



# HEGGIES

REPORT 20-1605-R6

Revision 0

## AIRPORT LINK CHANGED PROJECT NOISE & VIBRATION REPORT

PREPARED FOR

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26 MAY 2008

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*Incorporating*

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# AIRPORT LINK CHANGED PROJECT NOISE & VIBRATION REPORT

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## DOCUMENT CONTROL

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## TABLE OF CONTENTS

1	INTRODUCTION	4
	1.1 Construction	4
	1.2 Operational	4
2	CONSTRUCTION	4
	2.1 Driven Tunnelling	4
	2.2 Spoil Haulage	7
	2.3 Worksites	8
3	OPERATIONAL	10
	3.1 Bowen Hills	10
	3.2 Kedron	11
	3.3 Clayfield	13
4	RECOMMENDATIONS AND CONCLUSIONS	15

Appendix A Regenerated Noise and Vibration Predictions for Driven Tunnelling



## 1 INTRODUCTION

Heggies Pty Ltd (Heggies) has undertaken a review of the successful Brisconnections Airport Link tender design, referred to as the Changed Project in this report. This review has taken into account the information supplied to the State by the preferred tenderer.

The main design changes (in comparison to the Reference Project) with potential noise and vibration implications are:

### 1.1 Construction

1. Changes in the vertical and horizontal alignments for the driven tunnelling sections of the Changed Project.
2. Changes in the spoil haul routes and associated spoil haul truck movements associated with the Changed Project.
3. Changes in the size, location and/or function of work sites associated with the Changed Project.

### 1.2 Operational

Operational road traffic noise impacts were reviewed taking into account:

1. Revised portal area road layouts and preliminary roadside noise barrier design, and
2. Impacts on the greater road network given revised traffic forecasts.

No noise or vibration operational impacts are predicted for the tunnel sections of the Changed Project.

Please note that the barrier designs discussed in this report are subject to modification during the detailed design process. Based on the scenarios modelled to date, it is predicted that compliance with the Coordinator General's (CG) Conditions can be achieved.

## 2 CONSTRUCTION

### 2.1 Driven Tunnelling

The primary reason for the change in noise and vibration impacts for driven tunnelling activities is due to the changed vertical and horizontal alignments of the Changed Project.

Target goals for noise and vibration levels to guide construction planning and management were established in consultation with the EPA and specified in the CG's Conditions. The CG's Conditions also provide that where the goals are likely to be exceeded for a period of time, the Proponent is required to implement mitigation measures to manage the impact on affected residents. These goals and triggers for additional mitigation measures remain relevant and appropriate for the Changed Project.

**Appendix A** outlines the following information for each section of TBM and roadheader driven tunnel:

- The depth of the tunnel crown below existing ground level
- Predicted maximum vibration levels from driven tunnelling and predicted Maximum Instantaneous Charge (MIC) to achieve 10 mm/s blasting goal (blasting applicable to roadheader sections only), OR
- Predicted regenerated noise level from driven tunnelling



- Possible impacts (based on Tables 7 and 62 for vibration and Tables 3 and 68 for regenerated noise from the EIS Noise & Vibration Technical Paper)
- Mitigation recommendations

The Changed Project includes tunnelling works (roadheader and TBM) under Woolloowin State School and in close proximity to the Kedron State High School. The predicted “worst case” regenerated noise and vibration levels at these 2 schools are:

- Woolloowin: Reg. Noise = 38 dBA Vibration = 0.16 mm/s
- Kedron: Reg. Noise = 34 dBA Vibration = 0.18 mm/s

While these may result in detectable regenerated noise and possibly just detectable vibration within classrooms, calculations indicate compliance with the relevant Australian Standards. Predicted vibration levels will be below the range of “low probability of reaction” recommendations in AS2670 *Evaluation of Human Exposure to Whole Body Vibration - Continuous and Shock-induced Vibration in Buildings (1 to 80 Hz)*. Regenerated noise levels comply with internal noise level recommendations in AS2107 *Acoustics - Recommended design sound levels and reverberation times for building interiors*. Importantly, this option does improve the surface works noise impacts at both schools. It does not entirely eliminate the need for heavy mobile construction equipment but less surface works are required and they are further away from the (highest affected) Woolloowin State School.

The changes in predicted vibration and regenerated noise in relation to driven tunnelling for the Changed Project are summarised below:

#### North / South Section (Cedric St to Felix St) - Roadheader

- Vibration
  - Reference Project - 0.006 to 0.08 mm/s - all “not felt”
  - Changed Project - 0.01 to 0.17 mm/s - all “not felt” except for at the southernmost end of the tunnel (where the depth below ground is the least) where vibration would just reach the “threshold of perception”. As for the Reference Project, blasting impacts will require mitigation to achieve an acceptable outcome for the community.
- Regenerated Noise
  - Reference Project - 26 dBA to 46 dBA - all possible impacts either “low” or “very low” except for residences at either end of the tunnels (where depths are least), the Rosemount Hospital and some residences located between Somerset St and Hadfield St where mitigation measures were recommended
  - Changed Project - 32 dBA to 52 dBA - Most residences along the North / South alignment are predicted to receive “moderate to high” impacts (as defined in the EIS), particularly if tunnelling is undertaken at night, and therefore mitigation measures are recommended. The Rosemont Hospital will also require mitigation during tunnelling in this area. Only some commercial properties may require mitigation measures. The primary reason for this change is shallower tunnel depths for the Changed Project, particularly at the southern most end.

#### Kedron Ramps (new to the Changed Project) - Roadheader

- Vibration - 0.02 to 0.2 mm/s - all “not felt”
- Regenerated Noise - 33 dBA to 54 dBA - Most residences in this area are predicted to receive “moderate to high” impacts (as defined in the EIS), particularly if tunnelling is undertaken at night, and therefore mitigation measures are recommended. Only some commercial properties may require mitigation measures. Acceptable noise levels are predicted for the 2 schools in this area.



## East / West Section (Felix St to Kalinga St) – Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM)

- Vibration
  - Reference Project - 0.16 to 0.33 mm/s - all above the “threshold of perception” but likely to be “barely noticeable”
  - Changed Project - 0.2 to 0.7 mm/s - all areas except for the easternmost section of the tunnel are above the “threshold of perception” but likely to be “barely noticeable”. At the easternmost end of the tunnel, vibration levels are predicted to exceed the 0.5 mm/s sleep disturbance goal established for this project. Mitigation measures will likely be required in this area.
- Regenerated Noise
  - Reference Project - 32 dBA to 38 dBA - all possible impacts either “low” or “very low” except at night-time for residences at either end of the tunnels (where depths are least) where mitigation measures were recommended
  - Changed Project - 30 dBA to 44 dBA - very similar to the Reference Design except that potential impacts are only identified at the eastern end of the tunnel (nothing at the western end as with the Reference Design) with predicted levels in this area higher than the Reference Design (again due to the Changed Project having shallower tunnels in this area). Mitigation measure will likely be required in this area.

Consistent with the CG’s Conditions, a vibration management plan will be implemented to ensure the actual regenerated noise and vibration conditions encountered are managed, the data from which will also be used to continually “fine tune” predictive regenerated noise and vibration modelling.

The vibration management plan will include vibration monitoring and a data management system specifically tailored to meet the requirements for the measurement of both blasting and mechanical (TBM and Roadheader) induced vibration. Assessments of predicted and acceptable effects will be undertaken taking into account expected levels of vibration, ground conditions and the expected response of building and other infrastructure to imposed vibrations or settlements. A comprehensive construction noise and vibration management plan will be implemented including the design of construction approaches to consider:



- predicted noise and vibration levels;
- assessment of the likely response to adjacent buildings and their inhabitants/contents to noise and vibration;
- required measures to prevent damage from vibration;
- noise and vibration monitoring, where appropriate;
- property condition monitoring, where appropriate, before, during and after construction;
- liaison with potentially affected property owners;
- community awareness programs; and
- a comprehensive and documented complaints system.

The following list identifies key changes to the Reference Project in relation to noise and vibration:

- Potential noise and vibration impacts along the East-West Tunnel will be reduced by constructing a deeper tunnel in this area and utilising improved rock strata found at depth except at the easternmost end of the tunnel where the tunnel will be shallower than the Reference Design and consequently predicted impacts are higher.
- The noise and vibration resulting from the construction of the ramps at Kedron is considered a significantly decreased impact when compared to the cut and cover works previously detailed in the Reference Project even though mitigation measures may need to be employed, particularly if night-time tunnelling is undertaken.
- Potential noise and vibration impacts along the North-South Tunnel have increased due to the shallower tunnel of the Changed Project however a comprehensive management plan has been proposed with a suite of mitigation options to adequately deal with any adverse impacts.

The only recommended change to the CG's Environmental Approval Conditions is to enhance the definition of tunnel shafts and portals where 24 hour tunnelling noise needs to be contained within an acoustic enclosure, or behind acoustic doors, to protect the local community. This would improve the clarity of this clause and ensure conformity with the intent of this clause.

## 2.2 Spoil Haulage

### ***Overall Truck Usage for Spoil Transport***

The Reference Design found that spoil traffic would generally not increase average traffic noise levels (LA10(18hr)) on spoil routes by more than about 0.5 dBA along major road corridors and would therefore not represent an impact. The Reference Design also indicated that night-time LA10(1hr) noise level changes would not significantly impact on the noise environment, except at O'Connell Terrace and Montpelier Road where the increase may be up to 5.2 dB(A) higher than existing levels. It was suggested that mitigation measures may be required for O'Connell Terrace and Montpelier Road and that any such measures should be negotiated with property owners on a case by case basis.

The Changed Report has shown that there will be an increase by 20-50% in spoil haulage by trucks compared with the Reference Project. This represents a minor increase in noise levels of (approximately) 1 dBA for the 20% increase and (approximately) 2 dBA for the 50% increase over the predictions for the Reference Project. It is likely, therefore, that along most arterial roads the impacts will remain insignificant, particularly given that heavy vehicles already travel along all streets identified for the haul routes both day and night and that the maximum passby noise levels will not increase above those levels that already exist. However, as the frequency of truck passbys will be greater (than existing) during construction, a number of streets may have an increase such that mitigation measures (to be negotiated with land owners) may be required. As in the Reference Design, these will be assessed on a case by case basis.



### ***Use of Alternative (Rode Rd) Northern Truck Route***

Daytime (LA10(18hour)) and night-time (LA10(1hr)) noise predictions have been undertaken for the Alternative Northern Truck Route based on required spoil truck movements for the Changed Project. Predicted changes in noise levels (above existing) for all roads along these 2 routes, either daytime or night-time, are 1 dBA or less and therefore considered negligible.

### ***Use of Local Streets around Worksites***

Spoil haulage along local (eg non arterial) streets, in order to reach the nearest arterial road, is proposed as part of Changed Project at the following worksites:

- Bowen Hills Site – Federation St, Gallway St
- Norman Ave Ramp Access Site– Colton Avenue, Perry St

The use of local streets for spoil haulage is likely to be an annoyance issue for residents during the day time as significant volumes of heavy vehicles is not currently experienced in these areas and as such the function of these local streets will change during periods of spoil haulage.

More significantly, should spoil haulage occur along these local streets at night, which is proposed for the Bowen Hills site but not the other 3 sites, it is predicted that internal noise levels within the adjacent residences will be in excess of both the existing noise environment and the sleep disturbance goals nominated for this project. Mitigation measures such as noise barriers (subject to access requirements), building treatments and/or relocation of residents will likely be required.

### ***Effects of Conveyor***

Noise predictions have been undertaken (using the 3-D SoundPLAN noise model developed for the EIS, updated to include the proposed conveyor as a 'line noise source') to assess the likely noise levels at residences adjacent its proposed route. These predictions have shown that compliance with the CG's Environmental Approval noise goals (Table 6-6: Internal Noise Goals - Night Time Construction) can be achieved at all neighbouring noise sensitive locations through the use of:

- "low" noise or "super low" noise idlers, and/or
- partial or full enclosure of the conveyor system - only partial enclosure is predicted to be required for the "low" and "super low" noise idlers and full enclosure is predicted to be required should conventional idlers be utilised

## **2.3 Worksites**

### **Worksites and Construction**

Further investigation of spoil haulage from the Bowen Hills worksite was undertaken given the proposed 24 hour haulage regime.



Prediction were undertaken with a noise wall separating haulage vehicles and the local residents (along Federation St, Morris St and Galway St). It is predicted that further mitigation measures may be required to achieve acceptable internal noise levels for uninterrupted sleep given that some of the residences in this area are somewhat removed from existing traffic noise from Lutwyche Rd and may not be accustomed to heavy vehicle traffic noise at night. As for the Reference Project, any such measures should be negotiated with property owners on a case by case basis.

### **Kedron Worksites and Construction**

The western site is changed to increase the area of the worksite to the north along the southern bank of Kedron Brook, and also to include an area of land at the current location of the DES swimming pool offices and change rooms to construct a shaft to gain early access to the driven tunnels and associated ramps. An acoustic enclosure will be provided over this Kedron shaft and the spoil stockpile/haul truck loading area to the north of the DES building.

The cut and cover tunnel works across Kedron Brook are proposed for 24 hours per day. Predictions show that construction noise levels will likely exceed the sleep disturbance goals nominated for this project at numerous residences without employing mitigation measures.

Mitigation measures (eg selective use of low noise equipment at night, noise barriers, acoustic enclosures, building treatments or relocation of residents) will therefore be required for these works in order to ensure an acceptable acoustic environment for neighbouring residences.

### **Clayfield Worksites and Construction**

The Changed Project will not require an acoustic shed as such in Kalinga Park west. The TBMs will be assembled and launched within the cut and cover, which will effectively operate as the acoustic enclosure. The surface will be rehabilitated within two years of construction apart from the tunnel roof openings. These openings in Kalinga Park west will be fitted with acoustic doors as horizontally mounted roller doors or drop in panels. The eastern opening of this cut and cover tunnel (which is effectively functioning as an acoustic enclosure) will also have acoustic doors fitted as required to achieve compliance with the CG's Environmental Approvals.

Launching TBMs from Kalinga Park changes the noise environment in the area associated with TBM set up activities. Whilst construction noise associated with setting up the TBMs from this site is different to the Reference Design, other construction noise was anticipated from this worksite for the EIS and all such activities will be limited to daytime hours (6:30am to 6:30pm) until the cut and cover tunnel is intact acoustically. Construction noise barriers are proposed to the north, west and south of this construction site to attenuate construction noise generally.

The spoil conveyor on this work site will not cause an adverse impact as it is contained within the spoil shed on the western side of Sandgate Rd (up to the tunnel portal) and then east of the tunnel portal, a combination of "low noise" idlers and/or enclosure is recommended should the conveyor to the airport be commissioned.

### **Shared Worksites with Northern Busway**

No acoustic shed has been proposed for the new Chalk Street worksite however no driven tunnelling (airborne) noise will emit from the site as both road headers (from the south) and TBMs (from the north) only "break through" at the site. It is proposed that due to its size, removal of the TBM sections will be required at night so that road closures can be arranged. This will likely result in numerous 'short-term' night-time noise impacts and appropriate mitigation measures (other than an acoustic shed) such as extensive community consultation, architectural treatments to properties and/or temporary relocations are recommended to achieve an acceptable outcome. All other construction activity will be limited to daytime (6:30am to 6:30pm) hours.



Due to the very close proximity of the Chalk St shaft (which will require blasting to construct) to the nearest residences, mitigation measures such as limiting the hours during which blasts can occur, blast noise and vibration monitoring, building condition surveys, extensive community consultation and/or temporary relocations are recommended to achieve an acceptable outcome.

More extensive construction activity is proposed at the Changed Project Truro St worksite however an acoustic shed will be constructed for all loading of haul trucks and construction noise barriers are proposed around the entire construction site to attenuate construction noise generally.

### 3 OPERATIONAL

#### 3.1 Bowen Hills

This review included examining revised LA10(18hr) noise predictions at the nearest noise sensitive locations with the proposed noise barriers in place for the Changed Project. The planning goal of 63 dBA LA10(18hr) was used to assess the effect of the Changed Project<sup>1</sup>, except for south of Enoggera Creek where the “status-quo” planning level was used due to high existing noise levels in this area.

Road traffic noise modelling has been undertaken for the Changed Project. Compliance with the Coordinator-General’s conditions of 63 dBA LA10(18hr) and “status quo” noise levels would be achieved in the Windsor-Bowen Hills area with noise mitigation through reasonable and feasible mitigation measures such as noise barriers and the opportunity through normal planning processes for redevelopment to introduce new buildings that act as noise barriers.

In particular, modelling has shown that:

- the Changed Project design reduces noise-related impacts on The Mews apartments, as recommended in the Coordinator-General’s Report<sup>2</sup>, by relocating the O’Connell Terrace connections as a grade-separated connection with Bowen Bridge Road, north of Butterfield Street. There is a consequential reduction in the noise mitigation required (no barrier required for O’Connell Terrace ramps) compared to the Reference Project. Barriers are already provided for the NSBT-ICB connection. Status quo noise levels can be reasonably and feasibly achieved for the Changed Project;
- there are no significant changes from the Reference Project to noise barriers required to achieve “status quo” noise levels at the Tufton Street apartments.
- with appropriate mitigation measures, the Changed Project can achieve the planning noise levels for residences in Northey and Victoria Streets Road affected by traffic noise emanating from the elevated on-ramp (north-bound) over Bowen Bridge Road;
- as for the Reference Project, the Changed Project can achieve the 63 dBA LA10(18hr) for the residential places of Windsor East, including for residences along the proposed new Galloway Street with relocation of the proposed noise barriers for the Reference Project

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<sup>1</sup> This goal is adopted at the Windsor – Bowen Hills portals for non State-controlled roads.

<sup>2</sup> Recommendation 7(e) - Road Network Connections



## Road Network Traffic Noise (Remote from Portals)

Noise predictions showing the upper limit of likely (operational) noise changes arising from the Changed Project are set out in **Table 1**.

Table 1 Effect of 2022 Tunnel Traffic on Noise from Major Southern Surface Connecting Routes

Roadway	Change in LA10 (18hr) Traffic Noise Level Due to Tunnel 2022 (with Northern Busway)
Bradfield Hwy	-0.2
Herston Rd	-1.2
Brunswick St	-5.3
Bowen Bridge Rd	-3.7
Inner City Bypass	1.4
Breakfast Creek Rd	0.2
Kingsford Smith Rd	0.4
Albion Rd/Albion Bypass	-1.0
Northey St	1.2
Newmarket Rd	-1.1

**Table 1** indicates that the expected operational noise changes (both increases and decreases) on the wider road network due to the Changed Project are negligible and unlikely to be noticed by most persons. Changes in noise levels of 2 dBA or less are generally considered to be undetectable to the human ear. The decrease on Bowen Bridge Rd (-3.7 dBA) and Brunswick St (-5.3 dBA) for the Changed Project would generally be considered a “noticeable” positive change as a result of the Changed Project.

### 3.2 Kedron

#### Portal Road Traffic Noise

The review included examining revised LA10(18hr) noise predictions at the nearest noise sensitive locations with the proposed noise barriers in place for the Changed Project. The planning goal of 63 dBA LA10(18hr) was used to assess the effect of the Changed Project, except for north of Kedron Brook, which is a State controlled Road and the 68 dBA LA10(18hr) planning goal applies.

The review of the modelling and assessment of the Changed Project highlighted some differences with the Reference Project in the following areas:

- South of Kedron Brook and west of Lutwyche Rd, the Reference Project recommended 2m to 5m high barriers and the Changed Project has recommends a shorter length of 3m high barrier.
- North of Kedron Brook, east of Gympie Rd and south of Leckie Rd, the Reference Project recommended 2m to 6.5m high barriers and the Changed Project recommends a shorter section of 1.5m to 3m high barrier.
- North of Kedron Brook, east of Gympie Rd and north of Leckie Rd, the Reference Project recommended 4m to 8m high barriers and the Changed Project recommends no barrier, instead recommending architectural treatments at one property.

Revised 3-D operational road traffic noise modelling has been undertaken for the Changed Project design both north and south of Kedron Brook to give confidence that the 63 dBA for south of Kedron Brook (which is non state-controlled road) and 68 dBA LA10(18hr) north of Kedron Brook criteria respectively can be achieved.



This modelling has shown that for the Changed Project:

- The residential area south of Kedron Brook and west of Lutwyche Rd (eg Perry St, Windsor Av, Norman Av area) would require noise barriers in the order of 6m high to achieve the 63 dBA LA10(18hr) criterion.
- The residential area north of Kedron Brook, east of Gympie Rd and south of Leckie Rd (eg Park Tce, Lasseter St and Erskine Av area) would require noise barriers in the order of 3m to 6m high to achieve the 68 dBA LA10(18hr) criterion.
- The residential area north of Kedron Brook, east of Gympie Rd and north of Leckie Rd would require a noise barrier in the order of 6m high to achieve the 68 dBA LA10(18hr) criterion should a barrier be required as a solution through the detailed design phase of the project.

In conclusion, it is expected that compliance with the CG's Environmental (Noise) Conditions of 63 dBA LA10(18hr) and 68 dBA LA10(18hr) noise goals (south and north of Kedron Brook respectively) can be achieved in the Kedron area for the Changed Project with 'reasonable and feasible' noise barriers.

### Road Network Traffic Noise (Remote from Portals)

Noise predictions showing the upper limit of likely (operational) noise changes arising from the Changed Project are set out in Error! Reference source not found.2.

Table 2 Effect of 2022 Tunnel Traffic on Noise from Major Northern Surface Connecting Routes

Roadway	Change in LA10 (18hr) Traffic Noise Level Due to Tunnel 2022 (with Northern Busway)
Stafford Road	1.7
Webster Road	-0.6
Gympie Rd (North of Stafford Rd)	0.8
Leckie Rd	-1.0
Rode Rd (West of Gympie Rd)	0.5
Rode Rd (East of Gympie Rd)	0.2
Lutwyche Rd	-0.2
Park Rd	-1.1
Maygar St	-0.7

**Table 2** indicates that the expected operational noise changes (both increases and decreases) on the wider road network due to the Changed Project are negligible and unlikely to be noticed by most persons. Changes in noise levels of 2 dBA or less are generally considered to be undetectable to the human ear.

### Airport Link Operations Centre (ALOC)

The Changed Project has proposed an ALOC on the northern side of Stafford Rd between Gympie Rd and Clarence Rd. The Change Project resumes the residential properties fronting Stafford Rd in this area to construct the ALOC building which will comprise a visitors centre, offices and a mechanical services department.

3-D modelling has been undertaken with the residences removed and the proposed ALOC building in place to assess Year 2022 operational road traffic noise levels against the 68 dBA LA10(18hr) noise condition for this area. This modelling has shown that no additional noise mitigation (eg noise barriers) will be required to achieve this noise condition.



Noise emissions from the facility itself, primarily mechanical maintenance activities (likely to involve items of equipment similar to a general mechanical workshop) as well as vehicles entering and exiting the carpark have also been preliminarily assessed against the applicable Brisbane City Council's Noise Impact Assessment Planning Scheme Policy noise limits (comparison of like parameters and sleep disturbance). This investigation has shown that noise mitigation will likely be required to achieve acceptable noise limits for emissions from the ALOC facility itself. Such mitigation measures may include appropriate design and siting of the ALOC, limiting/controlling any "after hours" activities, noise barriers or building treatments.

Noise emissions from the ALOC should be further investigated during the detailed design process when specific activities associated with the ALOC and its hours of operation have been finalised.

### 3.3 Clayfield

#### ***Portal Road Traffic Noise***

This review included examining revised LA10(18hr) noise predictions at the nearest noise sensitive locations with the proposed noise barriers in place.

The review of the modelling and assessment east of Sandgate Rd did not highlight any significant differences from the Reference Project and therefore compliance with the 68 dBA LA10(18hr) goal is expected in this area. It is noted that the Reference Project recommended new noise barriers along the southern side of the East West Arterial:

- between 3m and up to 7m high between Sandgate Rd and Widdop St, and
- between 2m and up to 3m high east of Widdop St

The Changed Project has nominated new noise barriers in very similar locations to the Reference Project noise barriers along the southern side of the East West Arterial:

- between 2m and up to 7m high barriers between Sandgate Rd and Widdop St, and
- between 2m and up to 8m high east of Widdop St

West of Sandgate Road, the main line tunnels of the Changed Project would be open to the air for a distance of approximately 70m. The open extent of the connecting ramps from Sandgate Road however, have been reduced from the 180m identified in the Reference Project to approximately 130m for the northern off ramp and 80m for the southern on ramp.

Revised 3-D operational road traffic noise modelling has been undertaken for the Changed Project design west of Sandgate Rd to give confidence that the 63 dBA LA10(18hr) criterion (for new roads) can be achieved in this area given the design changes identified above. This modelling has not taken into account the above ground substation proposed in this area. However, the substation would only serve to further reduce noise levels from the tunnel portal area (as it is located between the road and some of the nearest residences and may, during detailed design, result in a reduction in required noise barriers). Therefore, this assessment is considered conservative.

This modelling has shown that for the residential areas directly south and west of the Airport Link (APL) portal area (eg Kalinga St, Alma Rd, Stuckey Rd and Elliott St), noise barriers in the order of 2m to 5m high (as nominated by the Changed Project) would be required to achieve the 63 dBA LA10(18hr) criterion, as opposed to barriers in the order of 4m to 8m high as proposed in the Reference Project. There are 3 reasons why the noise barrier design in this area has changed from that proposed in the Reference Design.



- the amount of road open to the air proposed by the Changed Project has changed;
- traffic forecasts have changed according to the new design, and
- the closest home to the portal area, which was the most critical at the time of the Reference Project, has been resumed for the sub-station and therefore those homes that remain are now at a greater distance.

In conclusion, it is expected that compliance with the conservative 63 dBA LA10(18hr) west of Sandgate Rd and the 68 dBA LA10(18hr) east of Sandgate Rd can be achieved in the Toombul area for Changed Project with 'reasonable and feasible' noise barriers.

Provided the substation is designed appropriately (during detailed design), noise emissions are not expected to be an issue. As with the ventilation stations, high levels of noise reduction are readily achieved for such facilities through the use of solid building constructions, industrial silencers and acoustic louvers.

### **Road Network Traffic Noise (Remote from Portals)**

Noise predictions showing the upper limit of likely (operational) noise changes arising from the Changed Project are set out in **Table 3**.

Table 3 Effect of 2022 Tunnel Traffic on Noise from Major Eastern Surface Connecting Routes

<b>Roadway</b>	<b>Change in LA10 (18hr) Traffic Noise Level Due to Tunnel 2022 (with Northern Busway)</b>
Sandgate Rd (North of East/West Arterial Rd)	-0.3
Sandgate Rd (South of East/West Arterial Rd - North of Junction Rd)	-1.2
Sandgate Rd (South of Junction Rd)	-1.2
Melton Rd	-0.9
East-West Arterial Rd	1.5
Nudgee Rd (North of East/West Arterial Rd)	-1.2
Nudgee Rd (South of East/West Arterial Rd)	1.5
Zillman Road	-0.4
Junction Rd/Rose St	-0.9

**Table 3** indicates that the expected operational noise changes (both increases and decreases) on the wider road network due to the Changed Project are negligible and unlikely to be noticed by most persons. Changes in noise levels of 2 dBA or less are generally considered to be undetectable to the human ear.



## 4 RECOMMENDATIONS AND CONCLUSIONS

### Construction

A detailed Noise and Vibration Environmental Management Plan (EMP) needs to be developed to ensure compliance with the CG's noise conditions. Issues that need to be specifically addressed in this EMP, additional to those issues identified in the EIS, are:

- spoil haulage on nominated local streets
- 24 hour construction across Kedron Brook
- acoustic enclosure of all tunnel shafts where 24 hour tunnelling is required

Based on the mitigation options nominally proposed by the proponents of the Changed Project (generally listed below), an acceptable Noise and Vibration EMP can be achieved.

- community consultation
- construction noise barriers/enclosures
- noise and vibration monitoring programs
- limiting hours of construction activity and/or certain items of plant
- building treatments
- relocation of residents

### Operational

During detailed design, 3-D noise modelling should be undertaken to ensure the CG's (external) noise conditions (either 63 dBA LA10(10hr) for non state-controlled roads, 68 dBA LA10(10hr) for state controlled roads and "status quo" where existing levels already significantly exceed the 63/68 dBA conditions) are achieved through the use of noise barriers (where reasonable and feasible to do so).

Based on the modelling undertaken for the Changed Project, this is likely to be achievable.

Further investigations of noise emissions from the proposed ALOC should also be undertaken during detailed design to ensure an acceptable acoustic environment for neighbouring residential properties.

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 1 Road Header Tunnelling Vibration Summary – North / South Section (Cedric Street to Felix Street) - Properties on Eastern Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Vibration Level, or Indicative max. Blast MIC</b>	<b>Guide Value (G) or Statutory Limit (L) for cosmetic damage</b>	<b>Possible Impact</b>	<b>Mitigation</b>
Gallway St to Cartwright St	Hospital	8.9m – 22.4m	Roadheader	0.03 to 0.17mm/s	5 mm/s (G)	TP	
			Blasting	0.15 kg	10 mm/s (L)	SN, CC	P, BCS, M
Cartwright St to Somerset St	Residential Commercial	21.2m – 26.8m	Roadheader	0.02 to 0.04mm/s	5 mm/s (G)	NF	
			Blasting	0.73 kg	10 mm/s (L)	SN, CC	P, BCS, M
Somerset St to Thondley St	Residential Commercial	15.3m – 28.5m	Roadheader	0.02 to 0.07mm/s	5 mm/s (G)	NF	
			Blasting	0.38 kg	10 mm/s (L)	SN, CC	P, BCS, M
Thondley St to Ada St	Residential Commercial	20.2m – 27.4m	Roadheader	0.02 to 0.04 mm/s	5 mm/s (G)	NF	
				0.66 kg	10 mm/s (L)	SN, CC	P, BCS, M
Ada St to Lowerson St	Residential Commercial	17.4m – 29.1m	Roadheader	0.02 to 0.05 mm/s	5 mm/s (G)	NF	
			Blasting	0.49 kg	10 mm/s (L)	SN, CC	P, BCS, M
Lowerson St to Felix St	Residential Commercial	22.5m – 27.3m	Roadheader	0.02 to 0.03 mm/s	5 mm/s (G)	NF	
			Blasting	0.82 kg	10 mm/s (L)	SN, CC	P, BCS, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 2 Road Header Tunnelling Vibration Summary – North / South Section (Cedric Street to Felix Street) - Properties on Western Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Vibration Level</b>	<b>Guide Value (G) or Statutory Limit (L) for cosmetic damage</b>	<b>Possible Impact</b> NF - Not felt TP - Threshold of perception BN - Barely noticeable SD – Sleep Disturbance N - Noticeable EN - Easily noticeable SN - Strongly noticeable VSN - Very strongly noticeable	<b>Mitigation</b> P = pre notification BCS = building condition survey BSS = building sensitive study M = monitoring
Gallway St to Cartwright St	Residential Commercial	15.4m – 30.7m	Roadheader	0.02 to 0.06 mm/s	5 mm/s (G)	NF	
			Blasting	0.39 kg	10 mm/s (L)	SN, CC	P, BCS, M
Cartwright St to Somerset St	Commercial	21.5m – 33.9m	Roadheader	0.02 to 0.04 mm/s	5 mm/s (G)	NF	
			Blasting	0.75 kg	10 mm/s (L)	SN, CC	P, BCS, M
Somerset St to Thondley St	Residential School	15.3m – 38.6m	Roadheader	0.01 to 0.07 mm/s	5 mm/s (G)	NF	
			Blasting	0.38 kg	10 mm/s (L)	SN, CC	P, BCS, M
Thondley St to Ada St	Residential Commercial	18.3m – 36.0m	Roadheader	0.01 to 0.05 mm/s	5 mm/s (G)	NF	
			Blasting	0.54 kg	10 mm/s (L)	SN, CC	P, BCS, M
Ada St to Lowerson St	Residential Commercial Religious	18.4m – 33.2m	Roadheader	0.02 to 0.05 mm/s	5 mm/s (G)	NF	
			Blasting	0.55 kg	10 mm/s (L)	SN, CC	P, BCS, M
Lowerson St to Felix St	Commercial	24m – 28.9m	Roadheader	0.02 to 0.03 mm/s	5 mm/s (G)	NF	
			Blasting	0.94 kg	10 mm/s (L)	SN, CC	P, BCS, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 3 Road Header Tunnelling Regenerated Noise Summary – North / South Section (Cedric Street to Felix Street) - Properties on Eastern Side of the Tunnel

Tunnel Section	Type of Building	Depth of Tunnel Crown	Excavation Method	Indicative max. Regenerated Noise Level (dBA)	AS/NZS 2107 Max. Guide Value - Internal Noise Levels (dBA)	Possible Impact <sup>1</sup> Very Low: > 5 dBA below criteria Low: Criteria to criteria – 5dBA Moderate: Low to criteria + 5dBA High: > criteria + 5dBA equates to sleep disturbance for residential properties	Mitigation P = pre-notification M = monitoring
Gallway St to Cartwright St	Hospital	8.9m – 22.4m	Roadheader	39 dBA to 52 dBA	40 day	Low to High	P, M
Cartwright St to Somerset St	Residential Commercial	21.2m – 26.8m	Roadheader	37 dBA to 40 dBA	40 Day 35 Night 45 dBA to 50 dBA	Moderate Very Low	P, M
Somerset St to Thondley St	Residential Commercial	15.3m – 28.5m	Roadheader	36 dBA to 44 dBA	40 day 35 Night 45 dBA to 50 dBA	Moderate to High Moderate (just)	P, M P, M
Thondley St to Ada St	Residential Commercial School	20.2m – 27.4m	Roadheader	37 dBA to 41 dBA	40 day 35 Night 45 dBA to 50 dBA 45 dBA	Moderate to High Low Low	P, M P P, M
Ada St to Lowerson St	Residential Commercial	17.4m – 29.1m	Roadheader	36 dBA to 43 dBA	40 day 35 night 45 dBA to 50 dBA	Moderate to High Low	P, M P
Lowerson St to Felix St	Residential Commercial	22.5m – 27.3m	Roadheader	37 dBA to 39 dBA	40 day 35 Night 45 dBA to 50 dBA	Low to Moderate Very Low	P, M

<sup>1</sup> For the most exposed rooms in many of the homes along the Bowen Bridge Rd/Lutwyche Rd corridor, this possible impact may be conservative as some masking of regenerated noise from tunnelling is likely due to internal road traffic noise levels attributable to this major road corridor

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 4 Road Header Tunnelling Regenerated Noise Summary – North / South Section (Cedric Street to Felix Street) - Properties on Western Side of the Tunnel

Tunnel Section	Type of Building	Depth of Tunnel Crown	Excavation Method	Indicative max. Regenerated Noise Level (dBA)	AS/NZS 2107 Max. Guide Value - Internal Noise (dBA)	Possible Impact <sup>1</sup> Very Low: > 5 dBA below criteria Low: Criteria to criteria – 5dBA Moderate: Low to criteria + 5dBA High: > criteria + 5dBA equates to sleep disturbance for residential properties	Mitigation P = pre-notification M = monitoring
Gallway St to Cartwright St	Residential Commercial	15.4m – 30.7m	Roadheader	35 dBA to 44 dBA	40 day 35 night 45 dBA to 50 dBA	Moderate to High Low	P, M P
Cartwright St to Somerset St	Commercial	21.5m – 33.9m	Roadheader	34 dBA to 40 dBA	45 dBA to 50 dBA	Very Low	
Somerset St to Thondley St	Residential School	15.3m – 38.6m	Roadheader	32 dBA to 44 dBA	40 day 35 night 45 dBA	Moderate to High Low	P, M P, M
Thondley St to Ada St	Residential Commercial	18.3m – 36.9m	Roadheader	33 dBA to 42 dBA	40 day 35 night 45 dBA to 50 dBA	Moderate to High Low	P, M P
Ada St to Lowerson St	Residential Commercial	18.4m – 33.2m	Roadheader	34 dBA to 42 dBA	40 day 35 night 45 dBA to 50 dBA	Moderate to High Low	P, M P
Lowerson St to Felix St	Commercial	24m – 28.9m	Roadheader	36 dBA to 38 dBA	45 dBA to 50 dBA	Very Low	-

<sup>1</sup> For the most exposed rooms in many of the homes along the Bowen Bridge Rd/Lutwyche Rd corridor, this possible impact may be conservative as some masking of regenerated noise from tunnelling is likely due to internal road traffic noise levels attributable to this major road corridor

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 5 TBM Tunnelling Vibration Summary – East / West Section (Felix Street to Kalinga Street) - Properties on Southern Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Vibration Level</b>	<b>Guide Value (G) or Statutory Limit (L) for cosmetic damage</b>	<b>Possible Impact</b> NF - Not felt TP - Threshold of perception BN - Barely noticeable SD - Sleep Disturbance N - Noticeable EN - Easily noticeable SN - Strongly noticeable VSN - Very strongly noticeable	<b>Mitigation</b> P = pre notification BCS = building condition survey BSS = building sensitive study M = monitoring
Felix St to Norman St	Residential	27.3m-35.8m	EPB	0.2 mm/s	5 mm/s (G)	TP	-
Norman St to Gorman St	Residential	34.5m-43.6m	EPB	0.1 to 0.2 mm/s	5 mm/s (G)	TP	-
Gorman St to Roseleigh St	Residential	31.1m – 34.2m	EPB	0.2 mm/s	5 mm/s (G)	TP	-
Roseleigh St to Dawson St	Residential	23.7m – 31.6m	EPB	0.2 mm/s	5 mm/s (G)	TP	-
Dawson St to Park Ave	Residential	19.2m – 24.7m	EPB	0.2 to 0.3 mm/s	5 mm/s (G)	TP (approaching BN)	-
Park Ave to Kalinga St	Residential	7.9m – 18.3m	EPB	0.3 to 0.7 mm/s	5 mm/s (G)	SD	P, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 6 TBM Tunnelling Vibration Summary – East / West Section (Felix Street to Kalinga St) - Properties on Northern Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Vibration Level</b>	<b>Guide Value (G) or Statutory Limit (L) for cosmetic damage</b>	<b>Possible Impact</b> NF - Not felt TP - Threshold of perception BN - Barely noticeable SD - Sleep Disturbance N - Noticeable EN - Easily noticeable SN - Strongly noticeable VSN - Very strongly noticeable	<b>Mitigation</b> P = pre notification BCS = building condition survey BSS = building sensitive study M = monitoring
Felix St to Norman St	Residential	28.9m-36.4m	EPB	0.2 mm/s	5 mm/s (G)	TP	-
Norman St to Gorman St	Residential School	33.7m-44.0m	EPB	0.1 to 0.2mm/s	5 mm/s (G)	TP	-
Gorman St to Roseleigh St	Residential	31.2m – 33.7m	EPB	0.2 mm/s	5 mm/s (G)	TP	-
Roseleigh St to Dawson St	Residential	23.6m – 31.2m	EPB	0.2 to 0.3 mm/s	5 mm/s (G)	TP (approaching BN)	-
Dawson St to Park Ave	Residential	19.1m – 25.1m	EPB	0.2 to 0.3mm/s	5 mm/s (G)	TP (approaching BN)	-
Park Ave to Kalinga St	Residential	8.4m – 17.9m	EPB	0.3 to 0.6 mm/s	5 mm/s (G)	SD	P, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 7 TBM Tunnelling Regenerated Noise Summary – East / West Section (Felix Street to Kalinga Street) - Properties on Southern Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Regenerated Noise Level (dBA)</b>	<b>AS/NZS 2107 Max. Guide Value (dBA)</b>	<b>Possible Impact</b> Very Low: > 5 dBA below criteria Low: Criteria to criteria – 5dBA Moderate: Low to criteria + 5dBA High: > criteria + 5dBA equates to sleep disturbance for residential properties	<b>Mitigation</b> P = pre-notification M = monitoring
Felix St to Norman St	Residential	27.3m-35.8m	EPB	32 dBA to 34 dBA	40 day, 35 night	Low	P
Norman St to Gorman St	Residential	34.5m-43.6m	EPB	30 dBA to 32 dBA	40 day, 35 night	Low	P
Gorman St to Roseleigh St	Residential	31.1m – 34.2m	EPB	32 dBA to 33 dBA	40 day 35 night	Low	P
Roseleigh St to Dawson St	Residential	23.7m – 31.6m	EPB	33 dBA to 35 dBA	40 day and 35 night	Low	P
Dawson St to Park Ave	Residential	19.2m – 24.7m	EPB	35 dBA to 37 dBA	40 day and 35 night	Low to Moderate	P, M
Park Ave to Kalinga St	Residential	7.9m – 18.3m	EPB	37 dBA to 44 dBA	40 day and 35 night	High	P, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 8 TBM Tunnelling Regenerated Noise Summary – East / West Section (Felix Street to Kalinga St) - Properties on Northern Side of the Tunnel

<b>Tunnel Section</b>	<b>Type of Building</b>	<b>Depth of Tunnel Crown</b>	<b>Excavation Method</b>	<b>Indicative max. Regenerated Noise Level (dBA)</b>	<b>AS/NZS 2107 Max. Guide Value (dBA)</b>	<b>Possible Impact</b> Very Low: > 5 dBA below criteria Low: Criteria to criteria – 5dBA Moderate: Low to criteria + 5dBA High: > criteria + 5dBA equates to sleep disturbance for residential properties	<b>Mitigation</b> P = pre-notification M = monitoring
Felix St to Norman St	Residential	28.9m-36.4m	EPB	32 dBA to 33 dBA	40 day, 35 night	Low	P
Norman St to Gorman St	Residential School	33.7m-44.0m	EPB	30 dBA to 33 dBA	40 day, 35 night 45 dBA	Low Very Low	P -
Gorman St to Roseleigh St	Residential	31.2m – 33.7m	EPB	32 dBA to 33 dBA	40 day, 35 night	Low	P
Roseleigh St to Dawson St	Residential	23.6m – 31.2m	EPB	33 dBA to 35 dBA	40 day, 35 night	Low	P
Dawson St to Park Ave	Residential	19.1m – 25.1m	EPB	35 dBA to 37 dBA	40 day, 35 night	Moderate	P, M
Park Ave to Jackson St	Residential	8.4m – 17.9m	EPB	37 dBA to 43 dBA	40 day, 35 night	High	P, M

## Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 9 Road Header Tunnelling Vibration Summary – Kedron ‘North West Connection’ Tunnel Ramps

Tunnel Section	Type of Building	Depth of Tunnel Crown	Excavation Method	Indicative max. Vibration Level,	Guide Value (G) or Statutory Limit (L) for cosmetic damage	Possible Impact NF - Not felt TP - Threshold of perception BN - Barely noticeable SD – Sleep Disturbance N - Noticeable EN - Easily noticeable SN - Strongly noticeable VSN - Very strongly noticeable CC = cosmetic cracking	Mitigation P = pre notification BCS = building condition survey BSS = building sensitive study M = monitoring
Northbound Off-Ramp to Gympie Rd - Chalk St to Felix St	Residential	23.0m – 25.5m	Roadheader	0.03 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.86 kg	10 mm/s (L)	SN, CC	P, BCS, M
Northbound Off-Ramp to Gympie Rd - Felix St to Norman St	Residential	16.0m – 22.4m	Roadheader	0.03 to 0.06 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.42 kg	10 mm/s (L)	SN, CC	P, BCS, M
Southbound On-Ramp from Gympie Rd - Kedron Park Rd to Norman St	Residential	13.2m – 26.0m	Roadheader	0.03 to 0.08 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.28 kg	10 mm/s (L)	SN, CC	P, BCS, M
	School						
Southbound On-Ramp from Gympie Rd - Norman St to Bradshaw St	Residential	21.4m – 24.5m	Roadheader	0.03 to 0.04 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.74 kg	10 mm/s (L)	SN, CC	P, BCS, M

## Appendix A

Report 20-1605-R6  
Page 10 of 12

### Regenerated Noise and Vibration Predictions for Driven Tunnelling

Eastbound On-Ramp from Gympie Rd - Kedron Park Rd to Kedron Park Rd	Residential	16.1m – 28.4m	Roadheader	0.02 to 0.06 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.42 kg	10 mm/s (L)	SN, CC	P, BCS, M
Eastbound On-Ramp from Gympie Rd - Kedron Park Rd to Park Rd	Residential	28.4m – 35.3m	Roadheader	0.02 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	1.31 kg	10 mm/s (L)	SN, CC	P, BCS, M
Westbound Off-Ramp to Gympie Rd - Eveleigh St to Kedron Park Rd	Residential	20.1m – 32.8m	Roadheader	0.02 to 0.04 mm/s	5 mm/s (G)	NF	-
	Commercial		Blasting	0.66 kg	10 mm/s (L)	SN, CC	P, BCS, M
South Ramp Kedron Park Rd to Lutwyche Rd	Residential	7.2m – 20.1m	Roadheader	0.04 to 0.2 mm/s	5 mm/s (G)	TP	-
	Commercial		Blasting	0.08 kg	10 mm/s (L)	SN, CC	P, BCS, M

Regenerated Noise and Vibration Predictions for Driven Tunnelling

Table 10 Road Header Tunnelling Regenerated Noise Summary – Kedron ‘North West Connection’ Tunnel Ramps

Tunnel Section	Type of Building	Depth of Tunnel Crown	Excavation Method	Indicative max. Regenerated Noise Level (dBA)	AS/NZS 2107 Max. Guide Value - Internal Noise (dBA)	Possible Impact <sup>1 1</sup> Very Low: > 5 dBA below criteria Low: Criteria to criteria – 5dBA Moderate: Low to criteria + 5dBA High: > criteria + 5dBA equates to sleep disturbance for residential properties	Mitigation P = pre-notification M = monitoring
Northbound Off-Ramp to Gympie Rd - Chalk St to Felix St	Residential	23.0m – 25.5m	Roadheader	38 dBA to 39 dBA	40 day, 35 night	Low to Moderate	P, M
	Commercial				45 dBA to 50 dBA	Very Low	-
Northbound Off-Ramp to Gympie Rd - Felix St to Norman St	Residential	16.0m – 22.4m	Roadheader	39 dBA to 44 dBA	40 day, 35 night	High	P, M
	Commercial				45 dBA to 50 dBA	Low	P
Southbound On-Ramp from Gympie Rd - Kedron Park Rd to Norman St	Residential	13.2m – 26.0m	Roadheader	37 dBA to 46 dBA	40 day, 35 night	High	P, M
	Commercial				45 dBA to 50 dBA	Low to Moderate	P, M
	School				45 dBA	Very low	P, M
Southbound On-Ramp from Gympie Rd - Norman St to Bradshaw St	Residential	21.4m – 24.5m	Roadheader	38 dBA to 40 dBA	40 day, 35 night	Moderate	P, M
	Commercial				45 dBA to 50 dBA	Very Low	-

## Appendix A

Report 20-1605-R6

Page 12 of 12

### Regenerated Noise and Vibration Predictions for Driven Tunnelling

Eastbound On-Ramp from Gympie Rd - Kedron Park Rd to Kedron Park Rd	Residential	16.1m – 28.4m	Roadheader	36 dBA to 44 dBA	40 day, 35 night	High	P, M
	Commercial				45 dBA to 50 dBA		Low
Eastbound On-Ramp from Gympie Rd - Kedron Park Rd to Park Rd	Residential	28.4m – 35.3m	Roadheader	33 dBA to 36 dBA	40 day, 35 night	Low to Moderate	P, M
	Commercial				45 dBA to 50 dBA		Very Low
Westbound Off-Ramp to Gympie Rd - Eveleigh St to Kedron Park Rd	Residential	20.1m – 32.8m	Roadheader	34 dBA to 41 dBA	40 day, 35 night	High	P, M
	Commercial				45 dBA to 50 dBA		Low
Westbound Off-Ramp to Gympie Rd - Kedron Park Rd to Lutwyche Rd	Residential	7.2m – 20.1m	Roadheader	41 dBA to 54 dBA	40 day, 35 night	High	P, M
	Commercial				45 dBA to 50 dBA		High

<sup>1</sup> For the most exposed rooms in many of the homes along the Bowen Bridge Rd/Lutwyche Rd corridor, this possible impact may be conservative as some masking of regenerated noise from tunnelling is likely due to internal road traffic noise levels attributable to this major road corridor