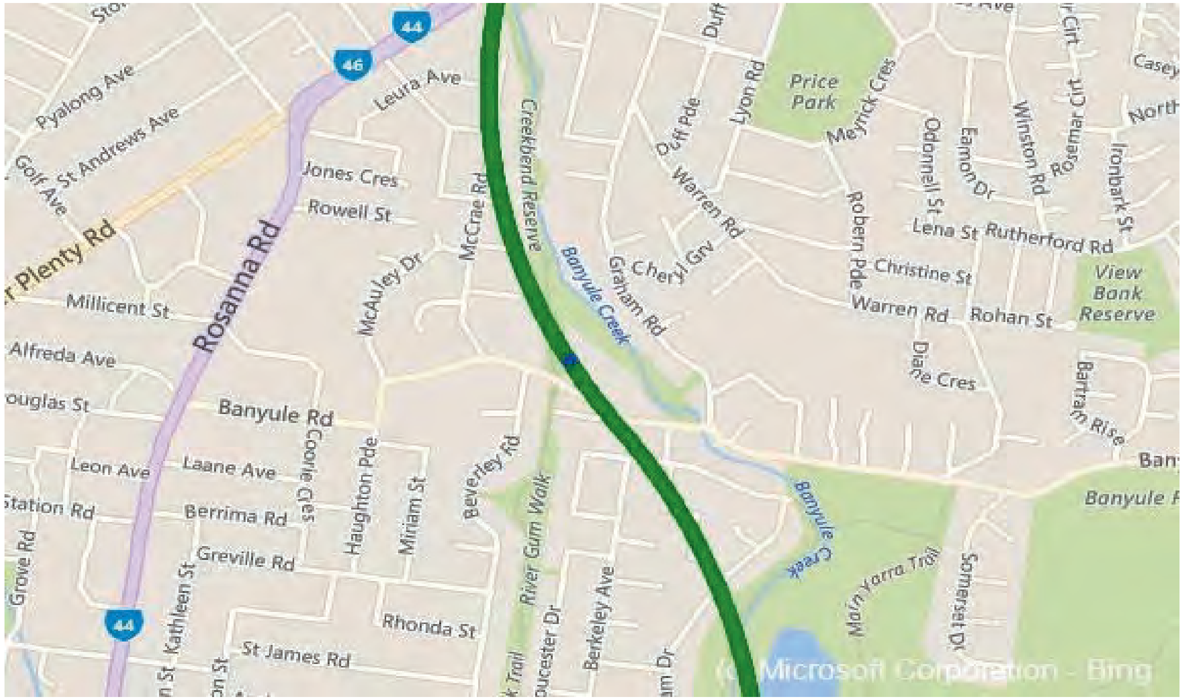
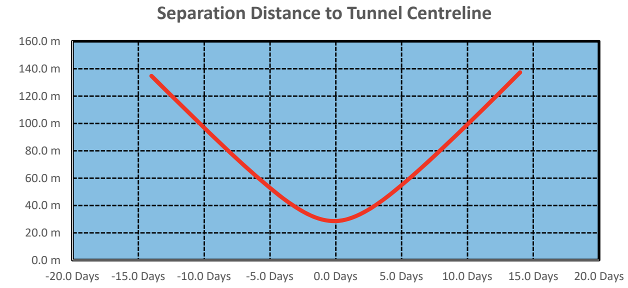
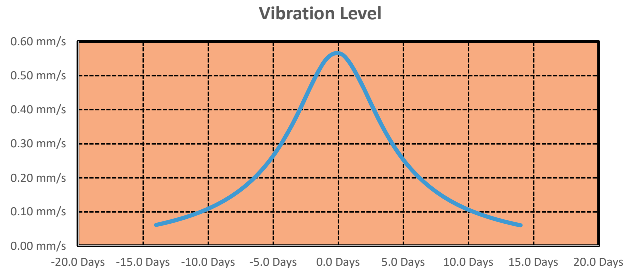
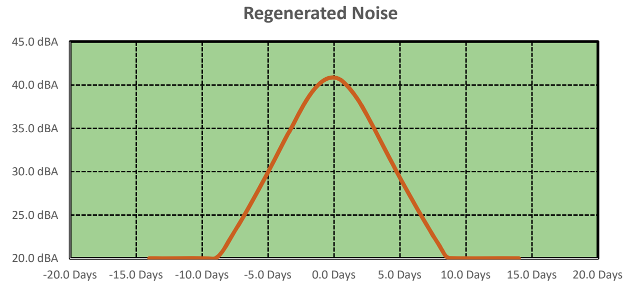
Assessment Location: Banyule Road - 89









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.6 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.4 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	28.6 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.50 mm/s
95% Vibration Level	0.55 mm/s
Maximum Vibration Level	0.57 mm/s
Average Regenerated Noise level	26.9 dBA
90% Regenerated Noise Level	39.2 dBA
95% Regenerated Noise Level	40.4 dBA
Maximum Regenerated Noise Level	40.8 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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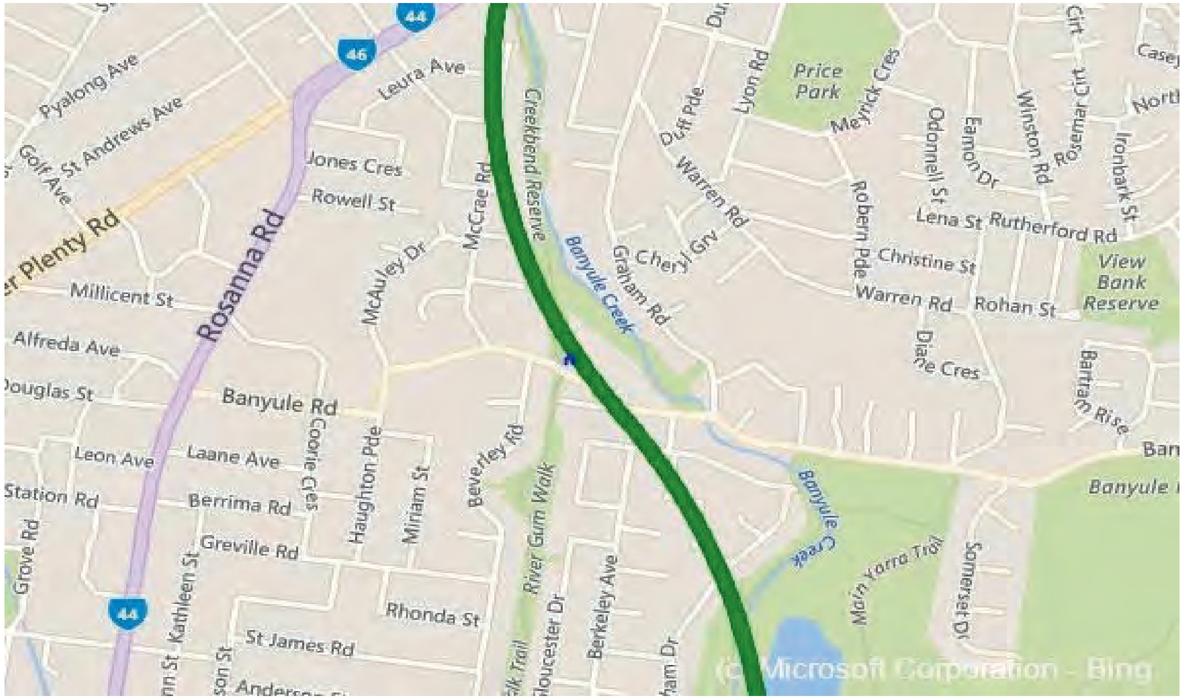
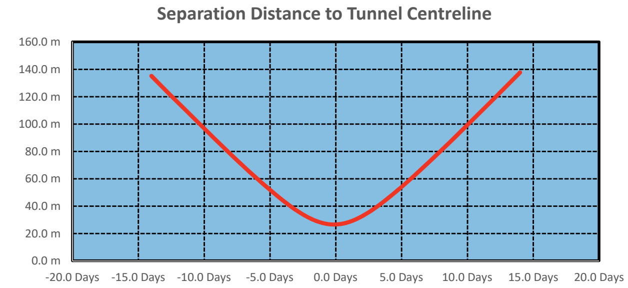
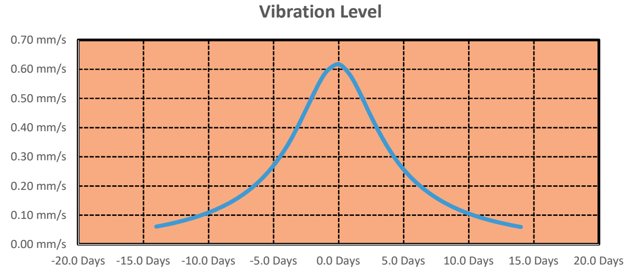
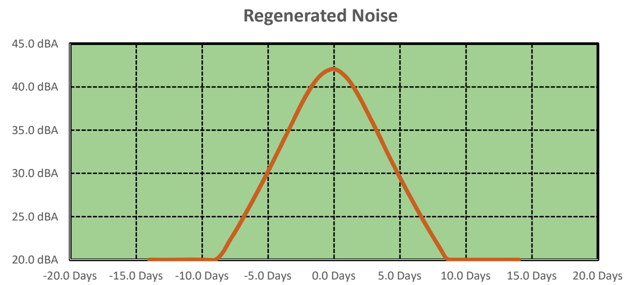
Assessment Location: Banyule Road - 91A









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	26.5 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.54 mm/s
95% Vibration Level	0.59 mm/s
Maximum Vibration Level	0.62 mm/s
Average Regenerated Noise level	27.2 dBA
90% Regenerated Noise Level	40.1 dBA
95% Regenerated Noise Level	41.4 dBA
Maximum Regenerated Noise Level	42.1 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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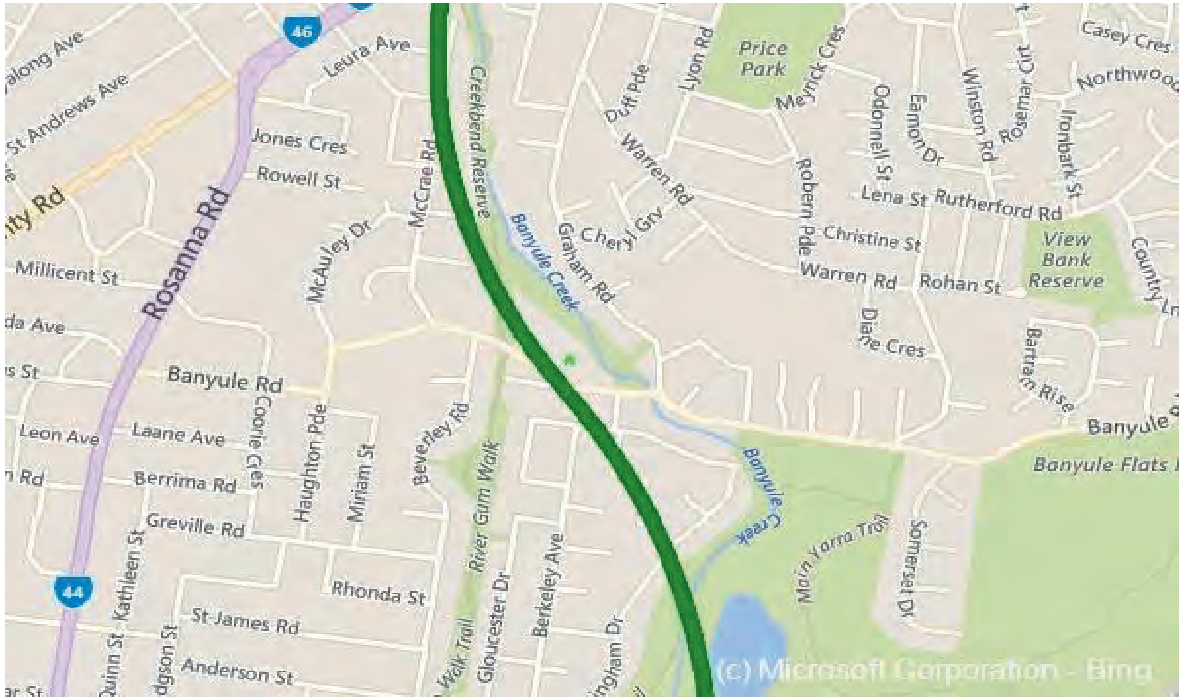
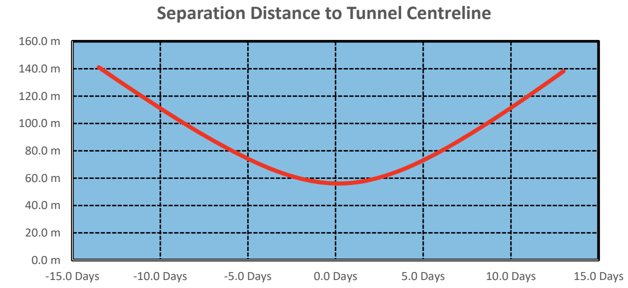
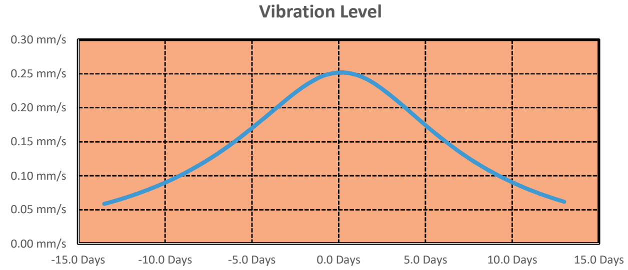
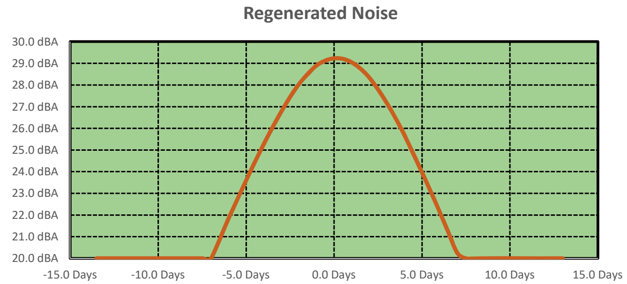
Assessment Location: Banyule Road - 107









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.2 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	56.0 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.25 mm/s
Maximum Vibration Level	0.25 mm/s
Average Regenerated Noise level	23.0 dBA
90% Regenerated Noise Level	28.7 dBA
95% Regenerated Noise Level	29.1 dBA
Maximum Regenerated Noise Level	29.2 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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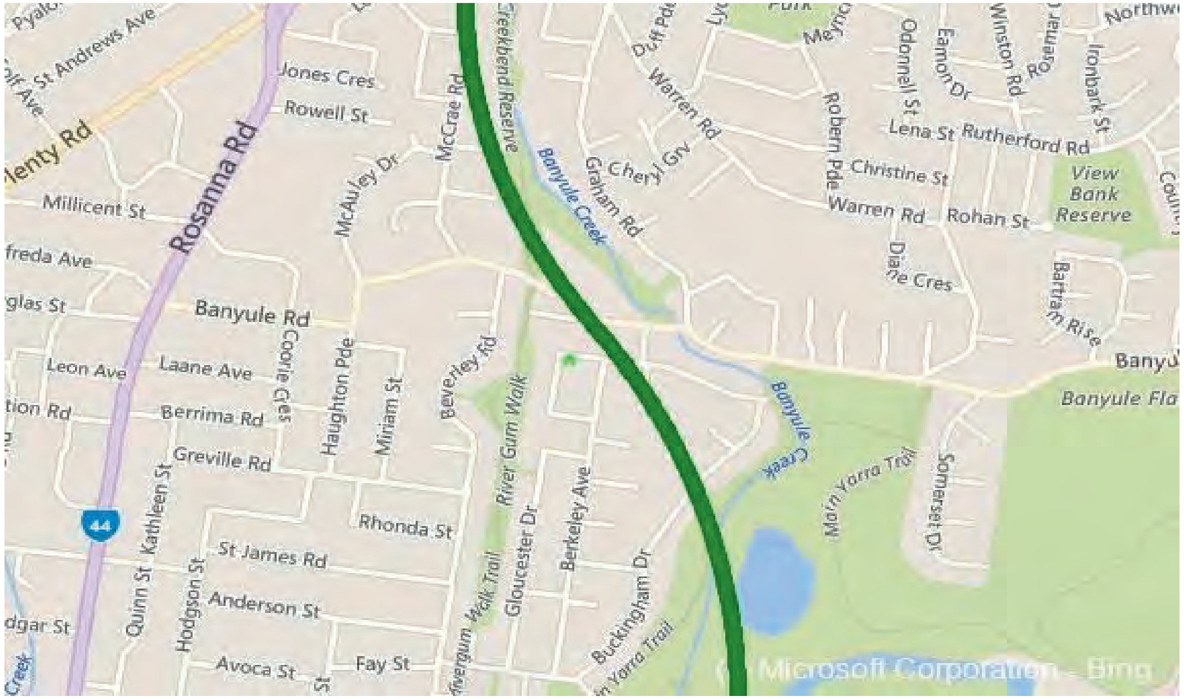
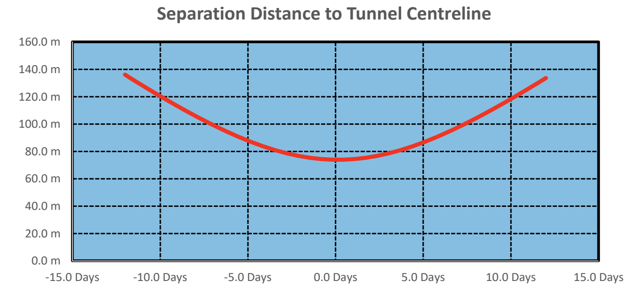
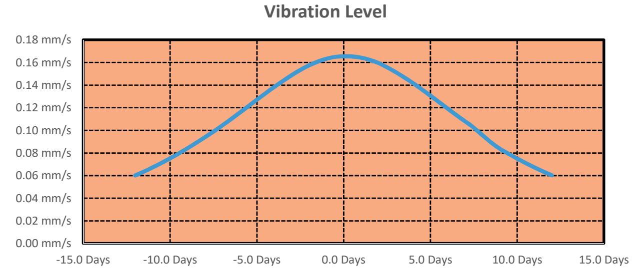
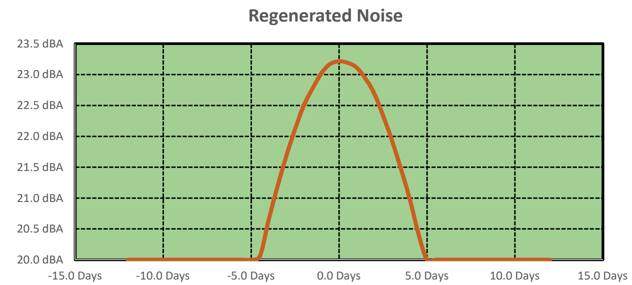
Assessment Location: Berkeley Avenue - 81









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	73.8 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.16 mm/s
95% Vibration Level	0.16 mm/s
Maximum Vibration Level	0.17 mm/s
Average Regenerated Noise level	20.8 dBA
90% Regenerated Noise Level	23.0 dBA
95% Regenerated Noise Level	23.1 dBA
Maximum Regenerated Noise Level	23.2 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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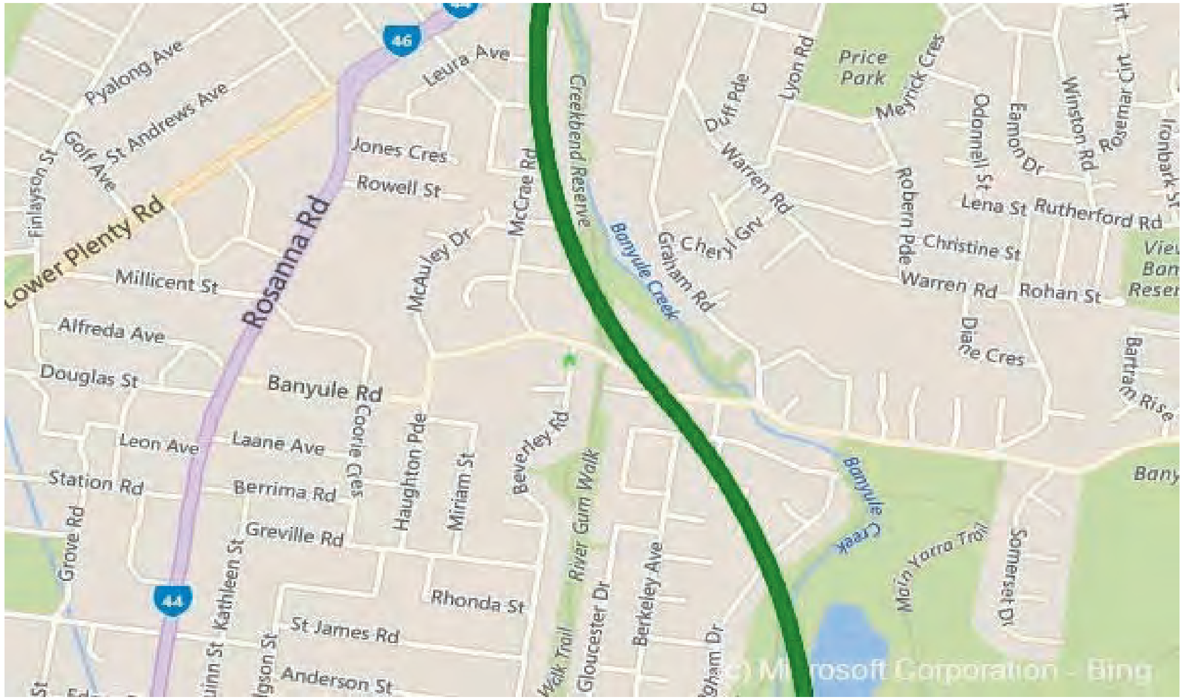
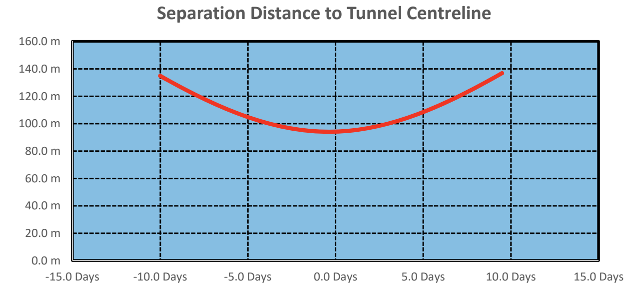
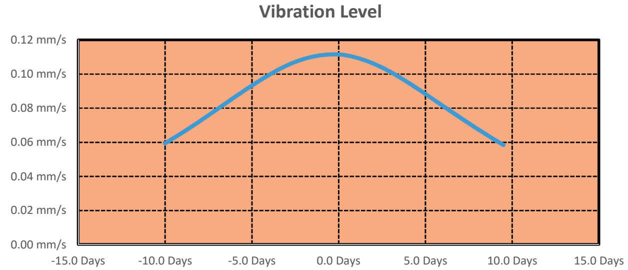
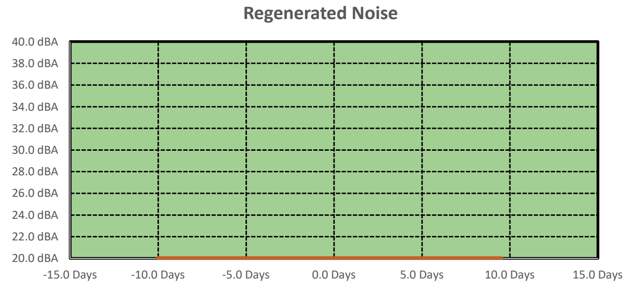
Assessment Location: Beverley Road - 188









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	94.0 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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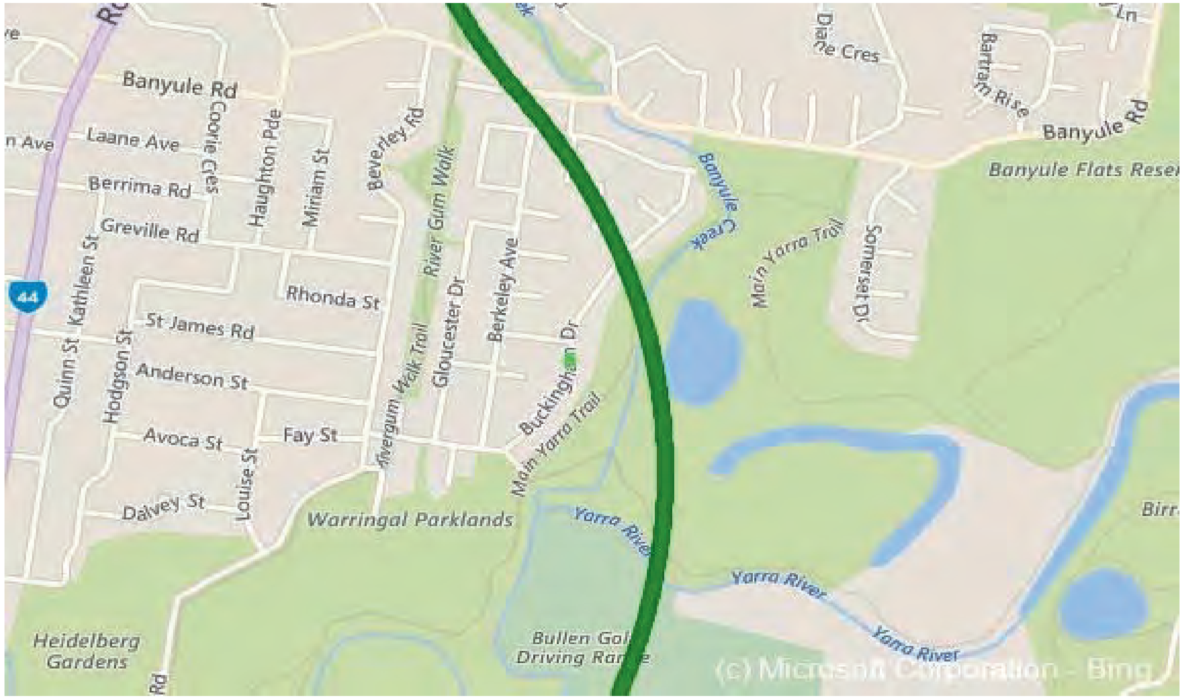
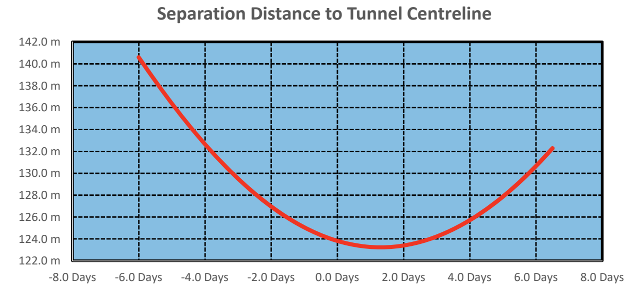
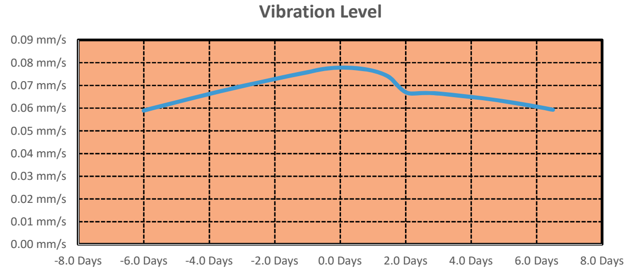
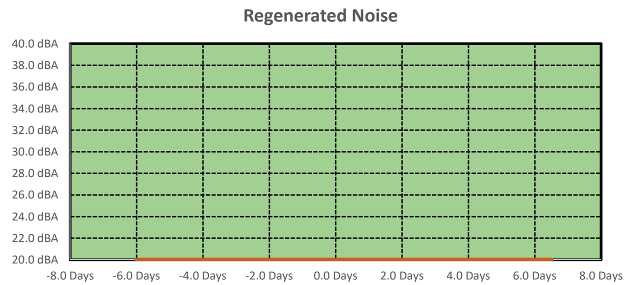
Assessment Location: Buckingham Drive - 58









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	123.2 m
Average Vibration Level	0.07 mm/s
90% Vibration Level	0.08 mm/s
95% Vibration Level	0.08 mm/s
Maximum Vibration Level	0.08 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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NORTH EAST LINK PROJECT

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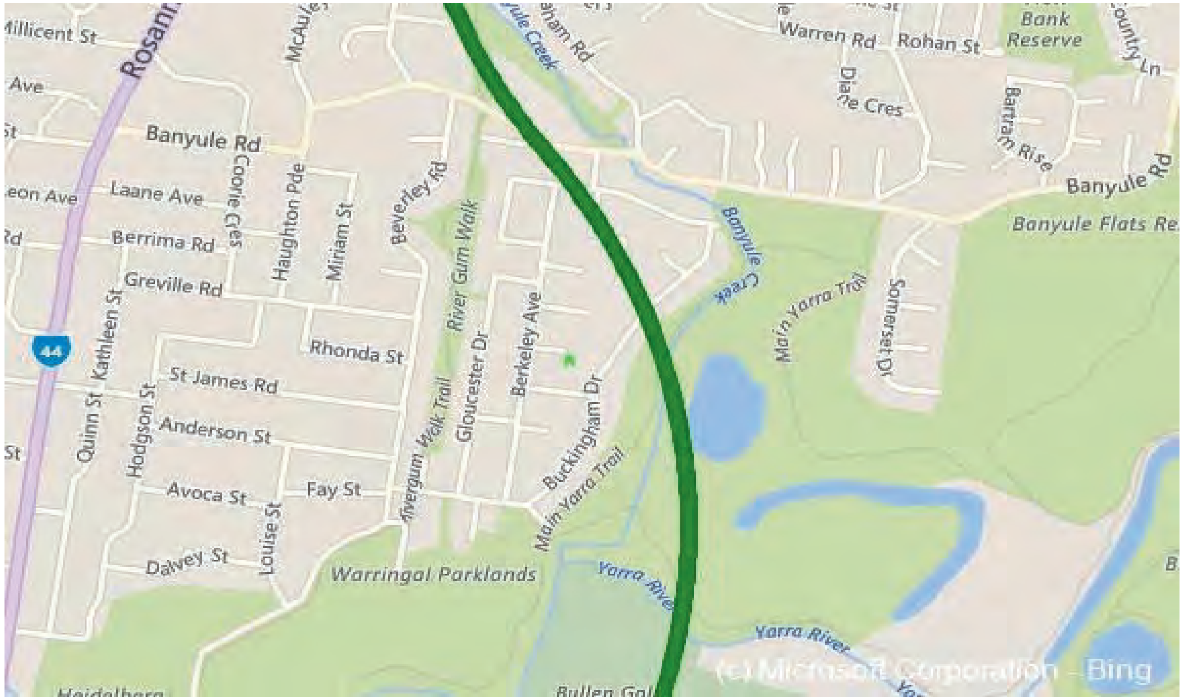
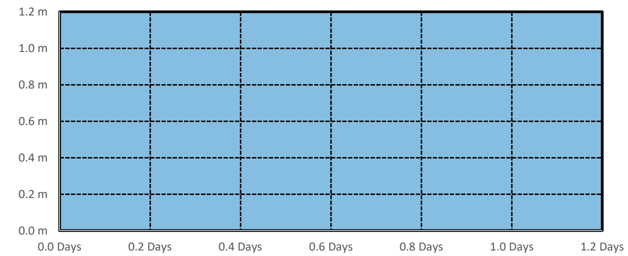
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

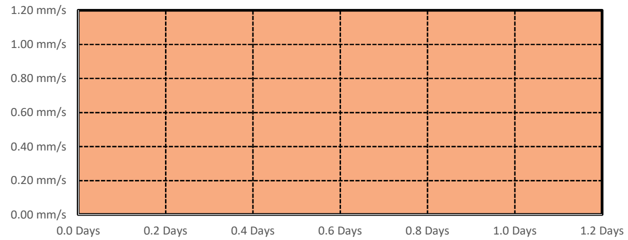
Assessment Location: Buckingham Drive - 65



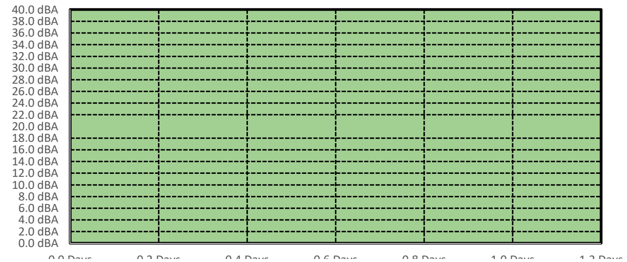
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	0.0 m
Average Vibration Level	#DIV/0!
90% Vibration Level	#NUM!
95% Vibration Level	#NUM!
Maximum Vibration Level	0.00 mm/s
Average Regenerated Noise level	#DIV/0!
90% Regenerated Noise Level	#NUM!
95% Regenerated Noise Level	#NUM!
Maximum Regenerated Noise Level	0.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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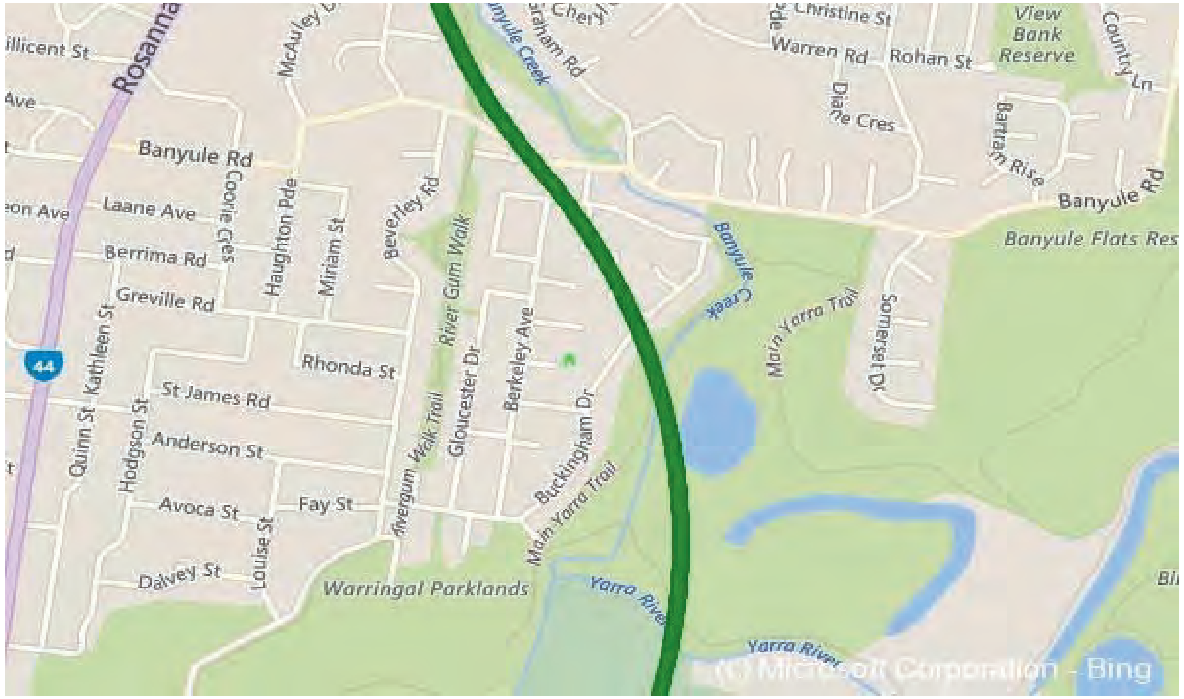
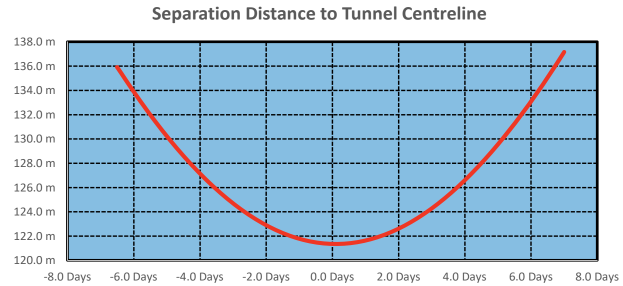
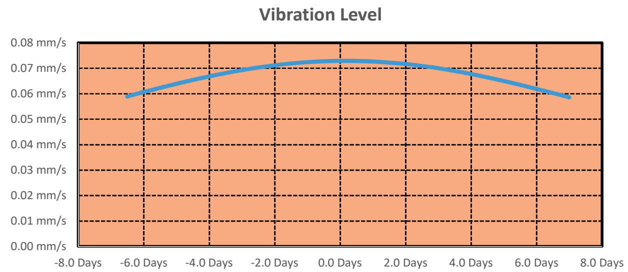
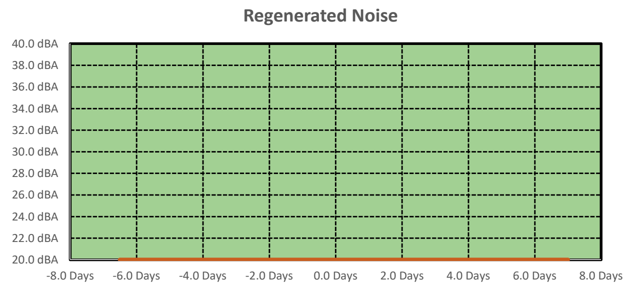
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Buckingham Drive - 69









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	121.4 m
Average Vibration Level	0.07 mm/s
90% Vibration Level	0.07 mm/s
95% Vibration Level	0.07 mm/s
Maximum Vibration Level	0.07 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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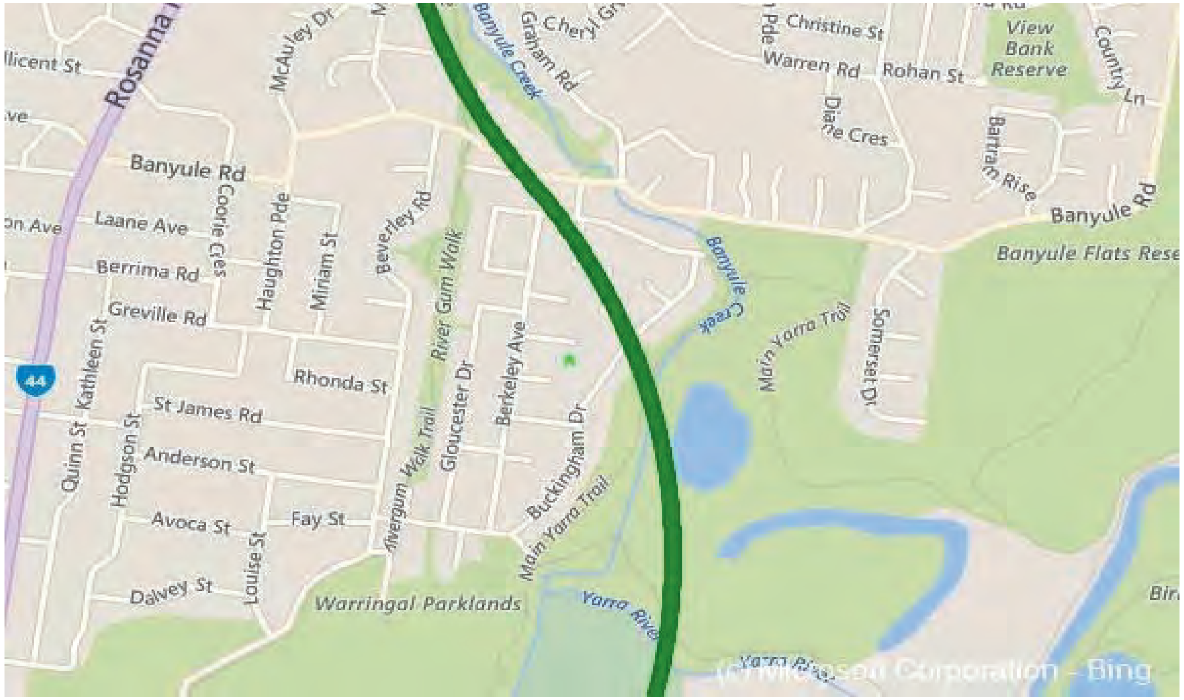
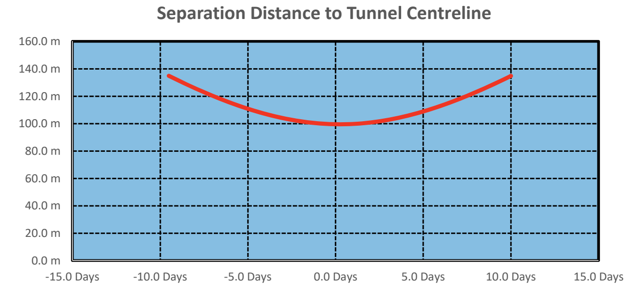
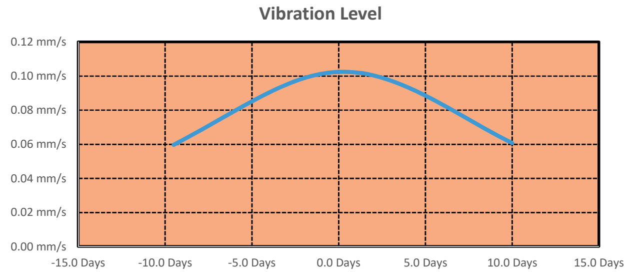
NORTH EAST LINK PROJECT

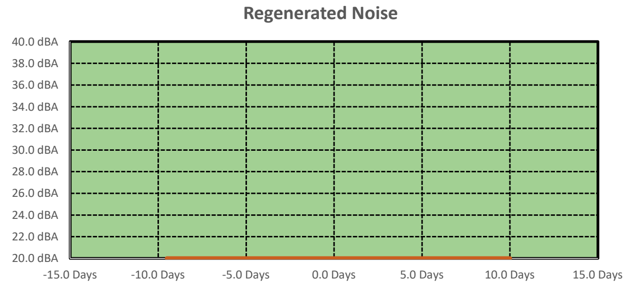
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Buckingham Drive - 73









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	99.5 m
Average Vibration Level	0.08 mm/s
90% Vibration Level	0.10 mm/s
95% Vibration Level	0.10 mm/s
Maximum Vibration Level	0.10 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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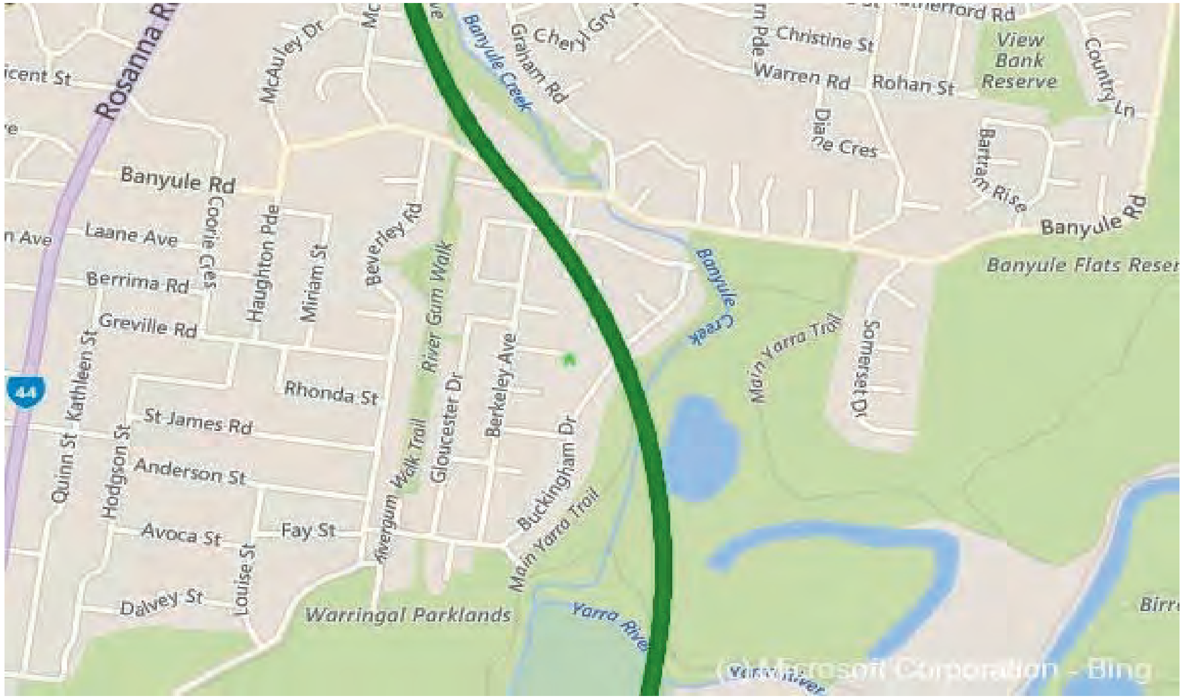
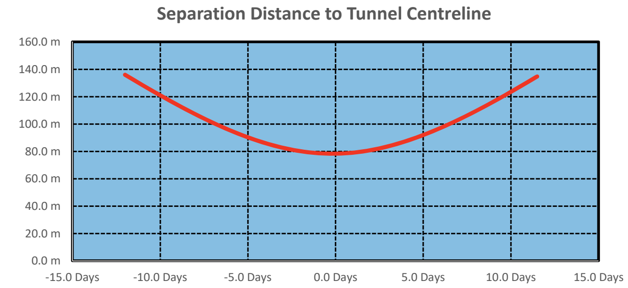
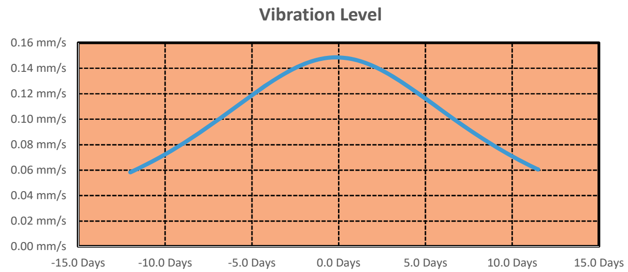
NORTH EAST LINK PROJECT

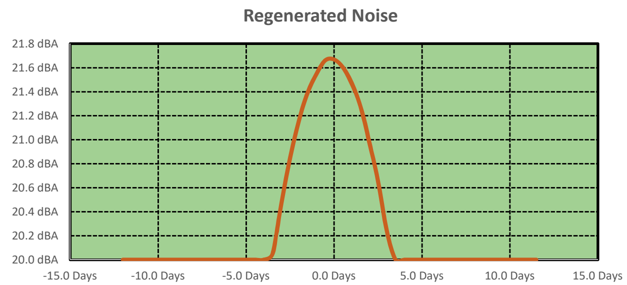
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Buckingham Drive - 77









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	78.3 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.15 mm/s
95% Vibration Level	0.15 mm/s
Maximum Vibration Level	0.15 mm/s
Average Regenerated Noise level	20.3 dBA
90% Regenerated Noise Level	21.4 dBA
95% Regenerated Noise Level	21.6 dBA
Maximum Regenerated Noise Level	21.7 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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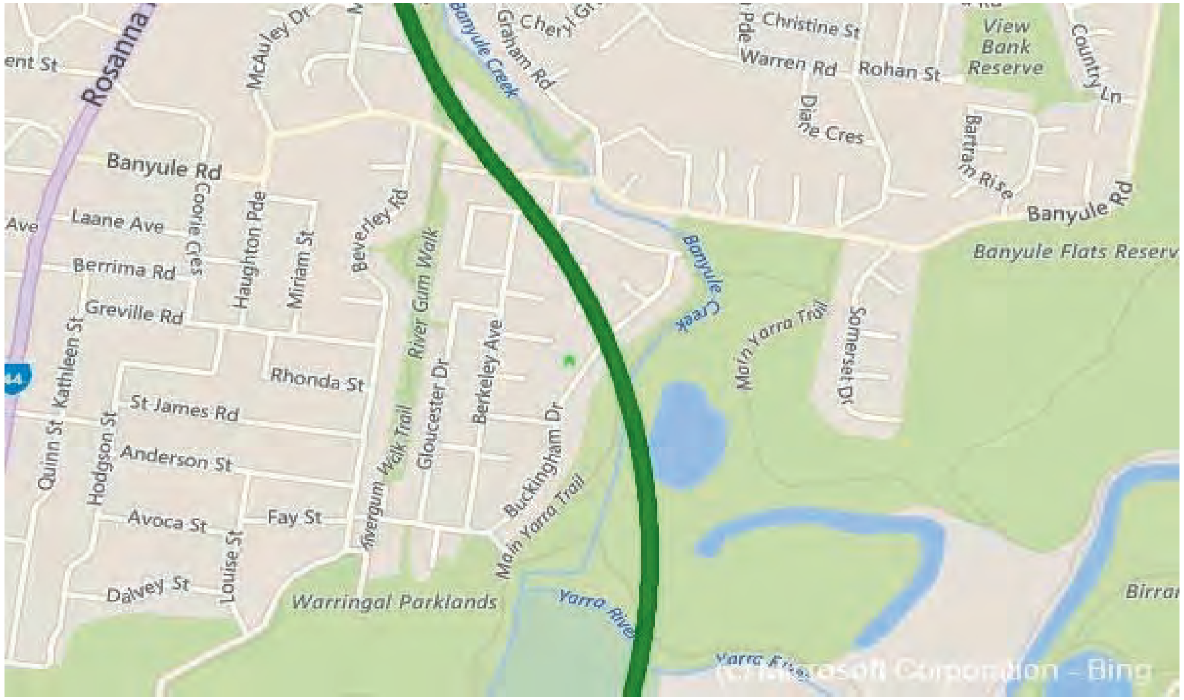
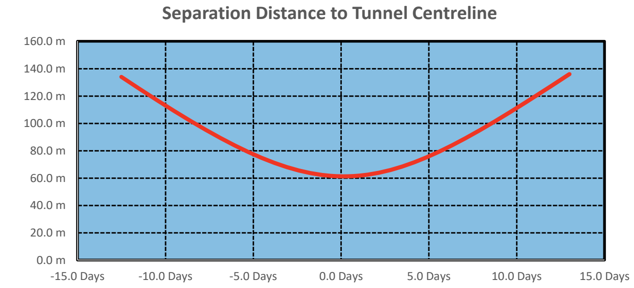
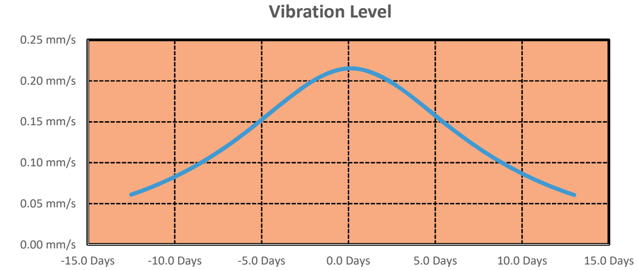
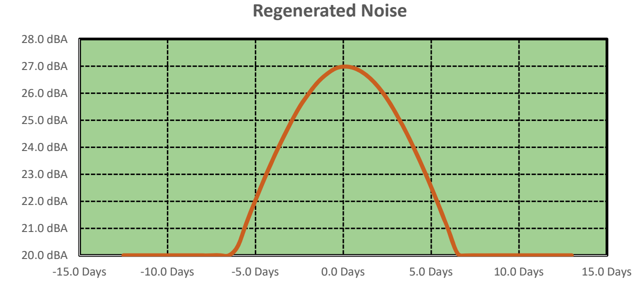
Assessment Location: Buckingham Drive - 80









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	61.1 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.21 mm/s
95% Vibration Level	0.21 mm/s
Maximum Vibration Level	0.22 mm/s
Average Regenerated Noise level	22.2 dBA
90% Regenerated Noise Level	26.5 dBA
95% Regenerated Noise Level	26.8 dBA
Maximum Regenerated Noise Level	27.0 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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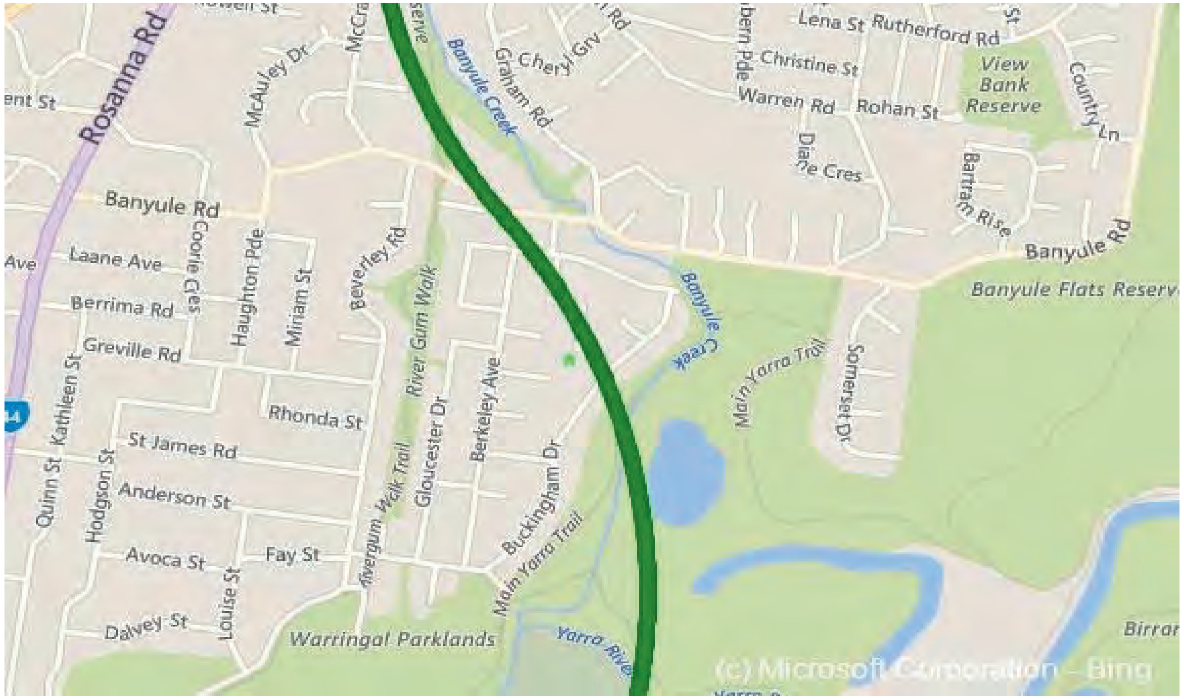
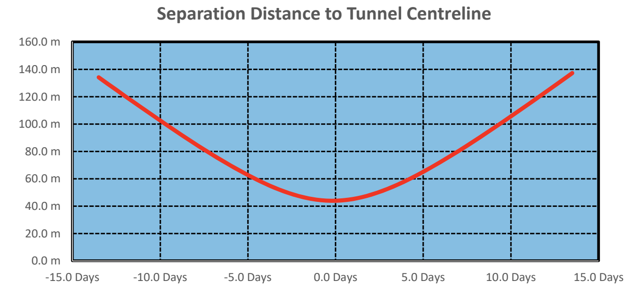
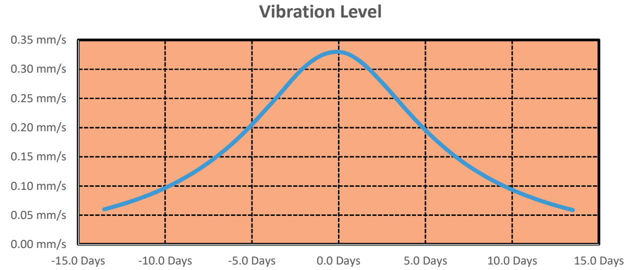
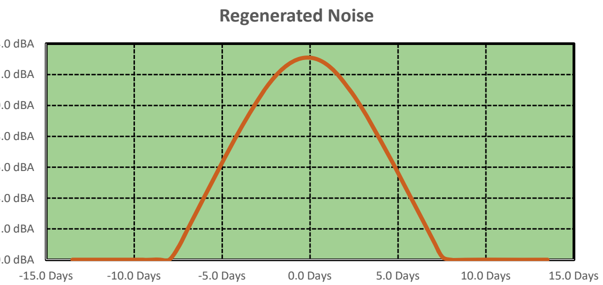
Assessment Location: Buckingham Drive - 83









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.4 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	43.9 m
Average Vibration Level	0.17 mm/s
90% Vibration Level	0.31 mm/s
95% Vibration Level	0.32 mm/s
Maximum Vibration Level	0.33 mm/s
Average Regenerated Noise level	24.4 dBA
90% Regenerated Noise Level	32.3 dBA
95% Regenerated Noise Level	32.9 dBA
Maximum Regenerated Noise Level	33.1 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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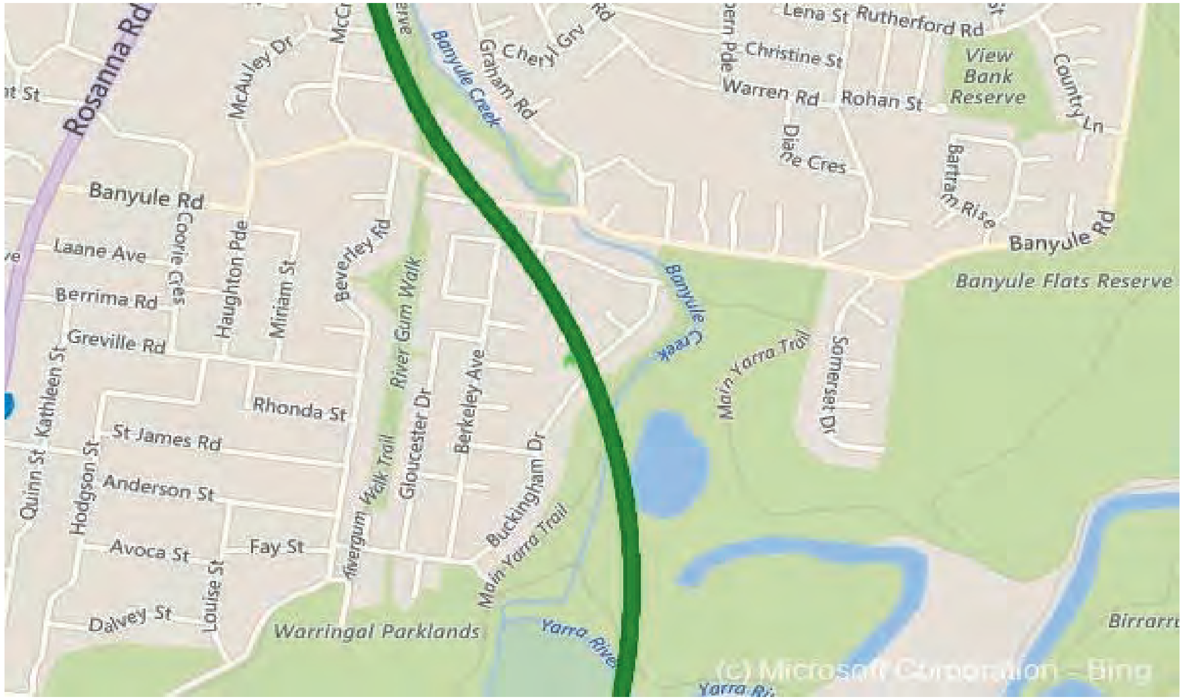
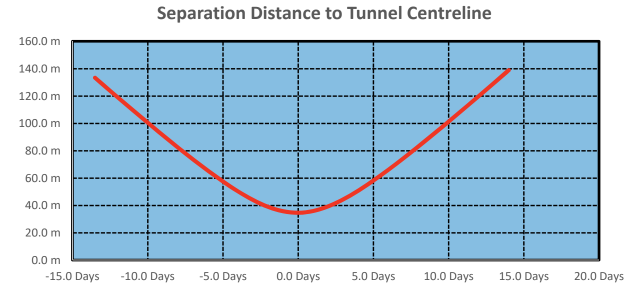
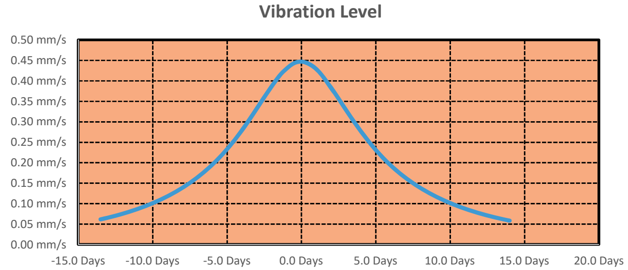
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

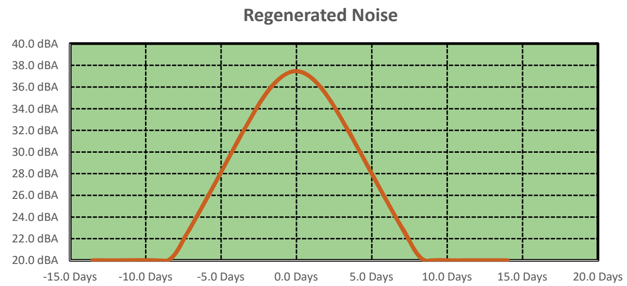
A B C D E F G H I J K L M

Assessment Location: Buckingham Drive - 90









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.9 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.9 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	34.6 m
Average Vibration Level	0.20 mm/s
90% Vibration Level	0.41 mm/s
95% Vibration Level	0.43 mm/s
Maximum Vibration Level	0.45 mm/s
Average Regenerated Noise level	25.9 dBA
90% Regenerated Noise Level	36.2 dBA
95% Regenerated Noise Level	37.0 dBA
Maximum Regenerated Noise Level	37.5 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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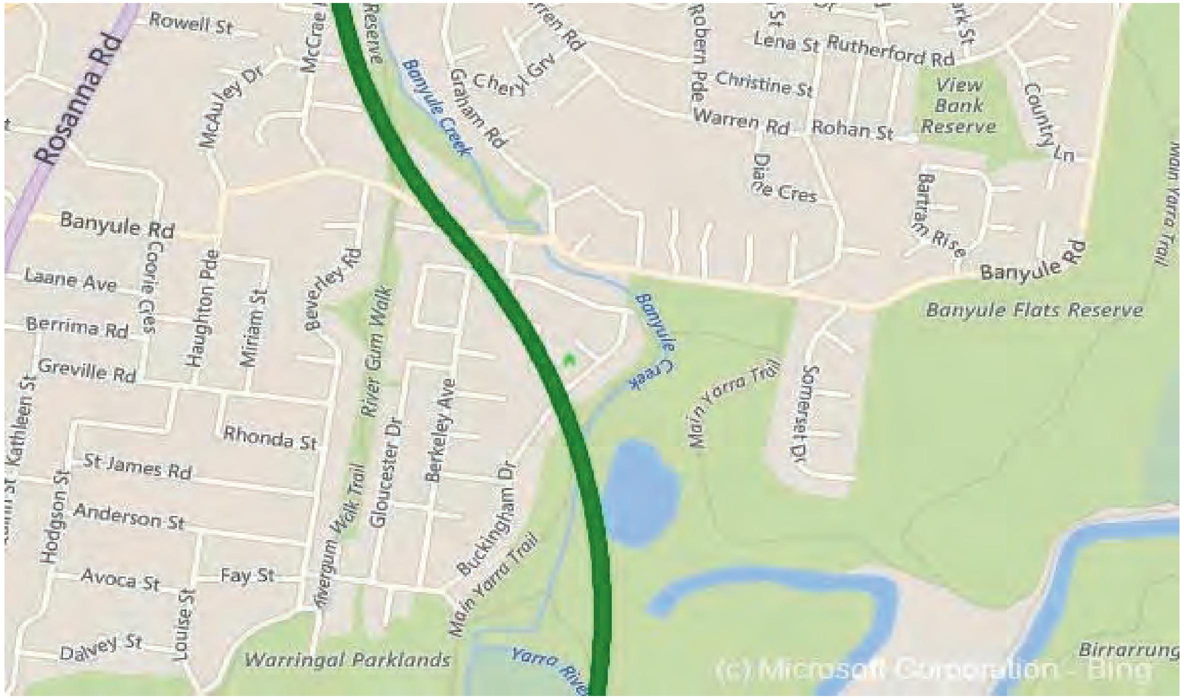
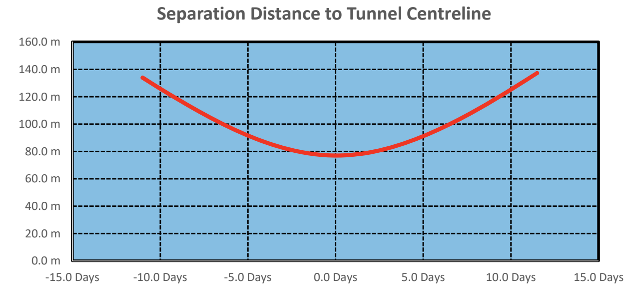
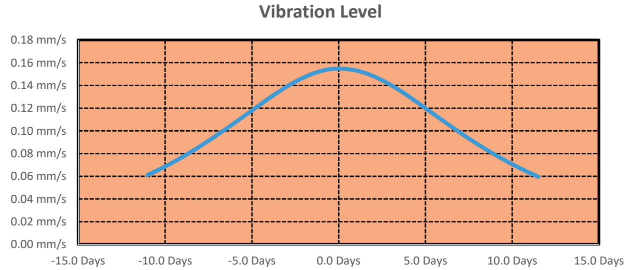
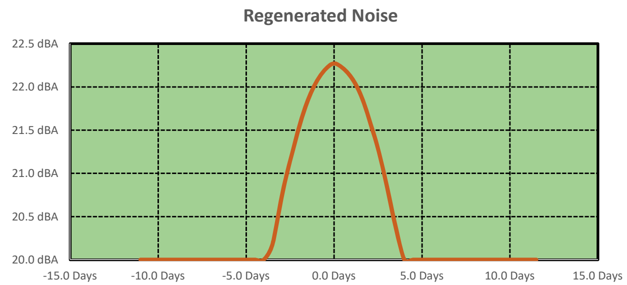
A B C D E F G H I J K L M

Assessment Location: Buckingham Drive - 100









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	77.0 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.15 mm/s
95% Vibration Level	0.15 mm/s
Maximum Vibration Level	0.15 mm/s
Average Regenerated Noise level	20.5 dBA
90% Regenerated Noise Level	22.0 dBA
95% Regenerated Noise Level	22.2 dBA
Maximum Regenerated Noise Level	22.3 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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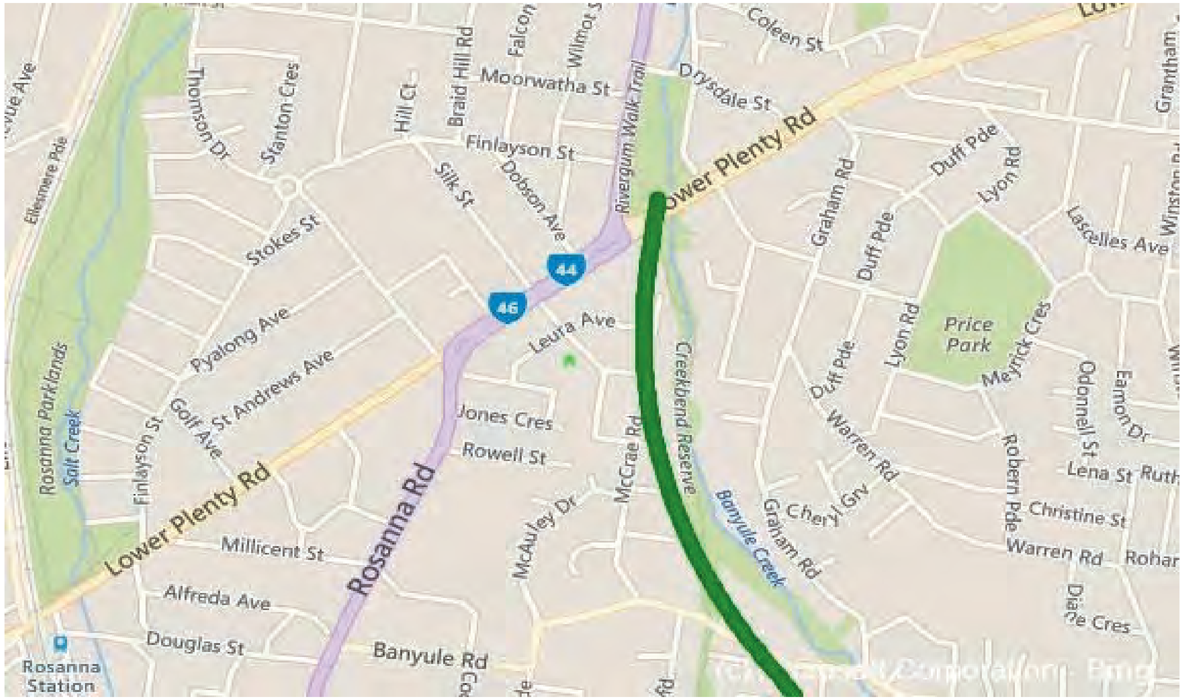
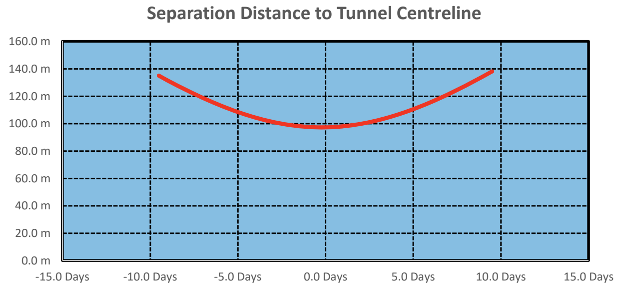
NORTH EAST LINK PROJECT

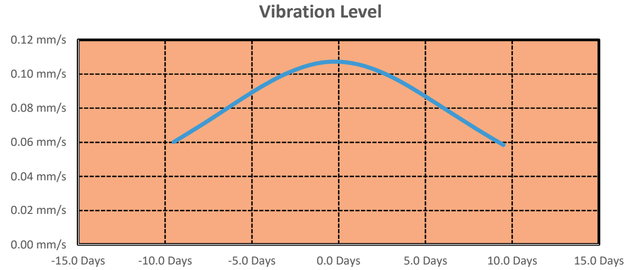
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

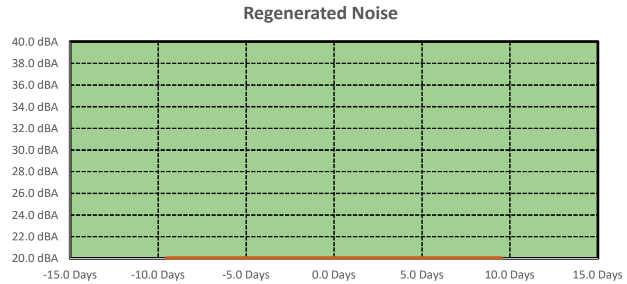
Created using TunnelTRAP Software

Assessment Location: Cantala Avenue - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	97.3 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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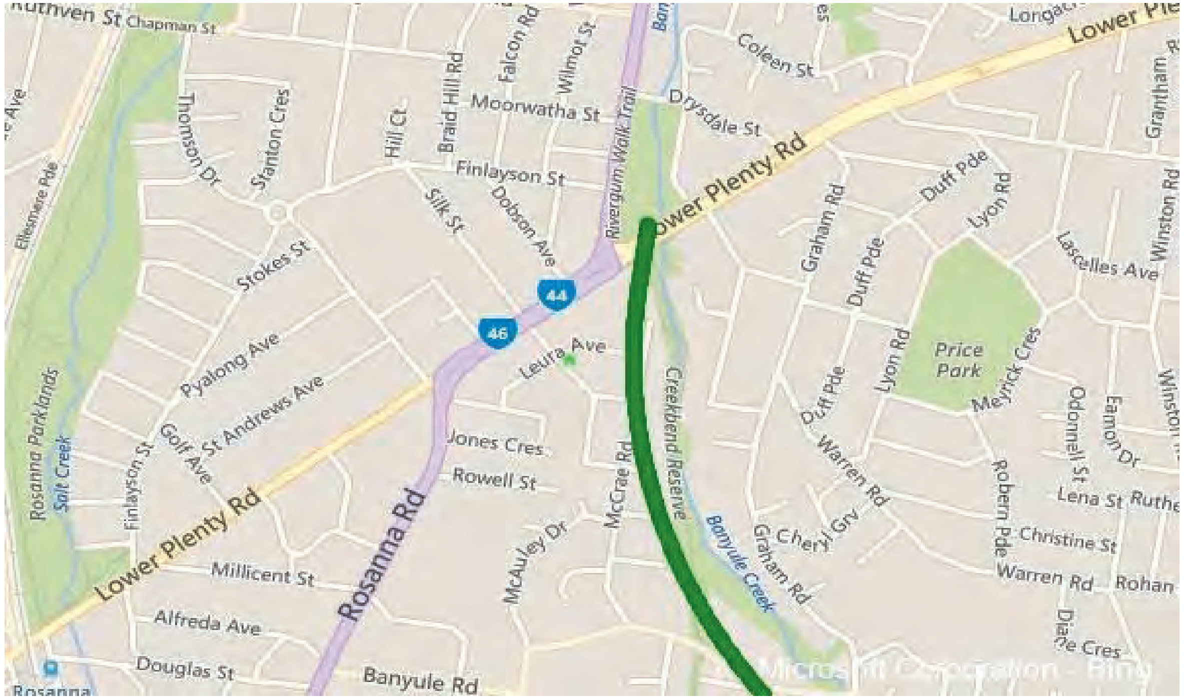
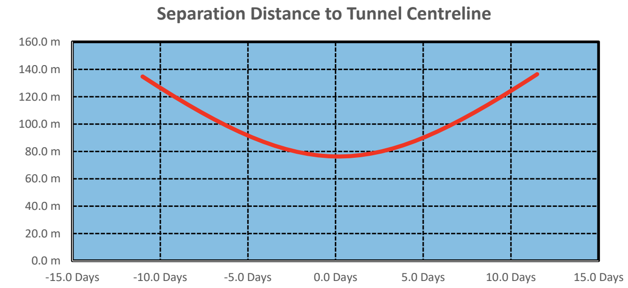
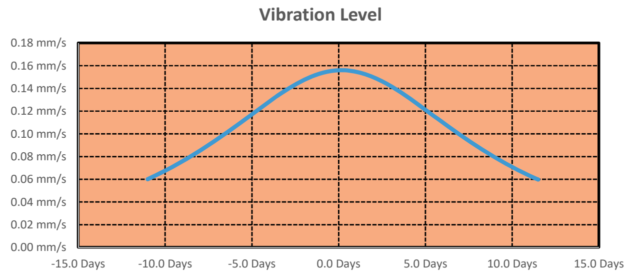
NORTH EAST LINK PROJECT

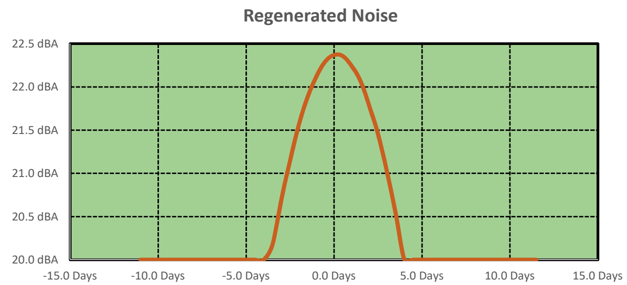
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Cantala Avenue - 10









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	76.2 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.15 mm/s
95% Vibration Level	0.15 mm/s
Maximum Vibration Level	0.16 mm/s
Average Regenerated Noise level	20.5 dBA
90% Regenerated Noise Level	22.1 dBA
95% Regenerated Noise Level	22.3 dBA
Maximum Regenerated Noise Level	22.4 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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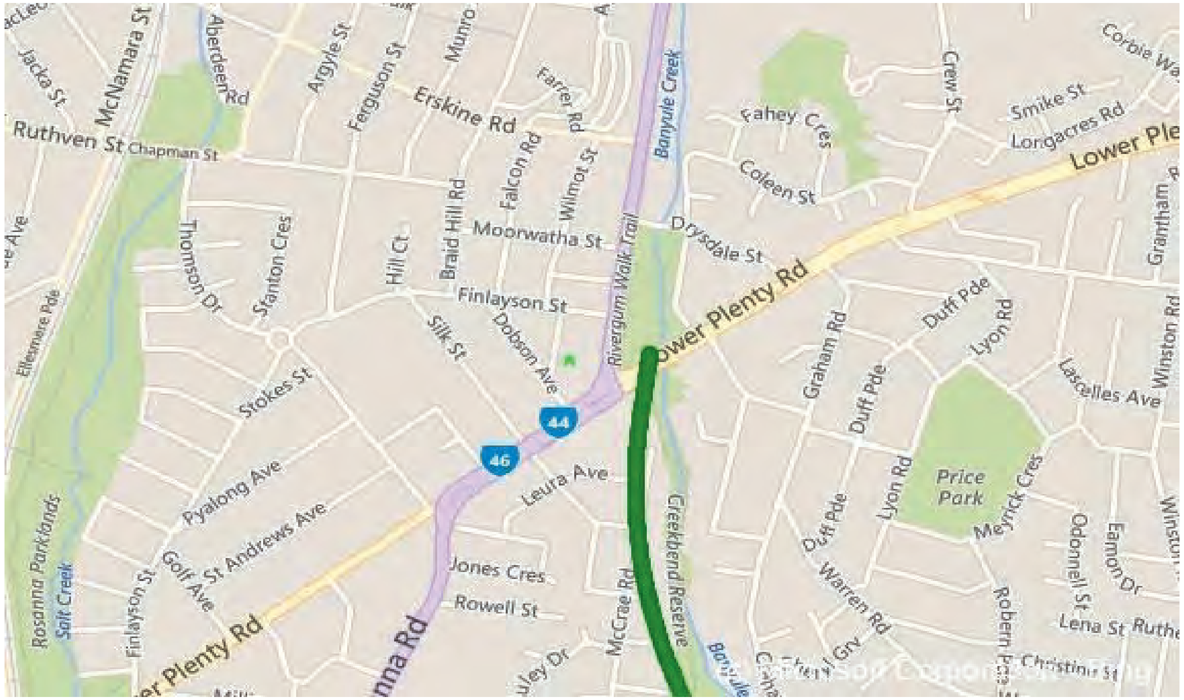
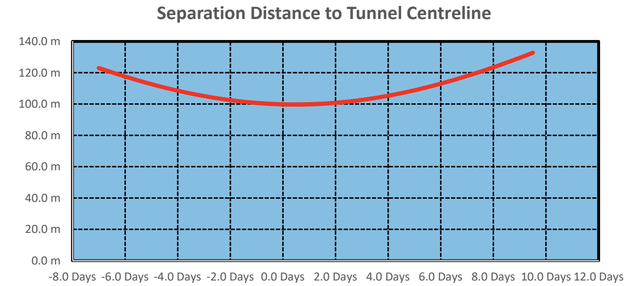
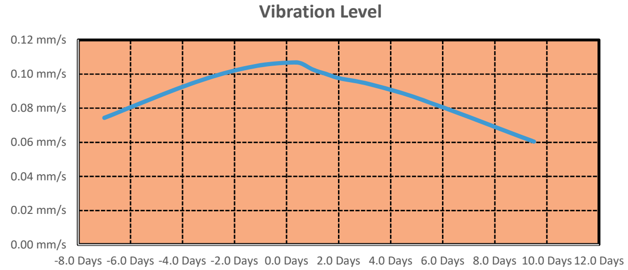
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

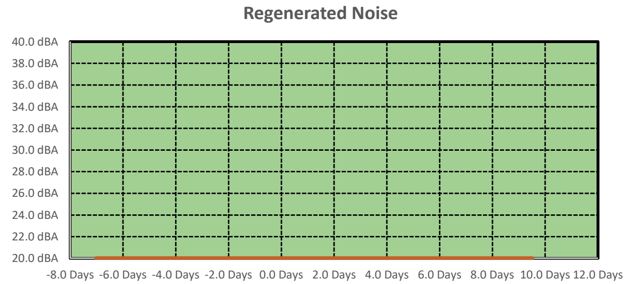
Created using TunnelTRAP Software

Assessment Location: Greensborough Road - 9









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	99.7 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.10 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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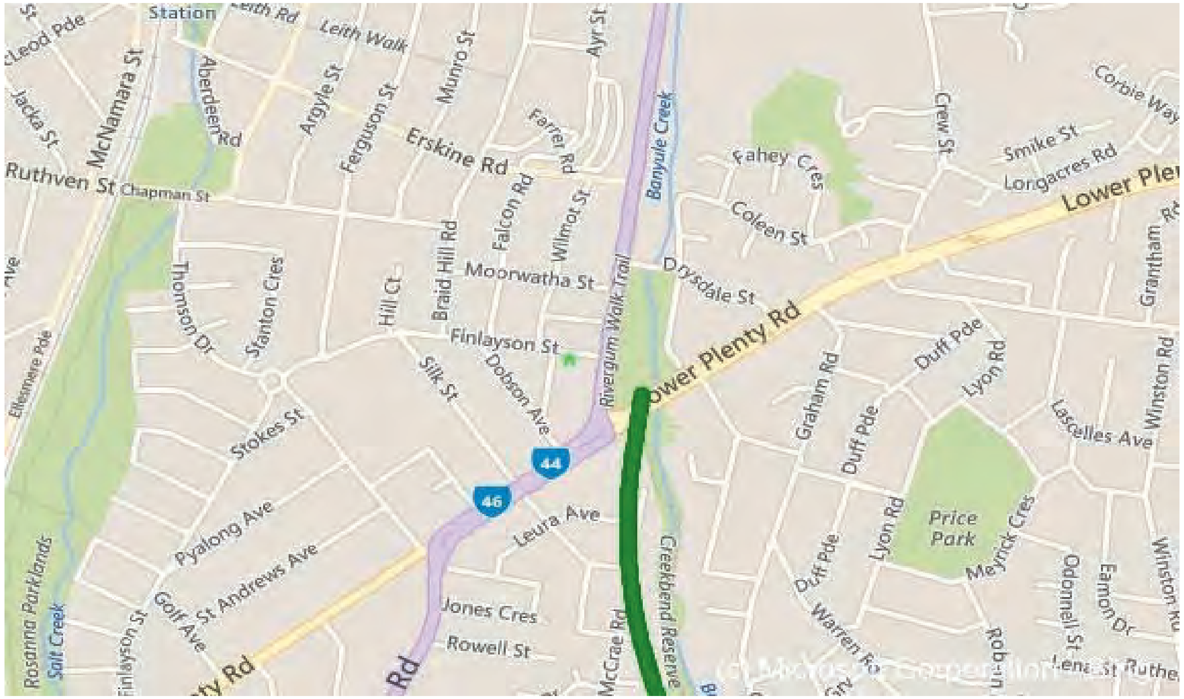
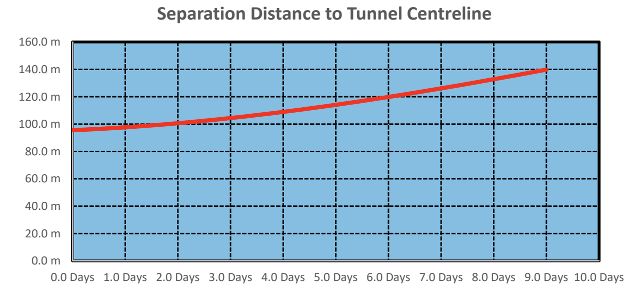
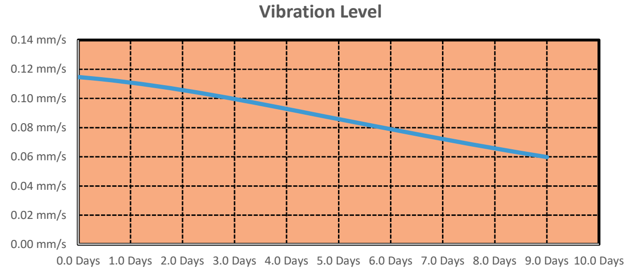
NORTH EAST LINK PROJECT

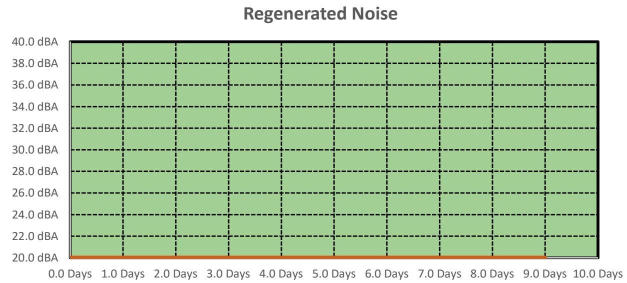
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Greensborough Road - 23









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	95.5 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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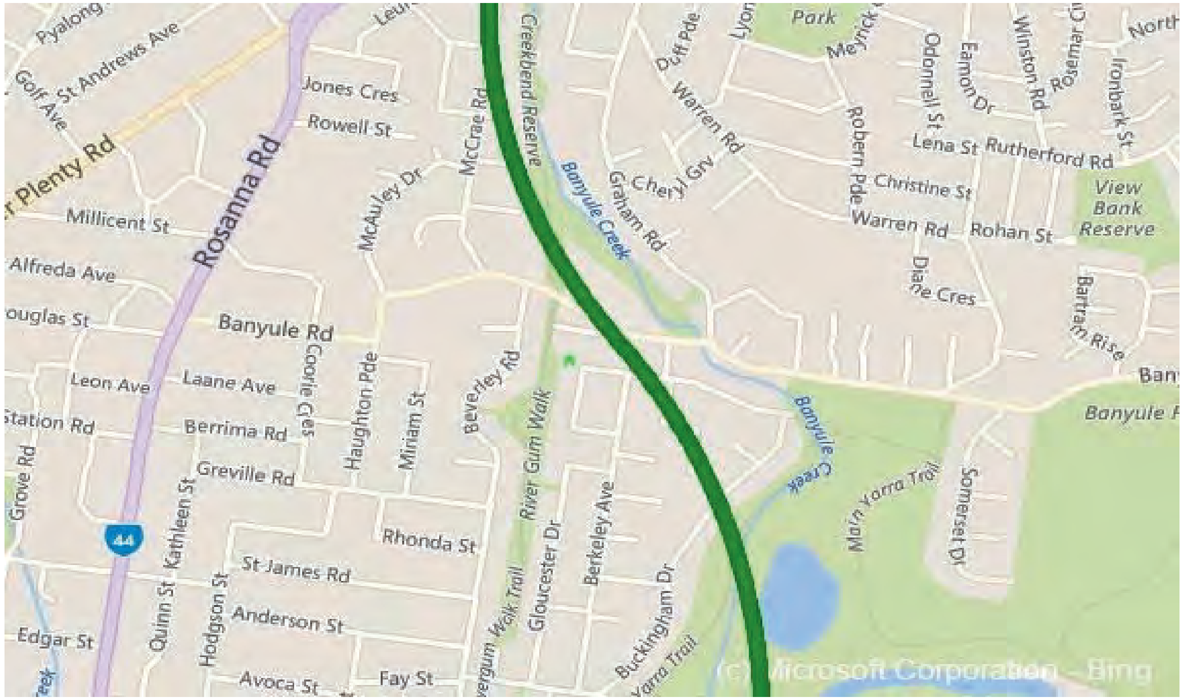
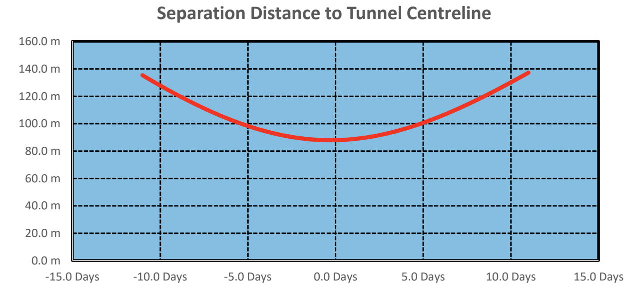
NORTH EAST LINK PROJECT

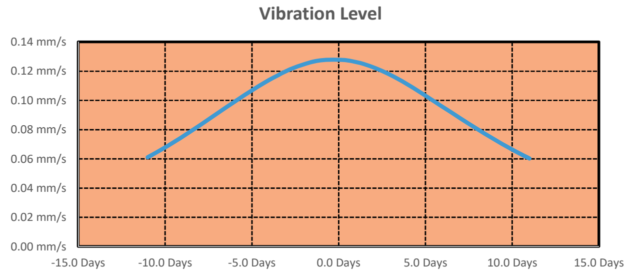
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

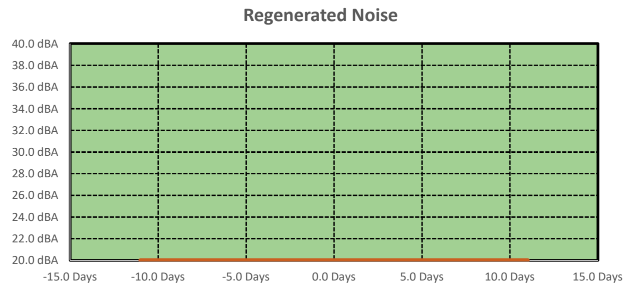
Created using TunnelTRAP Software

Assessment Location: Halifax Avenue - 22









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	87.9 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.13 mm/s
95% Vibration Level	0.13 mm/s
Maximum Vibration Level	0.13 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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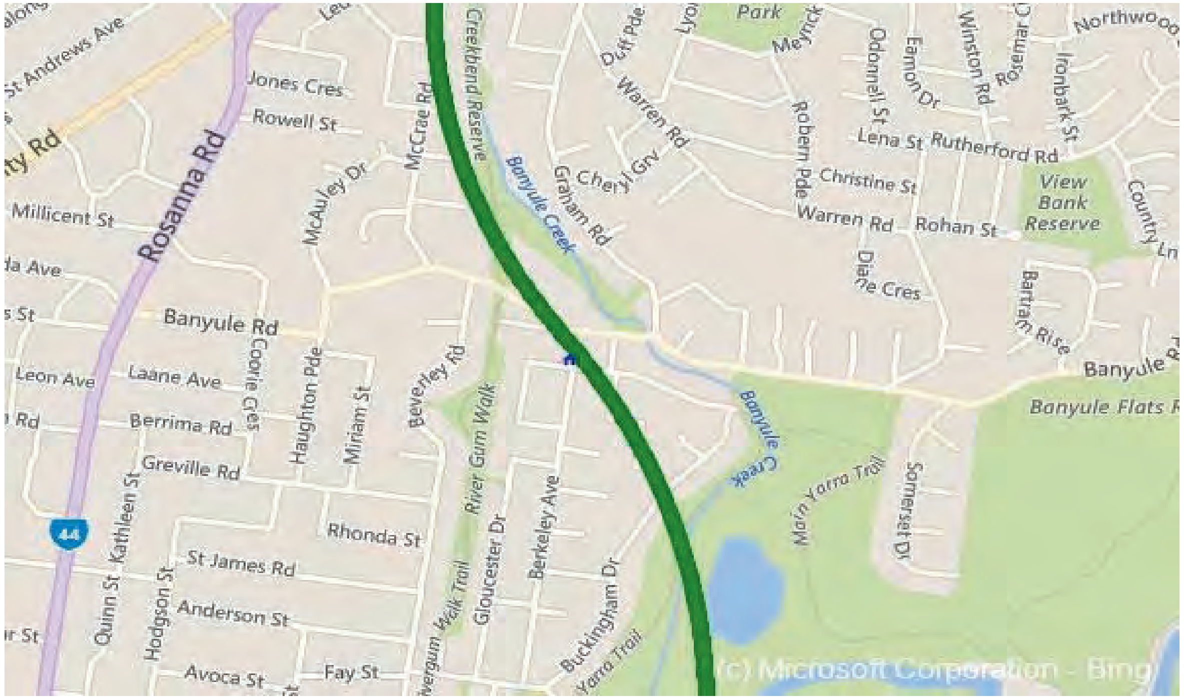
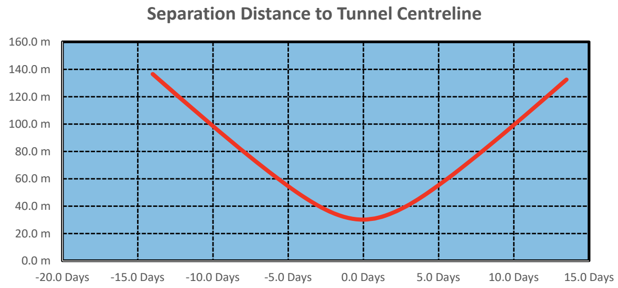
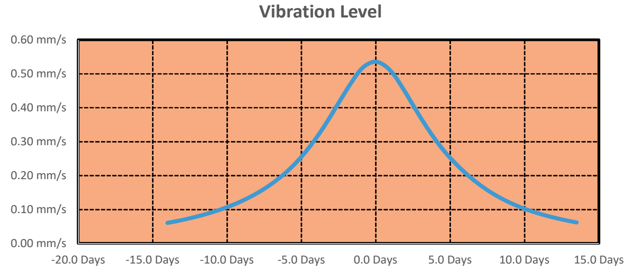
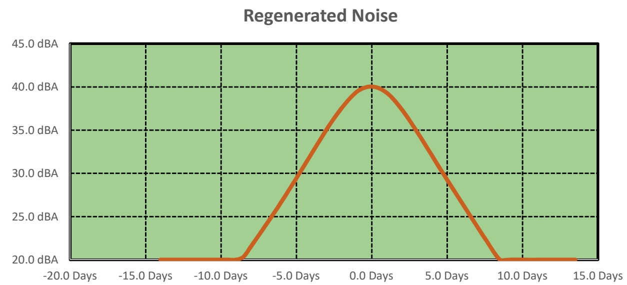
Assessment Location: Halifax Avenue - 34









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.5 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.2 days
Number of days above 40dBA	0.1 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	30.1 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.48 mm/s
95% Vibration Level	0.52 mm/s
Maximum Vibration Level	0.54 mm/s
Average Regenerated Noise level	26.8 dBA
90% Regenerated Noise Level	38.5 dBA
95% Regenerated Noise Level	39.5 dBA
Maximum Regenerated Noise Level	40.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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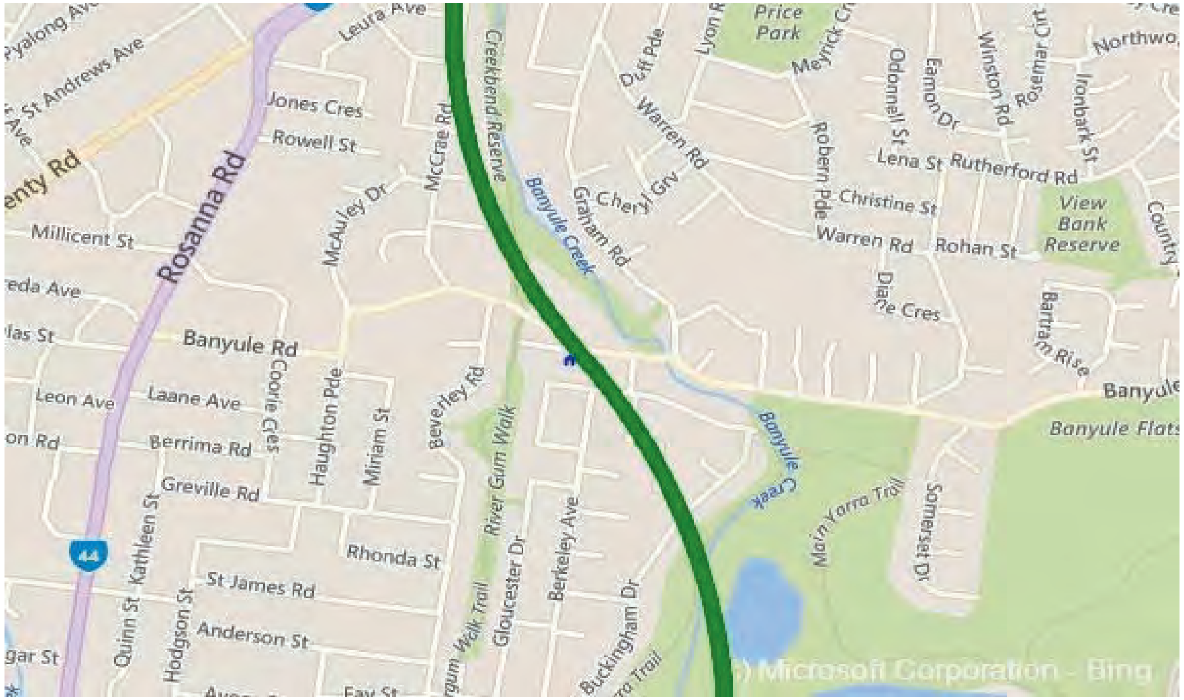
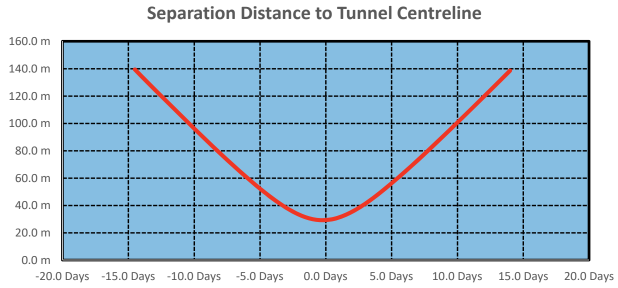
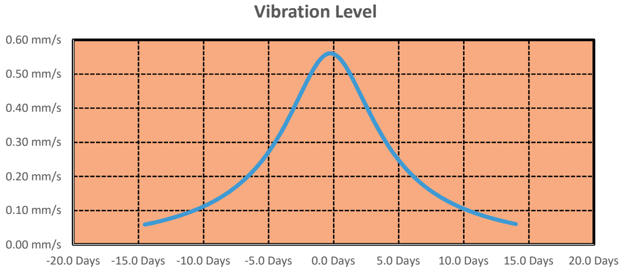
NORTH EAST LINK PROJECT

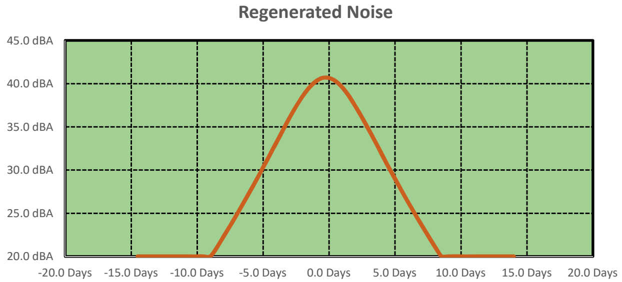
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Halifax Avenue - 51









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.6 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.2 days
Number of days above 40dBA	0.4 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	29.2 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.49 mm/s
95% Vibration Level	0.54 mm/s
Maximum Vibration Level	0.56 mm/s
Average Regenerated Noise level	26.8 dBA
90% Regenerated Noise Level	38.9 dBA
95% Regenerated Noise Level	40.3 dBA
Maximum Regenerated Noise Level	40.7 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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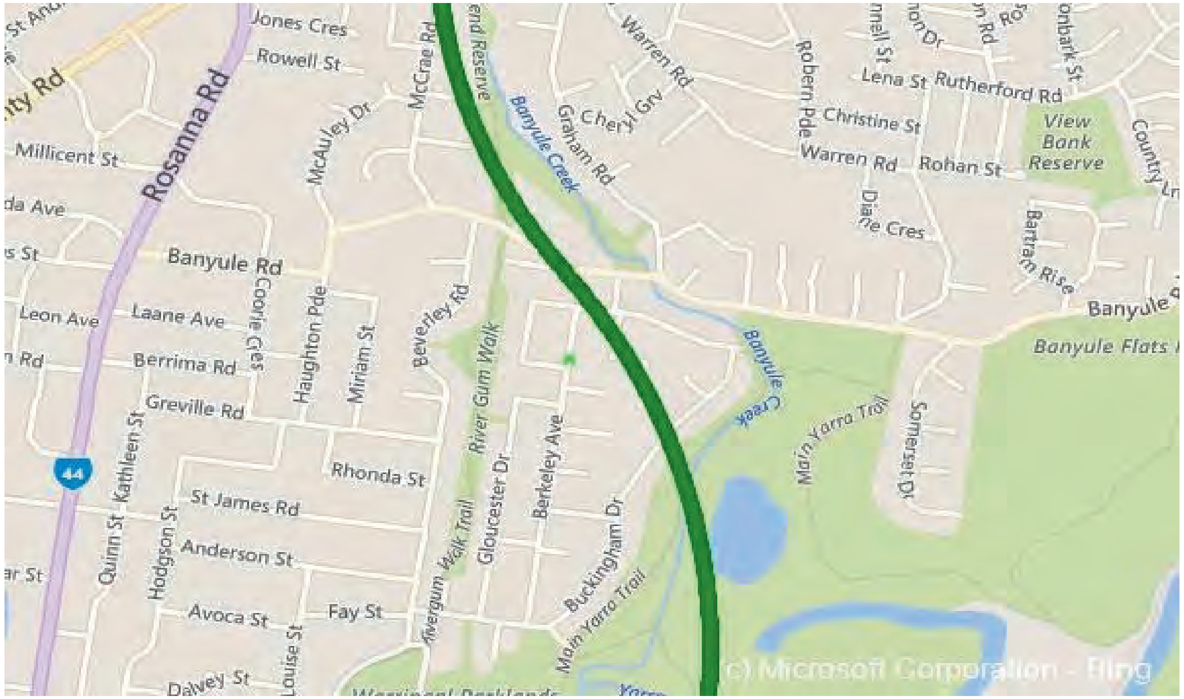
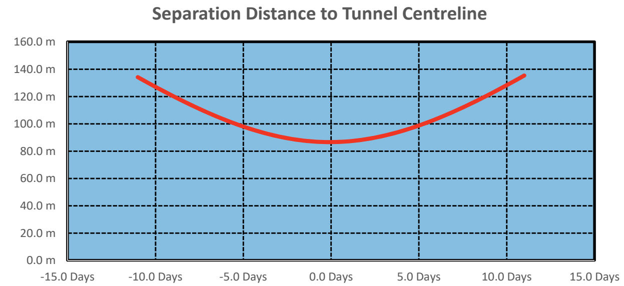
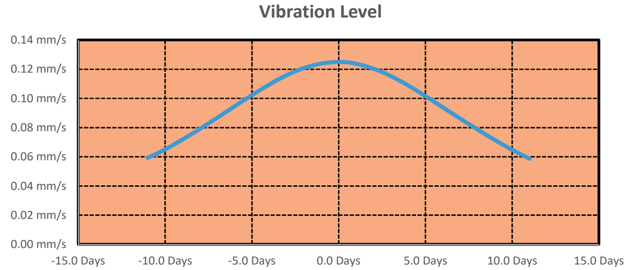
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

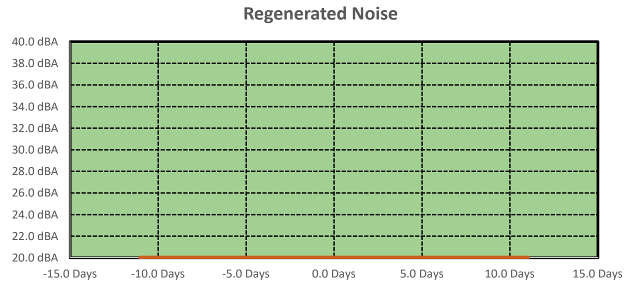
Created using TunnelTRAP Software

Assessment Location: Hastings Court - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	86.5 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.12 mm/s
95% Vibration Level	0.12 mm/s
Maximum Vibration Level	0.12 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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NORTH EAST LINK PROJECT

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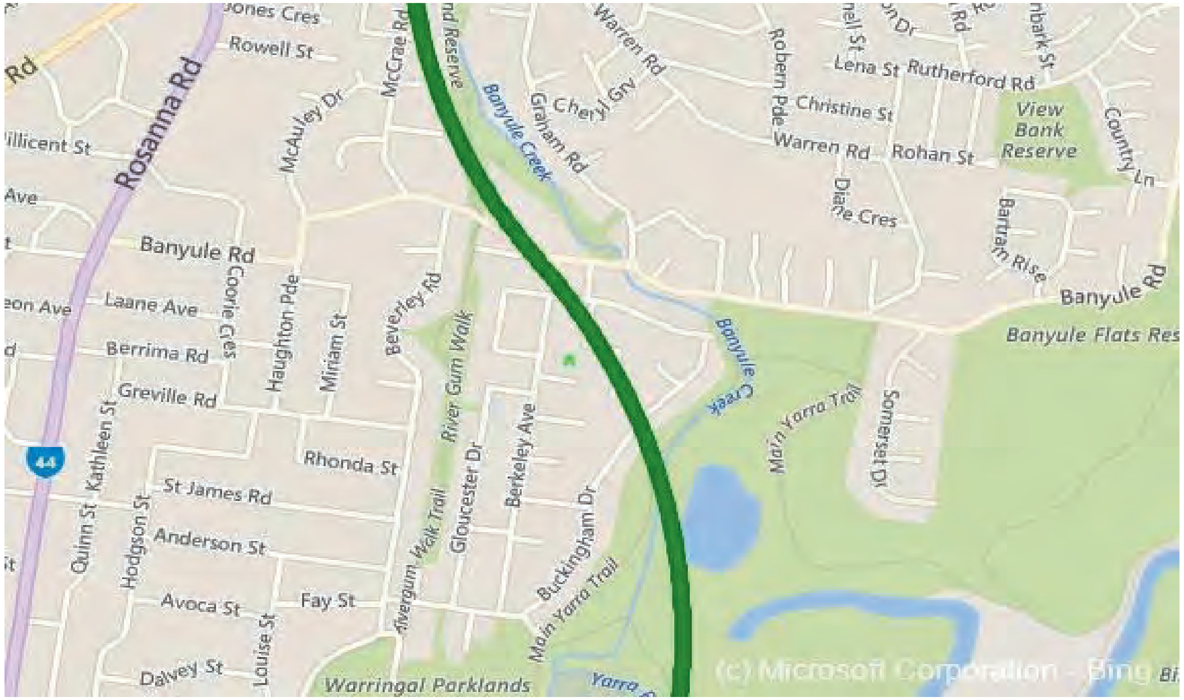
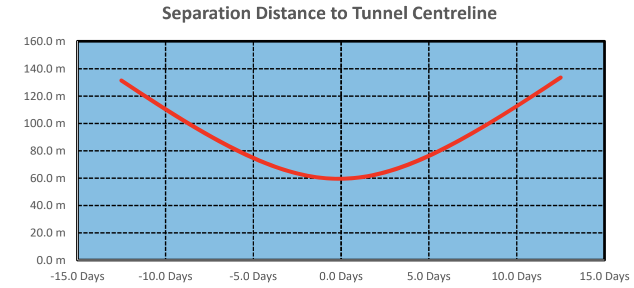
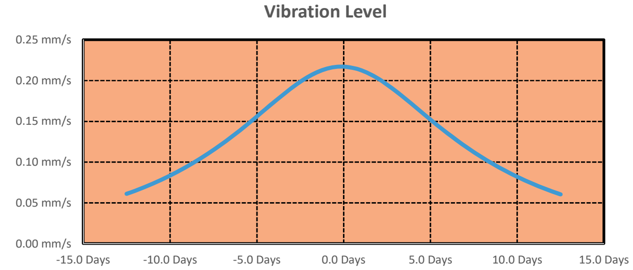
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

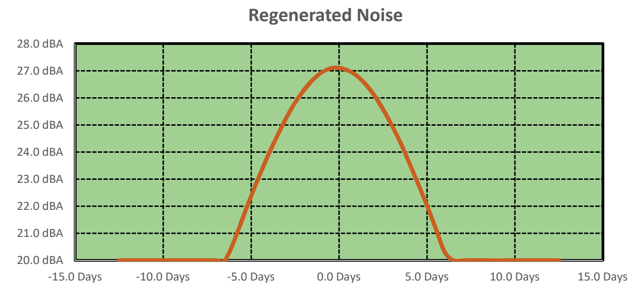
Created using TunnelTRAP Software

Assessment Location: Hastings Court - 11









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	59.4 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.21 mm/s
95% Vibration Level	0.22 mm/s
Maximum Vibration Level	0.22 mm/s
Average Regenerated Noise level	22.2 dBA
90% Regenerated Noise Level	26.7 dBA
95% Regenerated Noise Level	27.0 dBA
Maximum Regenerated Noise Level	27.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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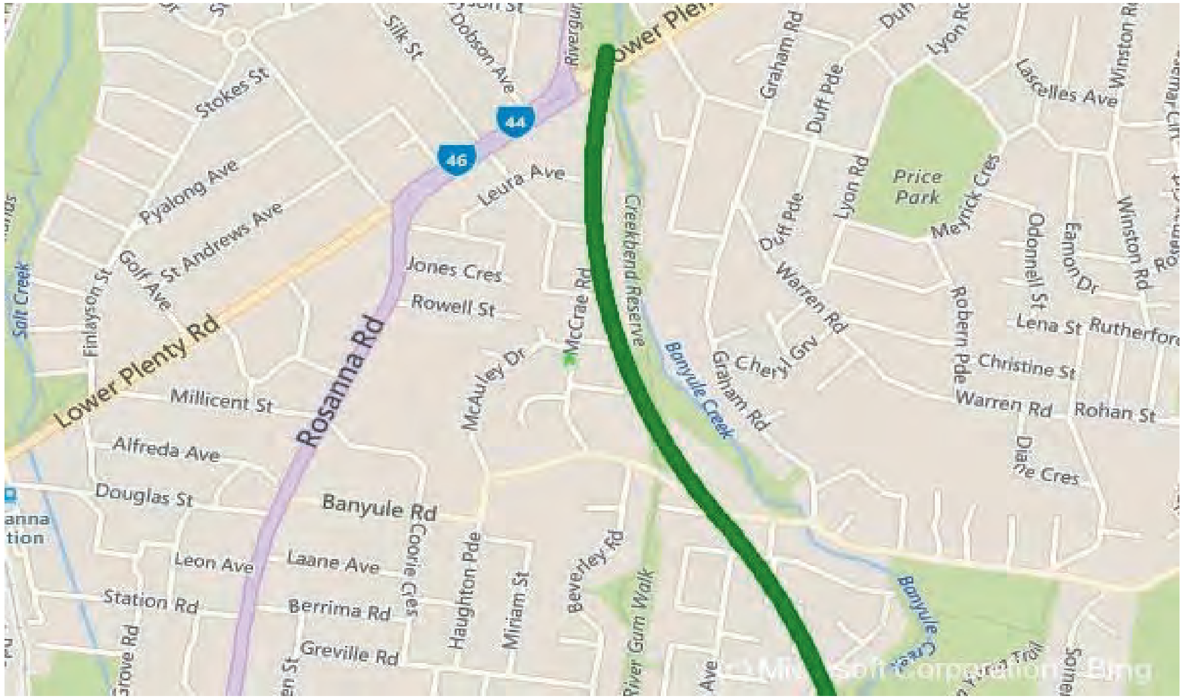
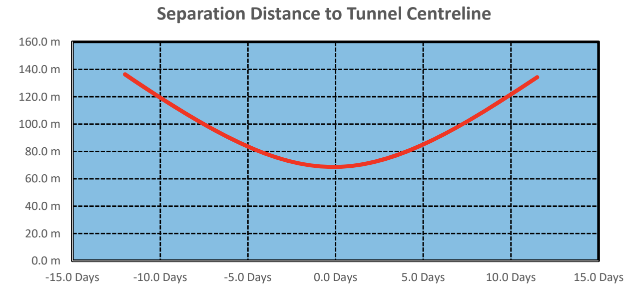
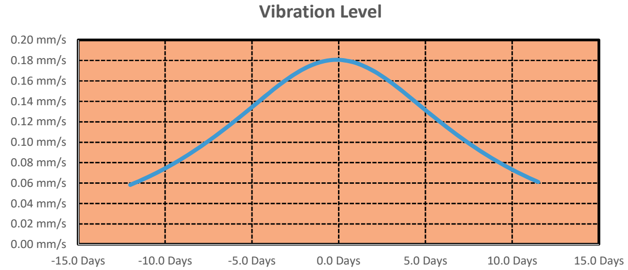
NORTH EAST LINK PROJECT

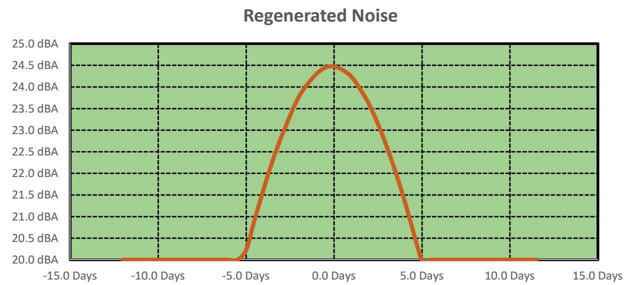
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Homewood Court - 3









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	68.6 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.18 mm/s
Maximum Vibration Level	0.18 mm/s
Average Regenerated Noise level	21.2 dBA
90% Regenerated Noise Level	24.1 dBA
95% Regenerated Noise Level	24.4 dBA
Maximum Regenerated Noise Level	24.5 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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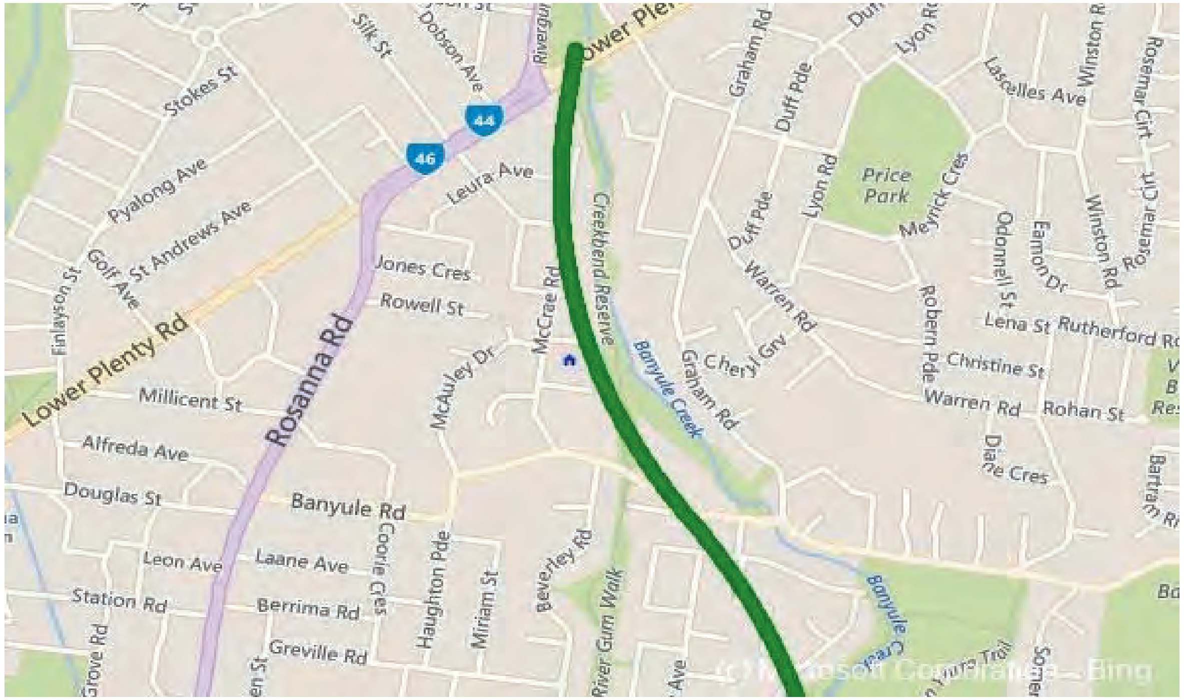
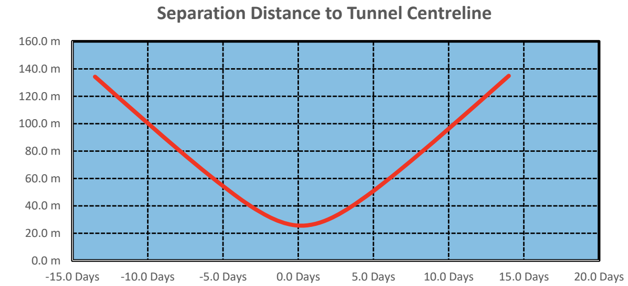
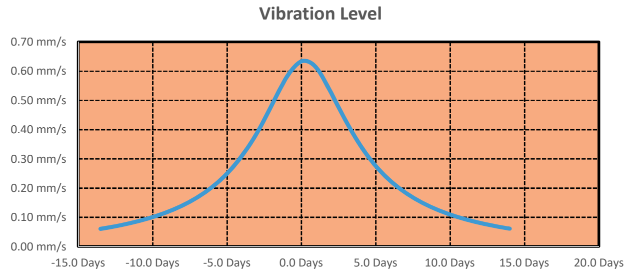
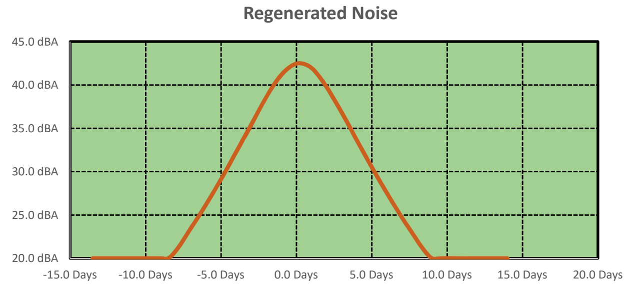
Assessment Location: Homewood Court - 11









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	25.6 m
Average Vibration Level	0.25 mm/s
90% Vibration Level	0.55 mm/s
95% Vibration Level	0.61 mm/s
Maximum Vibration Level	0.63 mm/s
Average Regenerated Noise level	27.4 dBA
90% Regenerated Noise Level	40.5 dBA
95% Regenerated Noise Level	42.0 dBA
Maximum Regenerated Noise Level	42.5 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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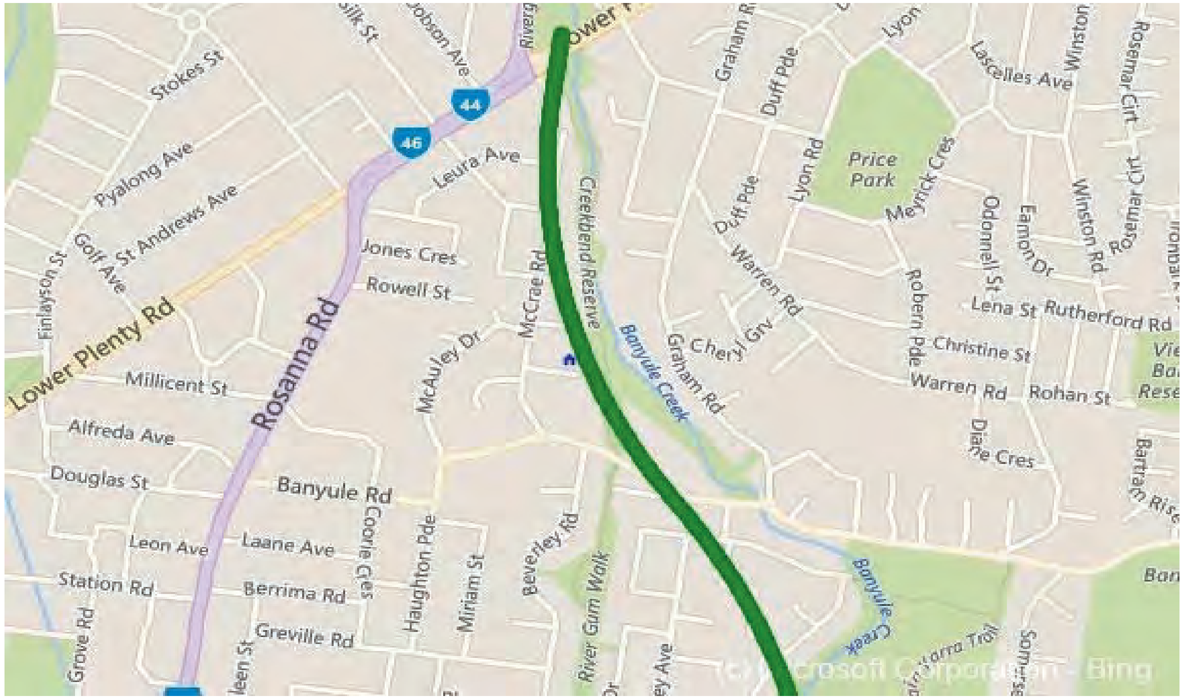
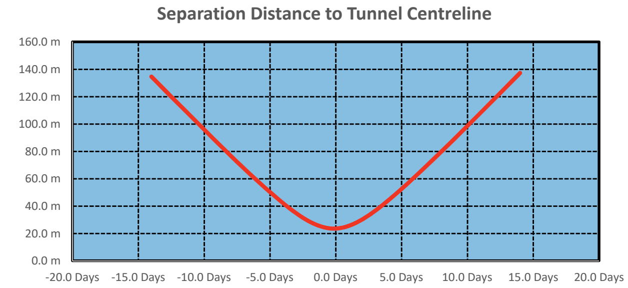
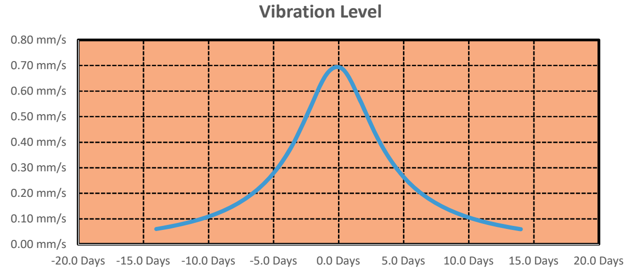
NORTH EAST LINK PROJECT

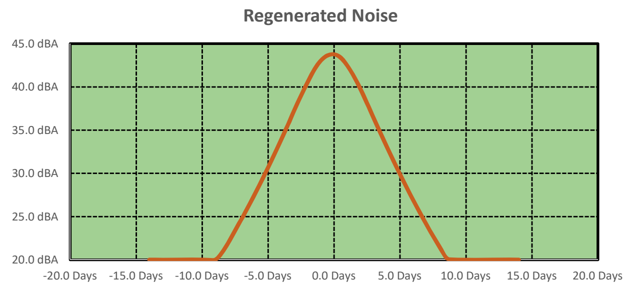
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Homewood Court - 17









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.9 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.8 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	23.6 m
Average Vibration Level	0.26 mm/s
90% Vibration Level	0.59 mm/s
95% Vibration Level	0.66 mm/s
Maximum Vibration Level	0.69 mm/s
Average Regenerated Noise level	27.6 dBA
90% Regenerated Noise Level	41.5 dBA
95% Regenerated Noise Level	43.1 dBA
Maximum Regenerated Noise Level	43.8 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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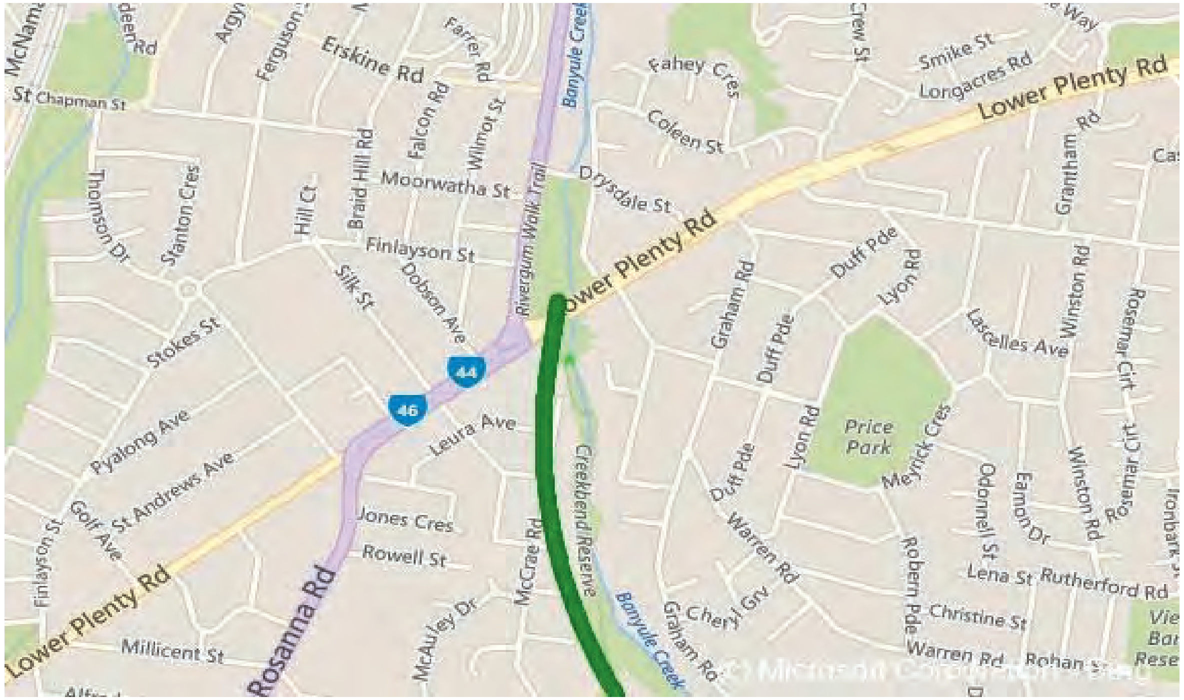
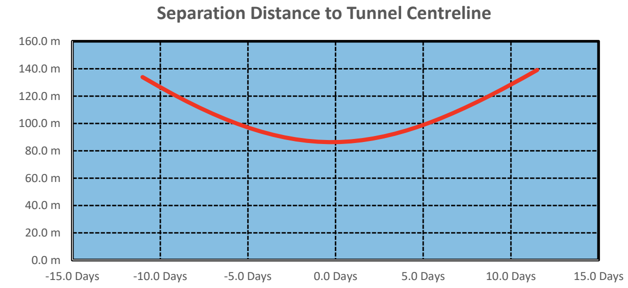
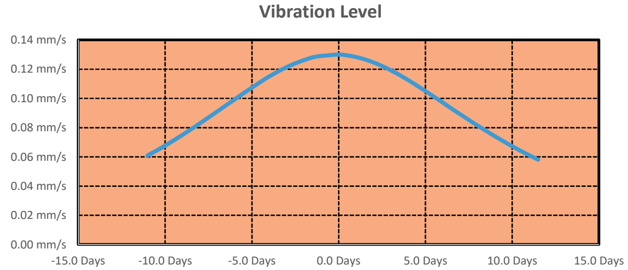
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

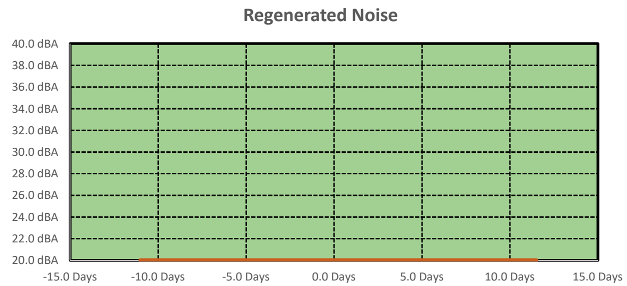
Created using TunnelTRAP Software

Assessment Location: Kallay Court - 7









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	86.3 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.13 mm/s
95% Vibration Level	0.13 mm/s
Maximum Vibration Level	0.13 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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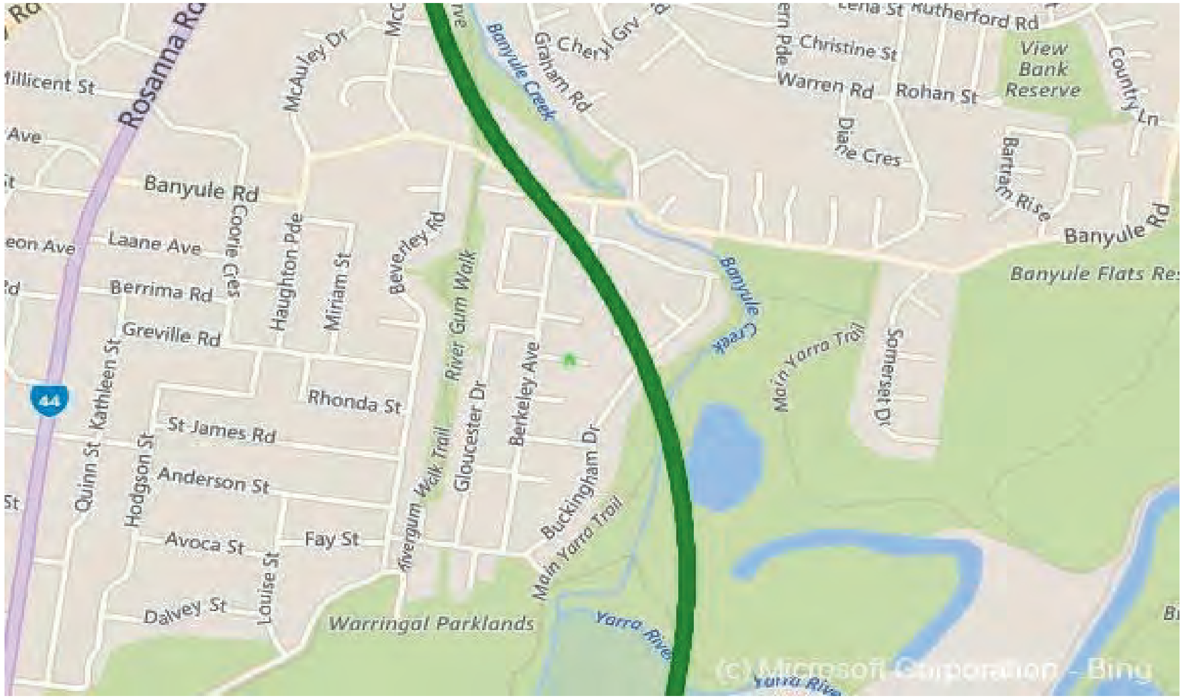
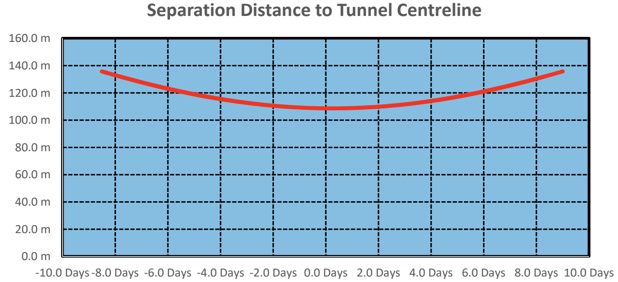
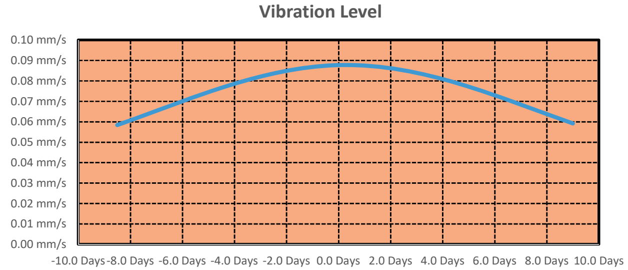
NORTH EAST LINK PROJECT

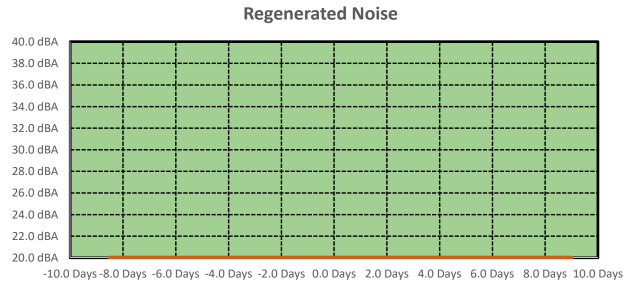
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Kent Court - 12









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	108.5 m
Average Vibration Level	0.08 mm/s
90% Vibration Level	0.09 mm/s
95% Vibration Level	0.09 mm/s
Maximum Vibration Level	0.09 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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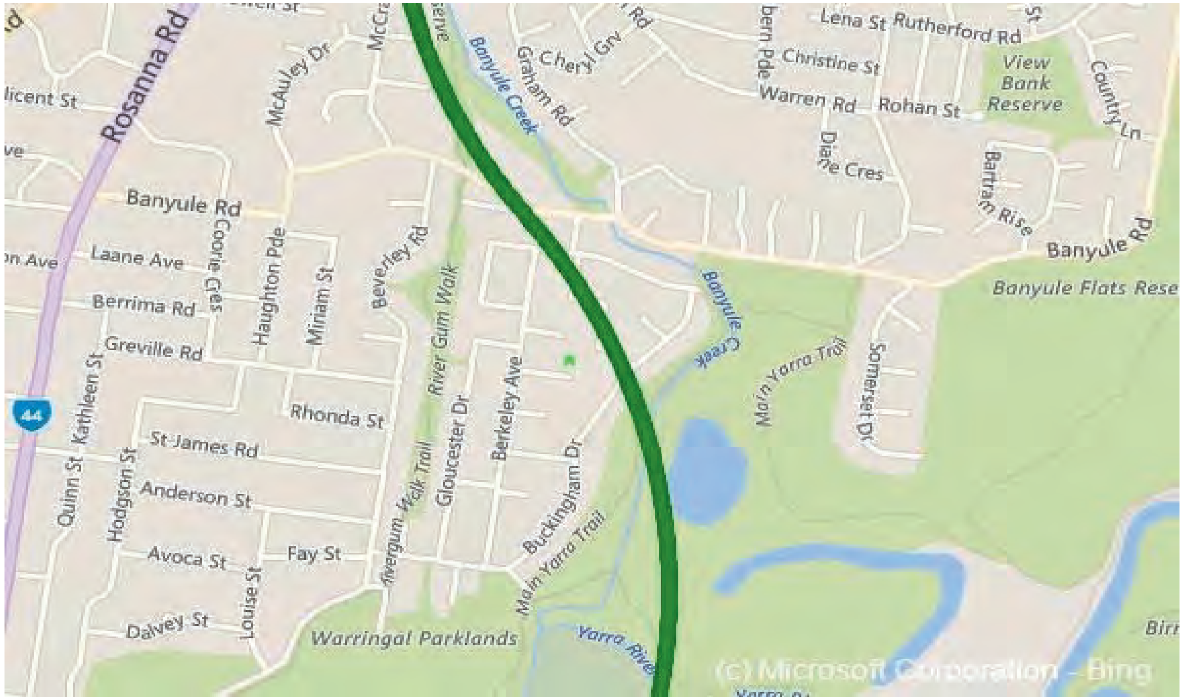
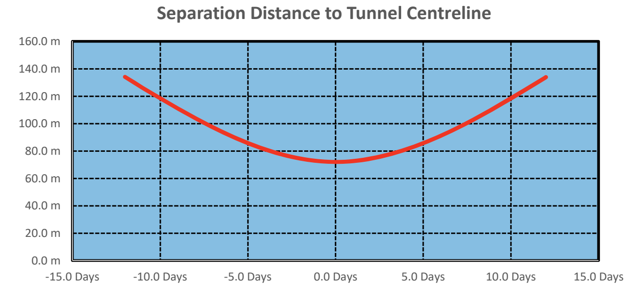
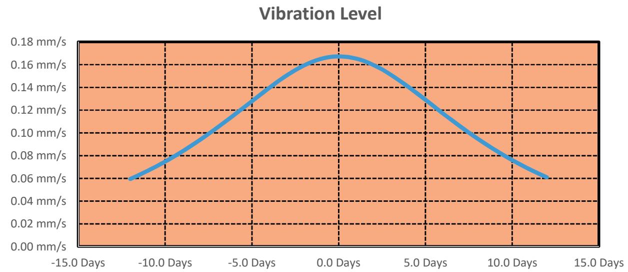
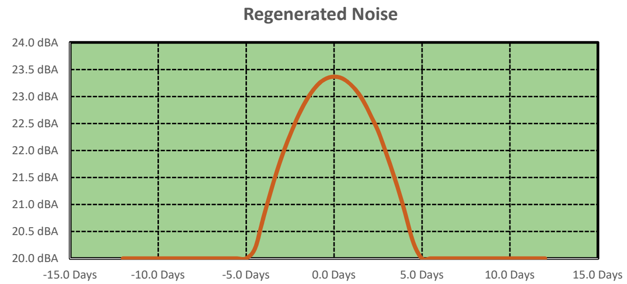
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Kent Court - 16









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	72.0 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.16 mm/s
95% Vibration Level	0.17 mm/s
Maximum Vibration Level	0.17 mm/s
Average Regenerated Noise level	20.8 dBA
90% Regenerated Noise Level	23.0 dBA
95% Regenerated Noise Level	23.3 dBA
Maximum Regenerated Noise Level	23.4 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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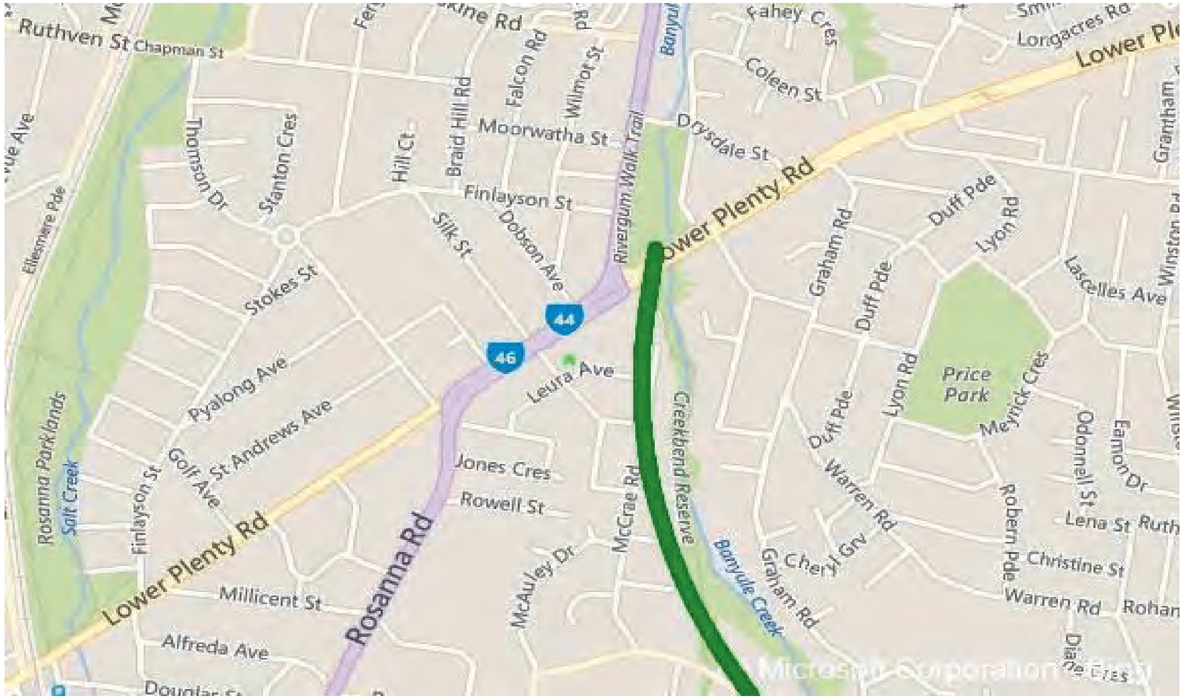
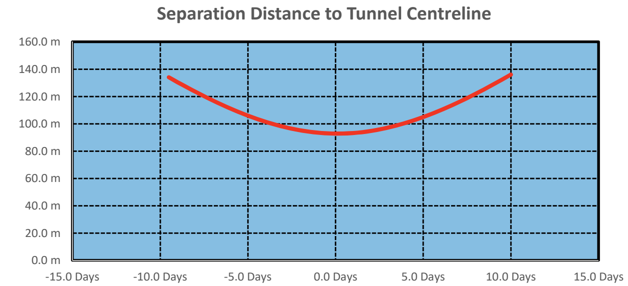
NORTH EAST LINK PROJECT

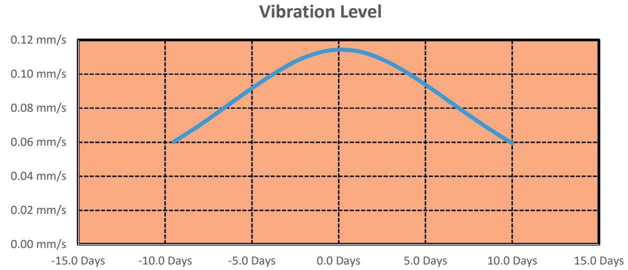
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

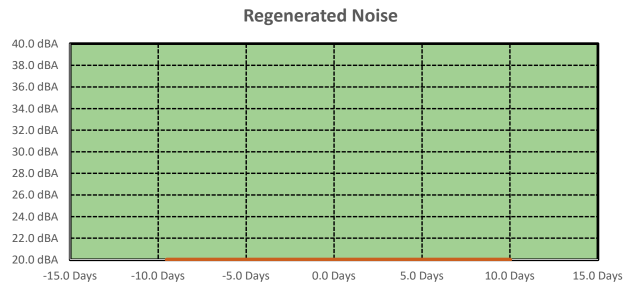
Created using TunnelTRAP Software

Assessment Location: Leura Avenue - 20/22









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	92.8 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.11 mm/s
95% Vibration Level	0.11 mm/s
Maximum Vibration Level	0.11 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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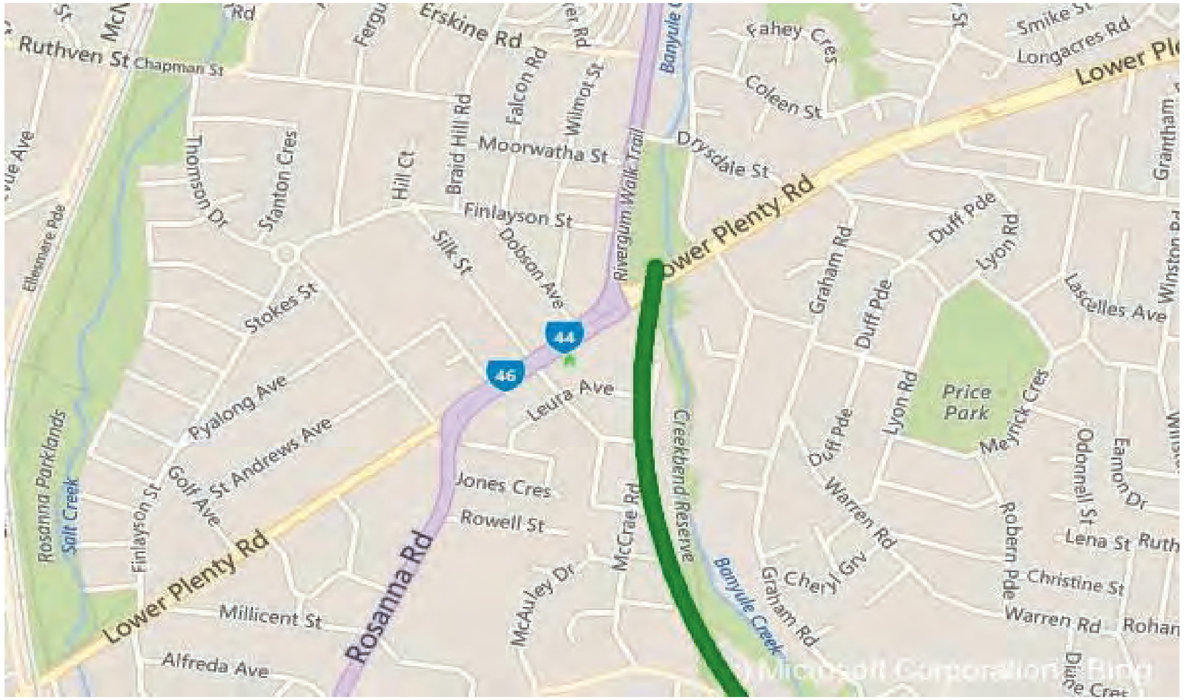
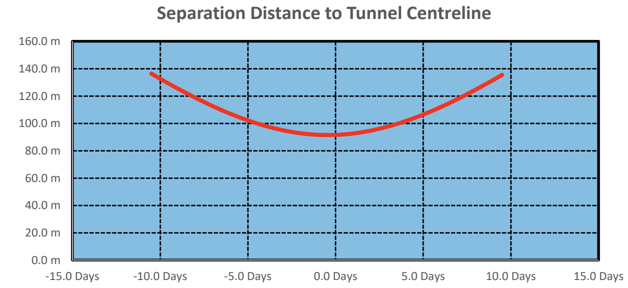
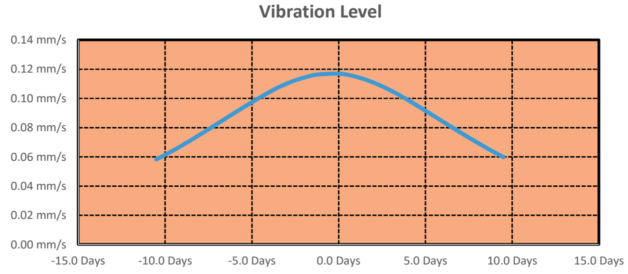
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

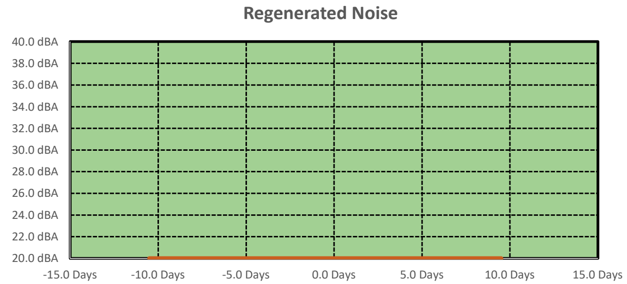
Created using TunnelTRAP Software

Assessment Location: Leura Avenue - 25









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	91.4 m
Average Vibration Level	0.09 mm/s
90% Vibration Level	0.12 mm/s
95% Vibration Level	0.12 mm/s
Maximum Vibration Level	0.12 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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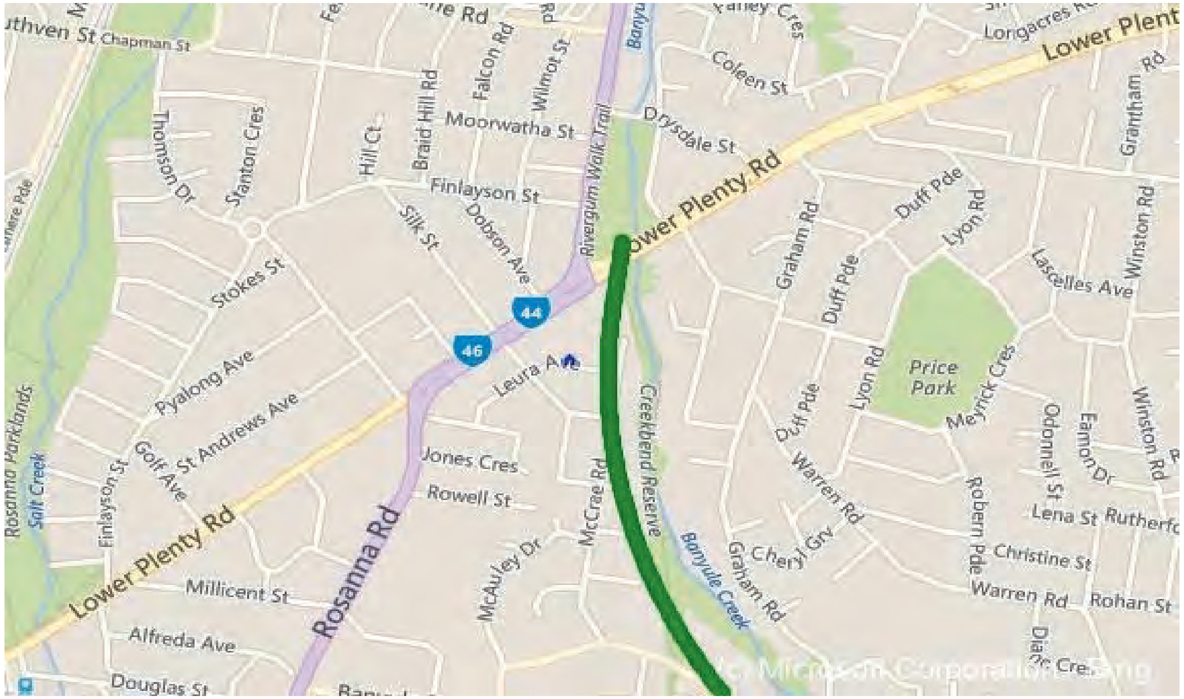
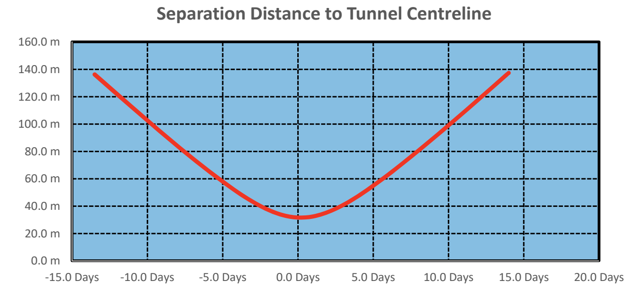
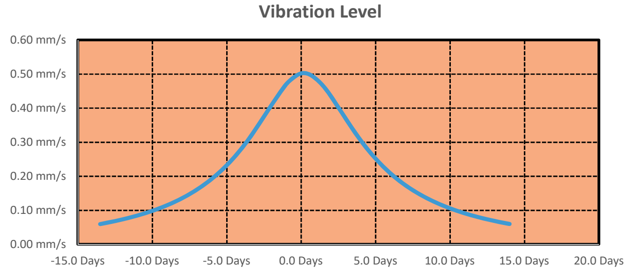
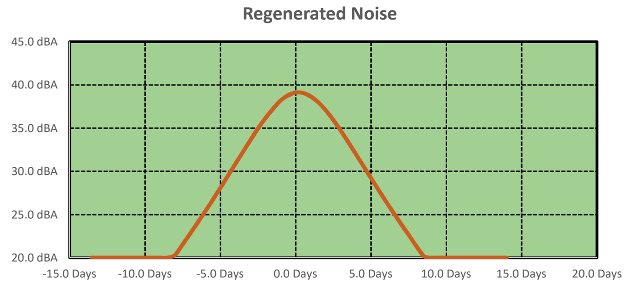
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Leura Avenue - 28









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.2 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.6 m
Average Vibration Level	0.22 mm/s
90% Vibration Level	0.45 mm/s
95% Vibration Level	0.49 mm/s
Maximum Vibration Level	0.50 mm/s
Average Regenerated Noise level	26.4 dBA
90% Regenerated Noise Level	37.6 dBA
95% Regenerated Noise Level	38.7 dBA
Maximum Regenerated Noise Level	39.1 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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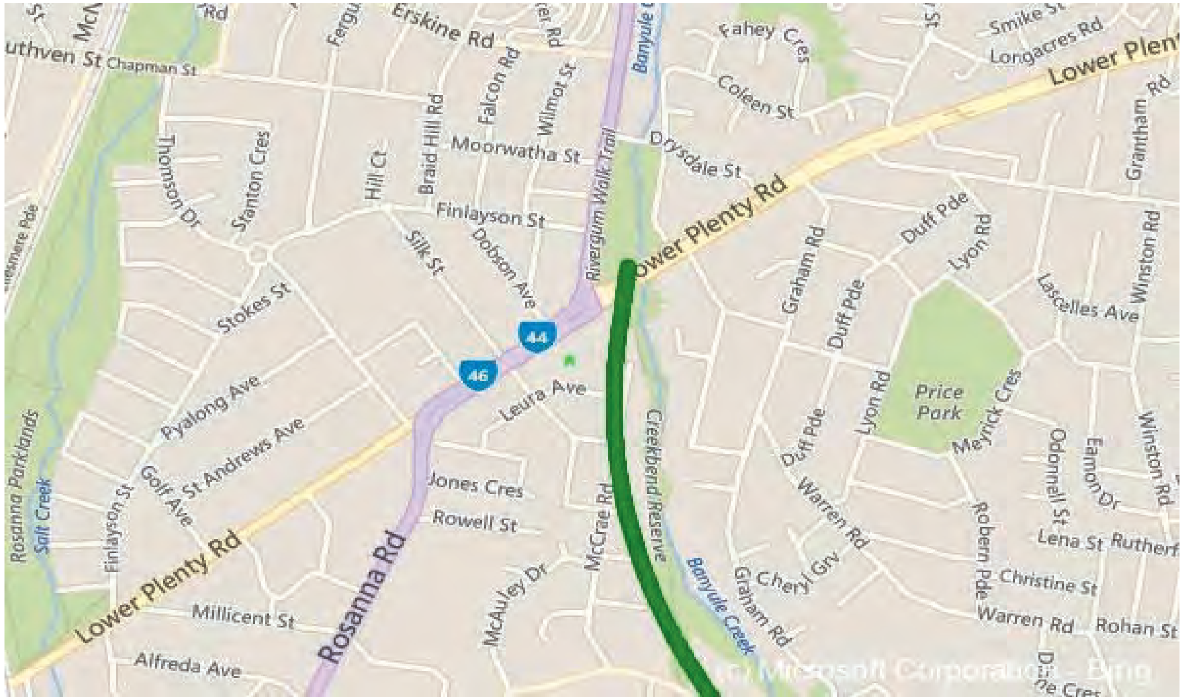
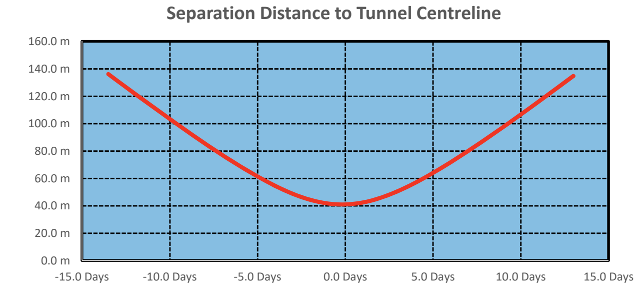
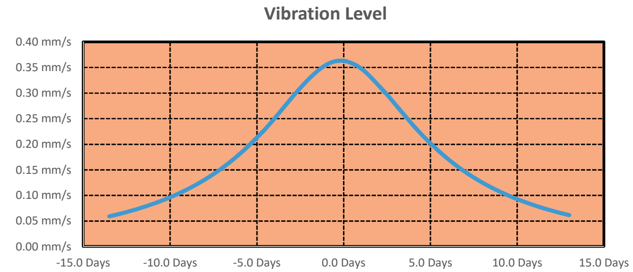
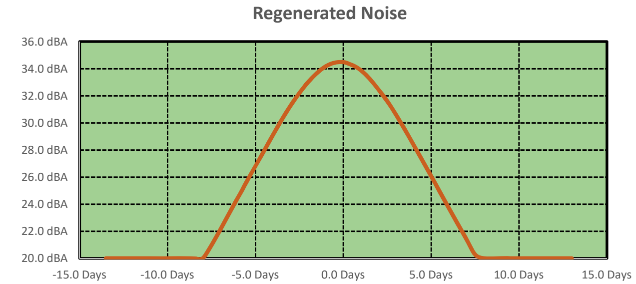
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Leura Avenue - 31









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.5 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	41.0 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.34 mm/s
95% Vibration Level	0.36 mm/s
Maximum Vibration Level	0.36 mm/s
Average Regenerated Noise level	24.9 dBA
90% Regenerated Noise Level	33.5 dBA
95% Regenerated Noise Level	34.2 dBA
Maximum Regenerated Noise Level	34.5 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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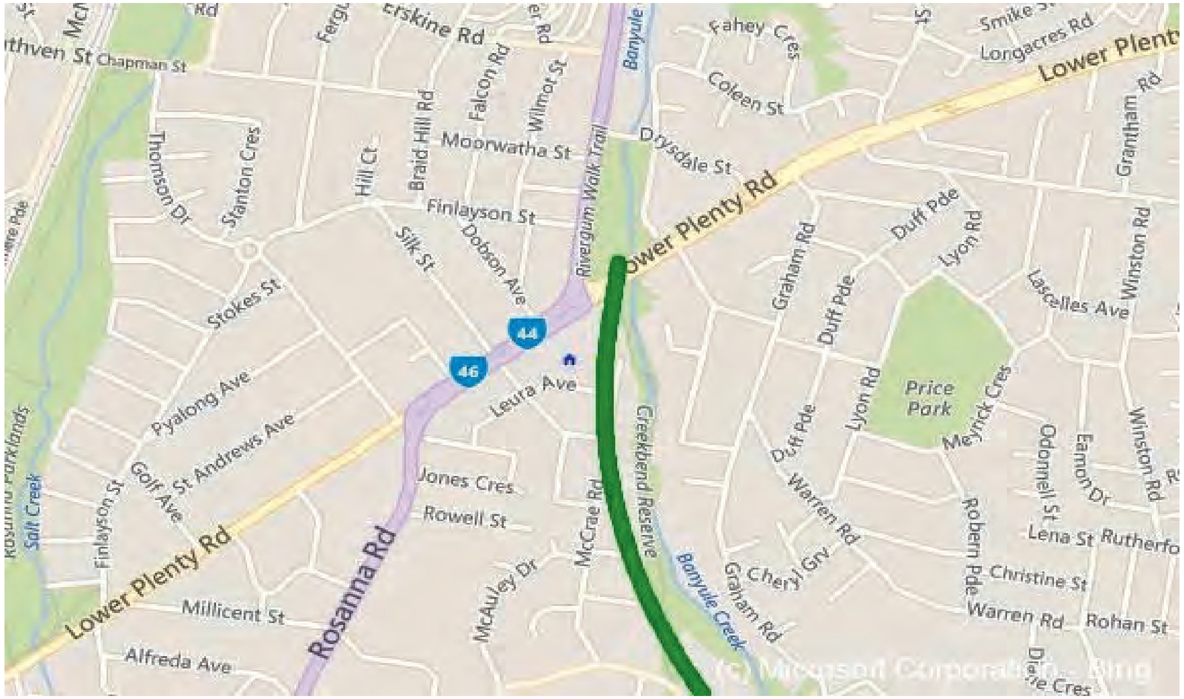
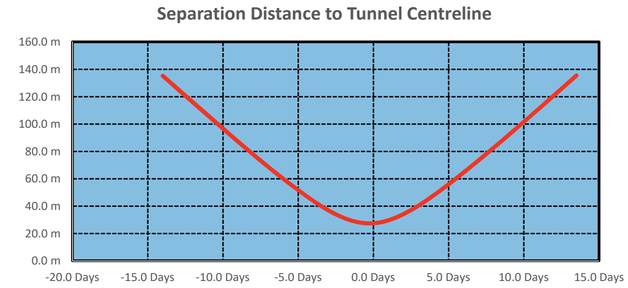
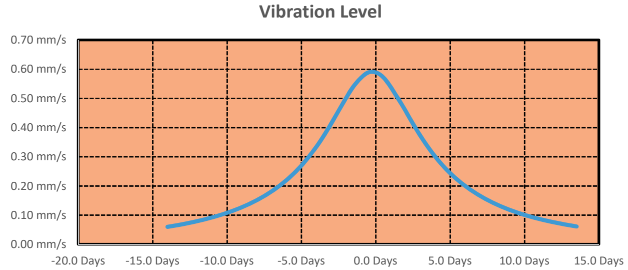
NORTH EAST LINK PROJECT

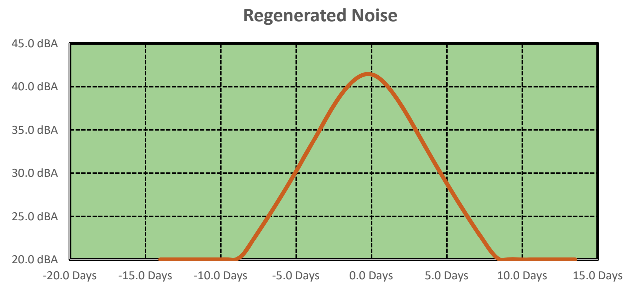
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Leura Avenue - 33









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.7 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.2 days
Number of days above 40dBA	0.6 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	27.4 m
Average Vibration Level	0.24 mm/s
90% Vibration Level	0.52 mm/s
95% Vibration Level	0.57 mm/s
Maximum Vibration Level	0.59 mm/s
Average Regenerated Noise level	27.1 dBA
90% Regenerated Noise Level	39.6 dBA
95% Regenerated Noise Level	41.0 dBA
Maximum Regenerated Noise Level	41.4 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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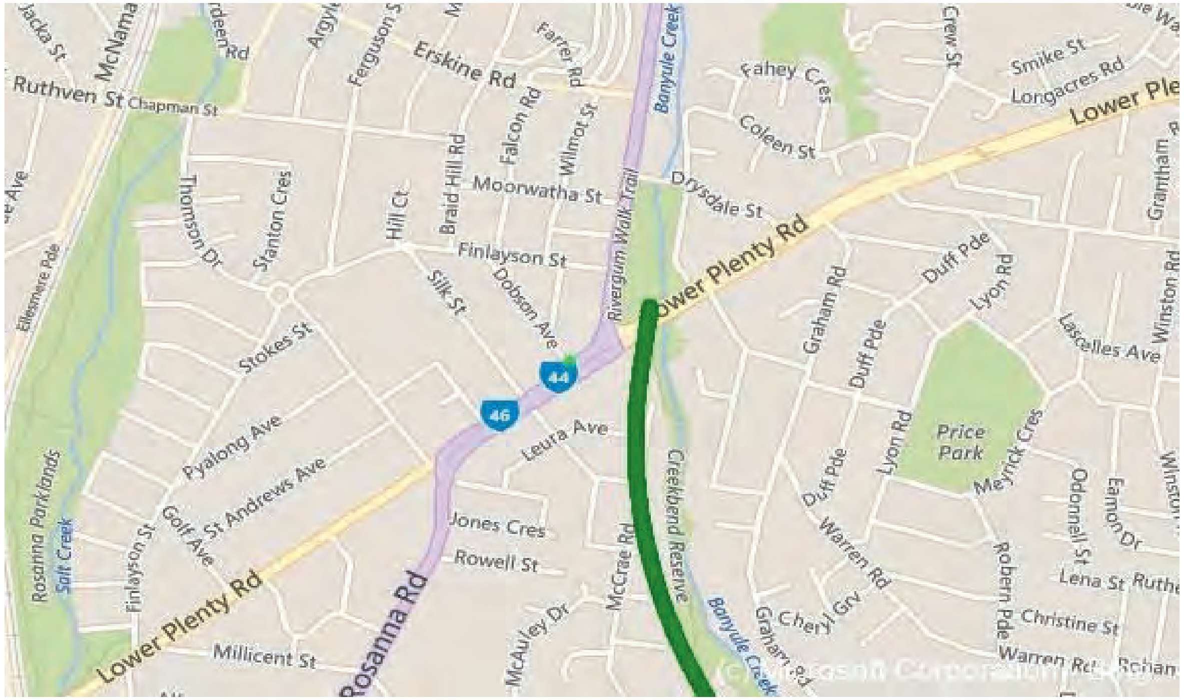
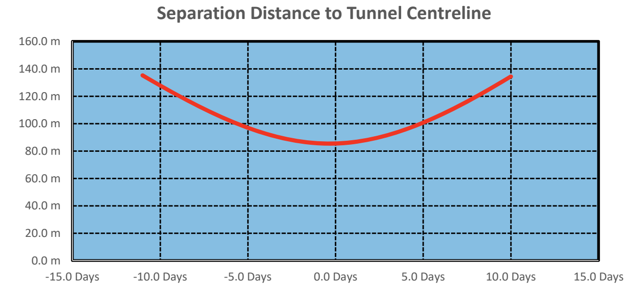
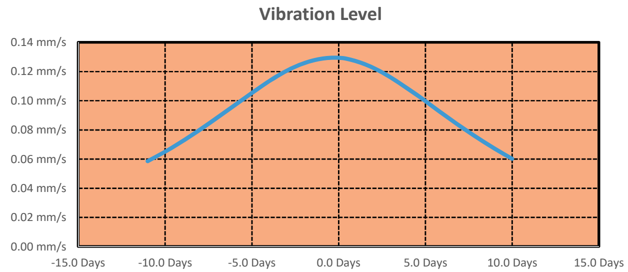
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

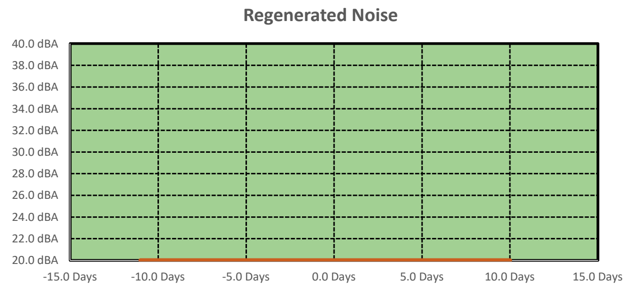
Created using TunnelTRAP Software

Assessment Location: Lower Plenty Road - 302A









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	85.4 m
Average Vibration Level	0.10 mm/s
90% Vibration Level	0.13 mm/s
95% Vibration Level	0.13 mm/s
Maximum Vibration Level	0.13 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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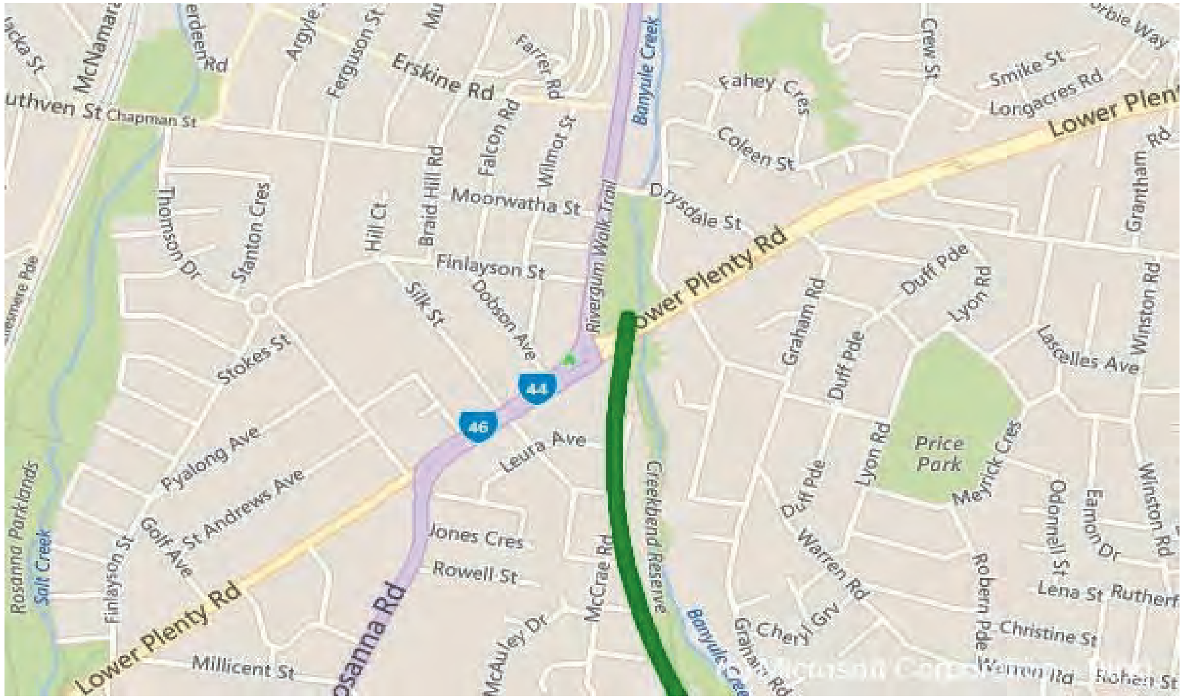
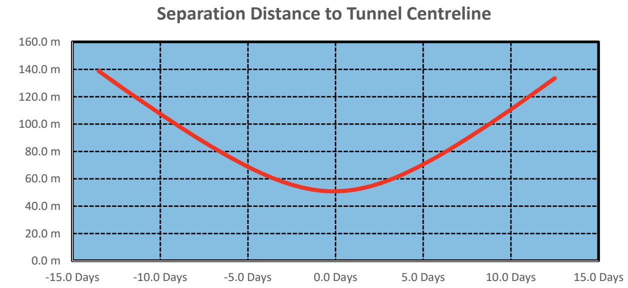
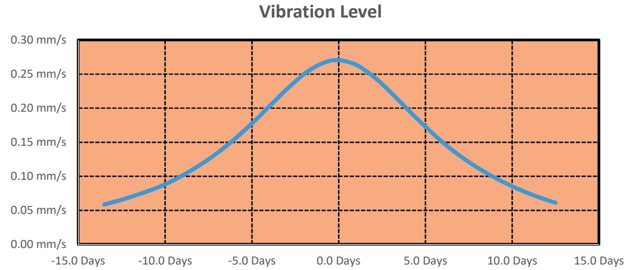
NORTH EAST LINK PROJECT

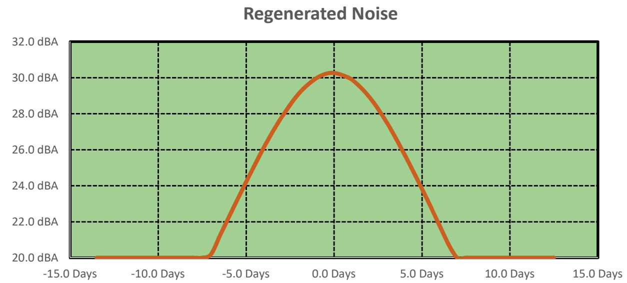
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Lower Plenty Road - 302D









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.7 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	50.8 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.26 mm/s
95% Vibration Level	0.27 mm/s
Maximum Vibration Level	0.27 mm/s
Average Regenerated Noise level	23.3 dBA
90% Regenerated Noise Level	29.6 dBA
95% Regenerated Noise Level	30.0 dBA
Maximum Regenerated Noise Level	30.3 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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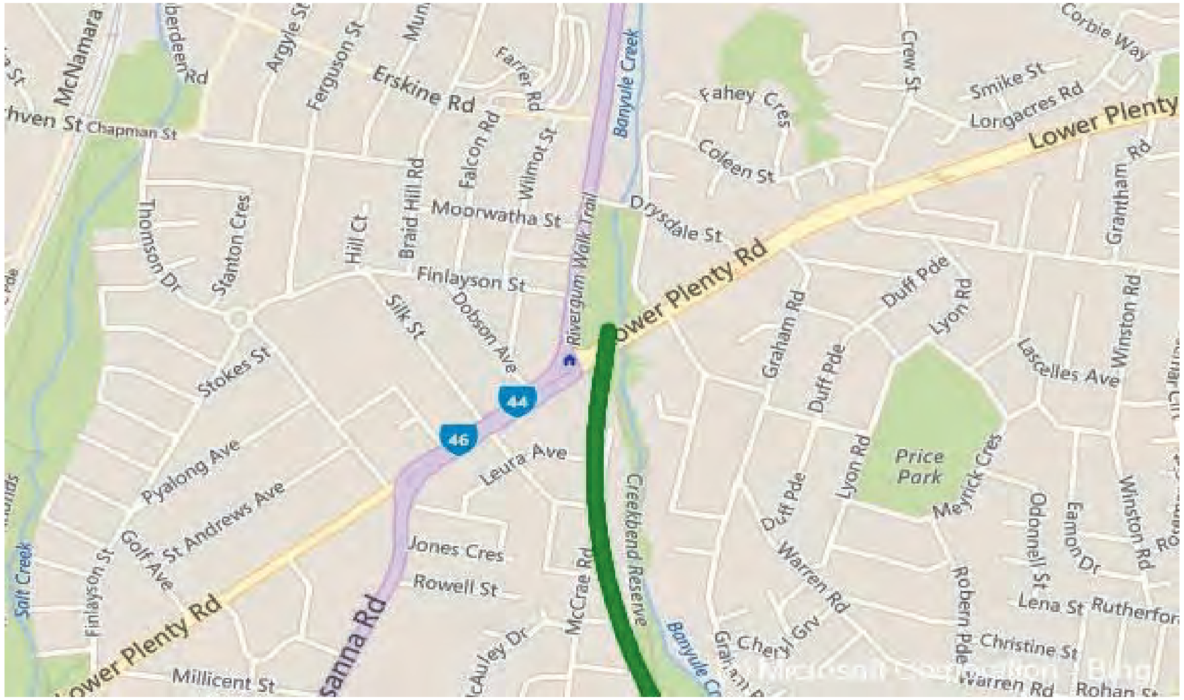
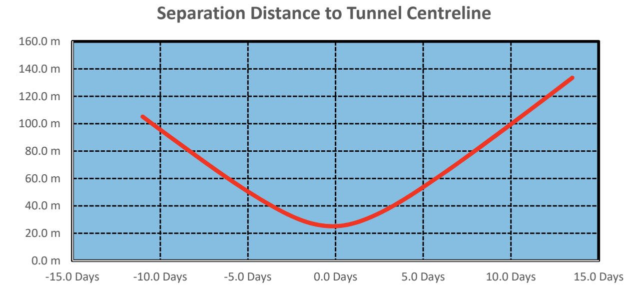
NORTH EAST LINK PROJECT

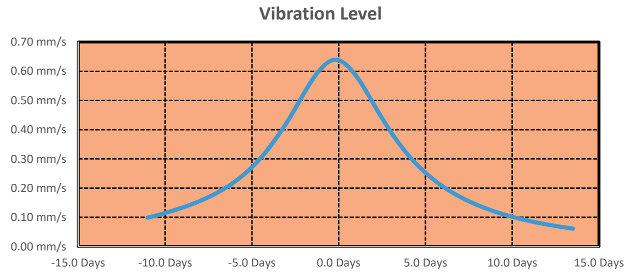
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

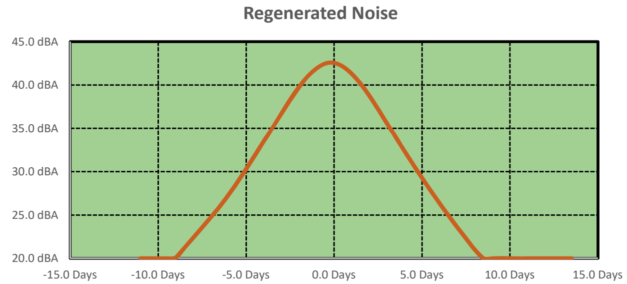
Created using TunnelTRAP Software

Assessment Location: Lower Plenty Road - 314









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.8 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.7 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	25.1 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.57 mm/s
95% Vibration Level	0.61 mm/s
Maximum Vibration Level	0.64 mm/s
Average Regenerated Noise level	28.3 dBA
90% Regenerated Noise Level	41.0 dBA
95% Regenerated Noise Level	42.0 dBA
Maximum Regenerated Noise Level	42.6 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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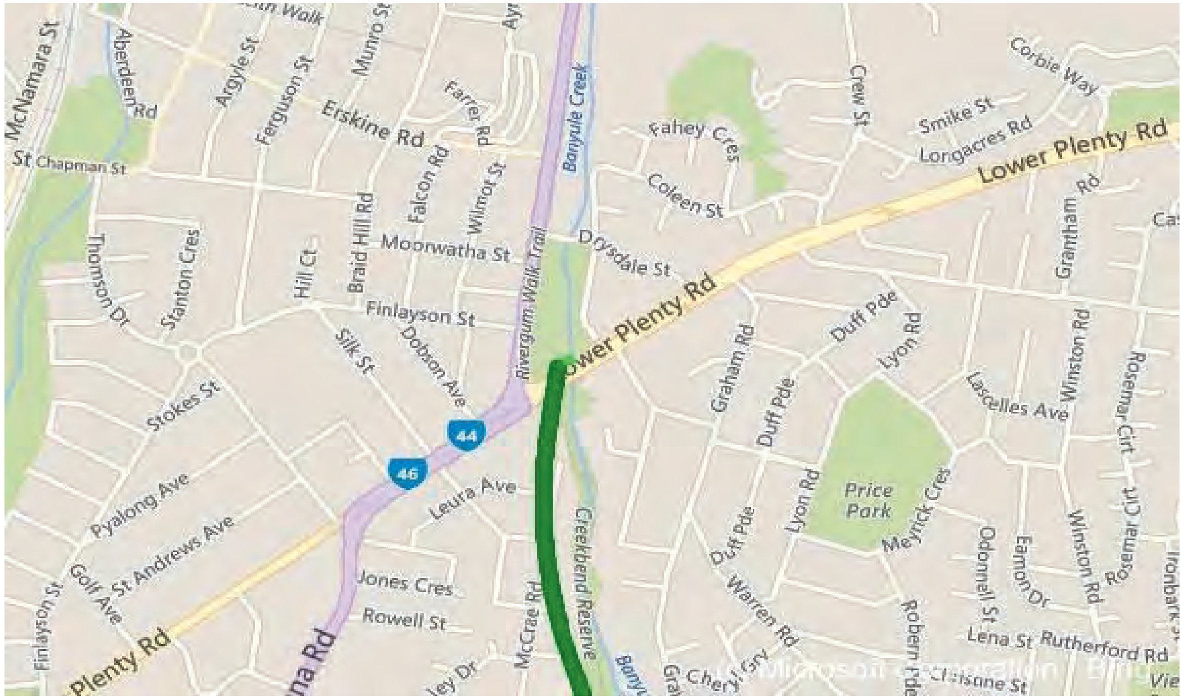
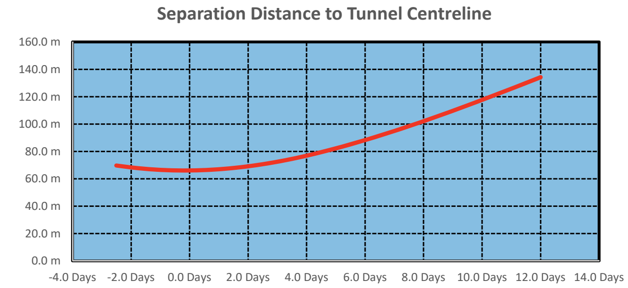
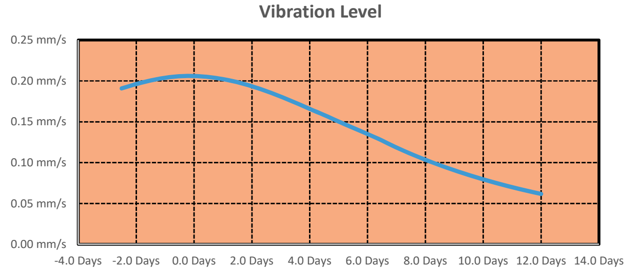
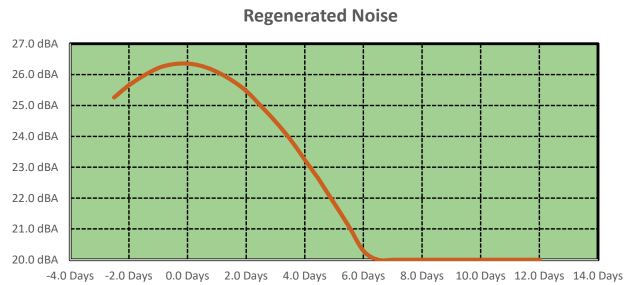
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Lower Plenty Road - 328A









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	66.1 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.20 mm/s
95% Vibration Level	0.21 mm/s
Maximum Vibration Level	0.21 mm/s
Average Regenerated Noise level	22.7 dBA
90% Regenerated Noise Level	26.2 dBA
95% Regenerated Noise Level	26.3 dBA
Maximum Regenerated Noise Level	26.4 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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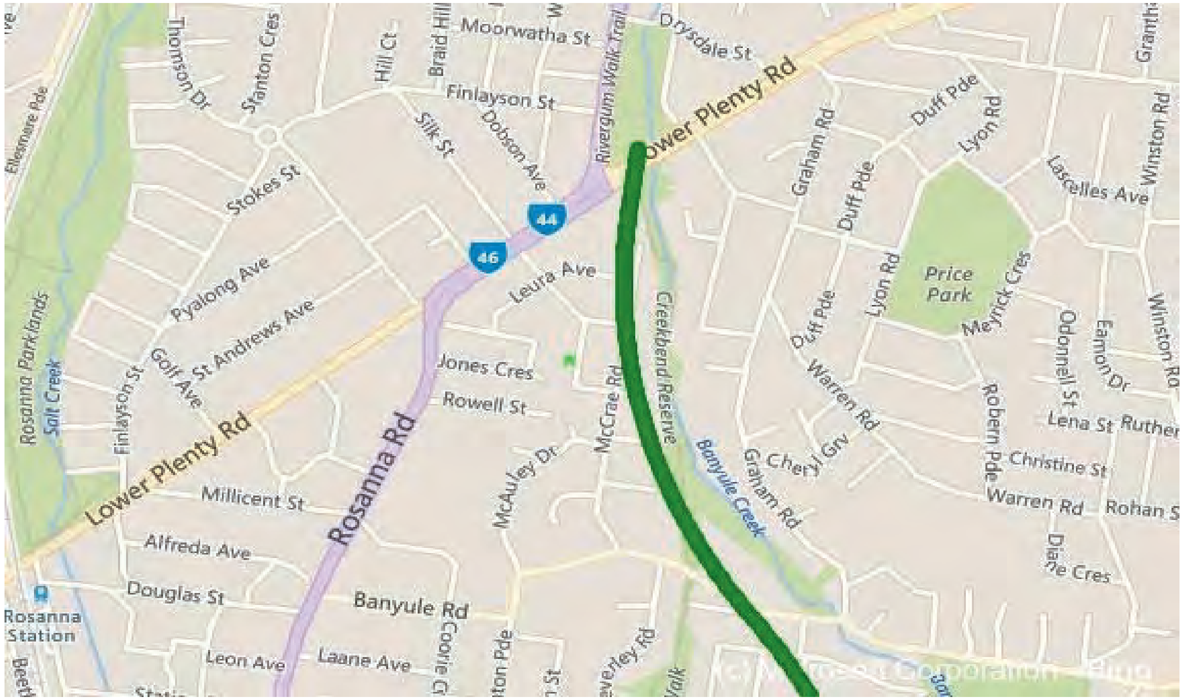
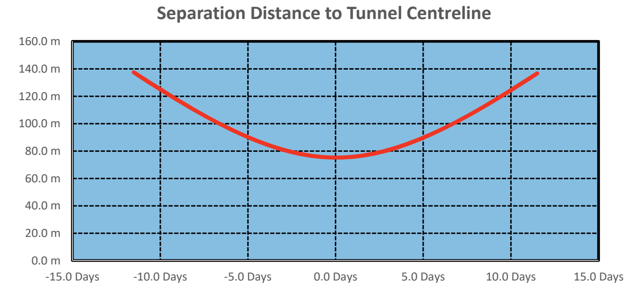
NORTH EAST LINK PROJECT

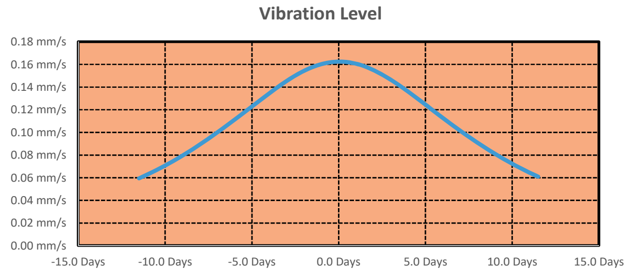
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

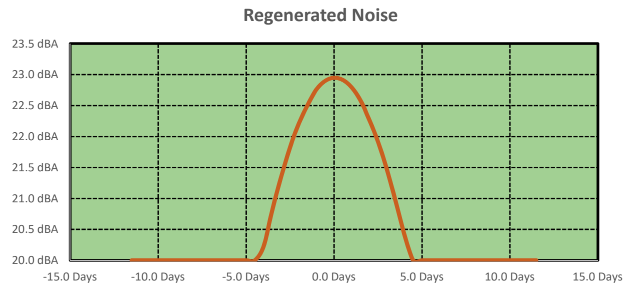
Created using TunnelTRAP Software

Assessment Location: Maleela Grove - 6









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	75.2 m
Average Vibration Level	0.11 mm/s
90% Vibration Level	0.16 mm/s
95% Vibration Level	0.16 mm/s
Maximum Vibration Level	0.16 mm/s
Average Regenerated Noise level	20.7 dBA
90% Regenerated Noise Level	22.7 dBA
95% Regenerated Noise Level	22.9 dBA
Maximum Regenerated Noise Level	22.9 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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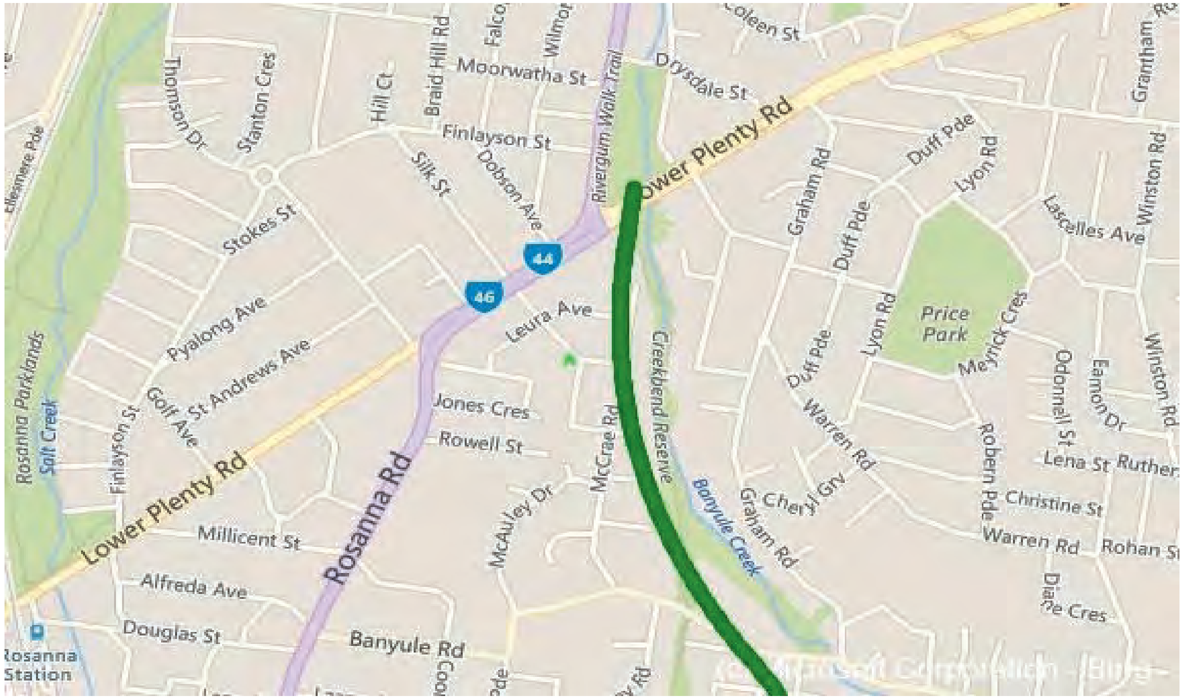
NORTH EAST LINK PROJECT

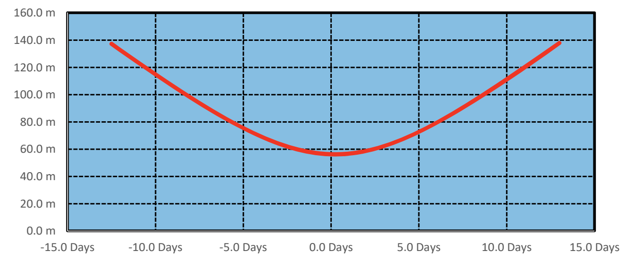
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

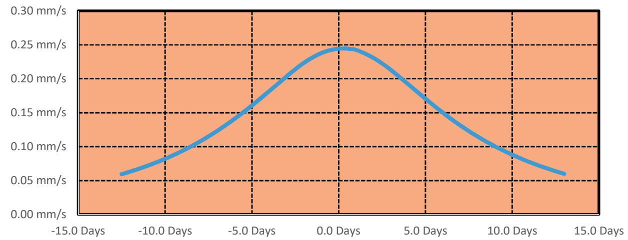
Assessment Location: Maleela Grove - 16



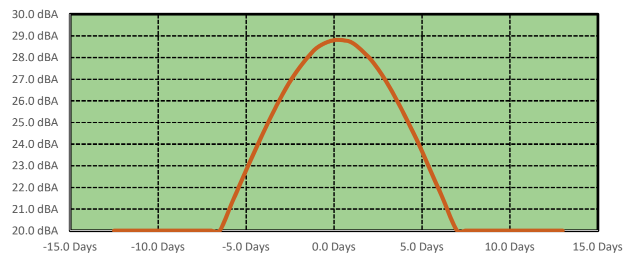
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	56.2 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.24 mm/s
Maximum Vibration Level	0.24 mm/s
Average Regenerated Noise level	22.8 dBA
90% Regenerated Noise Level	28.3 dBA
95% Regenerated Noise Level	28.7 dBA
Maximum Regenerated Noise Level	28.8 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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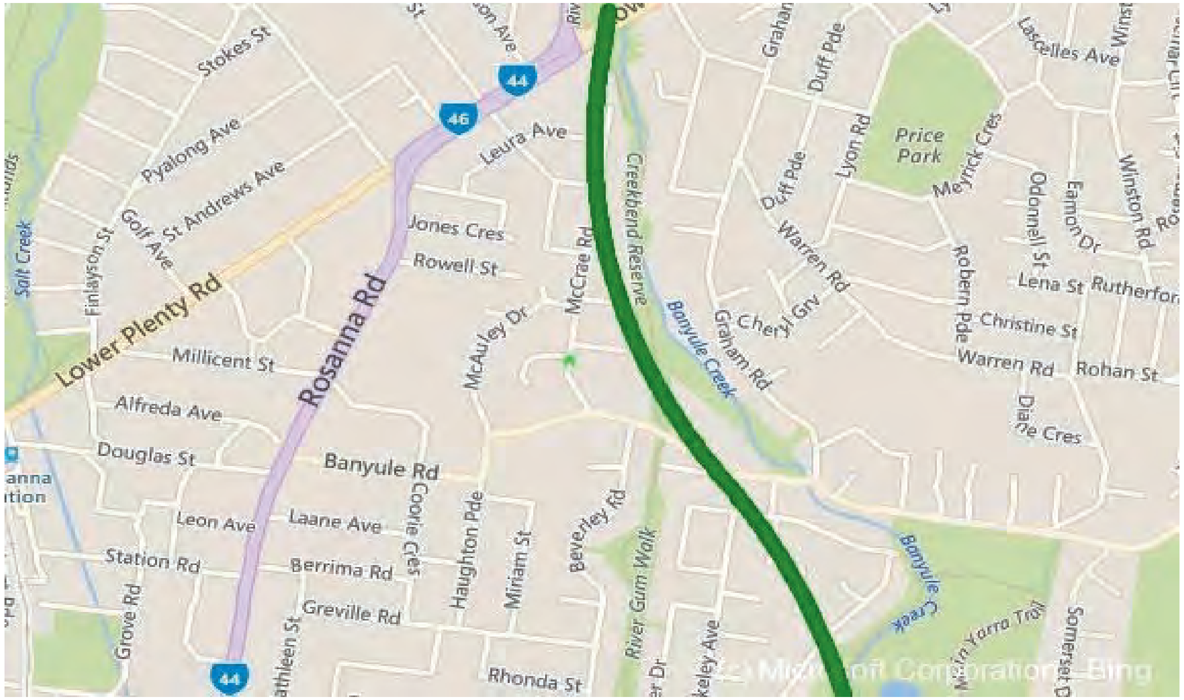
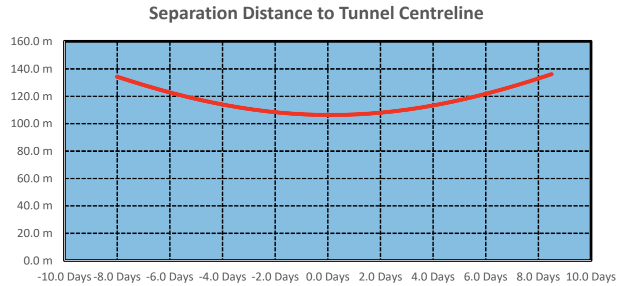
NORTH EAST LINK PROJECT

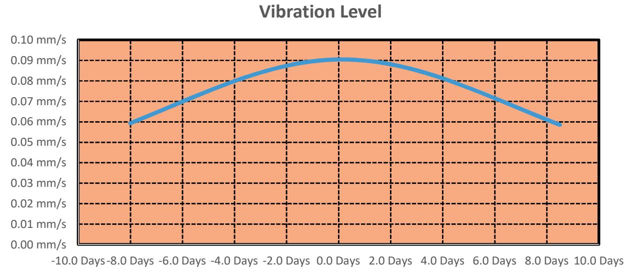
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

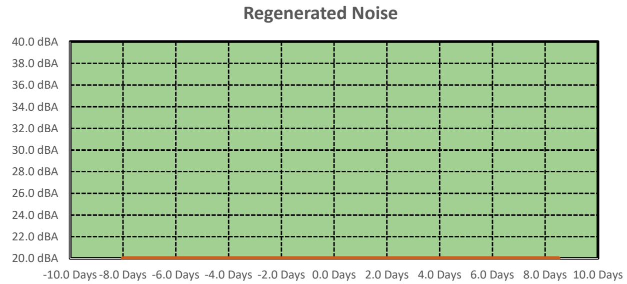
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 8









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	106.2 m
Average Vibration Level	0.08 mm/s
90% Vibration Level	0.09 mm/s
95% Vibration Level	0.09 mm/s
Maximum Vibration Level	0.09 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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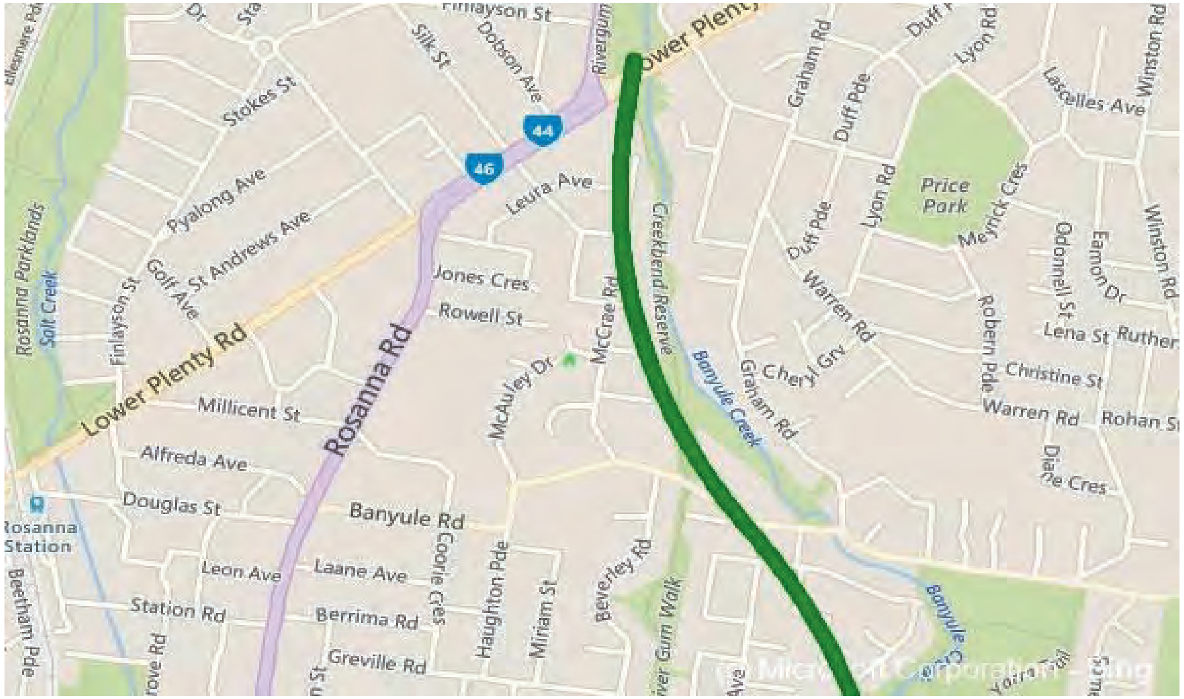
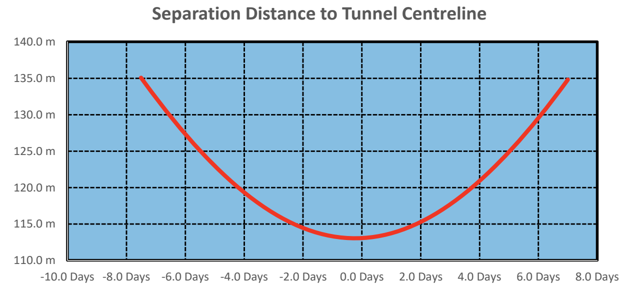
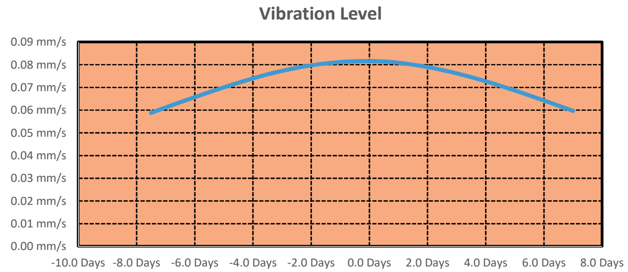
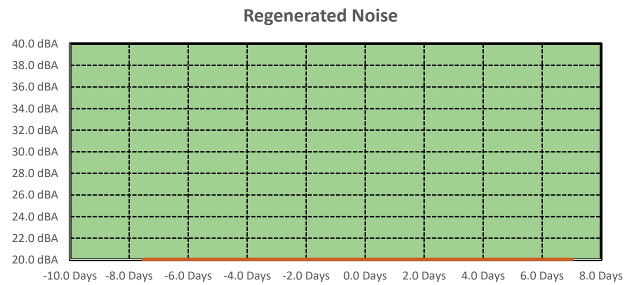
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 17









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	113.1 m
Average Vibration Level	0.07 mm/s
90% Vibration Level	0.08 mm/s
95% Vibration Level	0.08 mm/s
Maximum Vibration Level	0.08 mm/s
Average Regenerated Noise level	20.0 dBA
90% Regenerated Noise Level	20.0 dBA
95% Regenerated Noise Level	20.0 dBA
Maximum Regenerated Noise Level	20.0 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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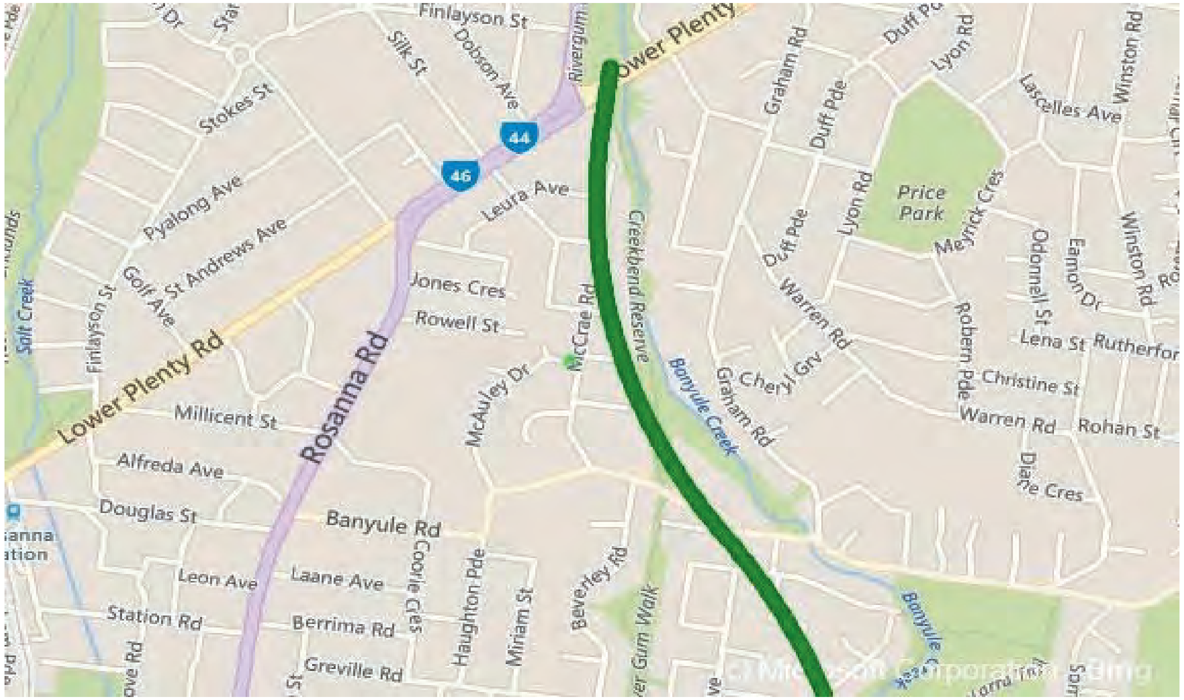
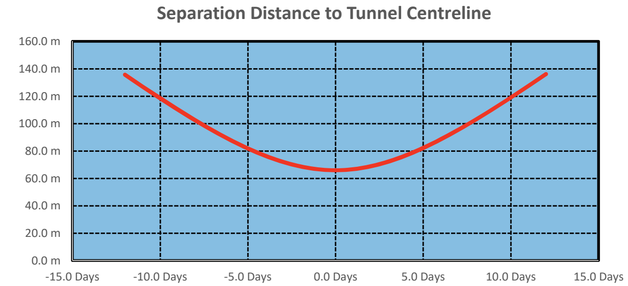
NORTH EAST LINK PROJECT

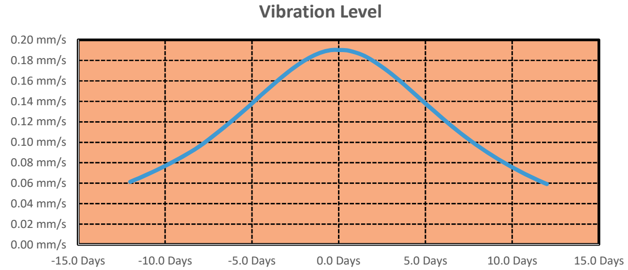
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

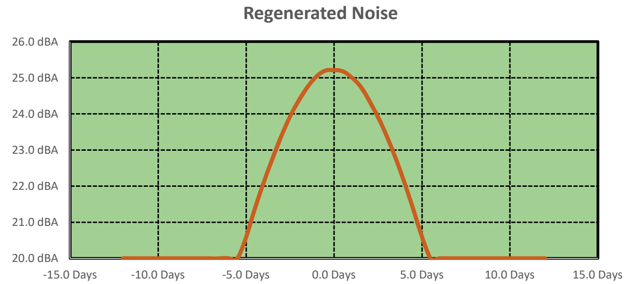
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 20









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	65.9 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.18 mm/s
95% Vibration Level	0.19 mm/s
Maximum Vibration Level	0.19 mm/s
Average Regenerated Noise level	21.5 dBA
90% Regenerated Noise Level	24.8 dBA
95% Regenerated Noise Level	25.1 dBA
Maximum Regenerated Noise Level	25.2 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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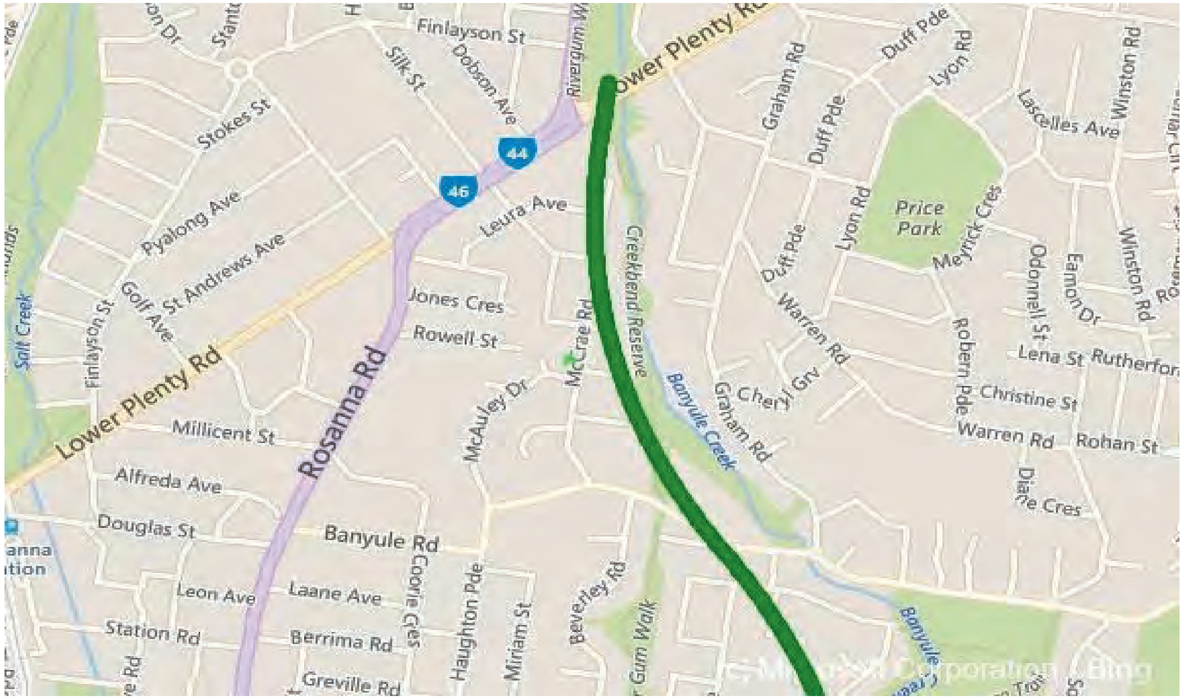
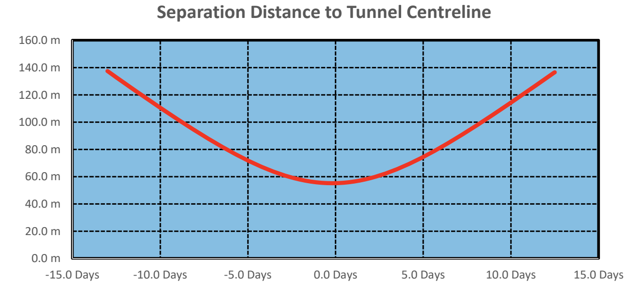
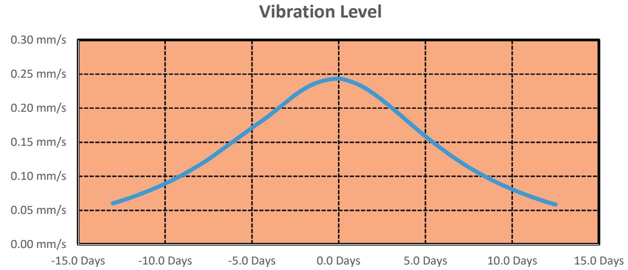
NORTH EAST LINK PROJECT

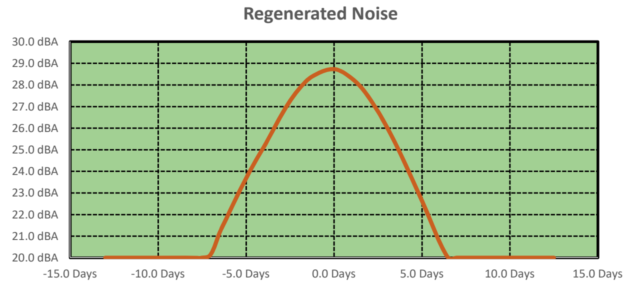
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 24









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	55.0 m
Average Vibration Level	0.14 mm/s
90% Vibration Level	0.23 mm/s
95% Vibration Level	0.24 mm/s
Maximum Vibration Level	0.24 mm/s
Average Regenerated Noise level	22.8 dBA
90% Regenerated Noise Level	28.2 dBA
95% Regenerated Noise Level	28.5 dBA
Maximum Regenerated Noise Level	28.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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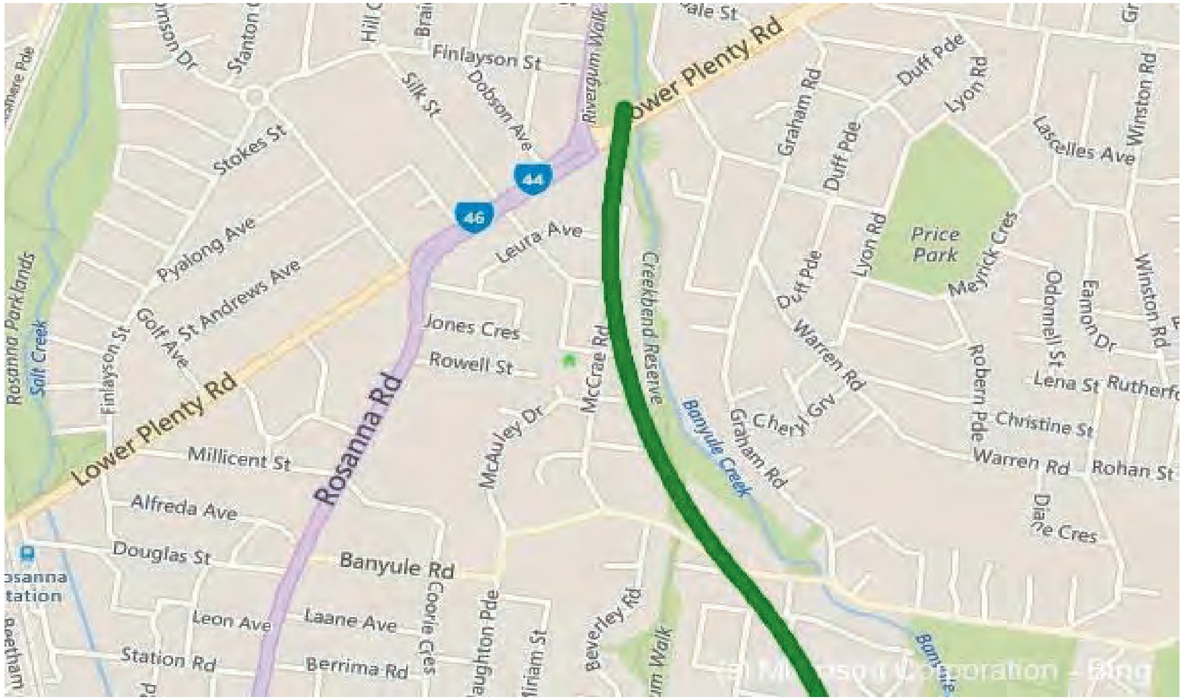
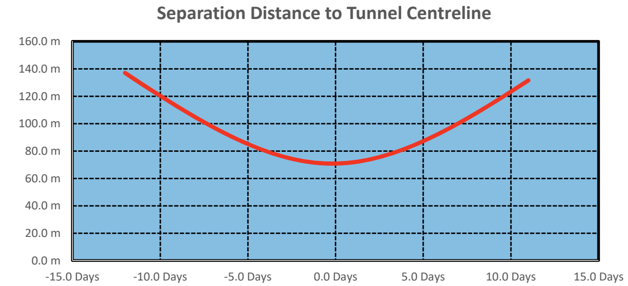
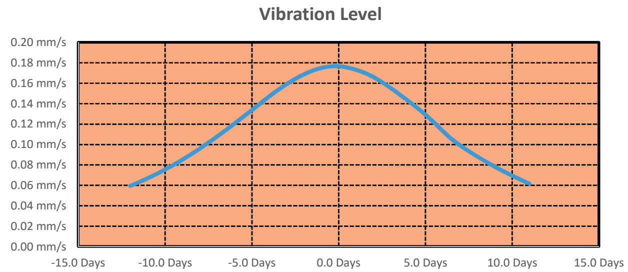
NORTH EAST LINK PROJECT

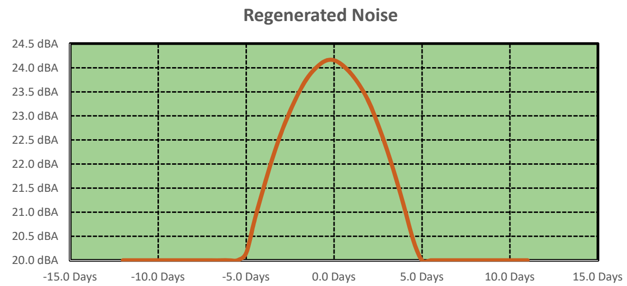
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 31









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	70.8 m
Average Vibration Level	0.12 mm/s
90% Vibration Level	0.17 mm/s
95% Vibration Level	0.18 mm/s
Maximum Vibration Level	0.18 mm/s
Average Regenerated Noise level	21.1 dBA
90% Regenerated Noise Level	23.8 dBA
95% Regenerated Noise Level	24.0 dBA
Maximum Regenerated Noise Level	24.2 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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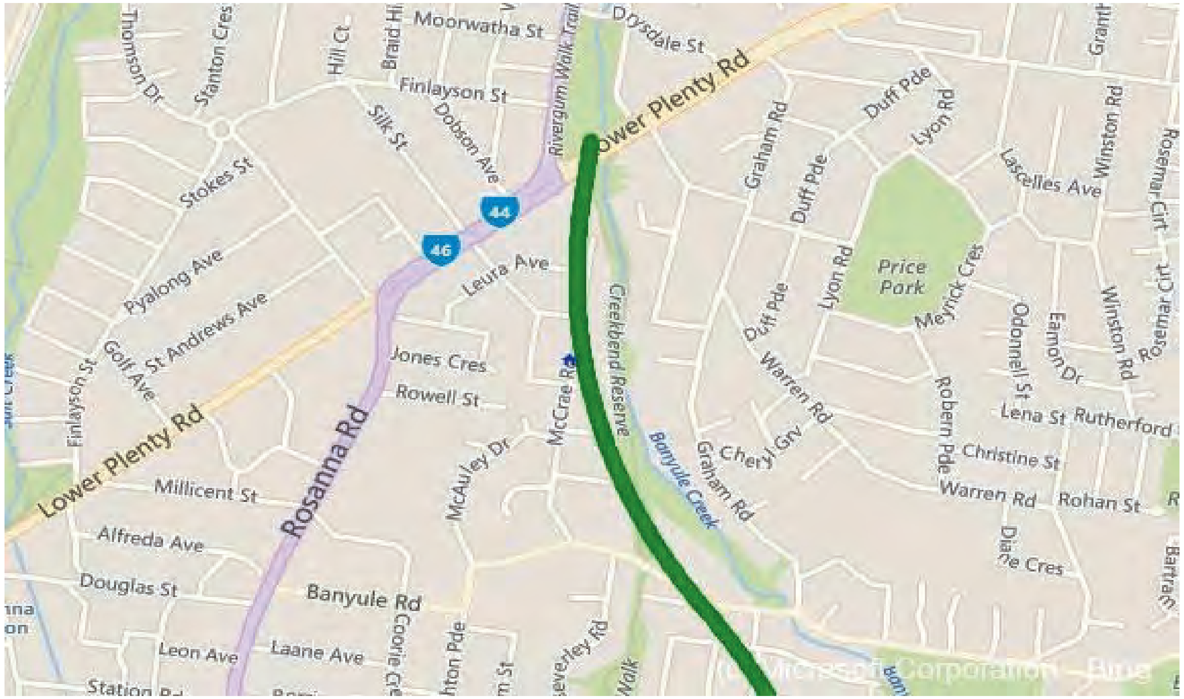
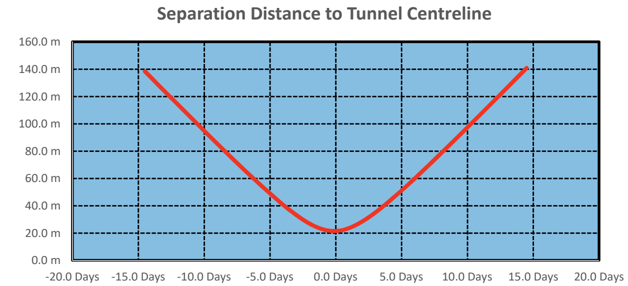
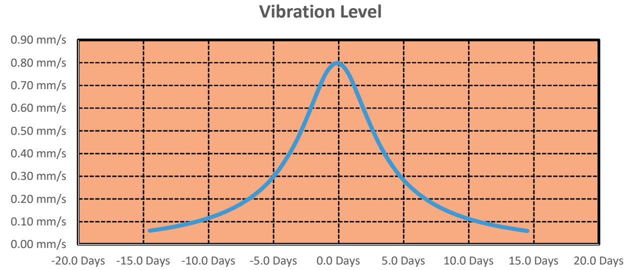
NORTH EAST LINK PROJECT

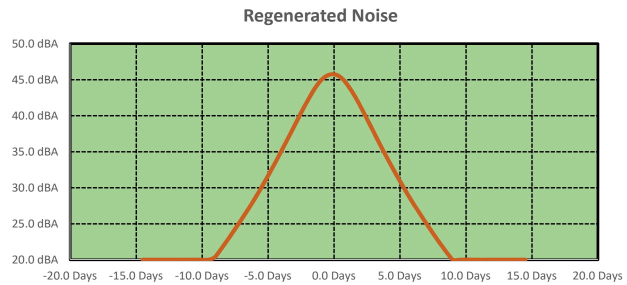
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 40









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.4 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.6 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.3 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.5 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.66 mm/s
95% Vibration Level	0.75 mm/s
Maximum Vibration Level	0.80 mm/s
Average Regenerated Noise level	28.1 dBA
90% Regenerated Noise Level	43.1 dBA
95% Regenerated Noise Level	44.9 dBA
Maximum Regenerated Noise Level	45.8 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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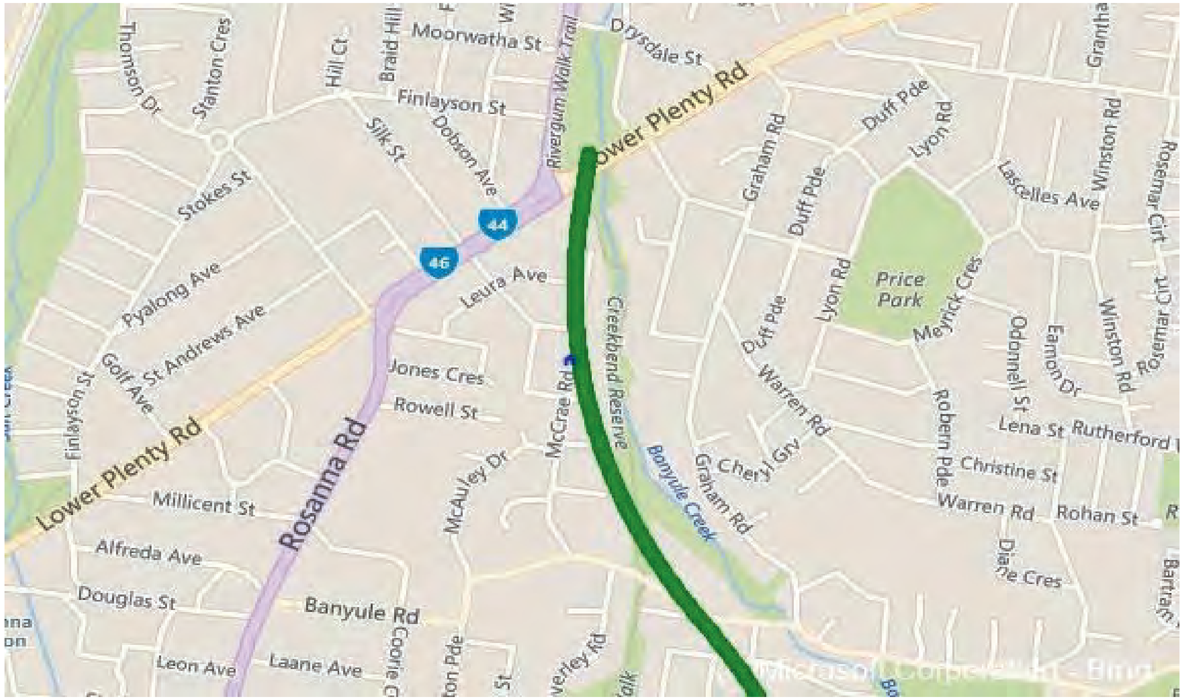
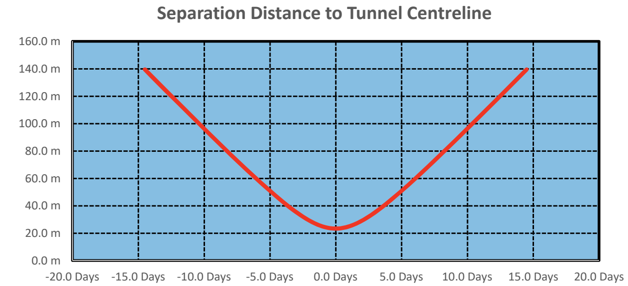
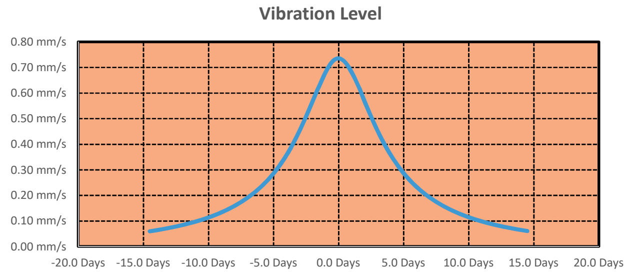
NORTH EAST LINK PROJECT

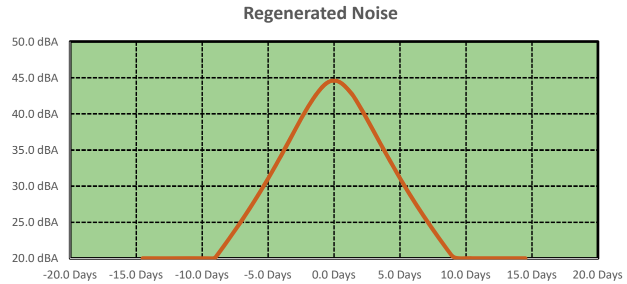
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 44









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	0.9 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	23.4 m
Average Vibration Level	0.26 mm/s
90% Vibration Level	0.63 mm/s
95% Vibration Level	0.68 mm/s
Maximum Vibration Level	0.74 mm/s
Average Regenerated Noise level	27.9 dBA
90% Regenerated Noise Level	42.3 dBA
95% Regenerated Noise Level	43.6 dBA
Maximum Regenerated Noise Level	44.6 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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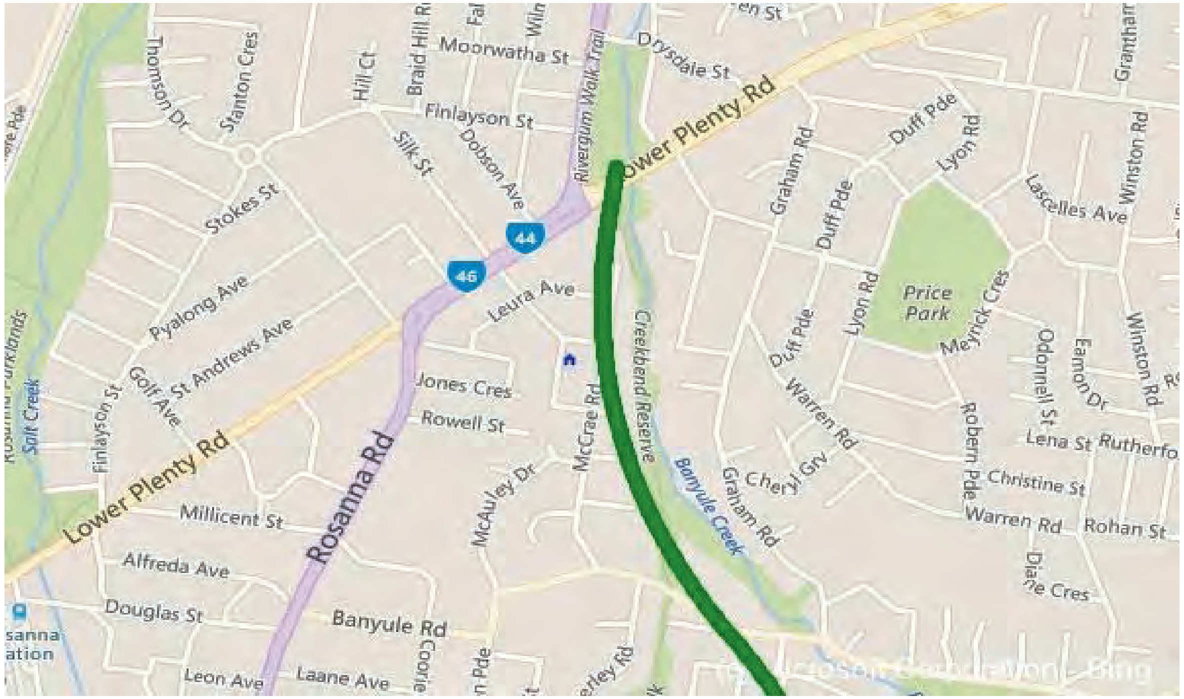
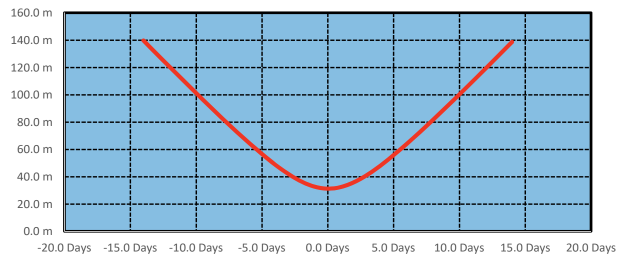
NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

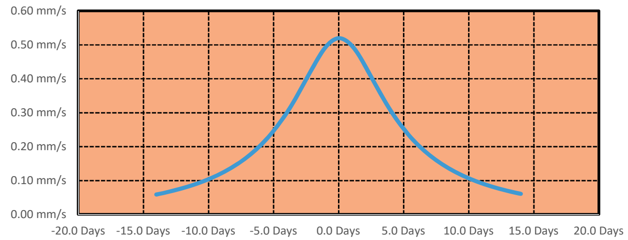
Assessment Location: McCrae Road - 47



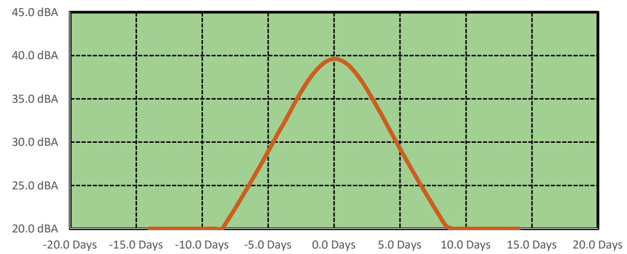
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.3 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.1 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.2 m
Average Vibration Level	0.22 mm/s
90% Vibration Level	0.47 mm/s
95% Vibration Level	0.50 mm/s
Maximum Vibration Level	0.52 mm/s
Average Regenerated Noise level	26.5 dBA
90% Regenerated Noise Level	38.1 dBA
95% Regenerated Noise Level	39.1 dBA
Maximum Regenerated Noise Level	39.6 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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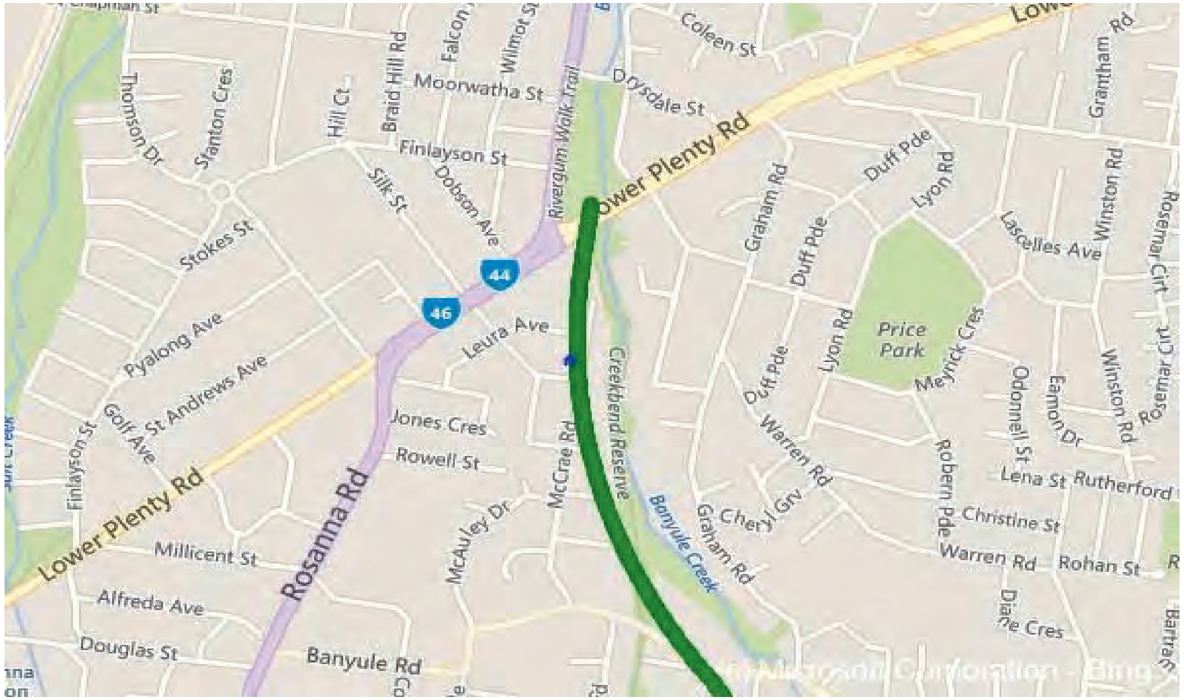
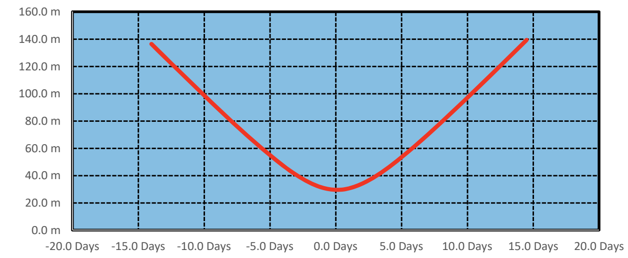
NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

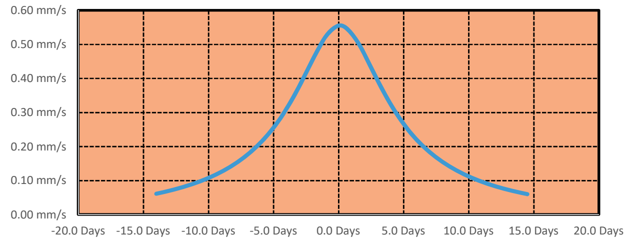
Assessment Location: McCrae Road - 58



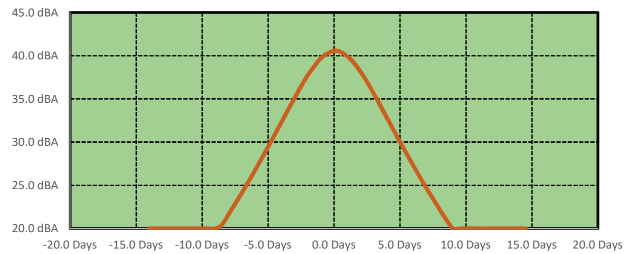
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	2.1 days
Number of days above 0.50mm/s	0.6 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.3 days
Number of days above 40dBA	0.3 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	29.6 m
Average Vibration Level	0.23 mm/s
90% Vibration Level	0.49 mm/s
95% Vibration Level	0.53 mm/s
Maximum Vibration Level	0.56 mm/s
Average Regenerated Noise level	26.8 dBA
90% Regenerated Noise Level	38.9 dBA
95% Regenerated Noise Level	40.0 dBA
Maximum Regenerated Noise Level	40.6 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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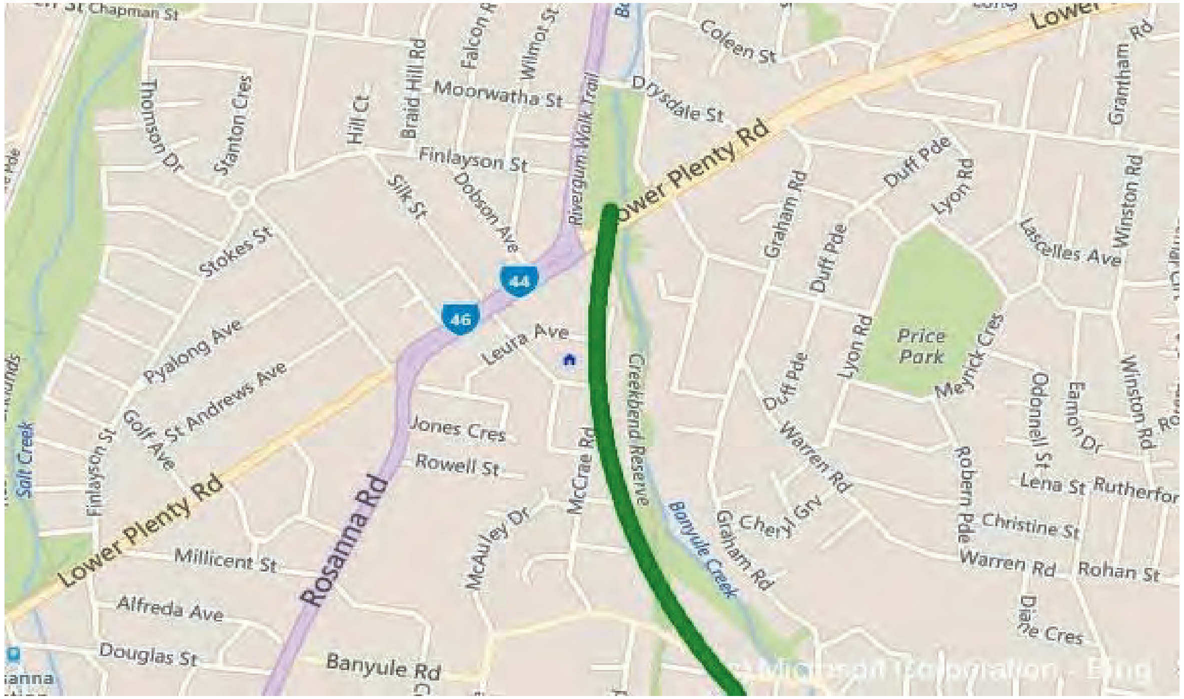
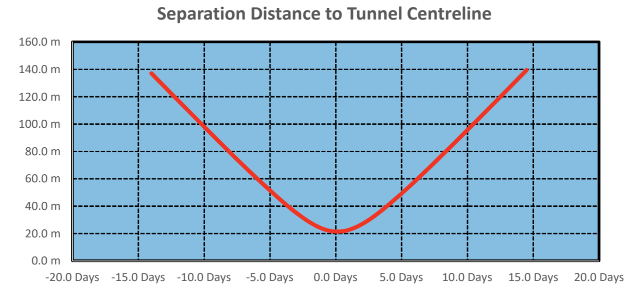
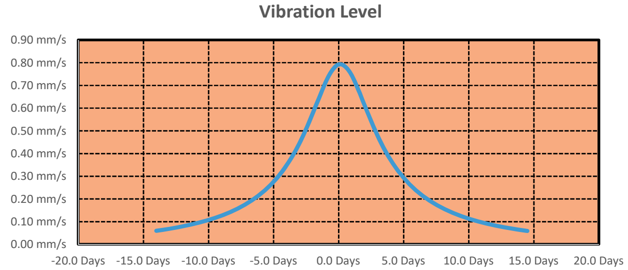
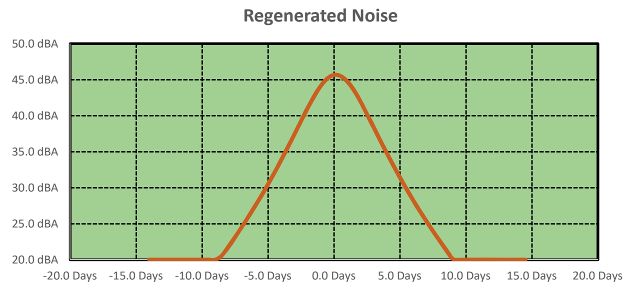
Assessment Location: McCrae Road - 61









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.3 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.3 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.3 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.66 mm/s
95% Vibration Level	0.75 mm/s
Maximum Vibration Level	0.79 mm/s
Average Regenerated Noise level	28.1 dBA
90% Regenerated Noise Level	43.0 dBA
95% Regenerated Noise Level	44.8 dBA
Maximum Regenerated Noise Level	45.7 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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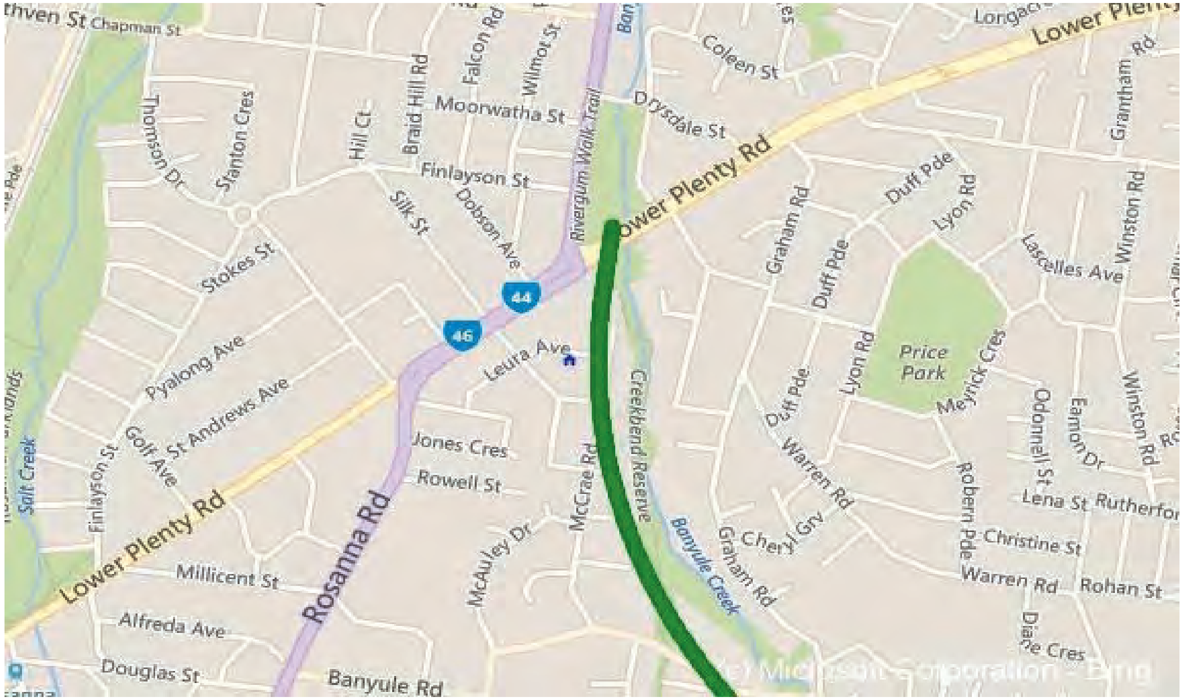
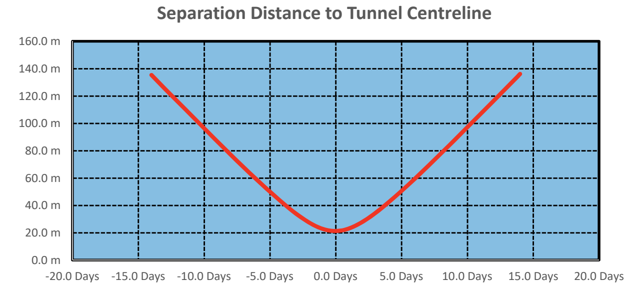
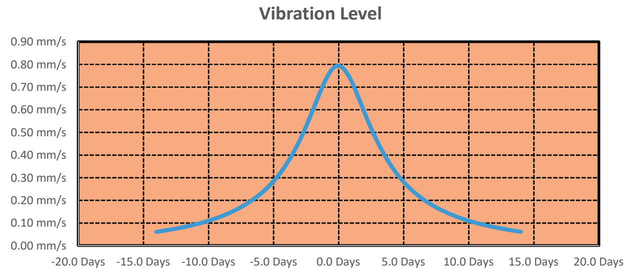
Plate Number		Date Exported	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

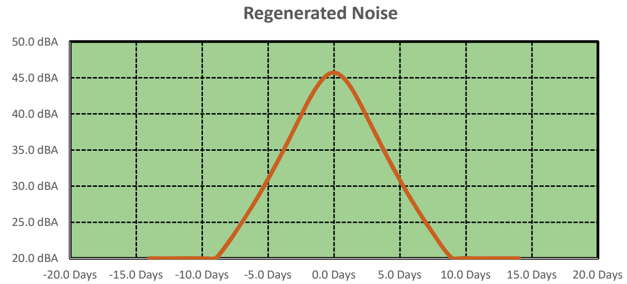
Created using TunnelTRAP Software

Assessment Location: McCrae Road - 65









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.3 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	0.9 days
Number of days above 45dBA	0.3 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.3 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.66 mm/s
95% Vibration Level	0.74 mm/s
Maximum Vibration Level	0.79 mm/s
Average Regenerated Noise level	28.2 dBA
90% Regenerated Noise Level	43.1 dBA
95% Regenerated Noise Level	44.7 dBA
Maximum Regenerated Noise Level	45.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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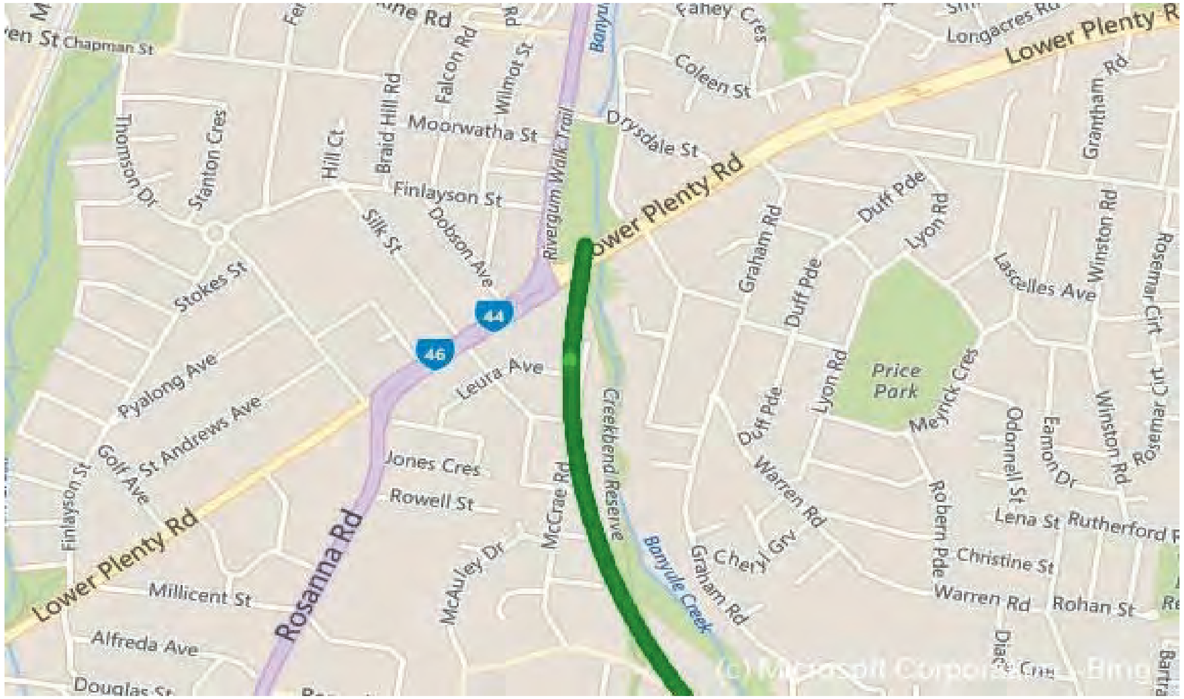
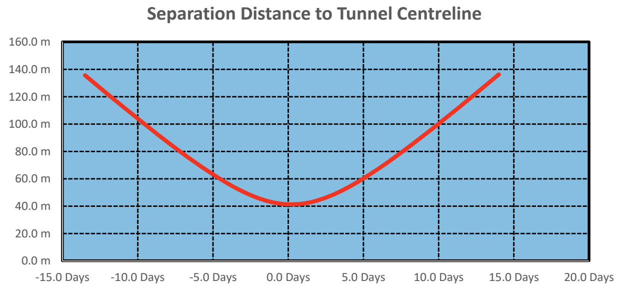
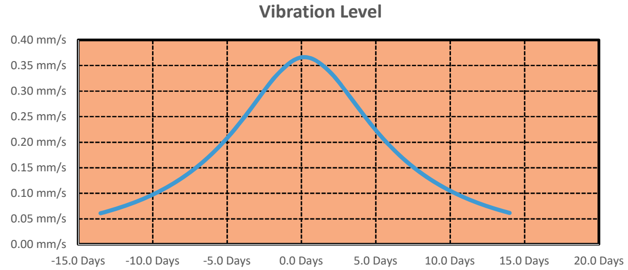
NORTH EAST LINK PROJECT

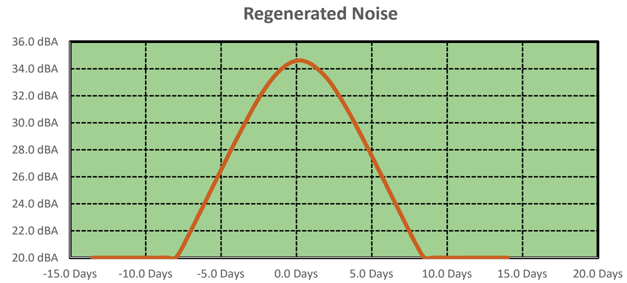
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 70









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.6 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	41.3 m
Average Vibration Level	0.18 mm/s
90% Vibration Level	0.34 mm/s
95% Vibration Level	0.36 mm/s
Maximum Vibration Level	0.37 mm/s
Average Regenerated Noise level	25.0 dBA
90% Regenerated Noise Level	33.6 dBA
95% Regenerated Noise Level	34.3 dBA
Maximum Regenerated Noise Level	34.6 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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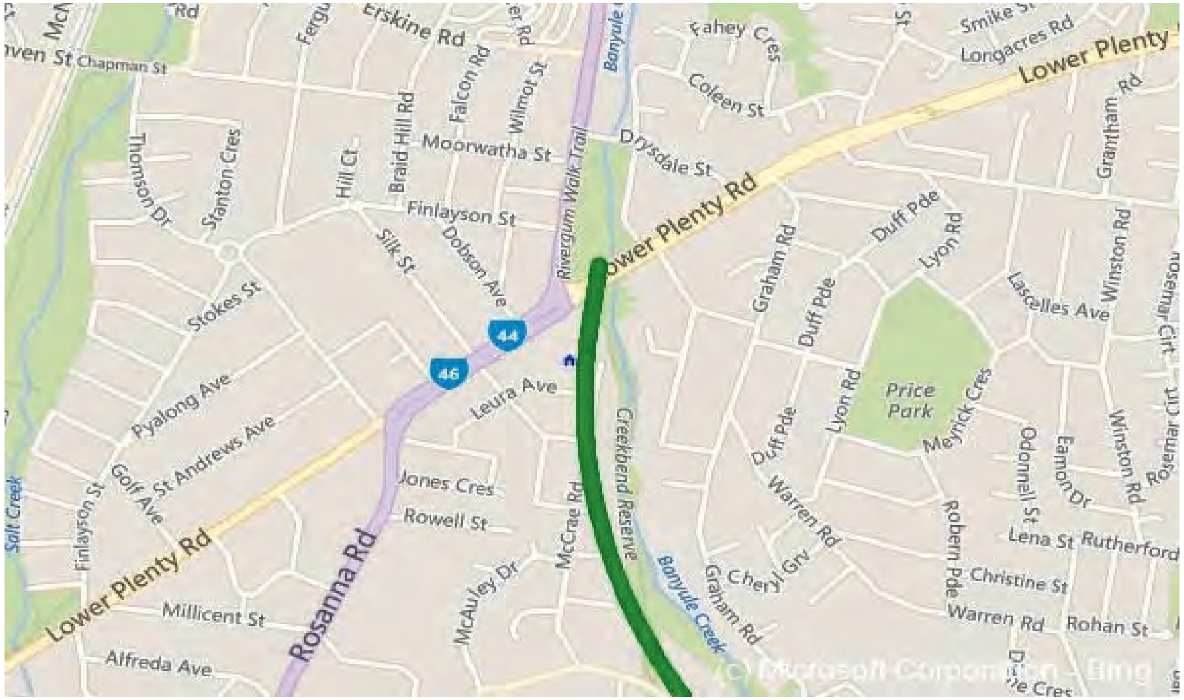
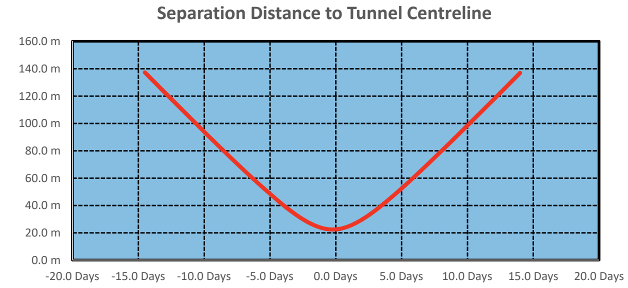
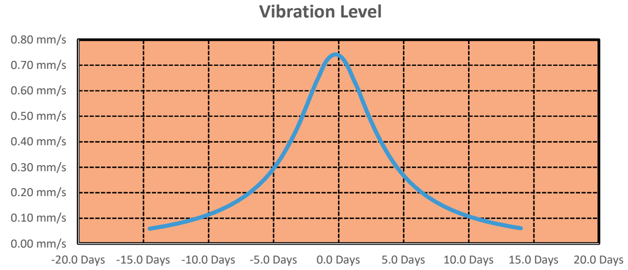
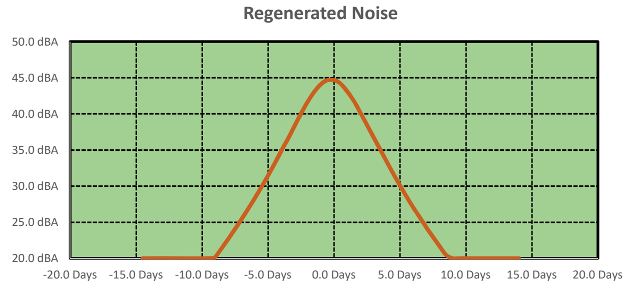
Assessment Location: McCrae Road - 75









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	22.5 m
Average Vibration Level	0.26 mm/s
90% Vibration Level	0.62 mm/s
95% Vibration Level	0.71 mm/s
Maximum Vibration Level	0.74 mm/s
Average Regenerated Noise level	27.9 dBA
90% Regenerated Noise Level	42.2 dBA
95% Regenerated Noise Level	44.1 dBA
Maximum Regenerated Noise Level	44.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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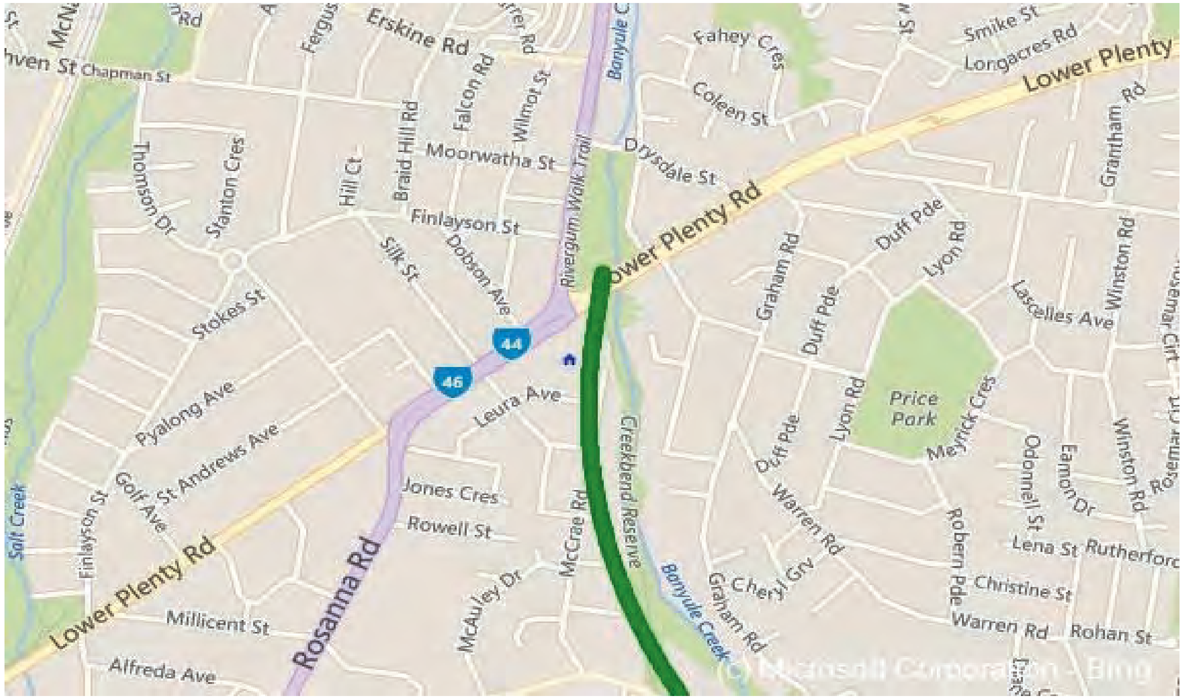
NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

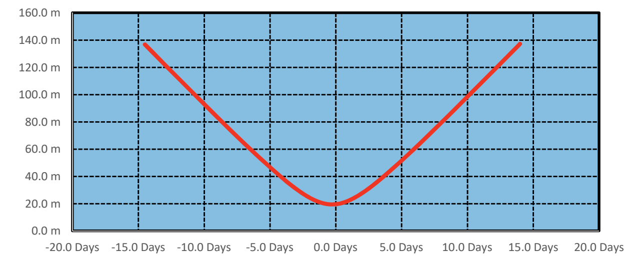
Assessment Location: McCrae Road - 77A



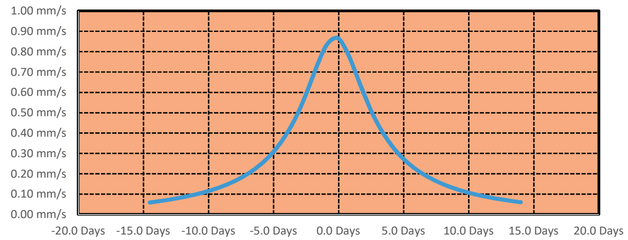
Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.2 days
Number of days above 0.75mm/s	0.5 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.6 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.4 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	19.5 m
Average Vibration Level	0.28 mm/s
90% Vibration Level	0.70 mm/s
95% Vibration Level	0.82 mm/s
Maximum Vibration Level	0.86 mm/s
Average Regenerated Noise level	28.4 dBA
90% Regenerated Noise Level	43.8 dBA
95% Regenerated Noise Level	46.1 dBA
Maximum Regenerated Noise Level	46.9 dBA

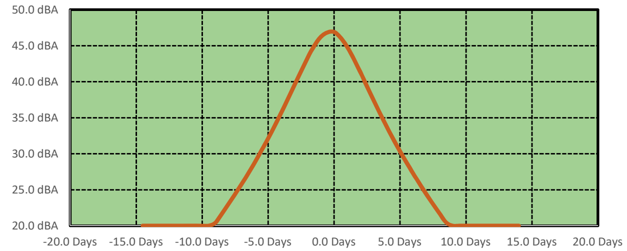
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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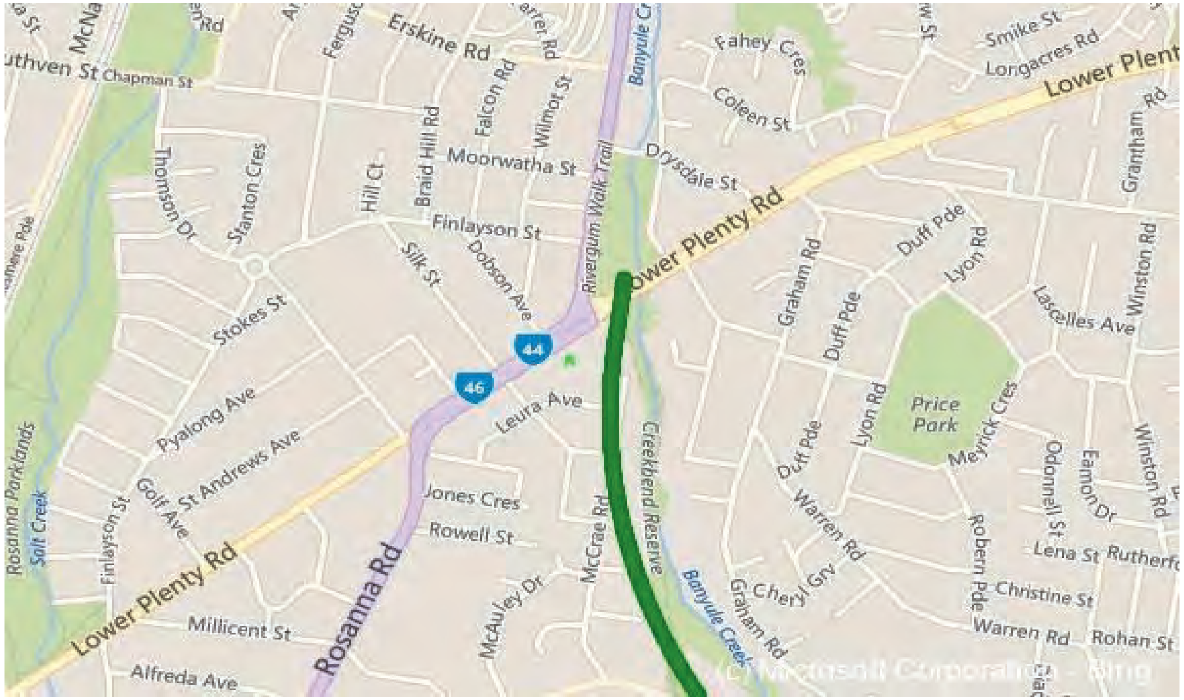
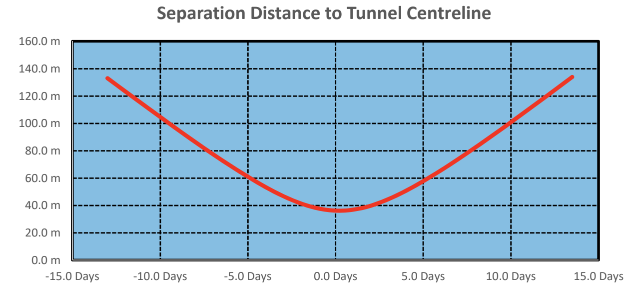
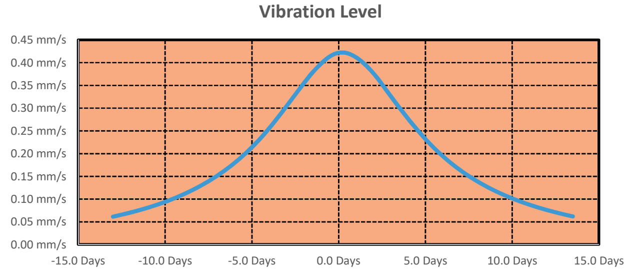
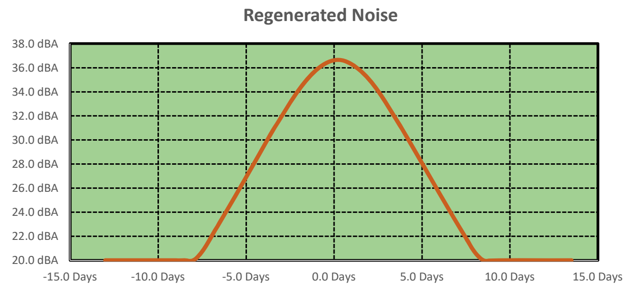
Assessment Location: McCrae Road - 77D









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.8 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.8 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	36.2 m
Average Vibration Level	0.20 mm/s
90% Vibration Level	0.39 mm/s
95% Vibration Level	0.41 mm/s
Maximum Vibration Level	0.42 mm/s
Average Regenerated Noise level	25.7 dBA
90% Regenerated Noise Level	35.5 dBA
95% Regenerated Noise Level	36.3 dBA
Maximum Regenerated Noise Level	36.6 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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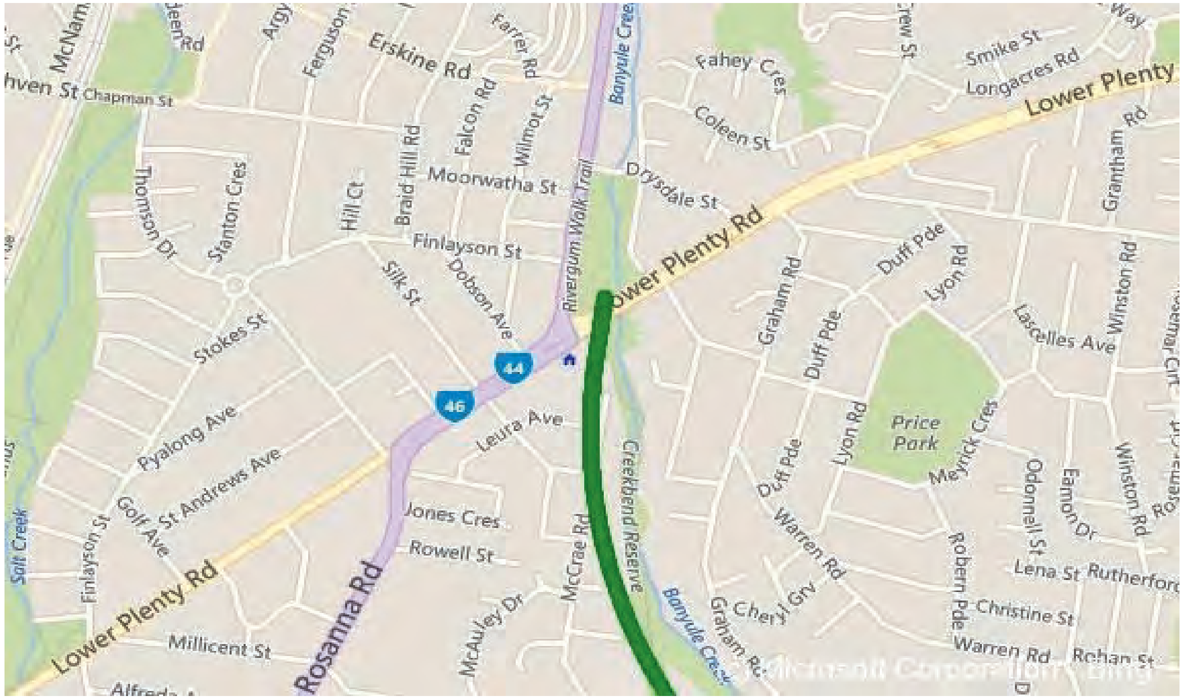
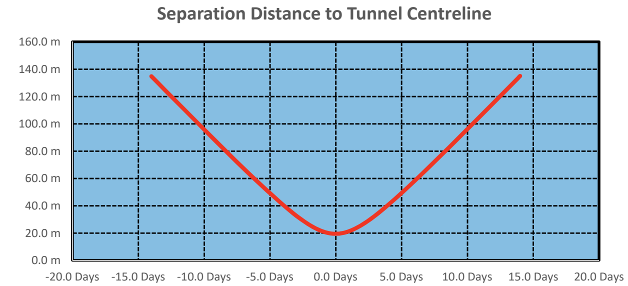
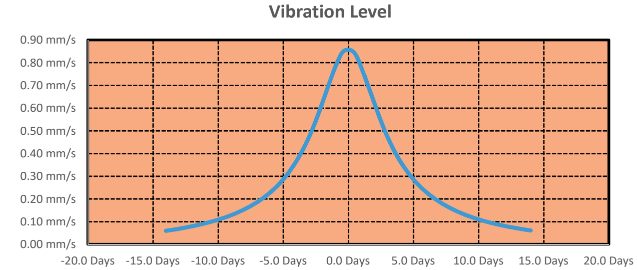
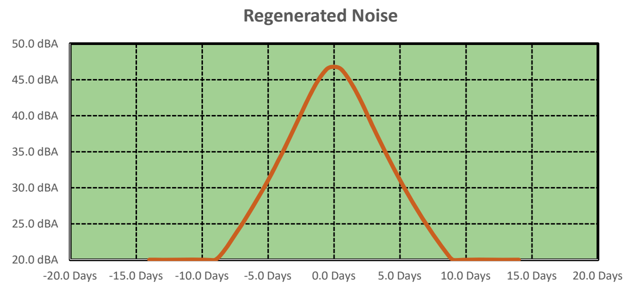
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: McCrae Road - 77L









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.3 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.5 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	1.1 days
Number of days above 45dBA	0.5 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	19.4 m
Average Vibration Level	0.28 mm/s
90% Vibration Level	0.70 mm/s
95% Vibration Level	0.79 mm/s
Maximum Vibration Level	0.86 mm/s
Average Regenerated Noise level	28.4 dBA
90% Regenerated Noise Level	43.9 dBA
95% Regenerated Noise Level	45.7 dBA
Maximum Regenerated Noise Level	46.8 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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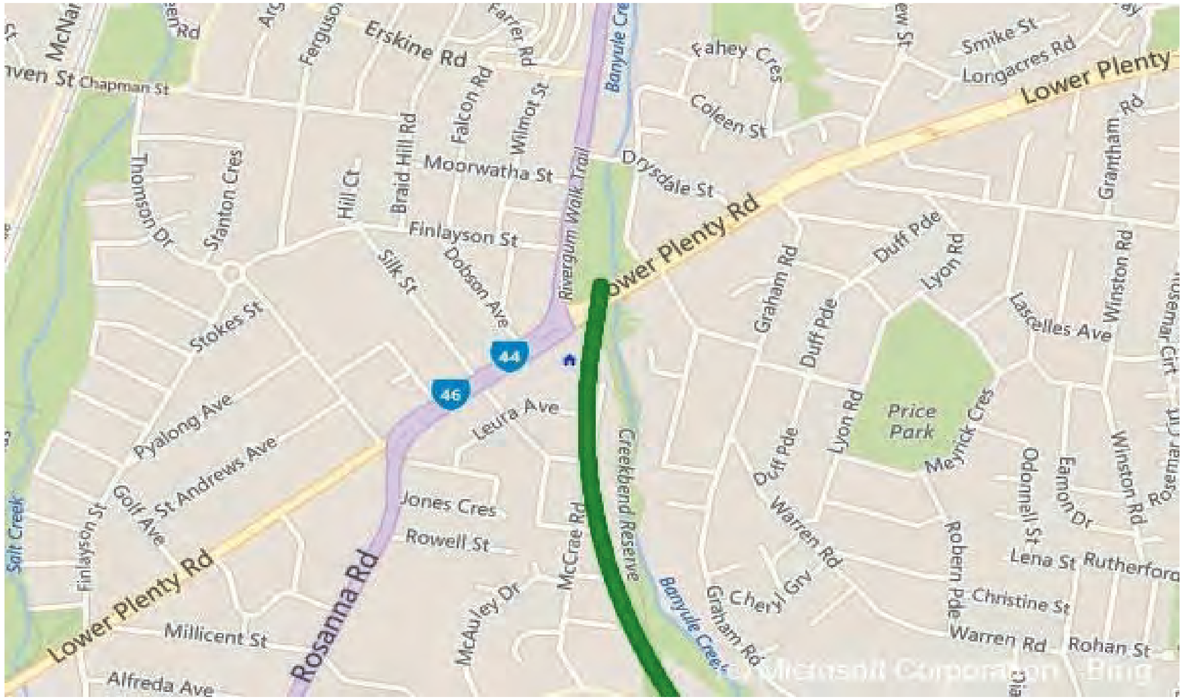
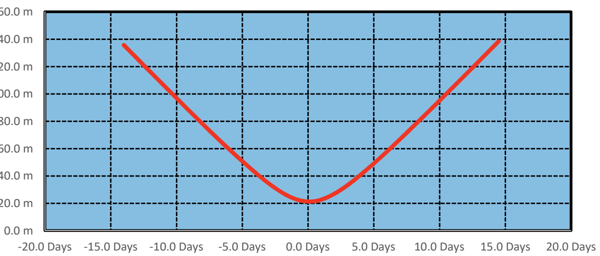
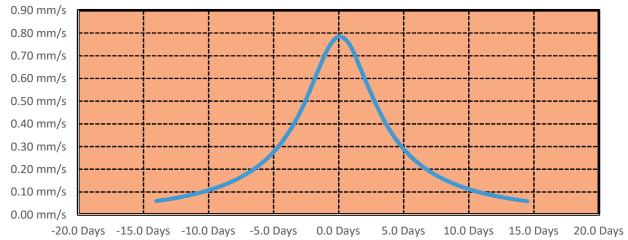
Assessment Location: McCrae Road - 77N



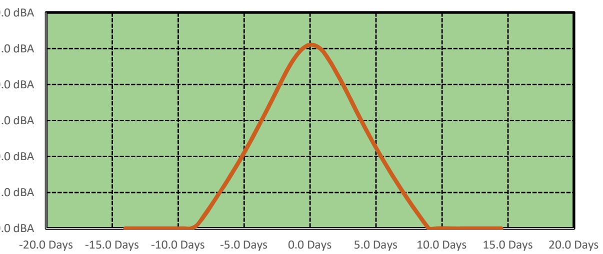
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.3 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.5 days
Number of days above 40dBA	0.9 days
Number of days above 45dBA	0.3 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	21.2 m
Average Vibration Level	0.27 mm/s
90% Vibration Level	0.65 mm/s
95% Vibration Level	0.74 mm/s
Maximum Vibration Level	0.78 mm/s
Average Regenerated Noise level	28.0 dBA
90% Regenerated Noise Level	42.9 dBA
95% Regenerated Noise Level	44.7 dBA
Maximum Regenerated Noise Level	45.5 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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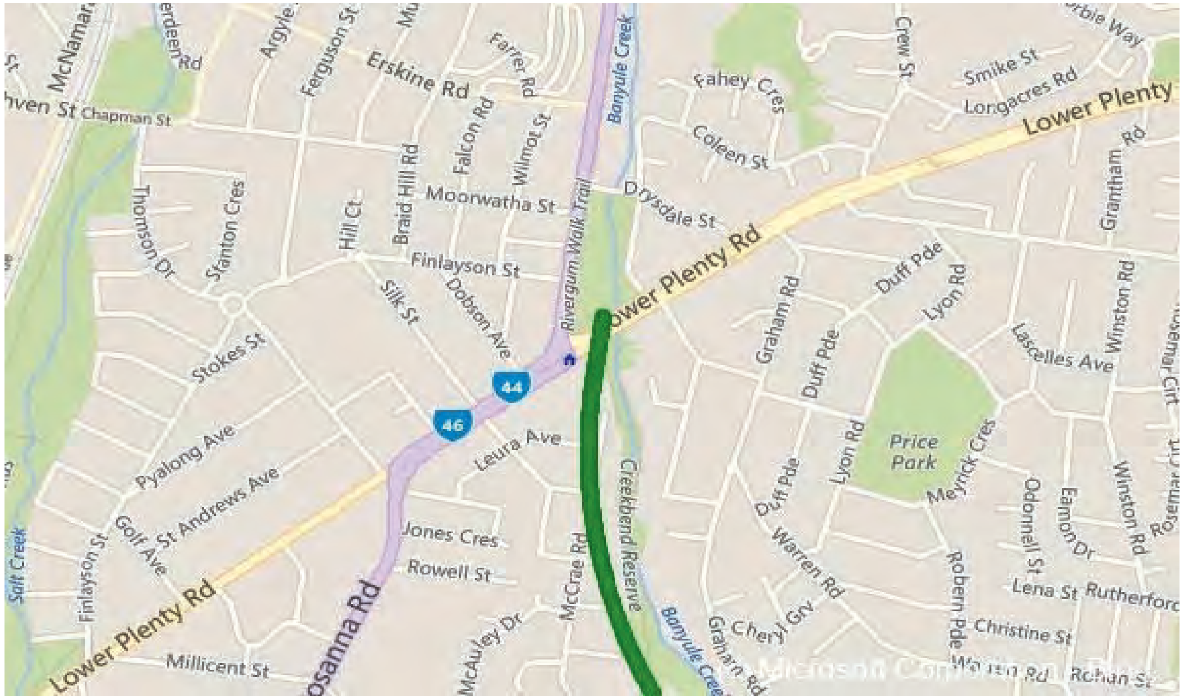
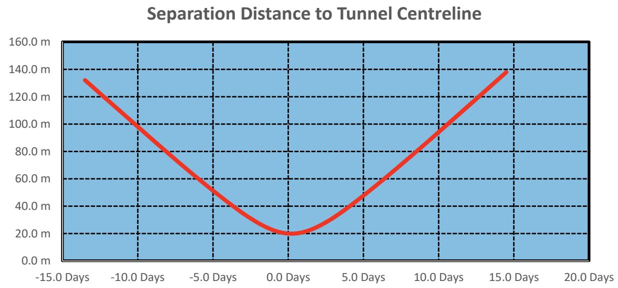
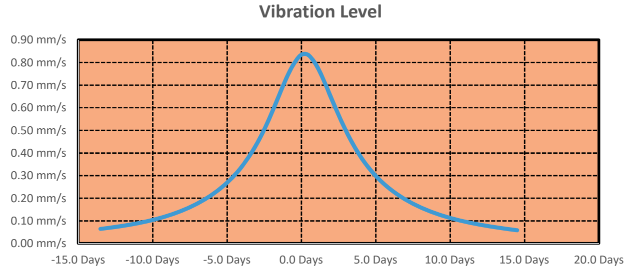
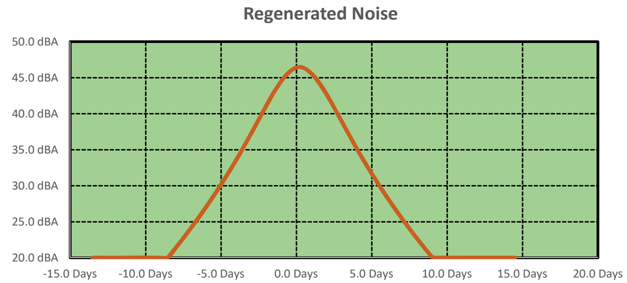
Assessment Location: McCrae Road - 85E









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	1.1 days
Number of days above 0.75mm/s	0.4 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.6 days
Number of days above 40dBA	1.0 days
Number of days above 45dBA	0.4 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	19.9 m
Average Vibration Level	0.28 mm/s
90% Vibration Level	0.68 mm/s
95% Vibration Level	0.79 mm/s
Maximum Vibration Level	0.83 mm/s
Average Regenerated Noise level	28.3 dBA
90% Regenerated Noise Level	43.5 dBA
95% Regenerated Noise Level	45.6 dBA
Maximum Regenerated Noise Level	46.4 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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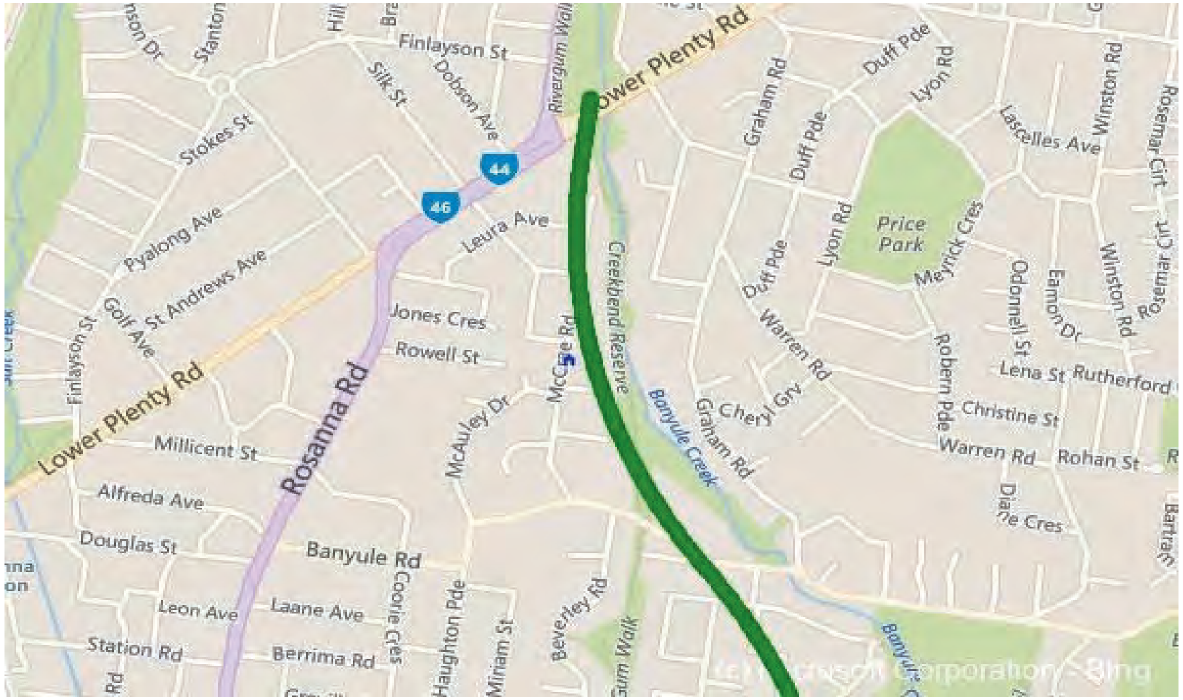
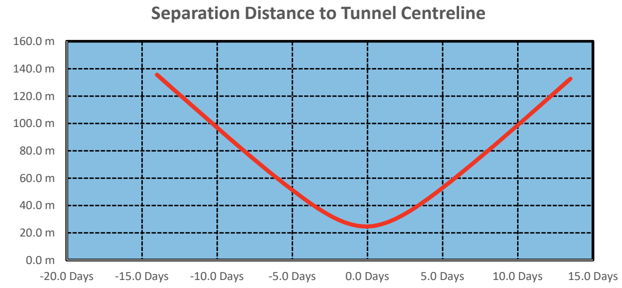
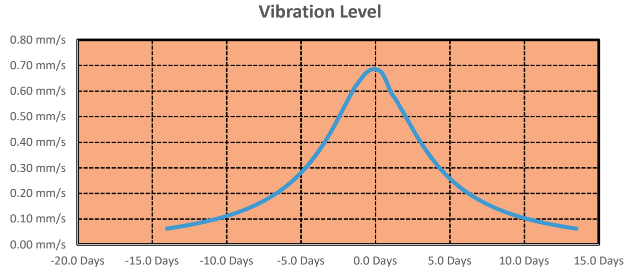
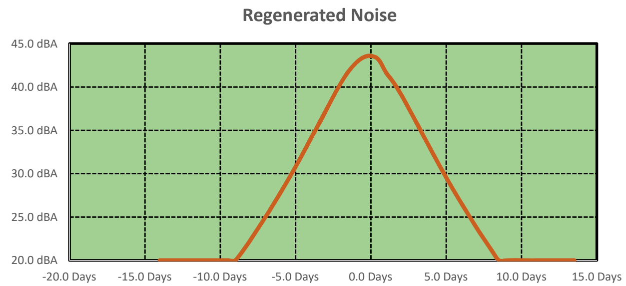
Assessment Location: Pilgrim Court - 5









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.2 days
Number of days above 0.50mm/s	0.9 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.4 days
Number of days above 40dBA	0.8 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	24.6 m
Average Vibration Level	0.26 mm/s
90% Vibration Level	0.58 mm/s
95% Vibration Level	0.65 mm/s
Maximum Vibration Level	0.69 mm/s
Average Regenerated Noise level	27.7 dBA
90% Regenerated Noise Level	41.1 dBA
95% Regenerated Noise Level	42.8 dBA
Maximum Regenerated Noise Level	43.6 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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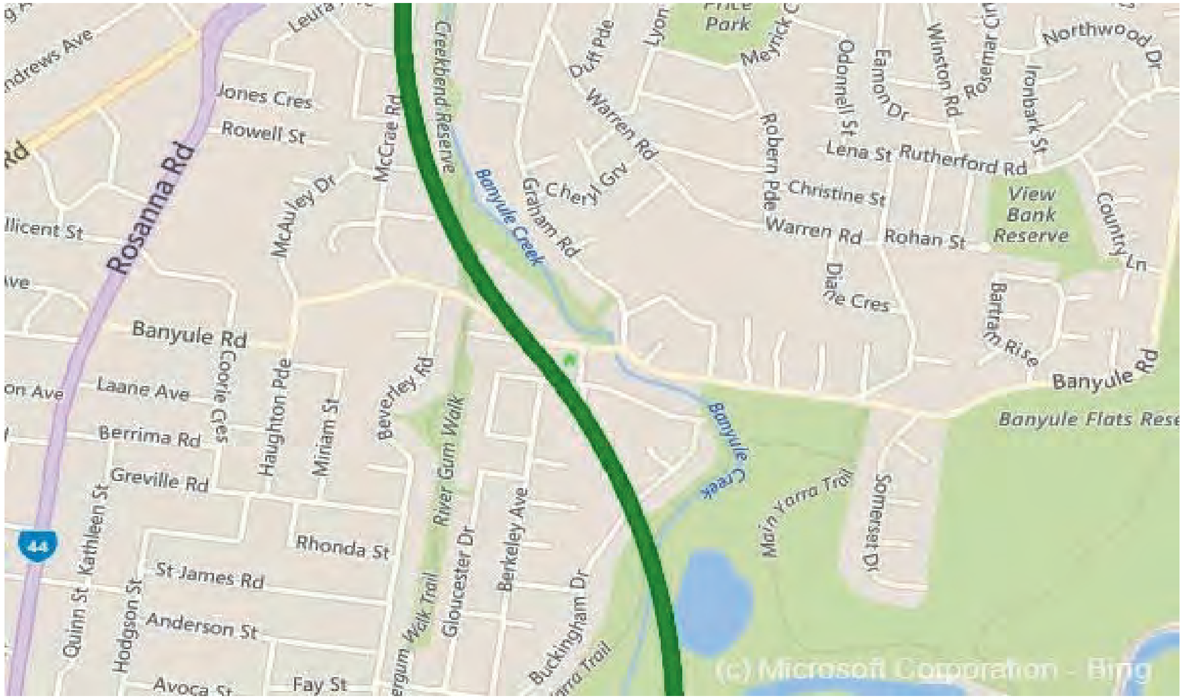
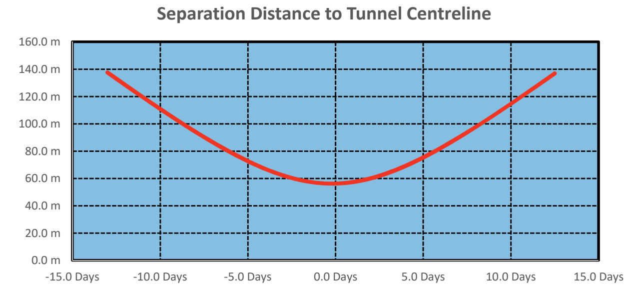
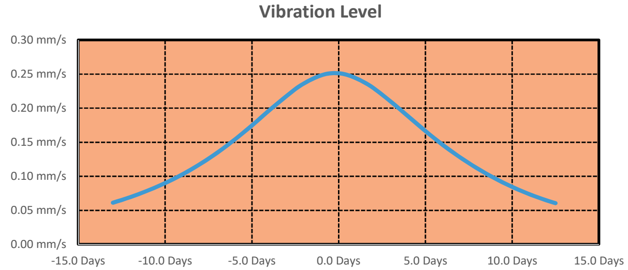
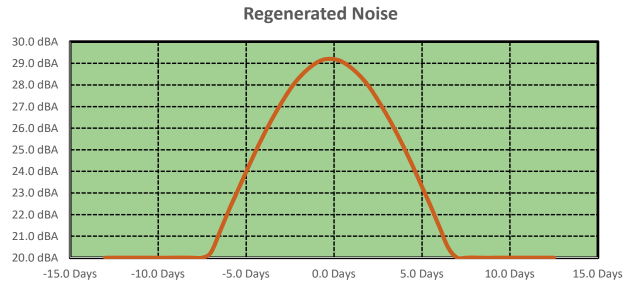
Assessment Location: Scarborough Drive - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	0.2 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	56.1 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.25 mm/s
Maximum Vibration Level	0.25 mm/s
Average Regenerated Noise level	23.0 dBA
90% Regenerated Noise Level	28.7 dBA
95% Regenerated Noise Level	29.0 dBA
Maximum Regenerated Noise Level	29.2 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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NORTH EAST LINK PROJECT

Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

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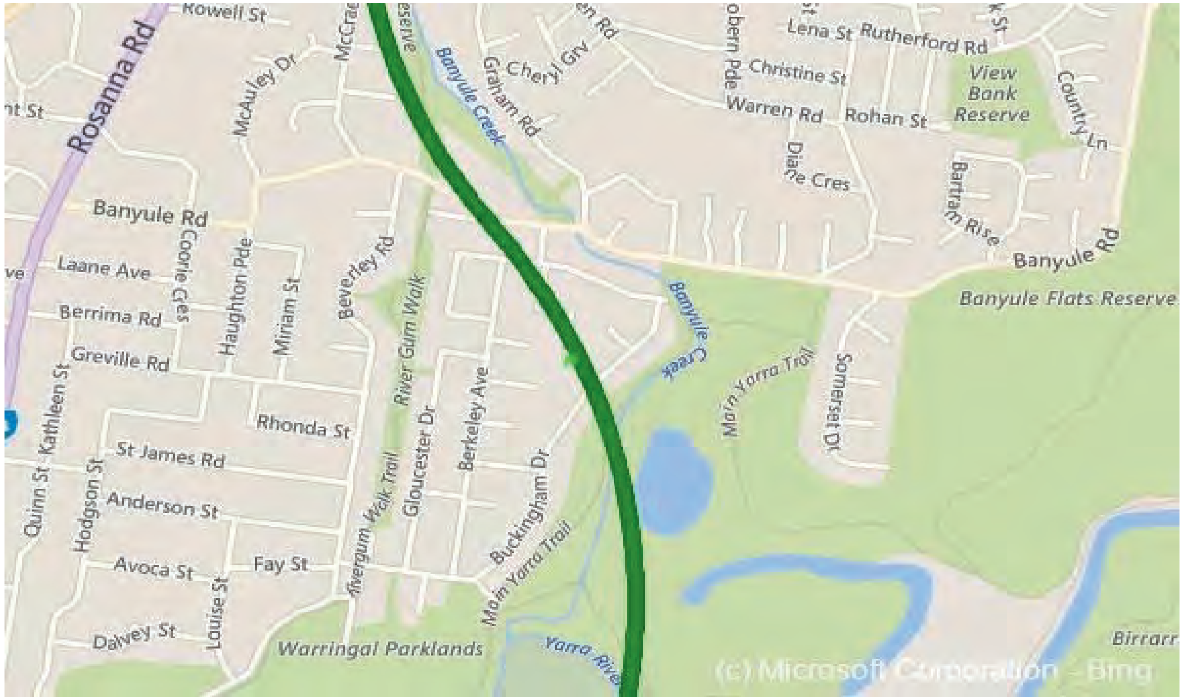
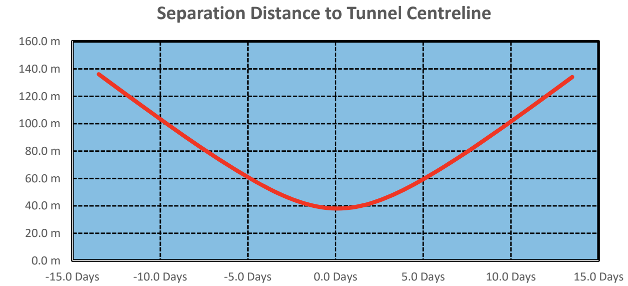
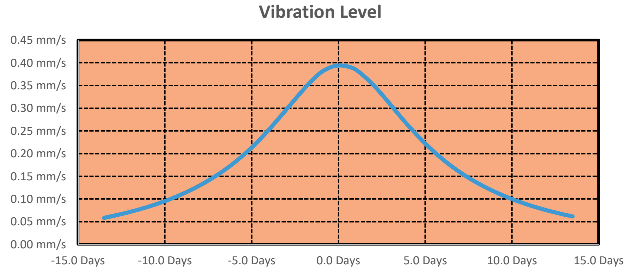
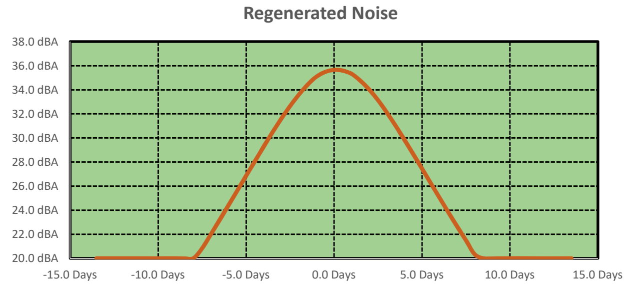
Assessment Location: Sevenoaks Avenue - 1









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.7 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.5 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	38.0 m
Average Vibration Level	0.19 mm/s
90% Vibration Level	0.37 mm/s
95% Vibration Level	0.39 mm/s
Maximum Vibration Level	0.39 mm/s
Average Regenerated Noise level	25.3 dBA
90% Regenerated Noise Level	34.6 dBA
95% Regenerated Noise Level	35.4 dBA
Maximum Regenerated Noise Level	35.7 dBA

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Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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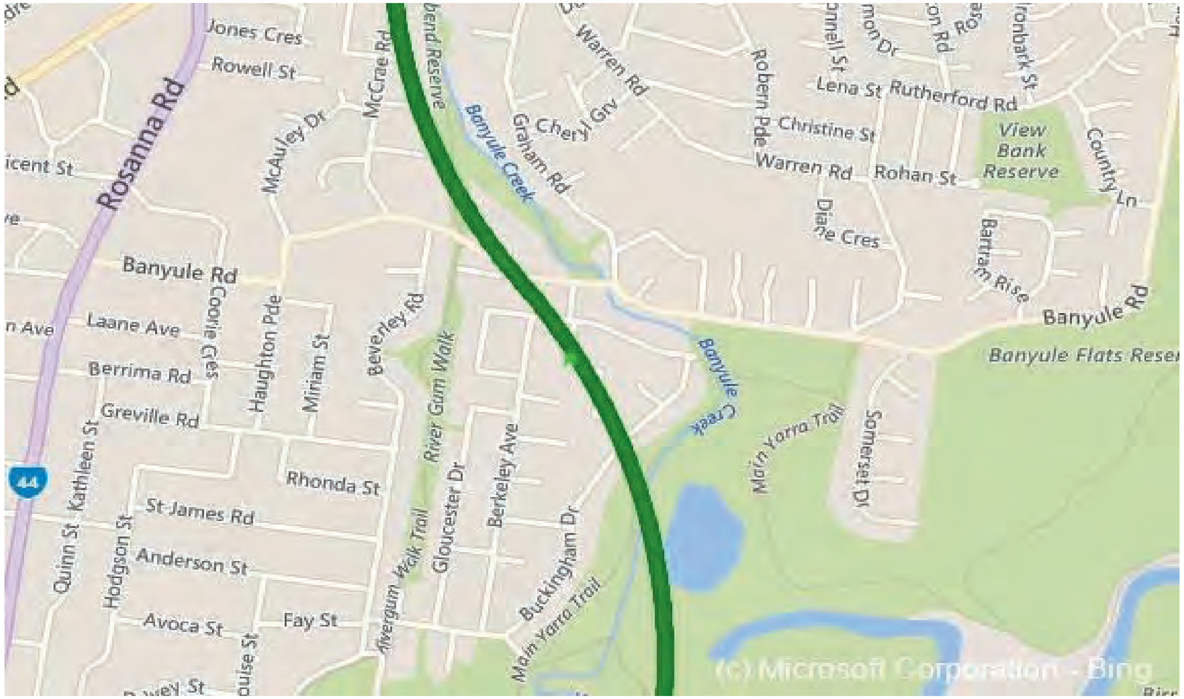
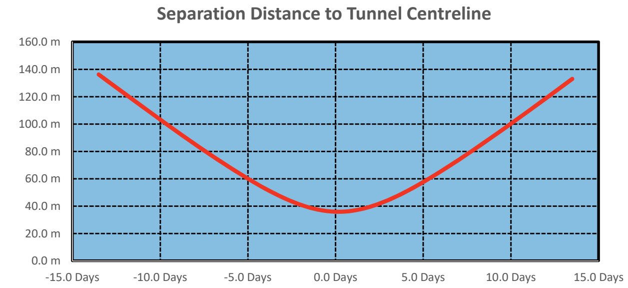
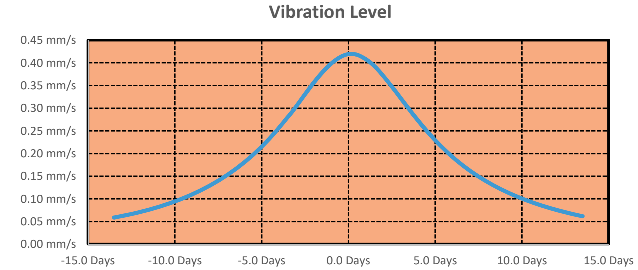
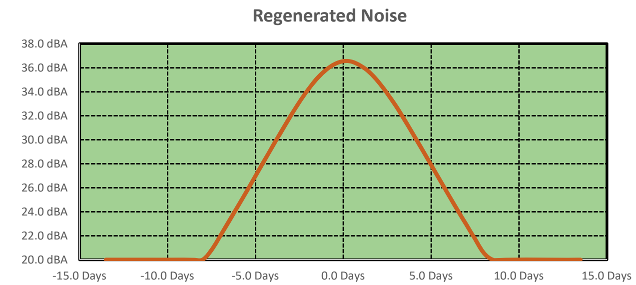
Plate Number		**Date Exported**	24-May-18
Revision History		**Reference**	
V1 - Original		**Job Number**	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Sevenoaks Avenue - 23









Vibration Assessment	Duration
Number of days above 0.25mm/s	1.8 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.7 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	35.9 m
Average Vibration Level	0.20 mm/s
90% Vibration Level	0.39 mm/s
95% Vibration Level	0.41 mm/s
Maximum Vibration Level	0.42 mm/s
Average Regenerated Noise level	25.5 dBA
90% Regenerated Noise Level	35.4 dBA
95% Regenerated Noise Level	36.2 dBA
Maximum Regenerated Noise Level	36.5 dBA

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Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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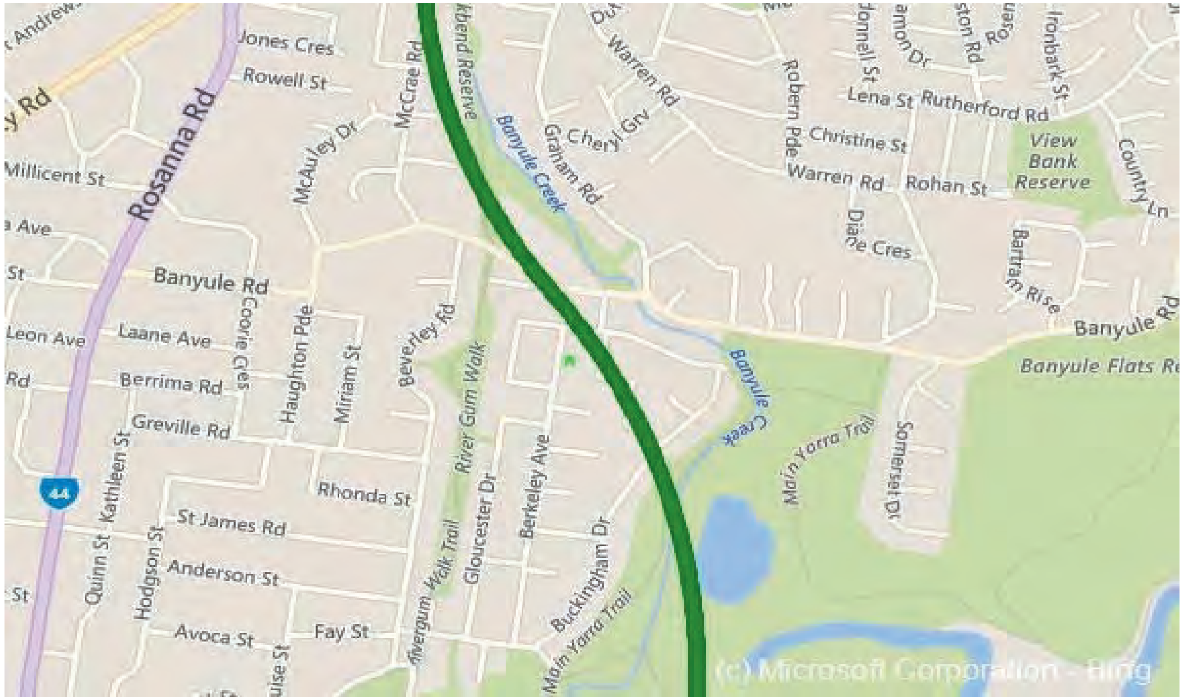
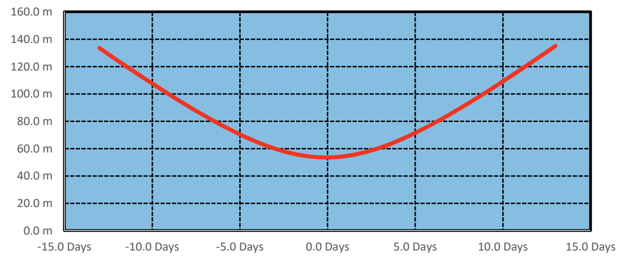
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

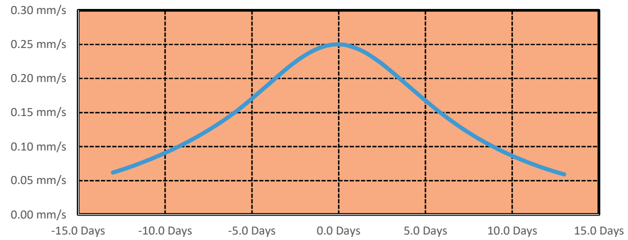
Assessment Location: Sevenoaks Avenue - 31



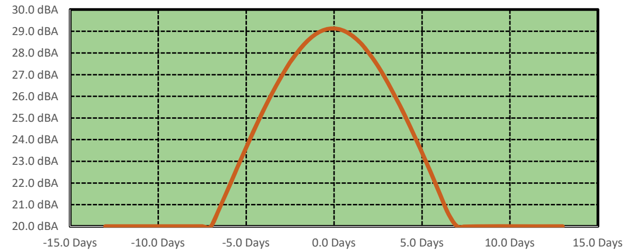
Separation Distance to Tunnel Centreline



Vibration Level



Regenerated Noise



Vibration Assessment	Duration
Number of days above 0.25mm/s	0.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	0.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	53.5 m
Average Vibration Level	0.15 mm/s
90% Vibration Level	0.24 mm/s
95% Vibration Level	0.25 mm/s
Maximum Vibration Level	0.25 mm/s
Average Regenerated Noise level	22.9 dBA
90% Regenerated Noise Level	28.5 dBA
95% Regenerated Noise Level	29.0 dBA
Maximum Regenerated Noise Level	29.1 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Created using TunnelTRAP Software

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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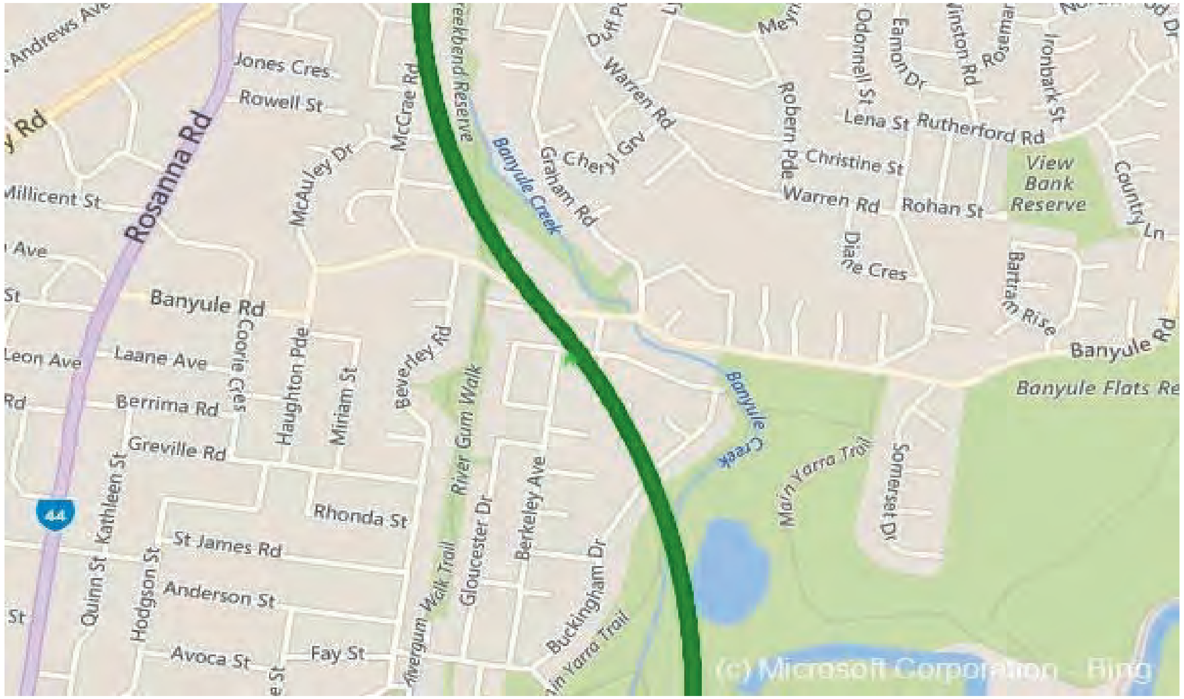
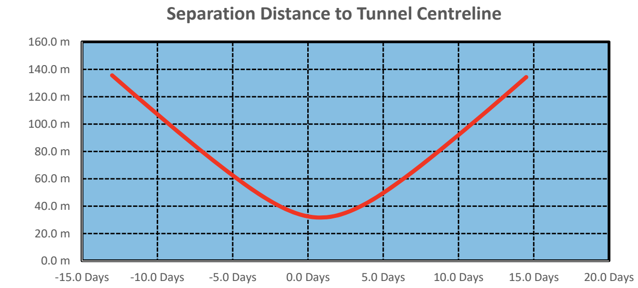
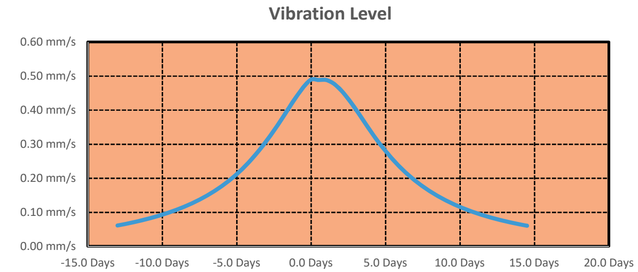
NORTH EAST LINK PROJECT

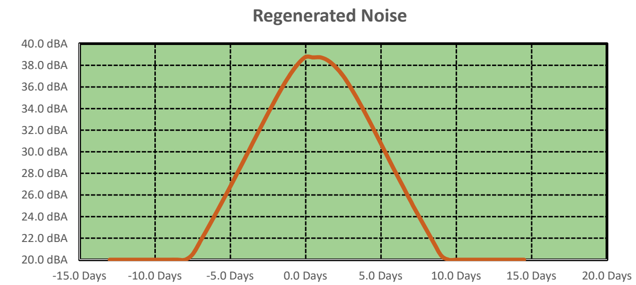
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Assessment Location: Sevenoaks Avenue - 39









Vibration Assessment	Duration
Number of days above 0.25mm/s	2.0 days
Number of days above 0.50mm/s	0.0 days
Number of days above 0.75mm/s	0.0 days
Number of days above 1.00mm/s	0.0 days
Number of days above 1.50mm/s	0.0 days
Regenerated Noise Assessment	**Duration**
Number of days above 35dBA	1.0 days
Number of days above 40dBA	0.0 days
Number of days above 45dBA	0.0 days
Number of days above 50dBA	0.0 days
Number of days above 55dBA	0.0 days

Parameter	Value
Mininum distance to tunnel axis	31.6 m
Average Vibration Level	0.22 mm/s
90% Vibration Level	0.45 mm/s
95% Vibration Level	0.48 mm/s
Maximum Vibration Level	0.49 mm/s
Average Regenerated Noise level	26.4 dBA
90% Regenerated Noise Level	37.5 dBA
95% Regenerated Noise Level	38.5 dBA
Maximum Regenerated Noise Level	38.8 dBA

NOTES: Disturbance envelopes are based upon a nominal advance rate of 10 metres per day. Quicker rates of advance will reduce the overall impact.
The regenerated noise levels are representative of a single storey, hard floor surface dwelling. Variations in the number of storeys, finishings within the property or unusual methods of will affect the level of regenerated noise

Project Description: NORTH EAST LINK - Southbound Tunnel - Effects envelope modelling for property representative of given location for TBM operation at advance rate of 10 metres per day

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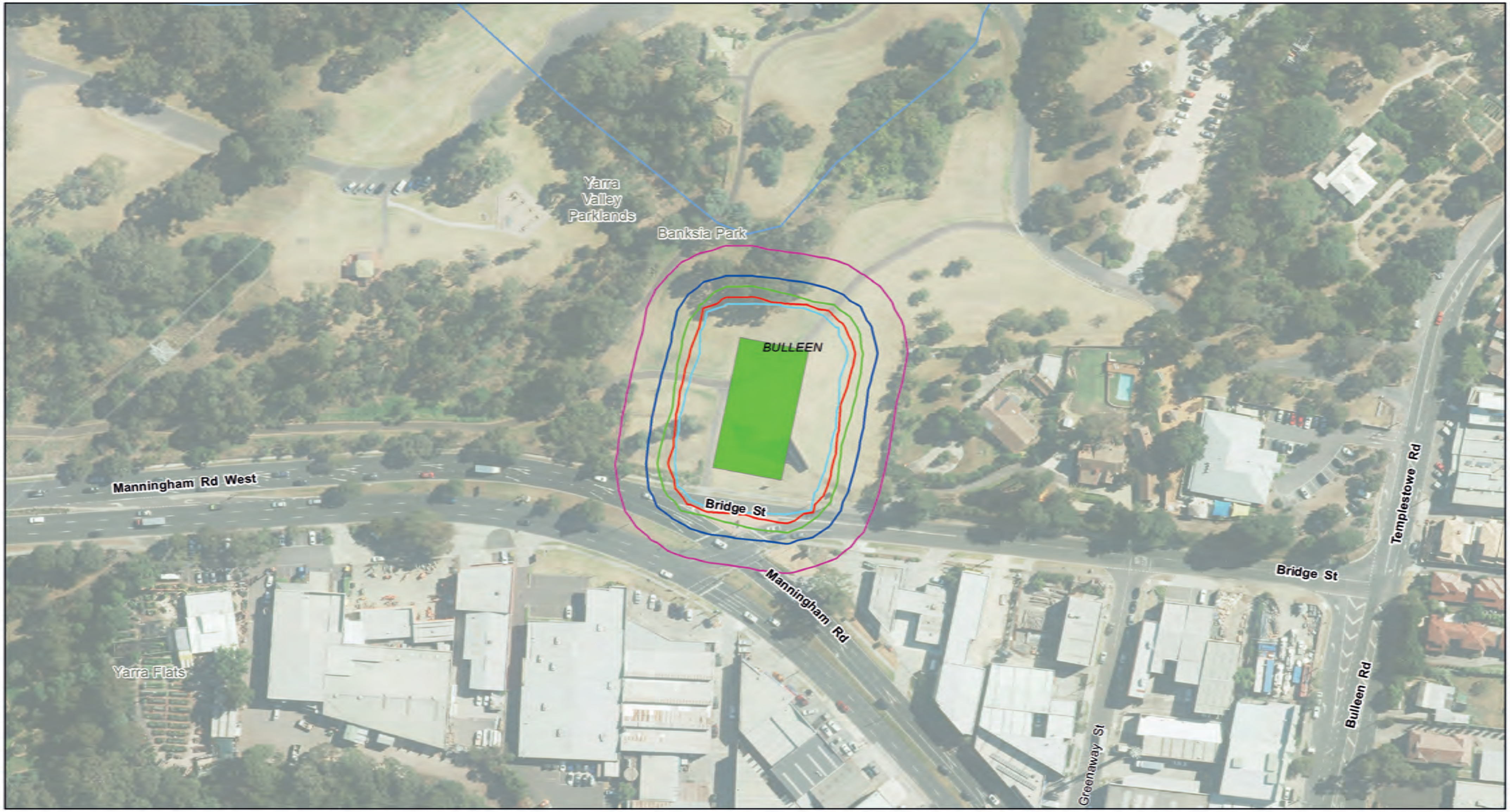
Plate Number		Date Exported	24-May-18
Revision History		Reference	
V1 - Original		Job Number	HP1704-1
		Directory	C:\Heilig & Partners\HP1704-1
		File	

Created using TunnelTRAP Software

Appendix H Predicted vibration and regenerated noise contours for TBM retrieval shafts



Paper Size A4

0 12.5 25 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- TBM Retrieval Shaft
- Stream
- Watercourse

North East Link Project

Job Number	31-35006
Revision	A
Date	18/01/2019

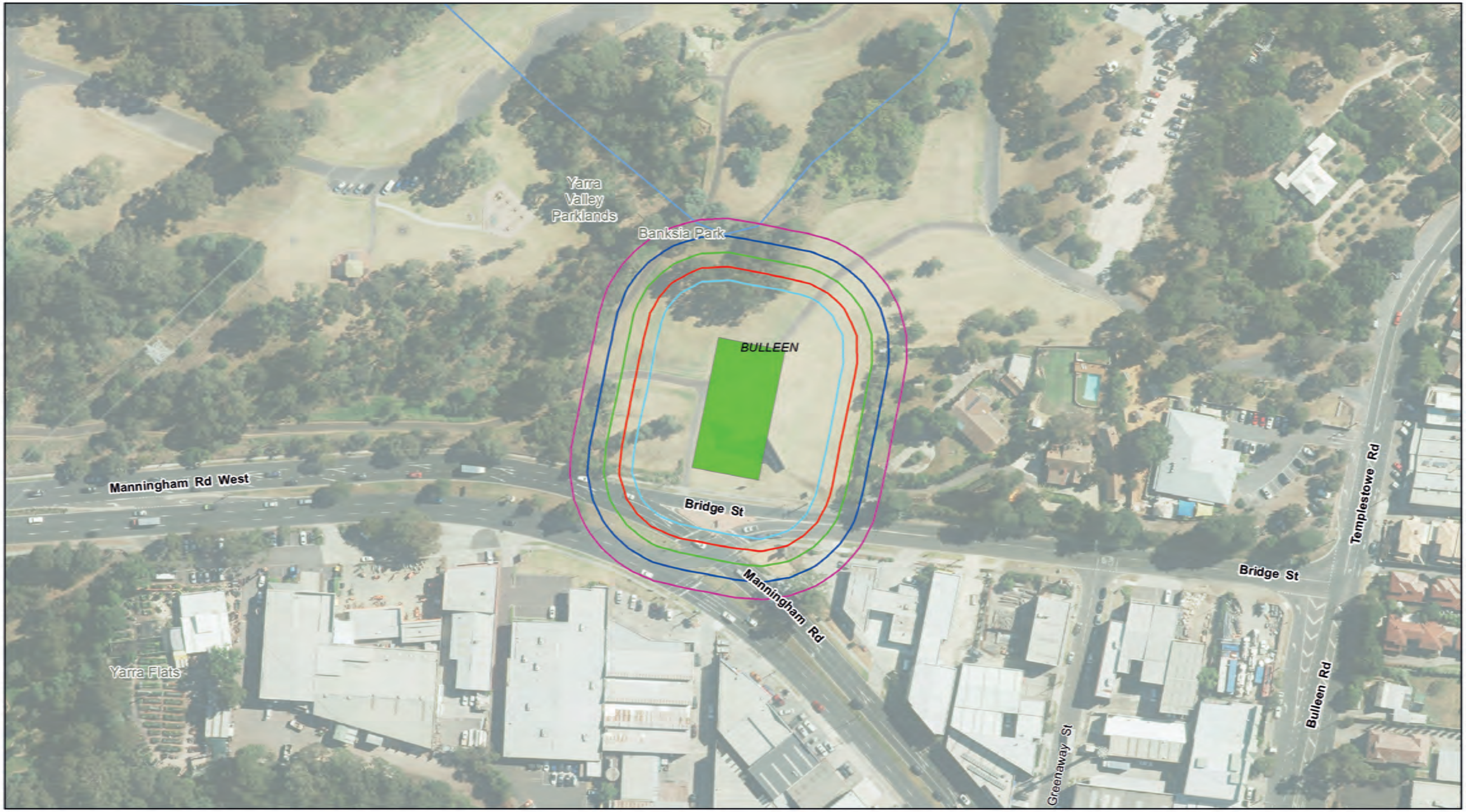
Surface Vibration Shaft 1

Figure 1

G:\31\35006\GIS\Maps\Working\KBM\EES_PER_Technical_Report\EES_Technical_Reports_A4L_CJ.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: CIP Imagery - DELWP - 2018 | roads, watercourses, parks, rail, localities - Vicmap - 2019, Surface vibration - Heilig & Partners -2019 Created by: Cjauniau



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

TBM Retrieval Shaft

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- Stream
- Watercourse

NORTH EAST LINK PROJECT

North East Link Project

Job Number	31-35006
Revision	A
Date	18/01/2019

Regenerated Noise Levels Shaft 1

Figure 2

G:\31\35006\GIS\Maps\Working\KBM\EES_PER_Technical_Report\EES_Technical_Reports_A4L_CJ.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: CIP Imagery - DELWP - 2018 | roads, watercourses, parks, rail, localities - Vicmap - 2019, Regenerated Noise Levels - Heilig & Partners -2019 Created by: Cjauniau

Paper Size A4

0 12.5 25 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Surface Vibration Levels

- 0.5 mm/s Vibration Contour
- 1.0 mm/s Vibration Contour
- 1.5 mm/s Vibration Contour
- 2 mm/s Vibration Contour
- 2.5 mm/s Vibration Contour
- TBM Retrieval Shaft
- Stream
- Watercourse

NORTH EAST LINK PROJECT

North East Link Project

Job Number 31-35006
Revision A
Date 18/01/2019

Surface Vibration Shaft 2

Figure 3

G:\31\35006\GIS\Maps\Working\KBM\EES_PER_Technical_Report\EES_Technical_Reports_A4L_CJ.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: CIP Imagery - DELWP - 2018 | roads, watercourses, parks, rail, localities - Vicmap - 2019, Surface vibration - Heilig & Partners -2019 Created by: Cjauniau

Paper Size A4

0 12.5 25 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Regenerated Noise Levels

- Expected 35dBA Regenerated Noise Contour
- Expected 40dBA Regenerated Noise Contour
- Expected 45dBA Regenerated Noise Contour
- Expected 50dBA Regenerated Noise Contour
- Expected 55dBA Regenerated Noise Contour
- TBM Retrieval Shaft
- Stream
- Watercourse

NORTH EAST LINK PROJECT

North East Link Project

Job Number	31-35006
Revision	A
Date	18/01/2019

Regenerated Noise Levels Shaft 2

Figure 4

G:\31\35006\GIS\Maps\Working\KBM\EES_PER_Technical_Report\EES_Technical_Reports_A4L_CJ.mxd

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Data source: CIP Imagery - DELWP - 2018 | roads, watercourses, parks, rail, localities - Vicmap - 2019, Regenerated Noise Levels - Heilig & Partners -2019 Created by: Cjauniau