DELIVERING OUR TRANSPORT FUTURE NOW

north-south corridor

northern connector

Project Impact Report

An environmental, social and economic assessment

Technical Reports

Government of South Australia
Department for Transport, Energy and Infrastructure

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Noise and vibration

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Project Impact Report

Technical Report No. 1

Government of South Australia
Department for Transport, Energy and Infrastructure

Northern Connector
Technical Report
Noise and vibration

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Executive summary

The proposed Northern Connector (the project) will be an integrated road and rail transport corridor comprising a new 15.6 km expressway standard road (three lanes in each direction) and a 30.9 km single track, national freight rail line. The road component would run west of the existing Port Wakefield Road, from the new Northern Expressway interchange with Port Wakefield Road in the north to the Port River Expressway and South Road interchange in the south (Figure 1.2). The rail component will primarily run west of the new road carriageways, and link with existing rail lines at Virginia to the north, Dry Creek to the south and Port Adelaide to the west (Figure 1.2).

The existing environment within the study area is characterised by significant road traffic noise levels at properties adjacent to Port Wakefield Road, with those residences further from the existing arterial roads having relatively low background noise during both the day and night periods. Some properties adjacent to Port Wakefield Road may be exposed to vibration levels from traffic above nuisance guideline levels, although generally there is no significant vibration impact on the existing environment.

Properties on the western side of Port Wakefield Road are not currently exposed to rail noise and vibration. However, a large number of residences adjacent to the freight rail line and Gawler Passenger Rail Line in Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury and Salisbury North currently experience significant rail noise and vibration levels. Residential properties in Ottoway are also subject to noise and vibration from a number of freight rail pass-bys to and from the LeFevre Peninsula. In particular, the maximum noise levels and vibration levels on the existing freight line at the nearest residential receivers in these areas are expected to exceed the relevant criteria from freight rail pass-bys.

The assessment of construction noise indicates that there is likely to be an impact on receivers within 200 m of construction work, particularly on those receivers with low existing background noise levels. Night time construction works near to sensitive receivers would be avoided where possible. Where night time construction works are necessary, and during day time construction works, all reasonable and feasible noise mitigation measures would be implemented.

During construction, residents within 75 m of construction work may perceive vibration and there may be some vibration effects on building contents for those receivers closest to the works. These impacts would be managed through the community engagement program and appropriate vibration mitigation measures. It is not expected that vibration due to construction work would cause structural damage at any sensitive receiver.

The operational noise and vibration assessment consisted of predicting road traffic noise and vibration impacts at the project opening in 2017 and at least ten years after opening in 2031. Noise and vibration impacts from rail operations were assessed based on predicted 2027 rail volumes and compared to existing rail noise levels predicted based on forecast 2017 rail volumes.

To calibrate the road traffic noise model, noise monitoring was performed from Monday 8 December 2008 to Friday 12 December 2008 at eight locations adjacent to the preferred route. Previous monitoring results from December 2006 at locations adjacent to Port Wakefield Road were also used for the calibration. Based on noise model predictions for the existing roads in 2017, appropriate day time and night time noise criteria were selected for noise sensitive receivers within 600 m of the preferred route.

This assessment has determined that without mitigation road traffic noise criteria would be exceeded at 189 existing properties at least ten years after the road opening. While noise levels at properties in Globe Derby Park and St Kilda located near the proposed route would be increased due to the Northern Connector, road traffic noise levels at properties adjacent to Port Wakefield Road are predicted to decrease. Overall, across the study area, the number of properties exposed to high road traffic noise levels (i.e. greater than 65 dB(A) $L_{eq,15hr}$ or 60 dB(A) $L_{eq,9hr}$) is predicted to decrease after the opening of the Northern Connector. Specific noise mitigation measures will be determined during detailed design.

The rail noise assessment has determined that rail noise criteria would be exceeded at up to five properties adjacent to the proposed Northern Connector rail alignment.

Diverting rail freight to the preferred Northern Connector alignment would considerably reduce the rail noise impact on properties adjacent to the existing lines in Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway. Given the significant number of properties within 30 to 50 m of the existing line that would currently exceed rail noise criteria, the Northern Connector rail would across the study area, bring about an overall reduction in rail noise impact on residential areas.

An assessment of operational road and rail vibration for the Northern Connector has found that vibration levels at sensitive receivers are expected to comply with both structural damage and nuisance guideline levels. Additionally, there would be a reduction in road vibration for residences adjacent to Port Wakefield Road and rail vibration for those residences adjacent to the existing freight rail line

This paper also presents a number of different design strategies to reduce the noise impact of the Northern Connector during construction and after project opening.

1 Introduction

1.1 The Northern Connector

The proposed Northern Connector (the project) will form a strategic link in road and rail between northern regions of South Australia, and further afield, to the Port of Adelaide, Adelaide metropolitan area and southern regions (Figure 1.1).

It will be an integrated road and rail transport corridor comprising a new 15.6 km expressway standard road (three lanes in each direction) and a 30.9 km single track, national freight rail line. The road component would run west of the existing Port Wakefield Road, from the new Northern Expressway interchange with Port Wakefield Road in the north to the Port River Expressway and South Road interchange in the south (Figure 1.2). The rail component will primarily run west of the new road carriageways, and link with existing rail lines at Virginia to the north, Dry Creek to the south and Port Adelaide to the west (Figure 1.2).

The project has been developed in response to the *South Australia's Strategic Plan* (Government of South Australia 2007a) and *The 30-Year Plan for Greater Adelaide* (Department of Planning and Local Government 2010) which forecasts a significant increase in population growth, road and rail traffic, and economic expansion in the northern Adelaide region.

The Northern Connector project has also been listed as a 'project with real potential' by the Australian Government. Infrastructure Australia identified the national significance of the project and the clear and positive contribution it would make to achieving Australia's policy goals.

The Northern Connector will form an integral component of Adelaide's North–South Corridor extending from the Northern Expressway at Gawler to the Southern Expressway at Old Noarlunga (Figure 1.2), as identified in the *Strategic Infrastructure Plan for South Australia: 2010 Discussion Paper* (DTEI 2010). It is both integrated (encompassing transport and land use priorities) and multi-modal (encompassing rail and road).

It would form a new link in the Adelaide Urban National Land Transport Network, connecting the Adelaide–Perth/Darwin corridor, mining activity in the states north, the Adelaide–Sydney corridor, areas of the Riverland and Barossa Valley in South Australia, and the Sunraysia area in New South Wales and Victoria, with key freight destinations in Adelaide's north-west suburbs, including the Port of Adelaide, rail terminals, industry zones and Adelaide Airport.

The completed road link will allow a largely unimpeded journey from Port Wakefield, the Mid North, Barossa Valley and Riverland to the Port of Adelaide and the future non-stop North–South Corridor (incorporating the South Road Superway).

Key Northern Connector road benefits will be:

- improved traffic conditions, access and safety for road users and local communities along the route by reducing freight on Port Wakefield Road and Main North Road

- improved freight efficiency and export opportunities
- a safer, faster connection to suburban destinations such as Adelaide Airport, sporting venues, beaches and businesses, in southern and western suburbs
- reduced travel times for commuters travelling to and from the northern suburbs
- reduced overall vehicle emissions due to smoother traffic flow.

The rail component is critical to the interstate freight network managed by Australian Rail Track Corporation. Key Northern Connector rail benefits will be:

- improved safety for road users and quality of life for nearby residents by significantly reducing freight rail traffic through suburban area to the east of Port Wakefield Road (Salisbury North and South, Parafield Gardens, Mawson Lakes)
- ‘unlocked’ commercial and industrial development opportunities along the corridor, including the Economic Development Precinct in Gillman and Defence SA in Port Adelaide
- a freight transport mode shift from road freight to rail freight
- less environmental impact of heavy rail freight transport through suburban communities
- improved rail freight transport efficiencies through higher speed and shorter connection to the port and intermodal facilities
- improved rail access to intermodal terminals in Adelaide and the Port of Adelaide for rail freight transport from the north and west of South Australia and from Darwin and Perth.

Construction and operation of the Northern Connector would bring significant benefits but many, often competing, environmental, social, economic and engineering issues have had to be balanced to achieve project objectives. Inevitably, due to the scale, nature and location of the project, some adverse impacts would occur. Where possible, measures will be put in place to minimise and/or offset these impacts.

The release of this *Project Impact Report* is part of the project’s planning and environmental impact assessment processes. It represents a key aspect in determining the appropriate location and extent of the project to enable a corridor to be defined for future construction.

The Department for Transport, Energy and Infrastructure (DTEI) is currently seeking and investigating funding for the construction of the Northern Connector project. If approved and funded in the near future, construction could be completed by 2017.

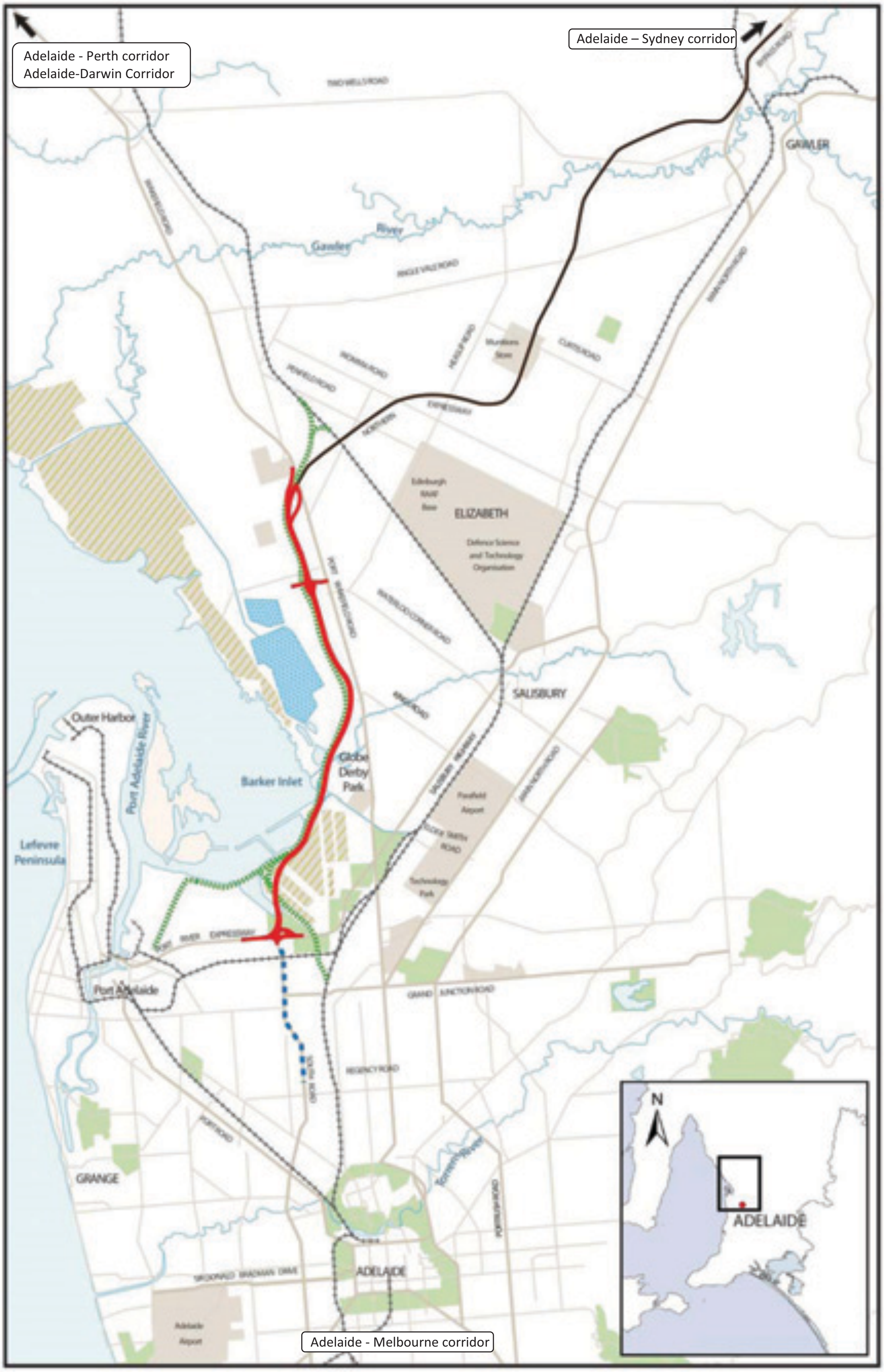


Figure 1.1. **Location Plan**

NORTH
0 3
Kilometres

Northern Connector road
Northern Connector rail
Northern Expressway
South Road Superway

Road
Rail
Existing main roads
Existing railway line

Bolivar Wastewater Treatment Plant
Industrial areas
Cheetham Salt Ltd salt fields

Source: DEH, DTEI, DPLG

NORTH

0 1 2
Kilometres

Figure 1.2 **The Northern Connector proposed road and rail route**

- Northern Connector road
- Northern Connector rail
- Spur line to Port Flat siding
- Northern Expressway
- South Road Superway
- Existing roads
- Existing railway

1.1.1 Project area

The project, located in Adelaide's outer northern metropolitan area, approximately 12 km north of Adelaide's central business district (Figure 1.1), will pass through three council areas —City of Playford, City of Salisbury and City of Port Adelaide Enfield — and through the suburbs of Virginia, Waterloo Corner, St Kilda, Bolivar, Globe Derby Park, Dry Creek, Wingfield and Gillman.

The project area has been zoned into three sections (Figure 1.2) to facilitate design, planning and assessment of the corridor:

- Northern section — relatively low population agricultural land, typically used for horticulture
- Central section — adjacent to and immediately east of the SA Water Bolivar Wastewater Treatment Plant
- Southern section — incorporates Globe Derby Park, with a small resident population on semi-rural land holdings used for horse agistment and training facilities; open land primarily used for salt production and the Greenfields and Barker Inlet wetlands; vacant land at Gillman; and the more densely populated urban industrial area of Wingfield.

1.1.2 Main elements of the project

The main elements of the project are:

- a new road (15.6 km), three lanes in each direction, between the Northern Expressway and the South Road–Port River Expressway junction
- four road interchanges: Northern, Waterloo Corner, Bolivar (on-ramp) and Southern
- Port Wakefield Road–Waterloo Corner and Port Wakefield Road–Bolivar Road intersection upgrades to connect to the Northern Connector interchange ramps
- approximately 30.9 kilometres of standard gauge, single-track freight rail line with maintenance/access track, generally located to the west of the road carriageways
- four rail bridges separating rail freight from road traffic
- two 2 km rail passing loops at Gillman and north of Waterloo Corner interchange
- a shared-use (pedestrian and cyclist) path
- Barker Inlet north wetland modifications
- wetland offset or rehabilitation areas (for flood storage, water quality treatment and habitat)
- swale drains and detention basins
- landscaping.

1.2 Policy and legislative requirements

Environment Protection Act 1993

Section 25 of the South Australian *Environment Protection Act 1993* (EP Act) states that: ‘A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practical measures to prevent or minimise any resulting environmental harm.’ Section 25(2) of the EP Act also specifies that regard must be given, amongst other things, to the nature of the pollution or potential pollution, the sensitivity of the receiving environment, the financial implications of various measures, and the current state of technical knowledge in considering the application of the various devices.

Department for Transport, Energy and Infrastructure *Road Traffic Noise Guidelines*

The Department for Transport, Energy and Infrastructure (DTEI) *Road Traffic Noise Guidelines* (RTNG) (2007) provide the criteria for assessing and treating road traffic noise from infrastructure projects for new roads or major upgrading of existing roads.

Environment Protection Authority *Draft Guidelines for the Assessment of Noise from Rail Operations*

The South Australian Environment Protection Authority (EPA) released the *Draft Guidelines for the Assessment of Noise from Rail Operations* (GANRO) for public consultation in June 2010. The GANRO provide criteria for assessing and mitigating noise and vibration from rail infrastructure projects.

DTEI *Management of Noise and Vibration: Construction and Maintenance Activities – Operational Instruction 21.7*

Public infrastructure construction works performed for DTEI are exempt from the *Environmental Protection (Noise) Policy 2007* (Noise EPP), which is a policy under the EP Act, if the contractor follows *Management of Noise and Vibration: Construction and Maintenance Activities – Operational Instruction 21.7* (OI 21.7). OI 21.7 establishes guidelines for managing noise and vibration impacts from public infrastructure construction works near sensitive receivers.

1.3 Assessment approach

1.3.1 Construction noise

Construction noise management

DTEI would develop a project-specific framework for the management of construction noise in accordance with OI 21.7 to ensure the minimisation of adverse construction noise impacts, where practicable. The management framework would be based on recent work done for major road projects, including the Bakewell Underpass project (opened 2008), Gallipoli Underpass project (opened 2009) and Northern Expressway project (opened 2010). The preferred construction contractor would respond to the framework with a construction noise and vibration management plan that they would be required to implement as part of the contractor's environmental management plan.

The construction time periods set down by DTEI, which are consistent with those prescribed by the EPA, are as follows:

- day time is defined as the hours between 7 a.m. and 7 p.m.
- night time is defined as the hours between 7 p.m. and 7 a.m.

During the design of appropriate construction noise management strategies for different areas, impacts on noise sensitive receivers will be considered based on the typical background noise levels in different areas. This recognises that construction noise may be more intrusive for residents in quieter areas. For example, residents living near Port Wakefield Road will likely be impacted less by construction noise than those living in areas without significant existing traffic noise.

Noise level targets

OI 21.7 outlines night time and day time noise level targets for sensitive receivers for different periods of the day and night. The noise level targets are presented in Table 1.1 and are based on the duration of the construction works near each sensitive receiver. Under OI 21.7, the Northern Connector project would be considered a Major Project, and the cumulative impact of infrastructure works should be considered and assessed holistically. Due to the length of time that the project would be expected to impact on individual receivers, the noise level targets for long-term works have been adopted.

Where predicted construction noise levels exceed the noise level targets, all reasonable and practicable mitigation measures are to be undertaken to minimise the noise impact. When the predicted noise levels are below the noise level targets, required mitigation measures are minimised.

Table 1.1. Construction noise level targets in dB(A)

Days	Time period	Short-term works – up to 2 days		Medium-term works – 2 to 14 days		Long-term works – exceeds 14 days	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	6 a.m.– 7 a.m.	65	75	60	75	55	75
	7 a.m.– 7 p.m.	All reasonable efforts to minimise noise					
	7 p.m.– 10 p.m.	75	90	70	85	65	80
	10 p.m.– 6 a.m.	45	75	45	75	45	75
Saturday	Midnight– 7 a.m.	45	75	45	75	45	75
	7 a.m.– 7 p.m.	All reasonable efforts to minimise noise					
	10 p.m.– midnight	45	75	45	75	45	75
Sunday and public holidays	Midnight– 7 a.m.	45	75	45	75	45	75
	7a.m.– 7 p.m.	All reasonable efforts to minimise noise					
	10 p.m.– midnight	45	75	45	75	45	75

In areas where background noise levels at a sensitive receiver are greater than the noise level targets, the noise level target becomes the background noise level.

OI 21.7 states that, for Major Projects, the targets presented in Table 1.1 may not be appropriate as achieving them could be unreasonable due to the nature of the construction work and/or due to the project timeframe. It is envisaged that the noise level targets would generally be achievable, though adjustments may be made during particular activities or to allow the construction process to be completed as efficiently as possible.

Prediction methodology

Construction noise levels have been predicted for a range of typical distances from identified road and rail construction activities. The levels have been predicted based on typical sound power levels for equipment and by taking into account relevant acoustic factors, such as distance attenuation and ground effects. Topographic shielding effects from terrain and fences have not been considered in the prediction of construction noise levels, making the predictions conservative.

OI 21.7 notes that a penalty may be applied, in accordance with the Noise EPP, for each of the characteristics of tonal, impulsive, low frequency or modulating noise. If the noise emission from a construction activity typically contains these characteristics, the L_{eq} noise level has been adjusted in the following way:

- if the noise from the noise source contains one characteristic, 5 dB(A) must be added to the L_{eq} noise level
- if the noise from the noise source contains two characteristics, 8 dB(A) must be added to the L_{eq} noise level
- if the noise from the noise source contains three or four characteristics, 10 dB(A) must be added to the L_{eq} noise level.

1.3.2 Operational traffic noise

Noise from road traffic on busy freeways, such as the proposed Northern Connector, is generally characterised by an overall traffic ‘hum’ when considered at noise sensitive receivers adjacent to the road. At speeds over 70 km/h, the noise generally consists of road tyre noise, with less influence from power-train noise (i.e. noise from drive train/drive system of a vehicle).

At night time, and other times of lower traffic flow, there may also be maximum noise events due to heavy vehicles braking to enter turn-offs, some acceleration of other vehicles and one-off events such as vehicles using horns. These events have the potential to cause annoyance if loud enough when compared to the background noise level at nearby residences.

The operational traffic noise impact from the proposed Northern Connector has been assessed against noise criteria specified as L_{eq} levels. The L_{eq} noise criteria represent the equivalent continuous (approximate average) noise levels from all road traffic over either the 15 hour day time period or the 9 hour night time period.

Traffic noise criteria

Community response to changes in noise levels

The average ability of an individual to perceive changes in noise levels is well documented. Generally, changes in noise levels of less than 3 dB(A) are barely perceptible to most listeners, whereas 10 dB(A) changes are normally perceived as a doubling (or halving) of noise levels.

Table 1.2 presents the typical human perception of changes in noise levels.

Table 1.2. Average person’s perception of changes in noise levels

Change (dB(A))	Human perception of sound
2–3	Barely perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A dramatic change
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt, Beranek and Neuman Inc. 1973.

Road Traffic Noise Guidelines

DTEI's RTNG are used to assess road traffic noise impacts. It sets out criteria for assessing road traffic noise for DTEI infrastructure projects.

Residents who currently experience little or no traffic noise are likely to be more affected by traffic noise from a new road than those already experiencing some road traffic noise where noise from traffic on a realigned or upgraded road may make little or no change.

To determine which criteria — 'new exposure' or 'existing exposure' — apply to the Northern Connector, the following key guideline points were considered:

- A site is defined as having an 'existing road traffic noise exposure' if the prevailing noise level from the existing road corridor(s) is equal to or greater than 55 dB(A) $L_{eq,15h}$ (day) or 50 dB(A) $L_{eq,9h}$ (night).
- A 'significant contribution to road traffic noise exposure' from a road development or upgrading project is defined as an increase in road traffic noise at any exposed façade of more than 2 dB over the road traffic noise level from the existing road.
- An alignment or realignment producing noise at a receptor from a different direction can make a 'significant contribution to road traffic noise exposure' (as defined above) on top of any increase in traffic noise from the same direction as present. If the new noise emission direction contributes more than 2 dB at any exposed façade, it is 'significant', and this means the new alignment or realignment is a 'new road traffic noise source'.

Therefore the adopted noise level criteria for the Northern Connector are:

- for areas presently exposed to road traffic noise of less than day time 53 dB(A) $L_{eq,15h}$ and night time 48 dB(A) $L_{eq,9h}$ the external target criteria for 2031 will be:
  - day time 55 dB(A) $L_{eq,15h}$ and night time 50 dB(A) $L_{eq,9h}$
- for areas presently exposed to road traffic noise greater than day time 53 dB(A) $L_{eq,15h}$ and night time 48 dB(A) $L_{eq,9h}$, the external target criteria for 2031 will be the lower of:
  - the existing noise level plus 2 dB(A)
  - a day time 65 dB(A) $L_{eq,15h}$ and night time 60 dB(A) $L_{eq,9h}$.

Assessment times are:

- day time — the 15 hour period between 7 a.m. and 10 p.m.
- night time — the 9 hour period between 10 p.m. and 7 a.m.

Noise levels are predicted or measured at a location 1 m from the most exposed window at a height of 1.5 m above floor level. Noise levels at this location are affected by reflections from the building façade, in which case all predictions are to include a façade reflection factor of +2.5 dB. If noise levels for individual properties are measured at locations not subject to reflections from the building façade, they are also subject to an adjustment factor of +2.5 dB to ensure that the comparison of noise levels against the noise level criteria are consistent.

Where predicted future road traffic noise levels exceed the external target criteria, all reasonable and practicable noise mitigation measures will be considered.

A flow chart outlining the applicable criteria and the extent of reasonable and practicable noise mitigation measures is included in Attachment A.

Traffic noise prediction methodology

Traffic noise predictions have been carried out in accordance with the *Calculation of Road Traffic Noise* (CoRTN) prediction method (UK DOE 1998), and using the latest SoundPlan version 7.0, produced by Braunstein + Berndt GmbH. SoundPlan implements the CoRTN algorithms and has been accepted by DTEI as appropriate modelling software for the purpose of assessing traffic noise impacts and the design of acoustic barriers.

The CoRTN standard is implemented and tested in SoundPlan to ensure that deviations do not exceed 0.2 dB from hand calculations. SoundPlan has also been tested against physical situations using actual noise measurements and the CoRTN methodology.

CoRTN states that reflections can only occur from the opposite façades. It is difficult for SoundPlan to evaluate the term ‘opposite façade’; it accounts only reflected noise passing over the road where it was emitted. Reflections that did not pass over the road once are not accounted in accordance with the CoRTN model. The same applies for reflections into side roads.

A 600 m search radius has been used within the calculation module as this represents the furthest distance at which CoRTN has been found to reliably predict road traffic noise levels. This means that for each receiver, SoundPlan only considers the road traffic noise emission from a section of road within 600 m of the receiver. Bridges are modelled such that noise can travel beneath the bridge.

Variations to the CoRTN procedure, as implemented in SoundPlan to improve procedures, are noted below. They are not considered to be significant:

- CoRTN requires every step to be rounded to the next 0.1 dB(A). SoundPlan does not do this, but performs whole calculations with double precision numbers and only rounds for final results.
- The multiple reflection assessment included in the CoRTN emission calculations for SoundPlan was derived from the German prediction method RLS 90. It is applied as a level addition to the basic LME within the German RLS 90, and it is applied in the same way for the CoRTN emission calculation in SoundPlan.

The CoRTN methodology was verified for Australian conditions in a comprehensive study for the Australian Road Research Board (Saunders et al. 1983) which was later updated (Austroads 2002). The validation of CoRTN suggested that the method generally over-predicted noise levels, but in some cases it does under-predict noise levels.

The implementation of the CoRTN method in SoundPlan has been verified both by the authors of SoundPlan and by AECOM.

Modelling parameters

Modelling predictions were undertaken for arterial roads in the existing road network for 2008, the existing road network in 2017, the network at the Northern Connector opening in 2017 and more than 10 years after the Northern Connector opening in 2031. Significant roads modelled were:

- Port Wakefield Road
- Northern Expressway
- Salisbury Highway
- Port River Expressway
- South Road
- Northern Connector.

The noise model for this project incorporated the features of:

- three-dimensional models of the existing and future road networks
- Annual Average Daily Traffic (AADT) volumes for each modelled road
- percentage of commercial vehicles (CVs) for each modelled road
- posted vehicle speeds
- corrections for pavement surface types
- receiver coordinates
- contributed noise from all relevant traffic sources to determine the cumulative noise impact at receiver locations
- correction of +2.5 dB for façade reflection factor

The most recent measured traffic volumes for 2008 were obtained from DTEI and are presented in Table 1.3.

Table 1.3. Measured traffic volumes

Road name	Measurement location	AADT	15 hr flow	15 hr % CVs	9 hr flow	9 hr % CVs
Port Wakefield	North Salisbury Highway	47,600	40,460	8.8%	7,140	30.0%
Port Wakefield	North Globe Derby Drive	39,700	33,745	9.6%	5,955	32.5%
Port Wakefield	North Bolivar Drive	27,300	23,205	12.9%	4,095	43.8%
Port Wakefield	North Waterloo Corner Road	17,600	14,960	11.0%	2,640	37.5%
Port Wakefield	North Northern Connector	14,000	11,900	10.7%	2,100	36.3%
Salisbury Hwy	East Northern Connector	48,200	40,970	8.8%	7,230	30.0%
Salisbury Hwy	West Northern Connector	23,600	20,060	9.2%	3,540	31.3%

These values were combined with predictions provided by DTEI to produce traffic volumes and compositions along all considered roads for four situations:

- existing road network in 2008
- existing road network in 2017
- proposed road network in 2017
- proposed road network in 2031.

The predicted future traffic volumes used in the modelling process are summarised in Attachment B.

The existing roads have been modelled with dense graded asphalt (DGA) surfaces, with the Northern Expressway, Northern Connector and on/off ramps surfaced with stone mastic asphalt (SMA). SMA surfaces have had a -1 dB correction applied relative to DGA surfaces, which were used for the model calibration.

The traffic speed modelled along each road was assumed to be the posted speed limit on that road. The speeds used for modelling are summarised in Table 1.4.

Table 1.4. Modelled traffic speeds

Road name	Speed (km/h)
Port Wakefield Road (south of St Kilda Road)	90
Port Wakefield Road (north of St Kilda Road)	110
Northern Expressway	110
Northern Connector	110
Salisbury Highway	90
Port River Expressway	90

Noise sensitive receivers

Noise sensitive receivers have been considered in this assessment if they are within 600 m of the preferred Northern Connector route. At distances greater than 600 m, traffic noise may be audible, but is expected to be significantly below RTNG noise assessment criteria. In order to summarise the results of a large number receivers, three noise catchment areas were established:

- Northern catchment area: including properties in Waterloo Corner and St Kilda. Properties are mainly low density, isolated dwellings on large properties.
- Central catchment area: including properties in Bolivar and Highway One Caravan Park. Properties in Bolivar are of medium density and located adjacent to Port Wakefield Road. Some isolated properties are also present west of Port Wakefield Road.
- Southern catchment area: including properties in Globe Derby Park. Properties in Globe Derby Park are generally low density, isolated dwellings, with many equine activities in the area. There are also some higher density residential developments east of Port Wakefield Road.

1.3.3 Operational rail noise

Noise from freight rail pass-bys on the preferred Northern Connector rail corridor would typically consist of low frequency noise as the locomotive passes, followed by mid-frequency noise as the rolling stock (comprising the carriages) passes. This noise would remain relatively constant in magnitude across the duration of the train pass-by. The L_{eq} metric is used to assess this noise, as it represents the equivalent continuous (energy average) noise level over the relevant time period.

Additionally, freight rail pass-bys can generate maximum noise events significantly above the background noise level. These maximum noise events may be generated due to the use of the warning horn, the use of brakes during deceleration, as well as wheel squeal noise and/or flanging noise on rail curves. It should be noted that these events are expected to be minimised on the Northern Connector corridor as it has been designed with no significant curves or level crossings to allow trains to travel at high speed without stopping. The L_{max} metric is used to assess maximum noise events from individual rail pass-bys.

The adopted rail noise criteria for the project address both the combined rail noise from all pass-bys over the day time and night time periods ($L_{eq,15h}$ and $L_{eq,9h}$ criteria respectively) as well as one-off maximum noise events from individual train pass-bys (L_{max} criterion).

Rail noise criteria

The Northern Connector project would potentially impact sensitive receivers by introducing rail noise into an area where receivers are not currently exposed to such noise. The operational rail noise impact of the project on these sensitive receivers has been assessed against relevant criteria.

However, the project would also benefit sensitive receivers adjacent to the existing freight rail alignment in Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury and Salisbury North. Freight rail movements would be redirected to the Northern Connector alignment, significantly reducing rail noise levels at residential locations adjacent to the existing line. In order to demonstrate positive effects of the project, predicted rail noise levels at these sensitive receivers have also been compared to relevant criteria both before and after opening of the Northern Connector.

The EPA’s GANRO, currently released for public consultation, have been used to assess rail noise impacts from the project. The GANRO specify day and night time noise criteria to be achieved at residential locations for both ‘new rail line’ situations and ‘upgraded rail line’ situations. The ‘upgraded rail line’ criteria apply where the existing rail noise levels at a residential location are at or above the criteria for a ‘new rail line’.

Table 1.5 presents the applicable rail noise criteria for sensitive receivers in the study area. The criteria should be achieved in 2027, at least 10 years after the opening of the Northern Connector rail line.

Table 1.5. Rail noise criteria for residential locations

Metric	New rail line	Upgraded rail line
Day time $L_{eq,15h}$	60 dB(A)	65 dB(A)
Night time $L_{eq,9h}$	55 dB(A)	60 dB(A)
L_{max}	80 dB(A)	85 dB(A)

Assessment times for rail noise are:

- day time — the 15 hour period between 7 a.m. and 10 p.m.
- night time — the 9 hour period between 10 p.m. and 7 a.m

As for the road noise criteria, the rail noise criteria refer to external noise levels to be predicted or measured at a location 1 m from the most exposed window. Noise levels at this location are affected by reflections from the building facade and all predictions are to include a facade reflection factor of +2.5 dB.

Where predicted future (2027) rail noise levels adjacent to the Northern Connector rail alignment exceed the criteria, all feasible and reasonable noise mitigation measures will be considered.

Rail noise prediction methodology

Three-dimensional models of the existing rail alignment and the proposed Northern Connector alignment were constructed in SoundPlan version 7.0 environmental noise modelling software. The modelling was conducted incorporating the following features:

- Line sources modelled to predict $L_{eq,15h}$ and $L_{eq,9h}$ noise levels along the existing and proposed freight rail lines, calibrated against measurements taken adjacent to the existing freight line between Dry Creek and Virginia.
- Line sources modelled to predict $L_{eq,15h}$ and $L_{eq,9h}$ noise levels along the existing Gawler Passenger Rail Line, assuming electrification of the line in 2013. The line sources have been calibrated against measured noise levels from three-car electric multiple units operating on the recently constructed Perth to Mandurah rail corridor (adjusted to account for speed differences), as no electric multiple units currently operate on the Adelaide passenger rail network.
- Point sources modelled to predict L_{max} noise levels from one-off events, calibrated against measurements taken adjacent to the existing freight and passenger rail lines. In accordance with GANRO, the L_{max} noise level not exceeded for 95% of rail pass-bys was predicted.
- Propagation of noise modelled using general acoustic principles such as distance attenuation, topographic shielding, ground effects and air absorption. Modelling assumed neutral weather conditions as the nearest sensitive receivers are within 60 metres of the existing and future rail alignments.
- All predictions include a facade reflection factor of +2.5 dB.

Note that no buildings have been included in the rail noise model. As buildings will provide shielding of noise generated by rail pass-bys, predictions are likely to be conservative for those receivers not located immediately next to the rail corridor.

The predicted future freight rail movements used in the modelling process are summarised in Attachment B.

2017 and 2027 rail volumes for the Gawler Passenger Rail Line have been based on information provided by DTEI and assume:

- passenger trains every 7.5 minutes in each direction between Adelaide and Elizabeth from 6:30 a.m. to 7:30 p.m.
- an additional train during peak 15 minute periods
- passenger trains every half hour in each direction between Adelaide and Elizabeth from 5 a.m. to 6.30 a.m. and from 7:30 p.m. to 1 a.m.

Residential receivers

Residential receivers for the assessment of the Northern Connector freight rail line are the same as those for the traffic noise assessment. Residential receivers adjacent to the existing freight and passenger rail lines through the areas of Mawson Lakes, Parafield Gardens, Salisbury and Salisbury North have also been considered to demonstrate positive effects of the Northern Connector on rail noise and vibration.

1.3.4 Vibration

Vibration management

Vibration impacts may cause concern to some residents, particularly during the construction phase of the project. Operational rail and road movements may also generate perceptible vibration at times but this would not generally be expected to impact significantly on sensitive receivers.

The effects of ground vibration may be segregated into the following categories:

- human annoyance — disturbance to building occupants: vibration that inconveniences or possibly disturbs the occupants or users of the building
- effects on building contents — vibration that may affect the building contents
- effects on building structures — vibration that may compromise the integrity of the building or structure itself.

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on building contents and structural damage. Hence, compliance with the more stringent limits dictated by human annoyance would ensure that compliance is also achieved for the other two categories.

In the case of vibration generated by operational road and rail movements, vibration criteria for human annoyance have been adopted as the relevant assessment criteria. However, construction work is typically assessed against the structural damage standards, as in some cases compliance with human annoyance criteria may not be practical. Adjustments to the criteria are warranted in some circumstances, as undue restriction on vibration levels may prolong operations and result in greater annoyance. The human annoyance vibration criteria have been presented as goals only for the construction phase, though it is not envisaged that vibration produced by the majority of construction work would result in adverse human response.

Where adverse human response is possible and/or structural damage criteria may be exceeded, appropriate operational or construction vibration mitigation measures would be implemented.

Human annoyance standards

Table 1.6 gives an indication of typical human perception of vibration.

Table 1.6. Vibration and human perception of motion, 8-80 Hz

Approximate vibration level (mm/s)	Degree of perception
0.1	Not felt
0.15	Threshold of perception
0.35	Barely noticeable
1.0	Noticeable
2.2	Easily noticeable
6.0	Strongly noticeable

Source: German Standard DIN 4150-1975, *Part 2 – Vibrations in Buildings – Influence on Persons in Buildings*.

Australian Standard (AS) 2670.2–1990, *Evaluation of human exposure to whole-body vibration, Part 2: Continuous and shock induced vibration in buildings* has been adopted as the relevant standard for nuisance vibration levels. AS 2670.2 is referenced by the GANRO as the relevant standard for the assessment of vibration from rail movements. The standard provides a collection of curves that specify acceptable vibration levels at each frequency for different circumstances.

Table 1.7 provides guidance on the magnitude of vibration at which adverse comment may arise. In most cases the vibration generated by transport corridors and construction activities is intermittent in character, and subject to the lower criteria.

Table 1.7. Human exposure vibration criteria – Peak Particle Velocity (PPV) building vibration levels in combined direction(1)

Type of building occupancy	Continuous/intermittent vibration (mm/s)	Transient vibration excitation with several occurrences per day (mm/s)
Residential – Night	0.2	0.2 – 2.8
Residential – Day	0.3 – 0.6	4.2 – 12.7
Office	0.6	8.5 – 18.1
Workshop	1.1	12.7 – 18.1

Note:

(1) Combined direction vibration is the peak vector sum of the three vibration axes.

The criteria presented in Table 1.3 are applicable to operational vibration produced by road traffic and trains operating on the Northern Connector, and should be achieved where feasible. However, they represent goals only for construction vibration.

Structural damage standards

Currently no Australian Standard exists for the assessment of building damage caused by ground vibration. Therefore, German Standard DIN 4150-1999, *Part 3 – Structural Vibration in Buildings – Effects on Structures* (DIN 4150) has been adopted as the relevant standard for the assessment of structural damage from construction vibration.

The structural damage 'safe limits' for short-term vibration, such as that produced by typical construction activities, specified by DIN 4150 (maximum levels measured in any direction at the foundation) are summarised in Table 1.8. These levels represent limits which should not be exceeded by vibration generated by construction activities.

Table 1.8. Structural damage 'safe limits' for building vibration

Group	Type of structure	Vibration velocity (PPV) in any direction (mm/s)		
		At foundation at a frequency of(1)		
		< 10 Hz	10–50 Hz	50–100 Hz
1	Commercial, industrial or similar buildings	20	20–40	40–50
2	Dwellings and buildings of similar design and/or use	5	5–15	15–20
3	Structures that, because of their particular sensitivity to vibration, do not correspond to 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3–8	8–10

Note:

(1) For frequencies above 100 Hz, the higher values in the 50-100 Hz column should be used.

These levels are 'safe limits' up to which no damage due to vibration effects has been observed for the particular class of building. DIN 4150 defines 'damage' to include minor non-structural effects, such as superficial cracking in cement render, enlargement of cracks already present, and separation of partitions or intermediate walls from load bearing walls. DIN 4150 also states that when vibrations higher than the 'safe limits' are present, it does not necessarily follow that damage will occur.

2 Existing conditions

2.1 Road and background noise monitoring

Existing environmental noise levels were measured using noise loggers at eight locations around the project area from Monday 8 December 2008 to Friday 12 December 2008 for at least 24 hours at each location under typical ambient conditions (i.e. no unusual traffic or meteorological conditions). Additional monitoring results from November/December 2006 at four locations adjacent to Port Wakefield Road were also used to assess the existing noise environment. The logging locations are presented in Table 2.1.

Table 2.1. Summary of logger locations

Location	Ref no.	Measurement period	Easting	Northing
Lot 51 Port Wakefield Road, Waterloo Corner	1	6.12.06 to 8.12.06	277684	6156893
Lot 8 Flight Road, Waterloo Corner	2	10.12.08 to 12.12.08	277436	6155490
Lot 1 Port Wakefield Road, Waterloo Corner	3	27.11.06 to 29.11.06	278623	6154040
Lot 2 Robinson Road, Waterloo Corner	4	8.12.08 to 10.12.08	277534	6153854
34 General Drive, Paralowie	5	27.11.06 to 29.11.06	279437	6151498
Port Wakefield Road, Globe Derby Park	6	4.12.06 to 6.12.06	279974	6147804
Whites Road, Globe Derby Park	7	8.12.08 to 10.12.08	278968	6147411
13 Trotters Drive, Globe Derby Park	8	8.12.08 to 10.12.08	279478	6147304
Port River Expressway East	9	10.12.08 to 12.12.08	279824	6144573
Port River Expressway North	10	10.12.08 to 12.12.08	278642	6142912
Port River Expressway West	11	8.12.08 to 10.12.08	276330	6142740
Port River Expressway South	12	10.12.08 to 11.12.08	278018	6142754

In cases where the microphone of the noise logger was positioned out in the open away from building façades (free field conditions), a façade reflection factor of +2.5 dB was added to the equivalent continuous noise level (L_{eq}) results to ensure direct comparison of ambient noise levels at all logging locations, in line with the RTNG. The measurements were unaffected by periods of excessive wind and there was no rainfall during the measurement periods and thus the measurement periods are indicative of existing environmental noise levels at each monitoring location. Weather data was collected from the Bureau of Meteorology weather station at Edinburgh.

Measurement results at each location are summarised in Table 2.2.

Table 2.2. Environmental noise logging results summary

Ref no.	L_{90} day(1)	L_{90} night(2)	$L_{eq,15h}$	$L_{eq,9h}$	$L_{eq,24h}$	Day peak $L_{eq,1h}$	Night peak $L_{eq,1h}$
1	45	40	60	60	60	66	65
2	46	40	57	45	55	66	52
3	54	48	68	66	67	71	70
4	38	37	56	45	54	68	53
5	54	43	64	61	63	66	66
6	52	49	62	60	61	67	63
7	40	37	48	43	47	52	50
8	43	40	49	46	48	55	55
9	61	51	67	64	66	69	70
10	64	62	66	63	65	68	68
11	65	62	71	67	70	74	74
12	-	49	-	53	55	57	53

Note:

(1) The day time L_{90} has been measured from 7 a.m. to 7 p.m. in accordance with the construction noise level targets.

(2) The night time L_{90} has been measured from 7 p.m. to 7 a.m. in accordance with the construction noise level targets.

In summary:

- Noise levels near St Kilda, north of Waterloo Corner Road are characterised by large decreases (approximately 10 dB(A)) in night time noise levels relative to the day time levels.
- Globe Derby Park experiences lower day time noise levels, with a smaller reduction in night time levels compared to those in St Kilda
- Background noise levels (L_{90}) for sites further from Port Wakefield Road and the Port River Expressway were low, with small variation over night and day at three out of four sites. Measured night time background noise levels were less than 40 dB(A).

All noise logger results, and correlated weather data, for each logging location are included in Attachment C. Figure 2.1 shows all noise logging locations relative to the Northern Connector.

Figure 2.1 **Noise logger locations**

Noise logger locations
Northern Connector road
Northern Connector rail
Spur line to Port Flat siding
South Road Superway
Northern Expressway
Existing railway
Existing roads

Source: DEH, DTEI, DPLG

2.2 Road vibration monitoring

Generally, sensitive receivers within the study area are not exposed to any significant traffic vibration levels.

In order to characterise existing vibration levels and to predict likely future vibration levels, measurements were taken adjacent to Port Wakefield Road (prior to upgrade works commencing) in the Globe Derby Park area, near smooth and rough sections of the asphalt surface. Measurements were taken at distances of 10 m and 20 m from the edge of the carriageway.

The vibration measurements, expressed in PPV, are presented in Table 2.2.

Table 2.2. Measured vibration levels for various sources

No.	PPV (mm/s, 10–87 Hz)	Distance (m)	Road surface	Vehicle	Comments*
1	0.037	10	Smooth	Cars	Vehicles in LH and RH lanes
2	0.026	10	Smooth	Cars	Vehicles in LH and RH lanes
3	0.040	10	Smooth	Cars	Vehicles in LH and RH lanes
4	0.140	10	Smooth	Truck	Vehicle in LH lane
5	0.169	10	Smooth	Truck	Vehicle in LH lane
6	0.065	10	Smooth	Truck	Vehicle in RH lane
7	0.046	20	Smooth	Truck	Vehicle in RH lane
8	0.071	20	Smooth	4 trucks	Vehicles in LH and RH lanes
9	0.025	20	Smooth	Mid-size truck	Vehicle in LH lane
10	0.125	10	Rough	Mid-size truck	Vehicle in LH lane
11	0.091	10	Rough	Cars	Vehicles in LH and RH lanes
12	0.252	10	Rough	2 trucks	Vehicles in LH lane
13	0.228	10	Rough	Truck	Vehicle in LH lane
14	0.159	20	Rough	B-double	Vehicle in LH lane
15	0.167	20	Rough	B-double	Vehicle in LH lane
16	0.148	20	Rough	Truck	Vehicle in LH lane
17	0.124	20	Rough	Truck	Vehicle in LH lane
18	0.135	20	Rough	Truck	Vehicle in LH lane

Note:

* LH = left hand; RH = right hand.

The vibration measurements range in magnitude from 0.02 to 0.3 mm/s. The presented vibration levels are indicative only, as the transfer of vibration from the ground to the building foundation and other building elements is variable, but not expected to change significantly.

In general, vibration levels within 10 m of a smooth road section are at or below the threshold of perception for ground vibration and are below night time residential levels from AS 2670.2 (0.2 mm/s for continuous or intermittent vibration). In areas where the road surface is rougher or in poor condition, vibration levels from truck pass-bys at 10 m may be noticeable and are above those levels given in AS 2670.2 for night time periods.

Presently there are some properties within 20 m of Port Wakefield Road that may be exposed to vibration levels above nuisance guideline levels depending on the condition of the road surface in the area.

All measured vibration levels within 10 m are well below DIN 4150 levels for structural damage.

2.3 Rail noise monitoring

Under the current rail system, freight trains heading north of Adelaide use the rail line between Dry Creek and Salisbury, which then veers north-west adjacent to the Edinburgh Royal Australian Air Force base. There are a large number of properties exposed to existing freight train noise in Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway.

Existing noise levels for freight train pass-bys were measured on the Adelaide to Darwin rail line at the now closed Moloney Road rail crossing at Virginia on 14 January 2009. The speed of the trains at the measurement location was typically 90 to 110 km/h. The rail noise measurements are summarised in Table 2.3.

Table 2.3. Existing freight rail noise measurements

Measurement	Distance (m)	Pass-by time (s)	L_{eq} (1) (dB(A))	L_{max} (dB(A))
Train at 90–110 km/h	40	78	75	-
Train at 90–110 km/h	40	30	77	-
Train at 90–110 km/h	55	76	70	88
Train at 90–110 km/h	55	78	67	76
Train at 90–110 km/h	55	30	70	81
Train at 90–110 km/h	70	76	67	-

Note:

(1) L_{eq} refers to the equivalent continuous noise level over the audible pass-by time.

The freight rail line in the area south of Edinburgh travels parallel to the Gawler Passenger Rail Line. Passenger rail movements on this line also contribute to existing rail noise levels in the study area.

At project opening (2017), the Gawler Passenger Rail Line will be electrified and serviced with electric trains. No electric passenger trains are currently in operation in South Australia so rail noise measurements conducted adjacent to the recently constructed Perth to Mandurah rail corridor in Western Australia have been used to predict future rail noise levels. The Perth to Mandurah rail corridor is serviced by three-car electric multiple units.

Table 2.4 presents measured noise levels from electric train pass-bys on the Perth to Mandurah rail corridor.

Table 2.4. Measured noise levels from electric train pass-bys

Measurement	Distance (m)	Pass-by time (s)	L_{eq}(1) (dB(A))	L_{max} (dB(A))
Electric train at 110 km/h	45	31	70	80
Electric train at 110 km/h	45	40	70	82
Electric train at 110 km/h	45	32	71	80
Electric train at 110 km/h	45	33	72	81

Note:

(1) L_{eq} refers to the equivalent continuous noise level over the audible pass-by time.

2.4 Rail vibration monitoring

Similarly to road traffic vibration, sensitive receivers adjacent to the Northern Connector rail alignment are not exposed to any rail vibration. However, those adjacent to the existing freight rail alignment in the areas of Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway are exposed to vibration from both freight rail and passenger rail movements.

Vibration levels were measured at the now closed rail crossing at Moloney Road, Virginia during freight train pass-bys on the Adelaide to Darwin rail line. The measurement results are outlined in Table 2.5.

Table 2.5. Measured vibration levels from freight train pass-bys

Measurement	Distance to train line (m)	PPV (mm/s)
Train at 90–110 km/h	20	0.5
Train at 90–110 km/h	25	0.4
Train at 90–110 km/h	45	0.2
Train accelerating to 60 km/h	20	0.3

Measured PPV levels at distances of up to 45 m exceed guideline levels for human annoyance from AS 2670.2 for night time residential areas (0.2 mm/s for continuous or intermittent vibration). Presently, a significant number of properties are within 30 to 50 m of the existing freight rail line through Salisbury and Waterloo Corner, and may be exposed to vibration levels above nuisance guideline levels.

3 Potential impacts of the project on the existing conditions

Preliminary noise and vibration assessments are presented in this section. More detailed noise and vibration assessments and any mitigation measures will be undertaken and determined during the detailed design phase of the project.

3.1 Construction noise and vibration

3.1.1 Construction noise

Noise generated by construction activities and equipment associated with the Northern Connector project would depend on the proximity of the receiver to the construction activities at the time. Noise levels would be relatively high when work is occurring immediately adjacent to a sensitive receiver but would decrease considerably as construction moves away along the route.

Typical construction activities and equipment are identified in Table 3.1.

Table 3.1. Construction noise activities

Construction activity	Description
Corridor clearing	Corridor clearing would take place early during construction. Typical operations may be either one plant operating on its own or a bulldozer, chainsaw and tub grinder/mulcher operating simultaneously.
Earthworks and drainage	The earthworks and drainage phase of the project would be likely to last the longest and generate the highest levels of construction noise, especially from the operation of heavy plant and equipment. This phase would include bulldozers, excavators and graders, and excavation involving loading, haulage and ground compaction.
Bridgeworks and retaining walls	Bridgeworks and retaining walls would take place at the interchanges along the route. Typical operations at interchange bridges may be either one plant operating on its own or a piling rig, power generator, pneumatic jackhammer and crane operating simultaneously. Retaining wall works would typically include a crane, welding equipment and tracked excavator operating.
Pavement	Pavement construction would take a considerable length of time along the expressway alignment and at the interchanges. Typically a paver, roller, generator and backhoe are all used simultaneously. Concrete cutting may also occur.

Construction activity	Description
Rail construction	Construction of the rail line would persist for a considerable length of time but works would not be expected to affect individual receivers for long periods at any one time. Typical plant for rail construction would be a front end loader, truck, grinder and excavator operating simultaneously.
Construction compound	Construction compounds would operate throughout the construction phase but their locations would be selected as far from residential areas as is feasible to assist in minimising noise impacts. Typical operations during site establishment may be either one plant operating or a backhoe, excavator and delivery truck operating simultaneously; also cranes, semi-trailer deliveries of offices, some minor concrete works, some minor earthworks in establishing hard stands for parking areas, includes use of graders and body trucks, backhoe for general drainage works.

A noise management strategy would be prepared that identifies measures to mitigate noise intensity, frequency and/or duration to affected residential locations. Such a strategy considers the methodology proposed by a construction contractor and the relative phasing of different construction activities in different areas to minimise noise.

The impact depends on the type of construction, the distance to affected residences or other noise sensitive uses, any natural or introduced shielding and the duration of the construction. A basic construction noise mitigation strategy for sensitive residential locations aims to:

- minimise construction duration
- maximise opportunities for simultaneous activities (minimising total duration)
- minimise equipment noise generation — quietest (or quietening) equipment
- minimise use of certain ‘noisy’ equipment in sensitive areas and/or time of day.

Table 3.2 lists predicted typical noise levels for a range of receptor distances from identified construction activities. Penalties have been added to the predicted noise levels where relevant, as discussed in Section 1.3.1. The calculations assume sound pressure loss from geometrical spreading only and that equipment is operating continuously, hence the predictions are conservative.

Table 3.2. Predicted construction noise levels without mitigation

Noise generating activity	Plant type	Predicted L_{eq} at various distances (dB(A))				
		7 m	25 m	50 m	100 m	200 m
Corridor clearing	Bulldozer	95	84	78	72	66
	Excavator	78	67	61	55	49
	Chainsaw	94	83	77	71	65

Noise generating activity	**Plant type**	**Predicted L_{eq} at various distances (dB(A))**				
		7 m	**25 m**	**50 m**	**100 m**	**200 m**
	Tub grinder and mulcher	96	85	79	73	67
	Front end loader	88	77	71	65	59
	Truck	83	72	66	60	54
	Water cart	82	71	65	59	53
Earthworks and drainage	Bulldozer	95	84	78	72	66
	Scraper	85	74	68	62	56
	Excavator	78	67	61	55	49
	Grader	85	74	68	62	56
	Vibratory roller	89	78	72	66	60
	Spreader	70	59	53	47	41
	Truck	83	72	66	60	54
	Water cart	82	71	65	59	53
Bridgeworks and retaining walls	Impact piling rig	105	94	88	82	76
	Bored piling rig	96	85	79	73	67
	Continuous Flight Augured (CFA) piling rig	88	77	71	65	59
	Power pack	78	67	61	55	49
	Crane	88	77	71	65	59
	Concrete pump	80	69	63	57	51
	Concrete vibrator	78	67	61	55	49
	Welding equipment	80	69	63	57	51
	Excavator	83	72	66	60	54
	Pneumatic jackhammer	93	82	76	70	65
	Truck	83	72	66	60	54
	Concrete truck	84	73	67	61	55
	Water cart	82	71	65	59	53
Pavement	Paver	89	78	72	66	60
	Truck	83	72	66	60	54
	Concrete vibrator	78	67	61	55	49
	Asphalt truck/sprayer	81	70	64	58	52
	Vibratory roller	89	78	72	66	60
	Concrete saw	98	87	81	75	69
	Generator	78	67	61	55	49
	Pneumatic jackhammer	93	82	76	70	65
	Backhoe	79	68	62	56	50
	Water cart	82	71	65	59	53

Noise generating activity	Plant type	Predicted L_{eq} at various distances (dB(A))				
		7 m	25 m	50 m	100 m	200 m
Rail construction	Truck	83	72	66	60	54
	Front End Loader	88	77	71	65	59
	Excavator	78	67	61	55	49
	Grader	85	74	68	62	56
	Vibratory roller	89	78	72	66	60
	Ballast tamper	91	80	74	68	62
	Regulator	90	79	73	67	61
	Sleeper laying machine	83	72	66	60	54
	Angle grinder	88	77	71	65	59
	Water cart	82	71	65	59	53
Construction compound	Backhoe	79	68	62	56	50
	Truck	83	72	66	60	54
	Excavator	78	67	61	55	49
	Crane	88	77	71	65	59
	Generator	78	67	61	55	49
	Light tower	66	55	49	43	37
	Backhoe	79	68	62	56	50

The prediction results indicate that, without any noise mitigation, the L_{eq} construction noise levels are typically expected to range from 50 to 70 dB(A) at a distance of 200 m from the works.

Based on the noise level predictions, night time construction work would be avoided where possible. Where night time construction works are necessary, and during day time construction works near to sensitive receivers, all reasonable and feasible noise mitigation measures would be implemented.

3.1.2 Construction vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist (and vary in dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency and number of occurrences of vibration all play an important role in both the annoyances caused and the strains induced in structures.

The pattern of vibration radiation is very different from the pattern of airborne noise radiation, but the potential for vibration to cause disturbance to residents or buildings is still largely dependent on the distance between the vibration generator and the receiver.

Major sources of ground vibration during construction of the Northern Connector would include pile drivers, bulldozers (ripping), hydraulic rock breakers, ballast tampers and vibratory rollers.

Table 3.3 indicates the approximate vibration levels that may be expected for various vibration sources (based on previous measurement experience on recent public infrastructure construction projects).

Table 3.3. Approximate generated vibration levels for various sources, mm/s

Activity	Typical PPV levels of ground vibration
Impact piling	Up to 15 mm/s at distances of 15 m Approximately 9 mm/s or less at distances greater than 25 m Typically below 3 mm/s at distances greater than 50 m
CFA piling	Negligible vibration at distances greater than 20 m
Bored piling	Negligible vibration at distances greater than 20 m
Ballast tamping	Less than 2 mm/s at distances greater than 10 m
Vibratory rollers	Up to 1.5 mm/s at distances of 25 m Higher levels could occur at closer distances but no damage would be expected for any standard residential building at distances greater than approximately 12 m (for a medium to heavy roller).
Hydraulic rock breakers (levels typical of a large rock-breaker operating in hard sandstone)	4.50 mm/s at 5 m 1.30 mm/s at 10 m 0.4 mm/s at 20 m 0.10 mm/s at 50 m.
Bulldozers	1–2 mm/s at distances of approximately 5 m; usually below 0.2 mm/s at distances greater than 20 m.
Truck traffic (over normal road surfaces)	0.01–0.2 mm/s at the footings of buildings located 10–20 m from a roadway.
Truck traffic (over irregular surfaces)	0.1–2.0 mm/s at the footings of buildings located 10–20 m from a roadway.

Vibration and human disturbance

Residents within 75 m of construction works may perceive vibrations, particularly during vibratory compaction of earthworks, albeit for a relatively short period because the earthworks plant moves often. During impact piling activities this distance may increase to 100 to 150 m but would not be expected to affect many receivers due to the typically large distance from residences to locations at the interchanges where piling would occur.

Resident perception of vibration is often accompanied by concerns of structural damage, thus increasing annoyance levels. Residents would be informed and consulted to reduce concerns as to potential building damage. The community engagement program would address vibration annoyance or structural concerns, and may include dilapidation surveys for affected residences.

Vibration effects on building contents

Typical frequencies of ground vibration from road and rail construction activities are from 8–100 Hz. Within this frequency range, building contents such as blinds and pictures would begin visible movement at 0.5 mm/s. At vibration levels higher than 0.9 mm/s, windows, crockery and loose objects would rattle and be audible and annoying.

Residences within 50 m of construction activities, such as compacting and piling, may experience some vibration effects on building contents. Given the distance of most residential buildings from the Northern Connector route, this vibration symptom would not be likely to affect most residents. Residents near works would be informed and consulted when works with the potential to produce significant vibration are occurring near to their property, to address concerns about possible damage to buildings or their contents.

Structural damage to buildings

The highest levels of vibration are typically generated by compactors, vibratory rollers and pile driving. In most cases, the generated vibration levels are too low in magnitude to cause structural damage to buildings greater than 25 m from the construction activity. For heritage-listed buildings, the distance within which structural damage is considered is generally increased to 50 m to reflect the increased significance and sensitivity of these buildings.

Since all residential buildings are located outside of this 25 m zone, and heritage-listed buildings are located outside of the 50 m zone from the Northern Connector corridor, structural damage due to vibration would not be likely. Building condition surveys and monitoring of vibration levels would be undertaken as necessary prior to and during construction to minimise the risk of structural damage.

3.2 Operational road traffic noise

3.2.1 Traffic noise criteria

The model of the existing road network and predicted 2017 road traffic volumes were used to predict the road traffic noise environment at noise sensitive locations should the Northern Connector not be constructed. Receivers were only considered if they were within 600 m of the proposed Northern Connector. Results have been summarised for receivers based on the study areas being investigated, which are:

- Northern catchment area: including properties in Waterloo Corner and St Kilda.
- Central catchment area: including properties in Bolivar and Highway One Caravan Park.
- Southern catchment area: including properties in Globe Derby Park, Dry Creek and Wingfield.

The catchment areas investigated are shown in Figure 1.2.

3.2.2 Noise prediction modelling

The noise model of the existing road network and the existing traffic volumes (2008) were used to predict current traffic noise levels at the eight measurement sites. An analysis on measured day time and night time noise levels found that generally, the model under-predicted night time noise levels, and over-predicted day time noise levels. Table 3.4 analyses the predicted (PNL) and measured (MNL) noise level data for receivers used for calibration.

Table 3.4. Comparison of measured and predicted results in dB(A) (2008)

Location	**Day time $L_{eq,15h}$**			**Night time $L_{eq,9h}$**		
	PNL	**MNL**	**PNL − MNL**	**PNL**	**MNL**	**PNL − MNL**
PRExy – East	68.3	71.0	−2.7	65.5	67.5	−2.0
PRExy – South	59.8	56.5	+3.3	57.0	52.8	+4.2
PRExy – North	61.7	66.4	−4.7	58.9	62.5	−3.6
PRExy – West	68.6	66.9	+1.7	65.9	63.5	+2.4
34 General Drive – Paralowie	66.6	64.3	+2.3	59.4	61.9	−2.5
Lot 1 PWR – Waterloo Corner	67.7	65.9	+1.8	65.5	65.7	−0.2
PWR – Globe Derby Park	63.5	60.5	+3.0	57.5	61.0	−3.5
Lot 51 PWR	63.0	59.7	+3.3	58.2	60.1	−1.9
Mean			+1.0			−0.9
Standard deviation			3.0			2.8

Based on the data presented in Table 3.4, a correction factor of −1.0 dB(A) and +0.9 dB(A) has been applied for day time and night time respectively in the noise model.

Assuming a normal distribution of results about the mean, it is anticipated that 68% of receivers would lie within one standard deviation of the mean, and 96% will lie within two standard deviations. The probability of a receiver exceeding the predicted night time noise level (after correction to the mean) is presented below in Table 3.5.

Table 3.5. Probability of exceeding predicted night time noise level

Variation over predicted level	Probability
+1 dB(A)	36%
+2 dB(A)	24%
+3 dB(A)	15%
+4 dB(A)	8%

The error function for predicted levels is presented in Figure 3.1. The function represents the probability of the actual night time noise level exceeding the predicted noise level by a given amount. For example, for a predicted night time noise level of 65 dB(A), there is a 15% chance that the actual noise level exceeds 68 dB(A), and similarly a 15% chance that the noise level is below 62 dB(A).

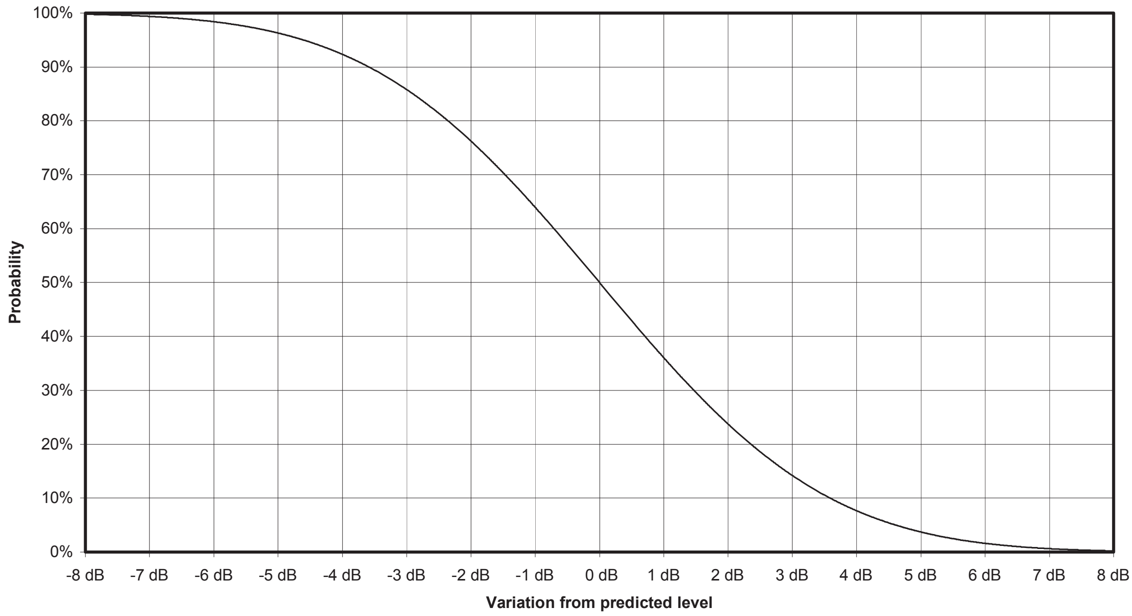


Figure 3.1. Probability of exceedance of predicted night time noise level

3.2.3 Predicted 2017 pre- and post-opening of the Northern Connector and 2031 traffic noise levels

Tables 3.6 and 3.7 summarise the 2017 pre-opening traffic noise impacts as well as the 2017 (post-opening) and 2031 traffic noise impacts for day time and night time for the proposed road route.

Table 3.6. Percent of sensitive receivers' day time ($L_{eq,15h}$) noise levels in each catchment for proposed road route

Catchment (receivers)	Model scenario	Day time noise level ($L_{eq,15h}$) in dB(A)				
		>70	65–70	60–65	55–60	<55
Northern (166)	2017 pre-opening	3%	8%	8%	9%	72%
	2017 post-opening	3%	1%	13%	26%	60%
	2031	0%	8%	19%	21%	53%
Central (193)	2017 pre-opening	0%	32%	53%	13%	2%
	2017 post-opening	0%	0%	32%	52%	16%
	2031	0%	1%	58%	34%	7%
Southern (346)	2017 pre-opening	0%	2%	19%	26%	53%
	2017 post-opening	0%	0%	9%	22%	69%
	2031	0%	1%	15%	24%	60%

Table 3.7. Percent of sensitive receivers' night time ($L_{eq,9h}$) noise levels in each catchment for proposed road route

Catchment (receivers)	Model scenario	Night time noise level ($L_{eq,9h}$) in dB(A)				
		>65	60–65	55–60	50–55	<50
Northern (166)	2017 pre-opening	10%	8%	8%	8%	66%
	2017 post-opening	0%	8%	19%	19%	53%
	2031	4%	17%	19%	18%	43%
Central (193)	2017 pre-opening	30%	51%	17%	3%	0%
	2017 post-opening	0%	4%	56%	33%	8%
	2031	1%	39%	50%	9%	2%
Southern (346)	2017 pre-opening	1%	16%	24%	21%	37%
	2017 post-opening	0%	3%	21%	24%	52%
	2031	0%	9%	22%	25%	44%

Table 3.8 summarises the differences between the predicted 2031 day time and night time noise levels and the noise criteria in each catchment area. Receivers have been grouped into five classes based on the amount by which the predicted noise levels exceed the noise criteria:

- greater than 8 dB(A) above criteria
- 5–8 dB(A) above criteria
- 3–5 dB(A) above criteria
- 1–2 dB(A) above criteria
- below criteria.

Attachment D provides details of all receivers predicted to be in excess of 2031 noise criteria without noise mitigation.

Table 3.8. Summary of predicted 2031 future road traffic noise levels for proposed road route

Catchment (receivers)	>8 dB(A) above	5–8 dB(A) above	3–5 dB(A) above	1–2 dB(A) above	Below criteria
Northern (166)	11	14	20	20	95
Central (193)	0	1	39	32	121
Southern (346)	4	4	8	36	295

Noise from the Northern Connector road traffic will generally be perceived as a steady 'hum' during day time periods, with noise levels rising slightly due to heavy vehicle pass-bys. During the night time period, the traffic 'hum' will be perceived at a lower noise level with a more noticeable rise and fall during pass-by of heavy vehicles.

In the areas immediately surrounding the proposed interchanges, noise levels will contain more noticeable variations, particularly during low traffic periods, from braking and accelerating of vehicles leaving and entering the Northern Connector.

Overall, the project would provide reductions in noise levels to receivers currently exposed to high noise levels from Port Wakefield Road. As presented in the above tables, for all catchments, the amount of properties exposed to high noise levels (night time above 60 dB(A)) is predicted to decrease after opening of the Northern Connector.

In particular, those properties adjacent to Port Wakefield Road are expected to achieve noticeable reductions in noise levels with reductions of up to 5 dB(A) expected.

3.2.4 Noise contours in 2031 without mitigation measures

Figures 3.2 to 3.7 indicate the predicted 2031 noise contours in 5 dB(A) intervals for both day time and night time respectively.

Noise level contours provide a visual noise 'footprint' indicating the extent of noise impact on the environment.

The predicted noise level contours do not include specific mitigation measures, such as noise walls or additional local shielding for residents, and therefore, present a base case effect.

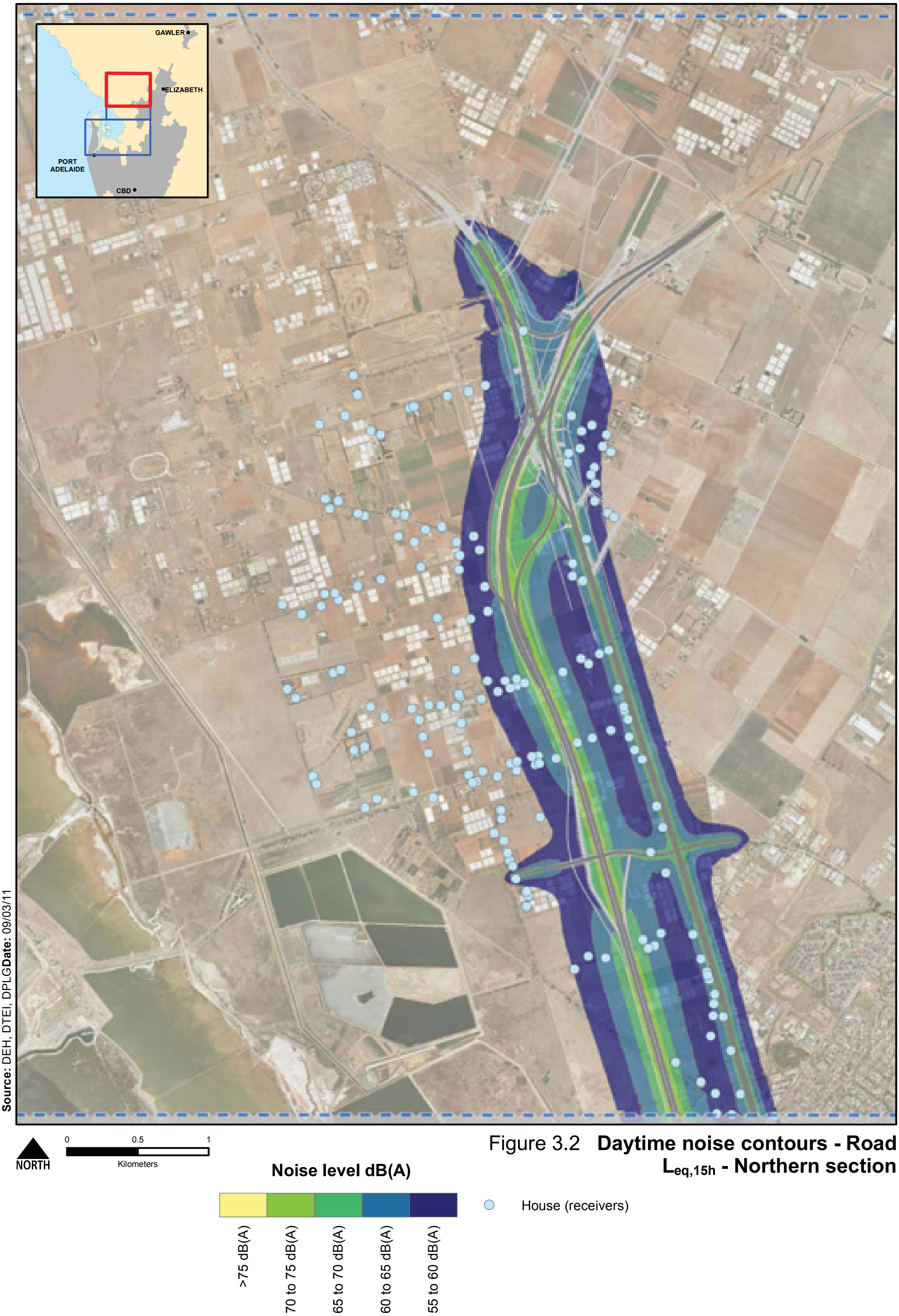
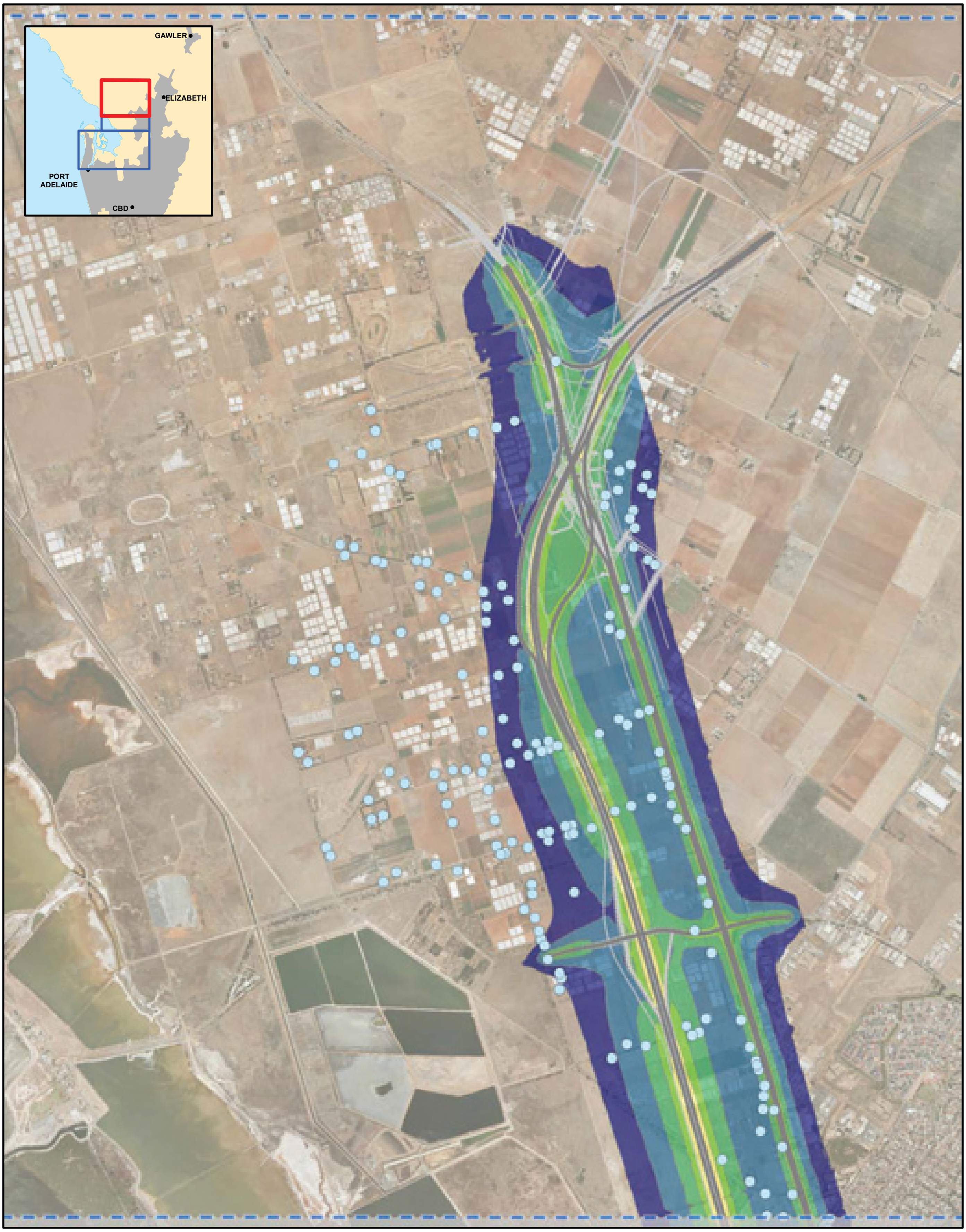


Figure 3.2 **Daytime noise contours - Road $L_{eq,15h}$ - Northern section**



Source: DEH, DTEI, DPLGDate: 09/03/11

NORTH

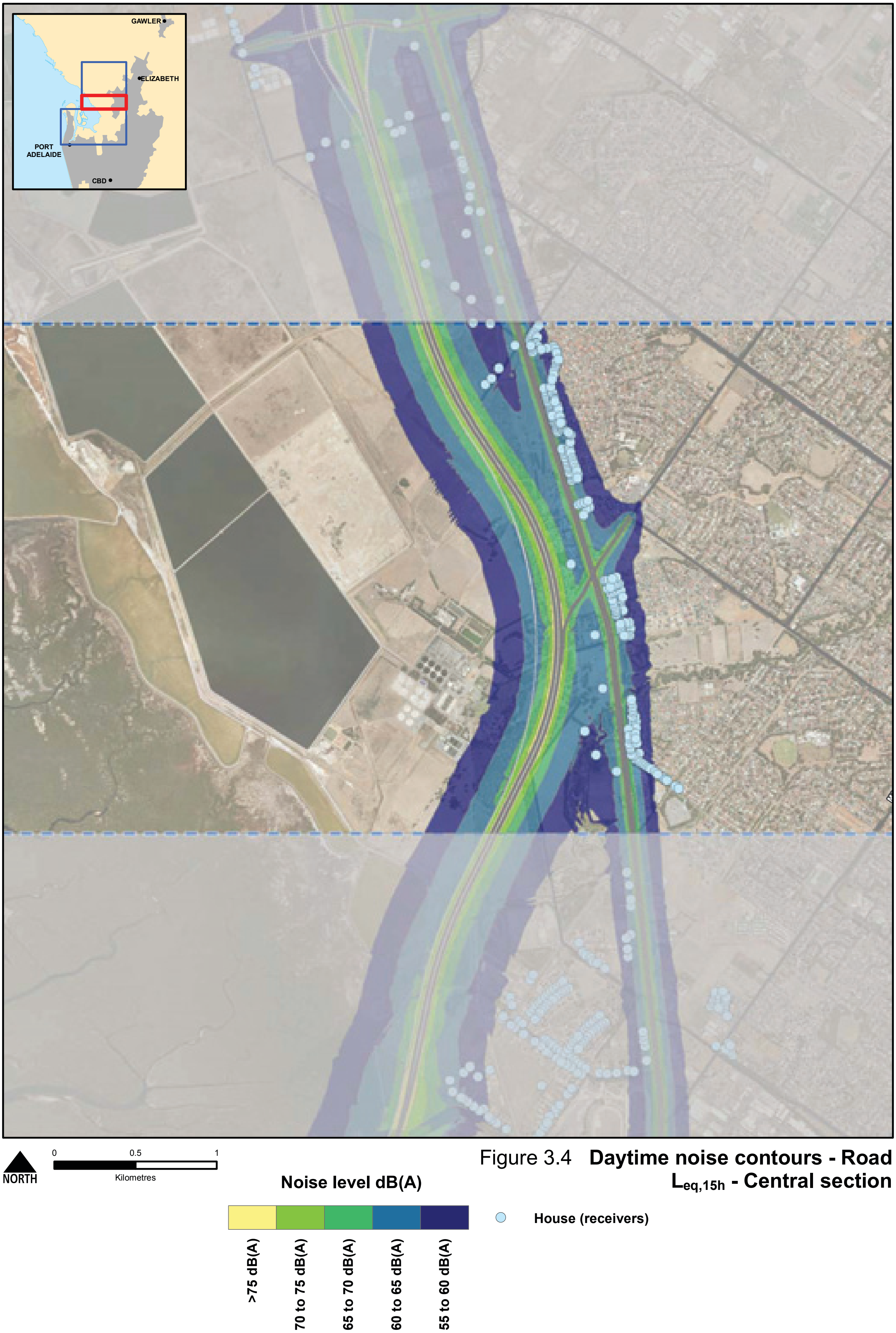
0 0.5 1
Kilometers

Figure 3.3 **Night time noise contours - Road $L_{eq,9h}$ - Northern section**

Noise level dB(A)

- **> 70 dB(A)**
- **65 to 70 dB(A)**
- **60 to 65 dB(A)**
- **55 to 60 dB(A)**
- **50 to 55 dB(A)**

House (receivers)



Source: DEH, DTEI, DPLG

Figure 3.4 **Daytime noise contours - Road $L_{eq,15h}$ - Central section**

Source: DEH, DTEI, DPLG

NORTH

0 0.5 1
Kilometres

Figure 3.5 **Night time noise contours - Road $L_{eq,9h}$ - Central section**

Noise level dB(A)

> 70 dB(A)
65 to 70 dB(A)
60 to 65 dB(A)
55 to 60 dB(A)
50 to 55 dB(A)

House (receivers)

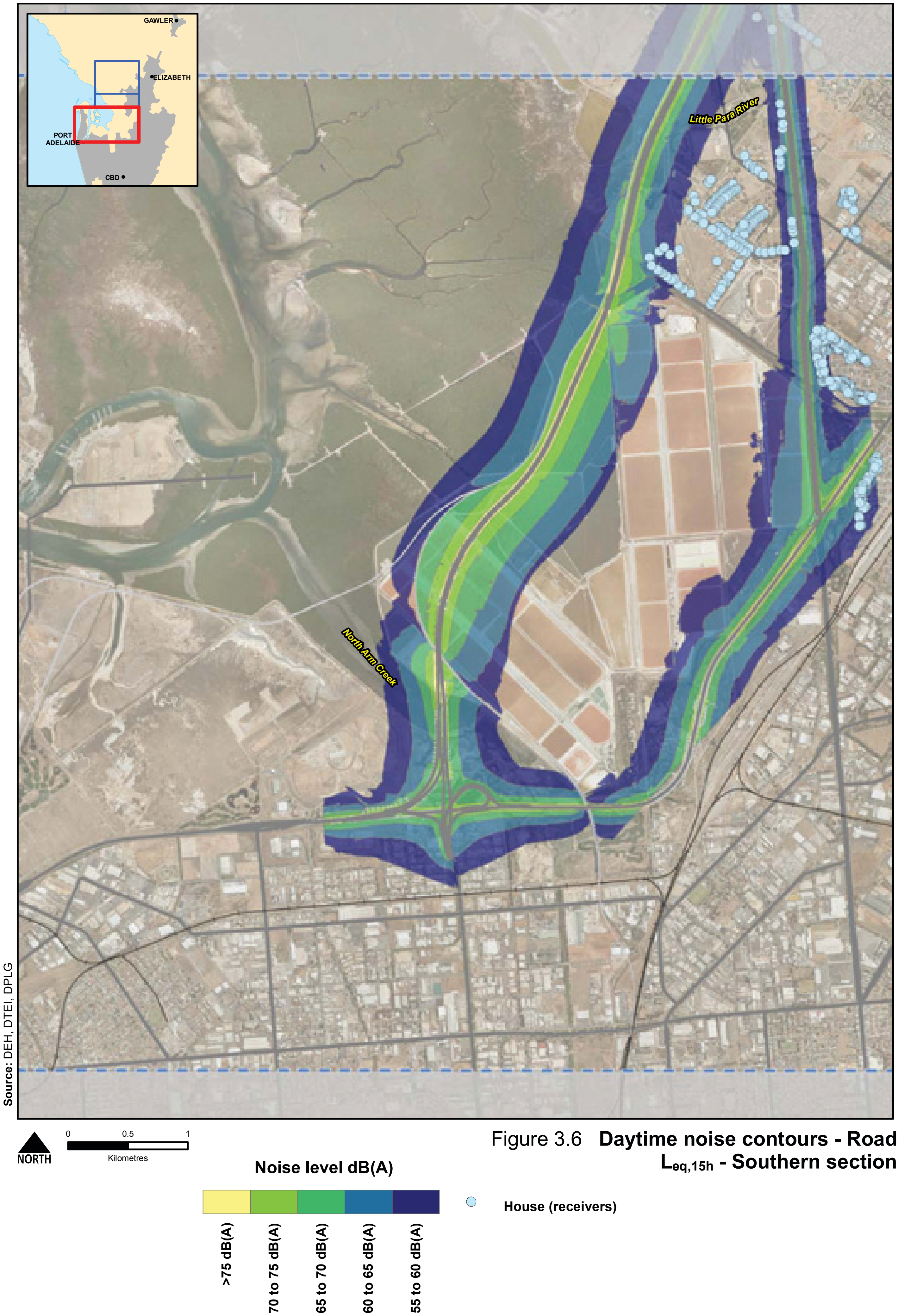
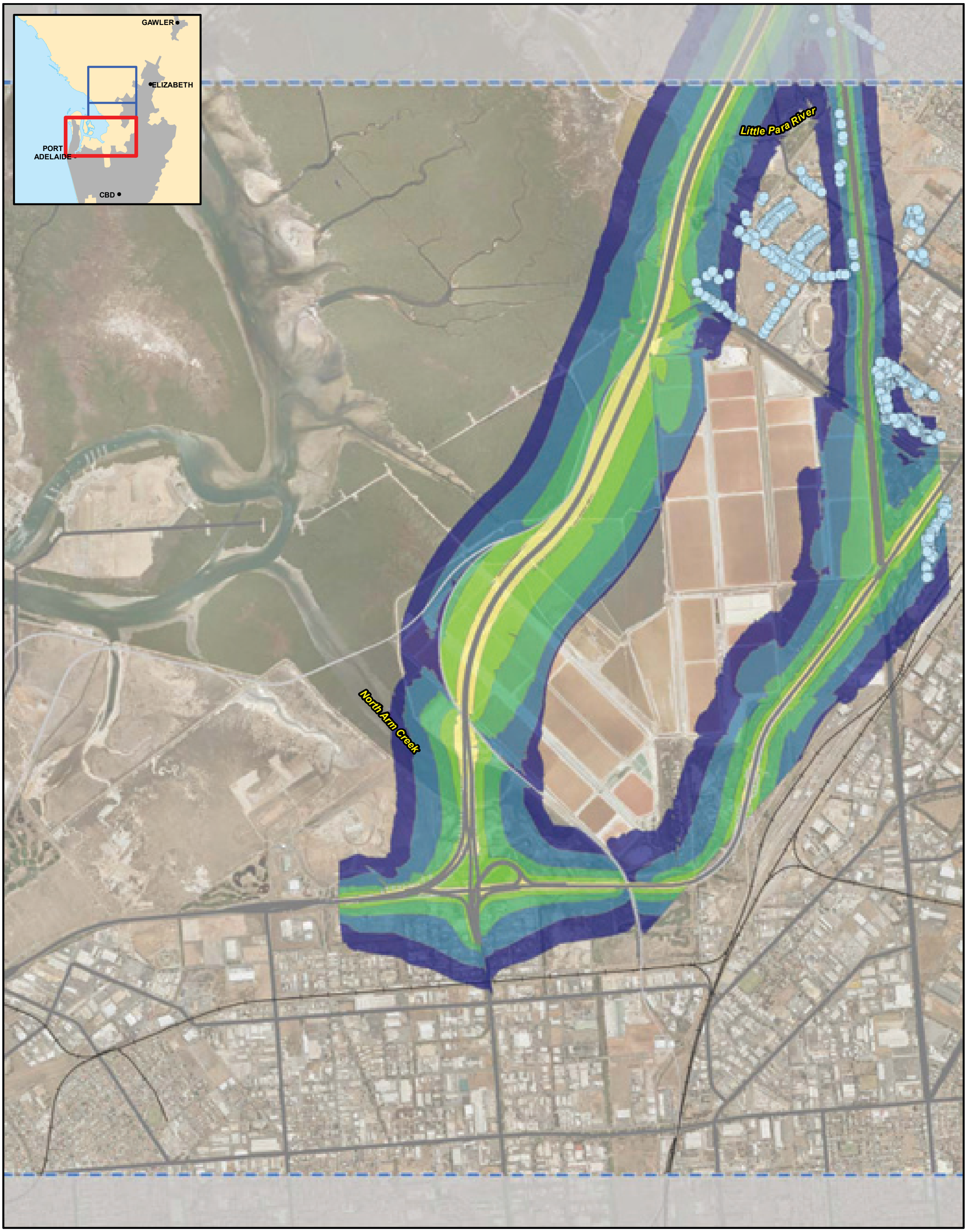


Figure 3.6 **Daytime noise contours - Road $L_{eq,15h}$ - Southern section**



Source: DEH, DTEI, DPLG

Figure 3.7 **Night time noise contours - Road $L_{eq,9h}$ - Southern section**

Noise level dB(A)

- **> 70 dB(A)**
- **65 to 70 dB(A)**
- **60 to 65 dB(A)**
- **55 to 60 dB(A)**
- **50 to 55 dB(A)**
- **House (receivers)**

3.3 Operational rail noise

3.3.1 Rail noise criteria

The rail noise criteria for all sensitive receivers adjacent to the Northern Connector route are:

- $L_{eq,15h}$ 60 dB(A)
- $L_{eq,9h}$ 55 dB(A)
- L_{max} 80 dB(A).

For those receivers adjacent to the existing freight rail lines through Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway, no rail noise criteria are applicable as no works are proposed on the rail line. However, the criteria for upgraded rail lines have been used as a reference for existing rail noise levels. The noise criteria for upgraded rail lines are:

- $L_{eq,15h}$ 65 dB(A)
- $L_{eq,9h}$ 60 dB(A)
- L_{max} 85 dB(A).

3.3.2 Noise prediction modelling

Predicted 2017 rail noise levels without the Northern Connector

The noise model of the existing rail alignments in 2017 was used to predict rail noise levels should the Northern Connector not be constructed.

Table 3.9 summarises the predicted 2017 rail noise levels at the nearest residential locations in areas currently exposed to rail noise. The noise levels are compared to the criteria for upgraded rail lines, which are provided as targets for reference purposes only.

Table 3.9. Summary of predicted 2017 rail noise levels without Northern Connector

Area	Day time $L_{eq,15h}$ (dB(A))		Night time $L_{eq,9h}$ (dB(A))		L_{max} (dB(A))	
	Predicted	Targets	Predicted	Targets	Predicted	Targets
Mawson Lakes	58 – 61	65	55 – 56	60	83 – 86	85
Parafield Gardens	60 – 64	65	55 – 60	60	83 – 89	85
Salisbury Downs	60 – 62	65	55 – 57	60	84 – 86	85
Salisbury	63 – 65	65	58 – 61	60	85 – 90	85
Salisbury North	59 – 60	65	58 – 59	60	88 – 90	85
Ottoway	53 – 57	65	52 – 56	60	81 – 87	85

The predictions indicate that day time and night time L_{eq} noise levels in 2017 would generally comply with the upgraded rail line criteria but may exceed the night time criteria marginally at the nearest residences in the Salisbury area.

The predicted 2017 L_{max} noise levels exceed the L_{max} criterion by up to 5 dB(A) at residential locations adjacent to the existing rail alignments due to freight rail movements adjacent to the residential areas.

Predicted 2027 rail noise levels with Northern Connector

The noise model of the Northern Connector rail alignment, including the predicted 2027 train volumes, was used to predict the future rail noise levels at the nearest sensitive receivers.

As for the operational road traffic noise assessment, the results have been summarised for receivers within 500 m of the Northern Connector corridor in three study areas:

- Northern catchment area: including properties in Waterloo Corner and St Kilda.
- Central catchment area: including properties in Bolivar and Highway One Caravan Park.
- Southern catchment area: including properties in Globe Derby Park, Dry Creek and Wingfield.

The noise model predictions indicate that, without noise mitigation, rail noise levels from movements on the Northern Connector corridor are expected to:

- exceed the day time $L_{eq,15h}$ criterion of 60 dB(A) by 1 dB(A) at one receivers
- exceed the night time $L_{eq,9h}$ criterion of 55 dB(A) by between 1 to 5 dB(A) at three receivers
- exceed the L_{max} criterion of 80 dB(A) by between 1 to 9 dB(A) at five receivers.

Attachment D provides details of all receivers adjacent to the Northern Connector predicted to exceed the rail noise criteria.

It should also be noted that the Northern Connector would reduce rail noise levels for many residences adjacent to the existing freight rail line through the Ottoway and Salisbury areas. This is due to freight rail, currently travelling through the suburban areas east of Port Wakefield Road, diverting to the Northern Connector corridor. There are a significant number of residences within 30 to 50 metres of the existing freight rail line, and diverting the rail to the proposed Northern Connector would considerably reduce the noise impact on these receivers.

Table 3.10 summarises the predicted 2027 rail noise levels at the nearest residential locations in the areas of Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway. The predicted noise levels are compared to the criteria for upgraded rail lines, which are provided as targets for reference purposes only.

Table 3.10. Summary of predicted 2027 rail noise levels with Northern Connector

Area	Day time $L_{eq,15h}$ (dB(A))		Night time $L_{eq,9h}$ (dB(A))		L_{max} (dB(A))	
	Predicted	**Target**	**Predicted**	**Target**	**Predicted**	**Target**
Mawson Lakes	55 – 61	65	49 – 53	60	59 – 70	85
Parafield Gardens	59 – 63	65	51 – 56	60	69 – 74	85
Salisbury Downs	59 – 61	65	51 – 53	60	68 – 70	85
Salisbury	62 – 64	65	55 – 57	60	72 – 75	85
Salisbury North	< 50	65	< 50	60	< 60	85
Ottoway	< 50	65	< 50	60	81 – 87	85

The predictions indicate that future noise levels would be expected to meet the upgraded rail noise criteria for residential locations in Mawson Lakes, Parafield Gardens, Salisbury Downs and Salisbury. While rail noise would still be audible in these locations due to the passenger rail movements on the Gawler Passenger Rail Line, maximum noise levels would be significantly reduced due to the redirection of freight rail to the Northern Connector.

For residences in Ottoway, maximum noise levels from occasional freight train pass-bys may still marginally exceed 85 dB(A). However, there would be a significant reduction in the number of freight train movements so that only one pass-by would be expected of these areas during each of the day and night time periods.

Figures 3.8 to 3.16 indicate the predicted 2027 day time, night time and maximum rail noise contours in 5 dB(A) intervals without noise mitigation measures. As the rail noise has been predicted at free-field receiver locations, the +2.5 dB correction has been added to the predictions to account for the façade reflection factor.

Source: DEH, DTEI, DPLG **Date:** 09/03/11

NORTH

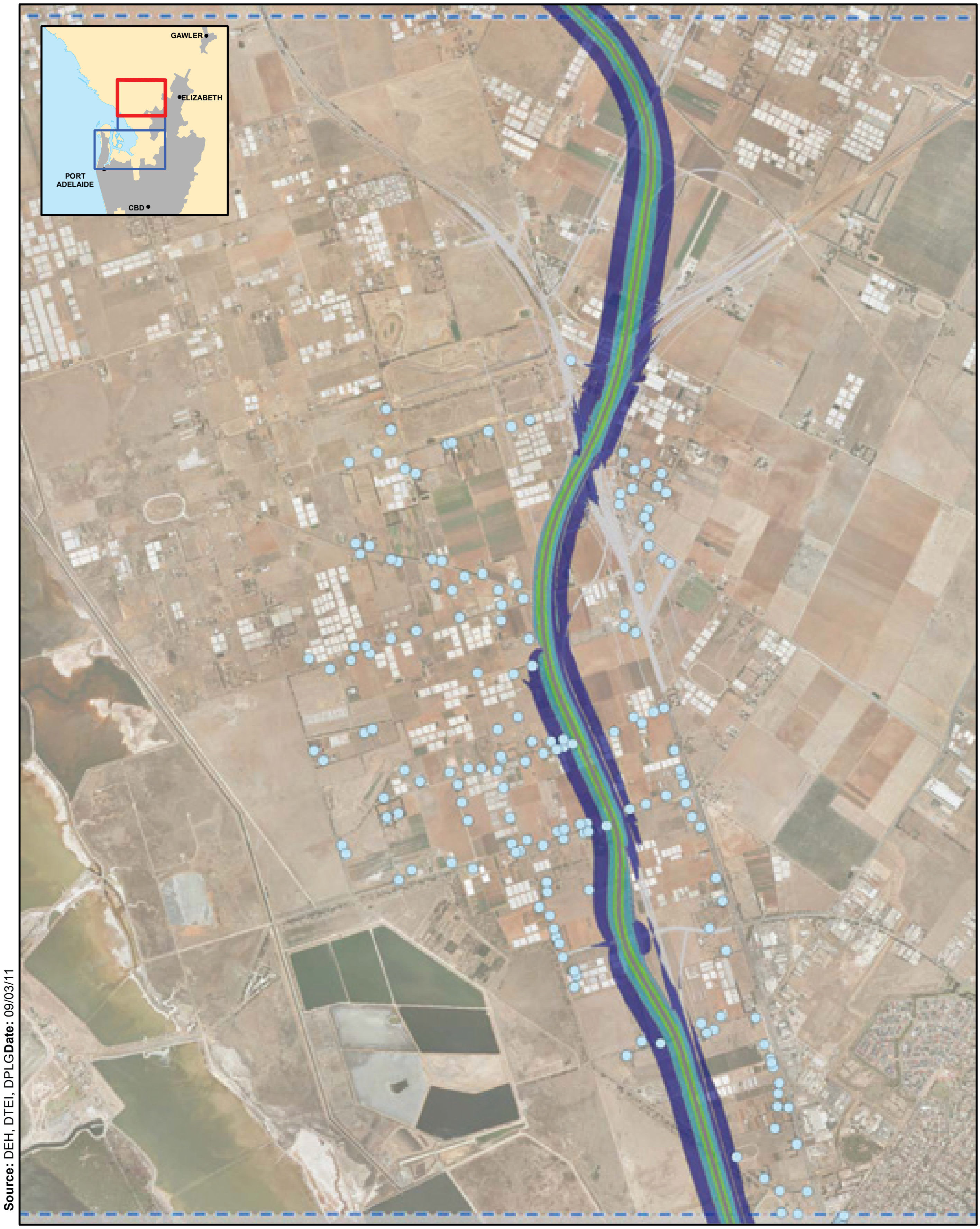
0 0.5 1
Kilometers

Figure 3.8 **Daytime noise contours - Rail**
$L_{eq,15h}$ - Northern section

Noise level dB(A)

>70 dB(A)
65 to 70 dB(A)
60 to 65 dB(A)
55 to 60 dB(A)

House (receivers)



NORTH

0 0.5 1
Kilometers

Figure 3.9 **Night time noise contours - Rail $L_{eq,9h}$ - Northern section**

Noise level dB(A)

- >65 dB(A)
- 60 to 65 dB(A)
- 55 to 60 dB(A)
- 50 to 55 dB(A)
- House (receivers)

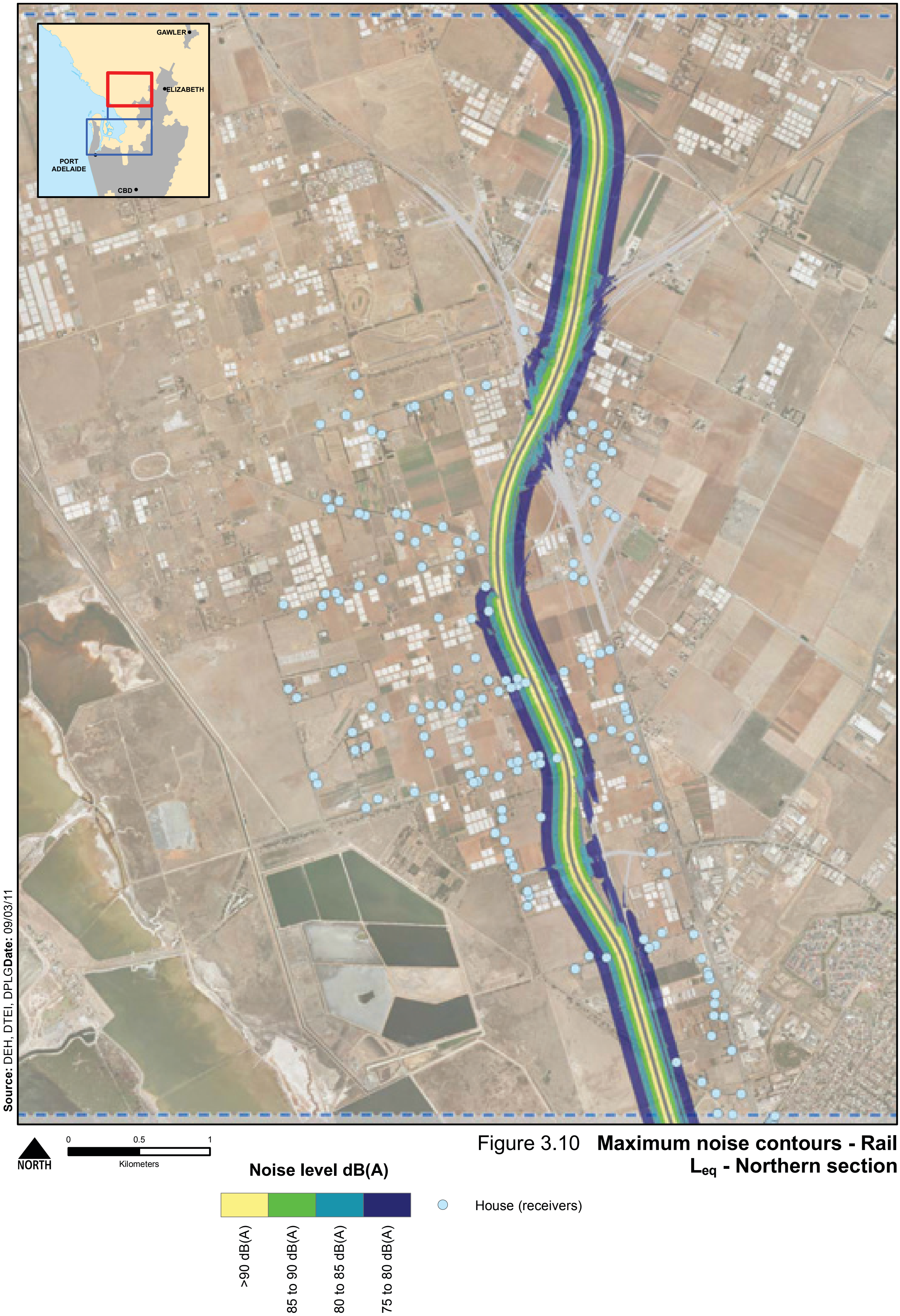


Figure 3.10 **Maximum noise contours - Rail L_{eq} - Northern section**

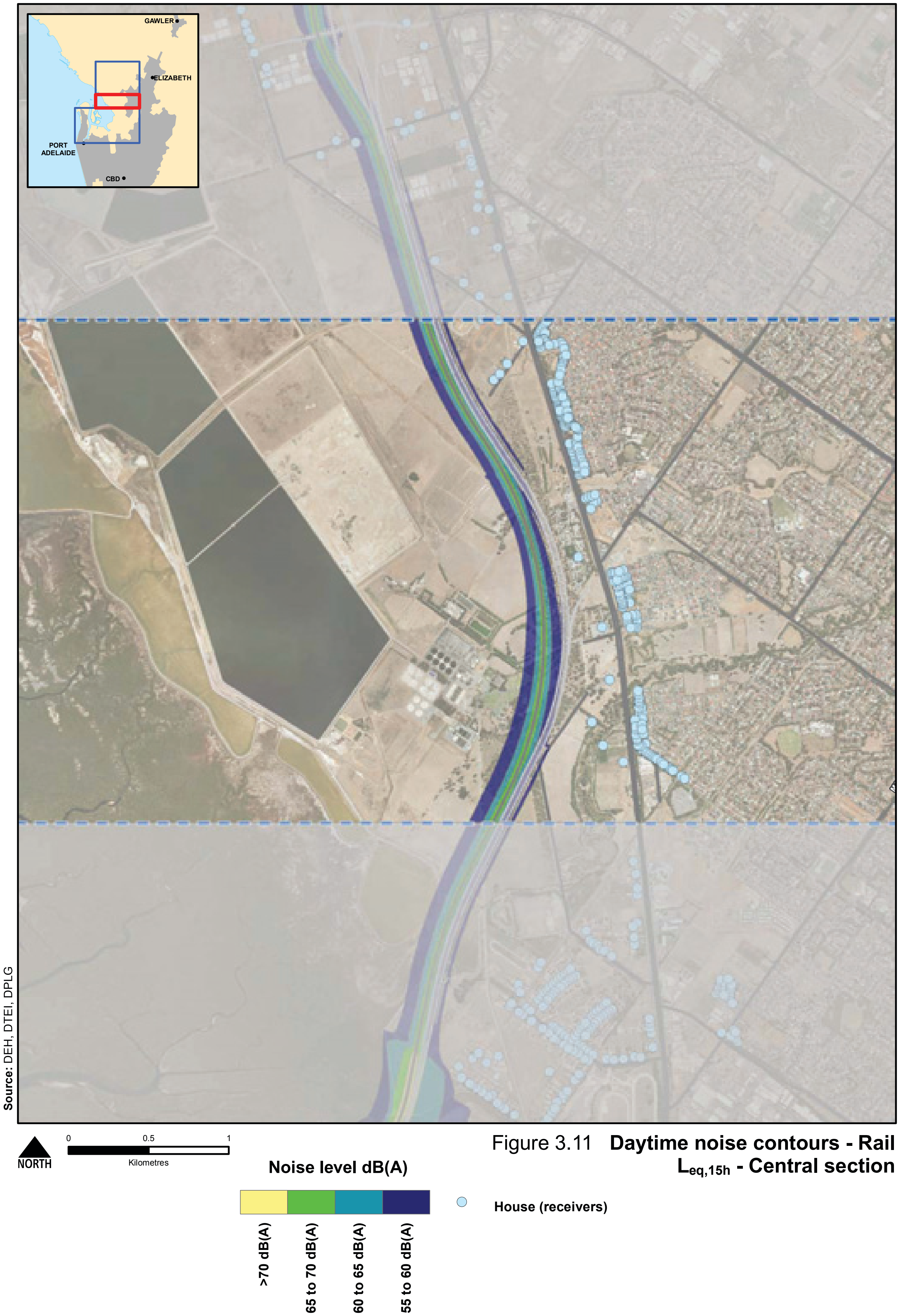


Figure 3.11 **Daytime noise contours - Rail $L_{eq,15h}$ - Central section**

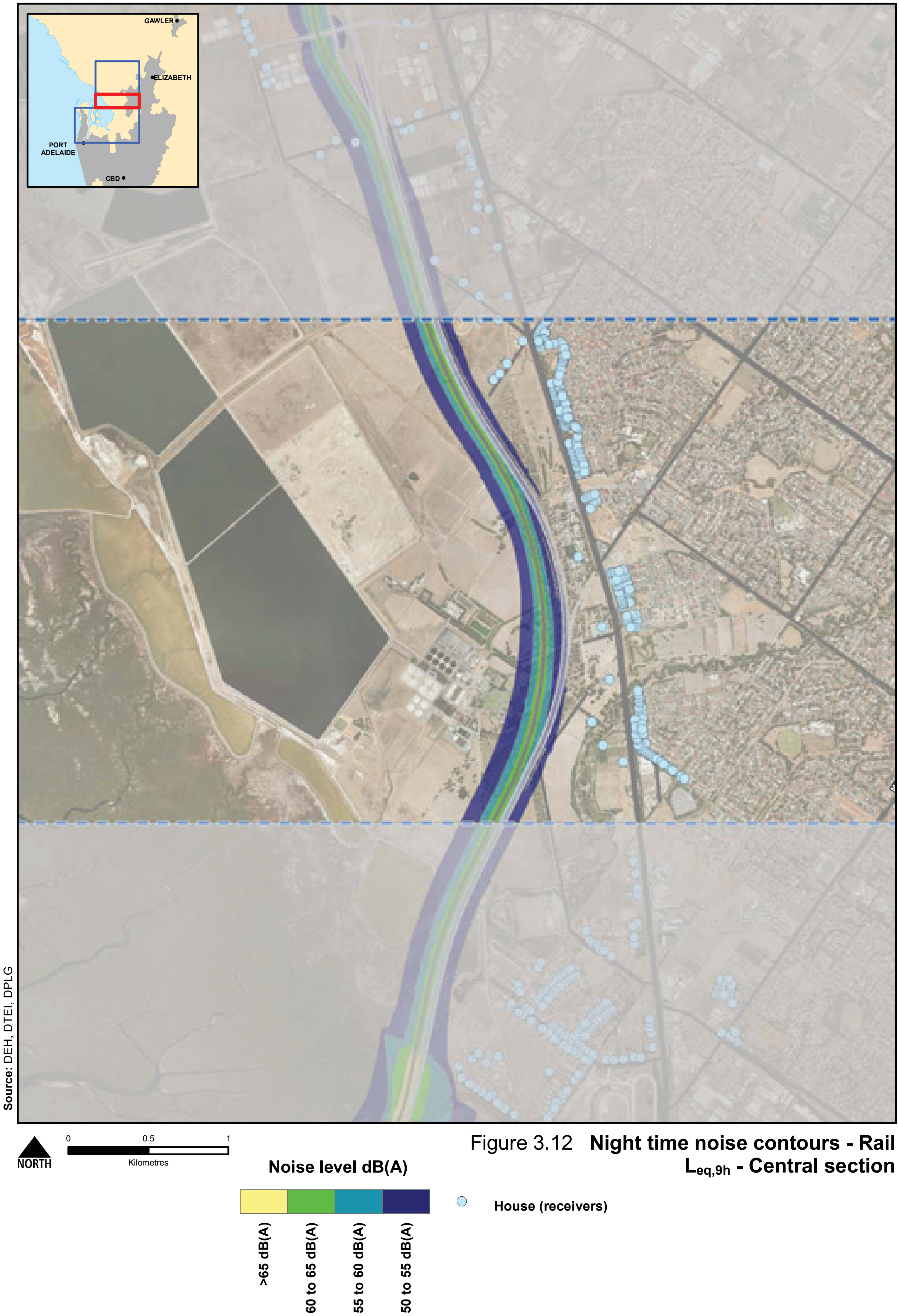
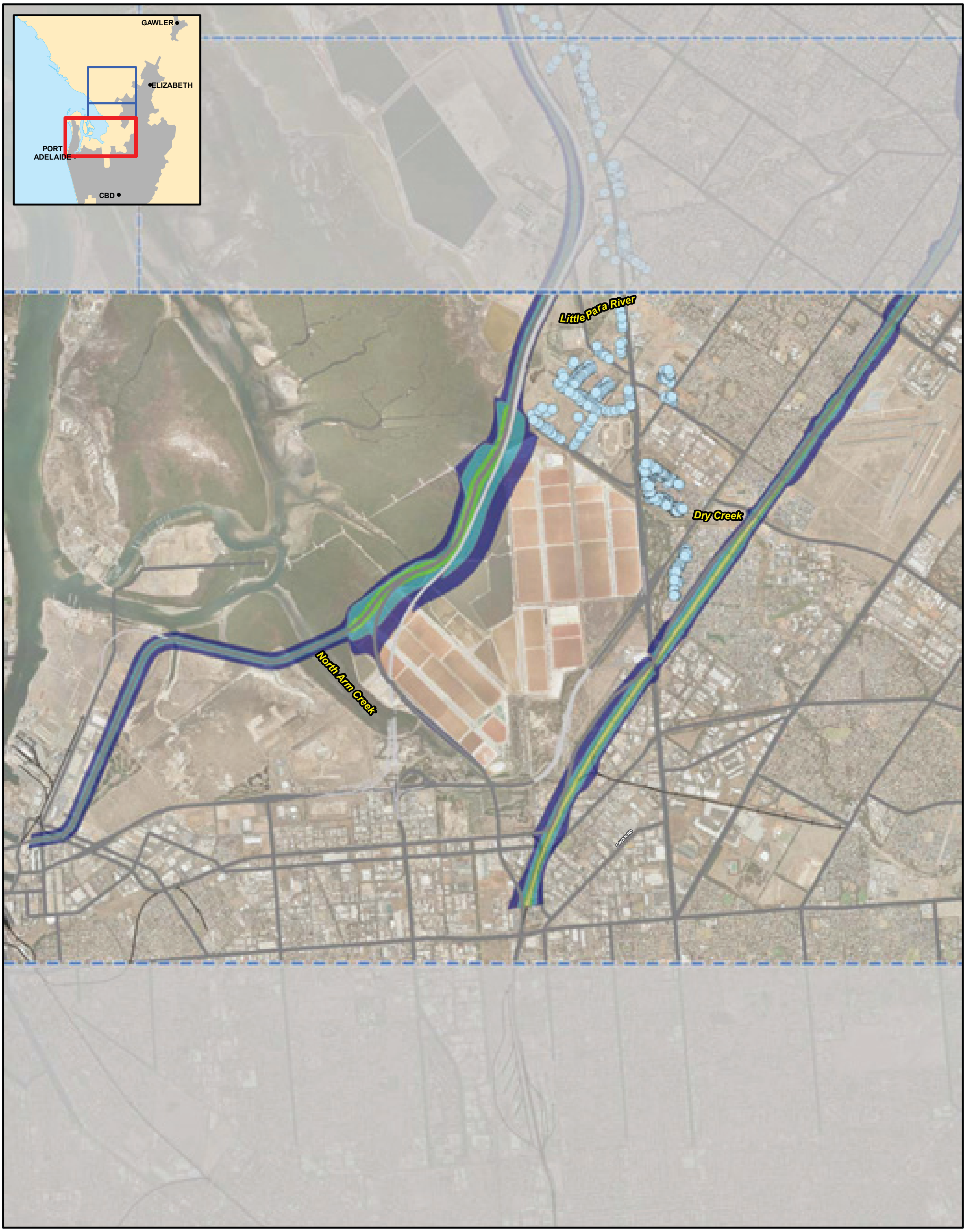


Figure 3.12 **Night time noise contours - Rail $L_{eq,9h}$ - Central section**

Source: DEH, DTEI, DPLG

Figure 3.13 **Maximum noise contours - Rail L_{eq} - Central section**



Source: DEH, DTEI, DPLG

NORTH

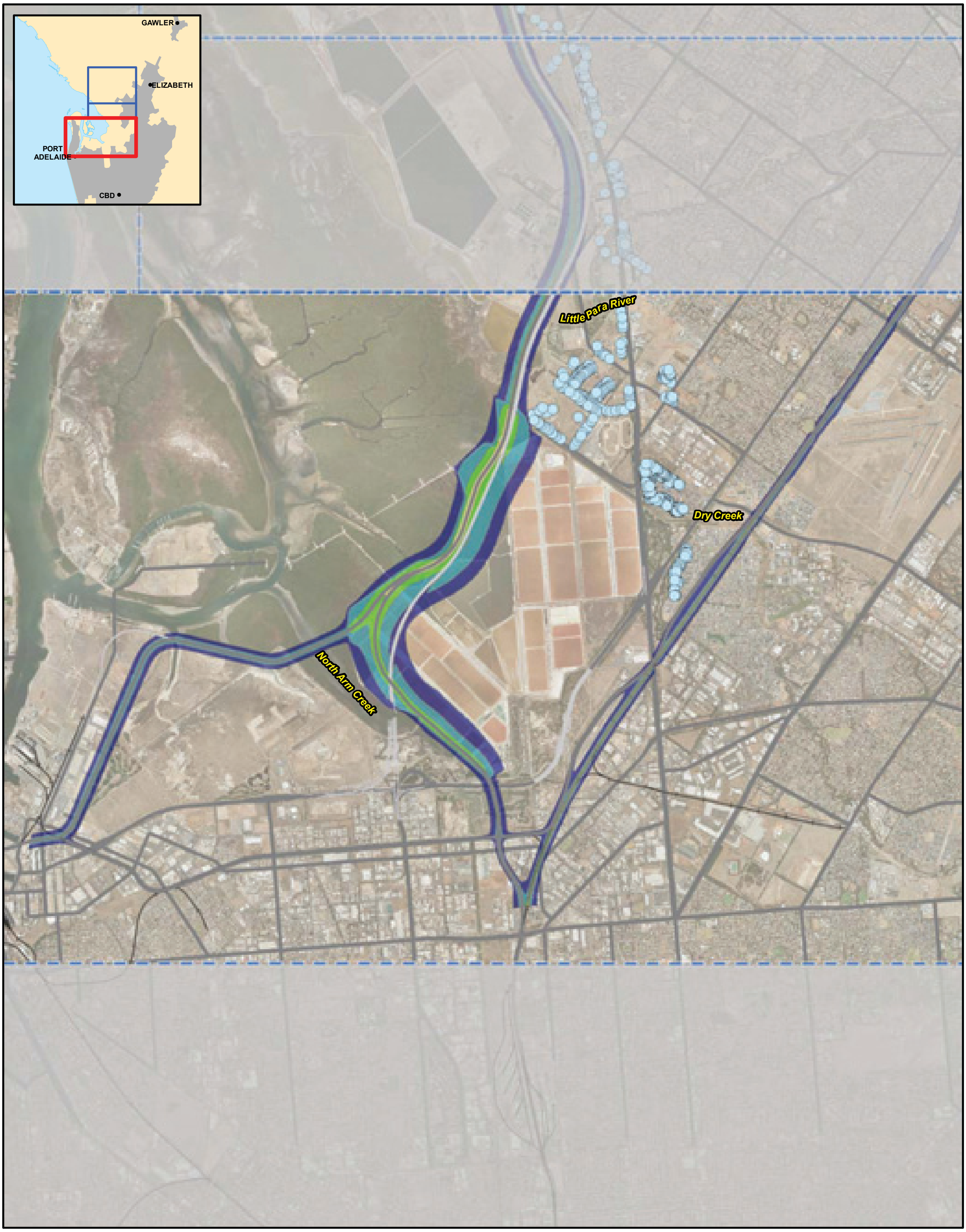
0 0.5 1
Kilometres

Figure 3.14 **Daytime noise contours - Rail $L_{eq,15h}$ - Southern section**

Noise level dB(A)

>70 dB(A)
65 to 70 dB(A)
60 to 65 dB(A)
55 to 60 dB(A)

House (receivers)



Source: DEH, DTEI, DPLG

NORTH

0 0.5 1

Kilometres

Figure 3.15 **Night time noise contours - Rail $L_{eq,9h}$ - Southern section**

Noise level dB(A)

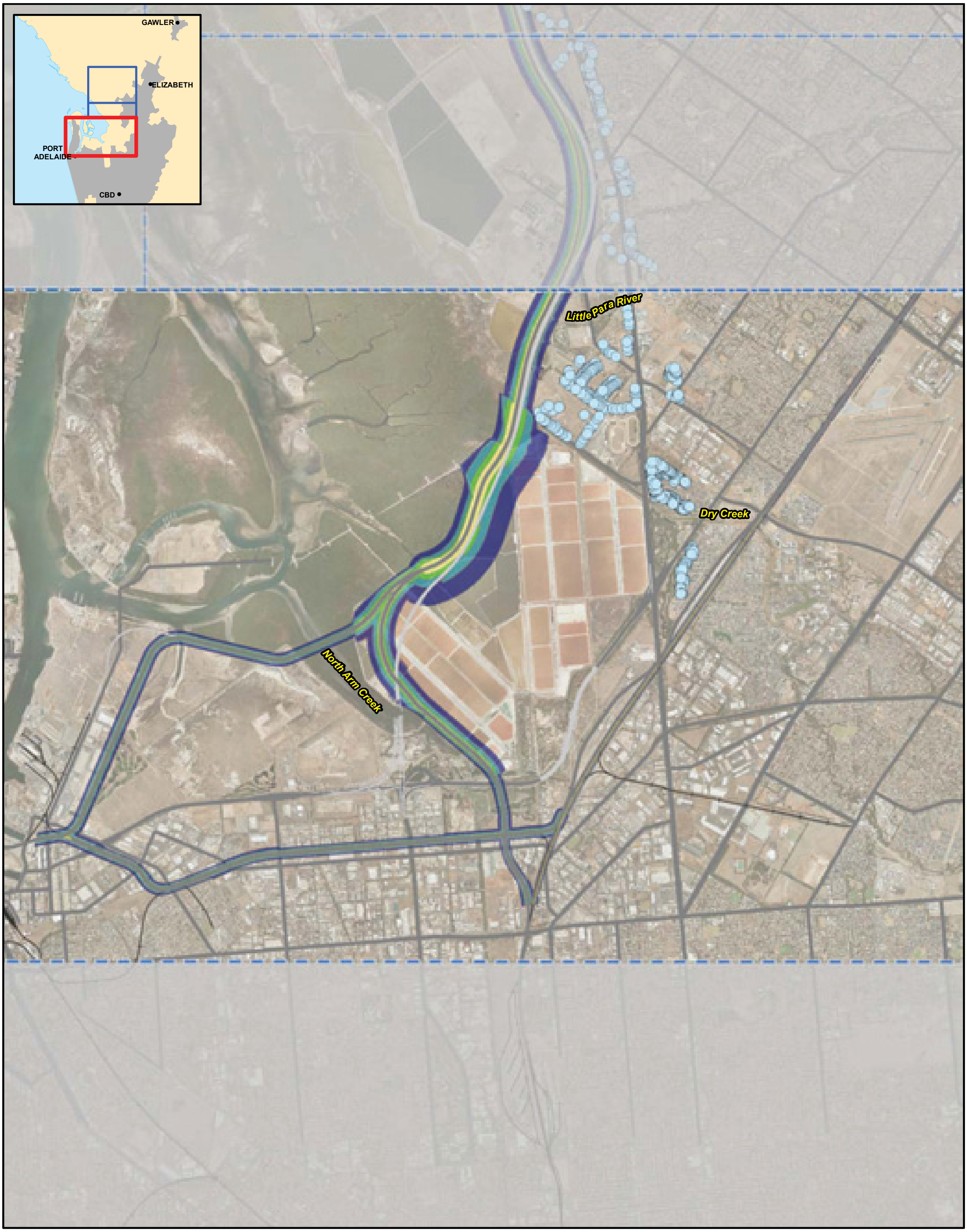
>65 dB(A)

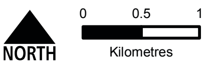
60 to 65 dB(A)

55 to 60 dB(A)

50 to 55 dB(A)

House (receivers)





Source: DEH, DTEI, DPLG

Figure 3.16 **Maximum noise contours - Rail**
L_{eq} - Southern section

Noise level dB(A)

>90 dB(A)
85 to 90 dB(A)
80 to 85 dB(A)
75 to 80 dB(A)

House (receivers)

3.4 Northern Connector noise in context

The aim of the proposed Northern Connector is to improve road and rail freight transfer by attracting vehicle movements from congested urban road networks and directing rail traffic more efficiently to the LeFevre Peninsula.

For residents living adjacent to Port Wakefield Road between Salisbury Highway and Taylors Road, this has the effect of up to an approximate halving of the perceived loudness of existing traffic noise. However the proposed Northern Connector would also have the effect of increasing noise for residents in Globe Derby Park (west) and St Kilda, as these localities are currently not exposed to any significant road traffic noise.

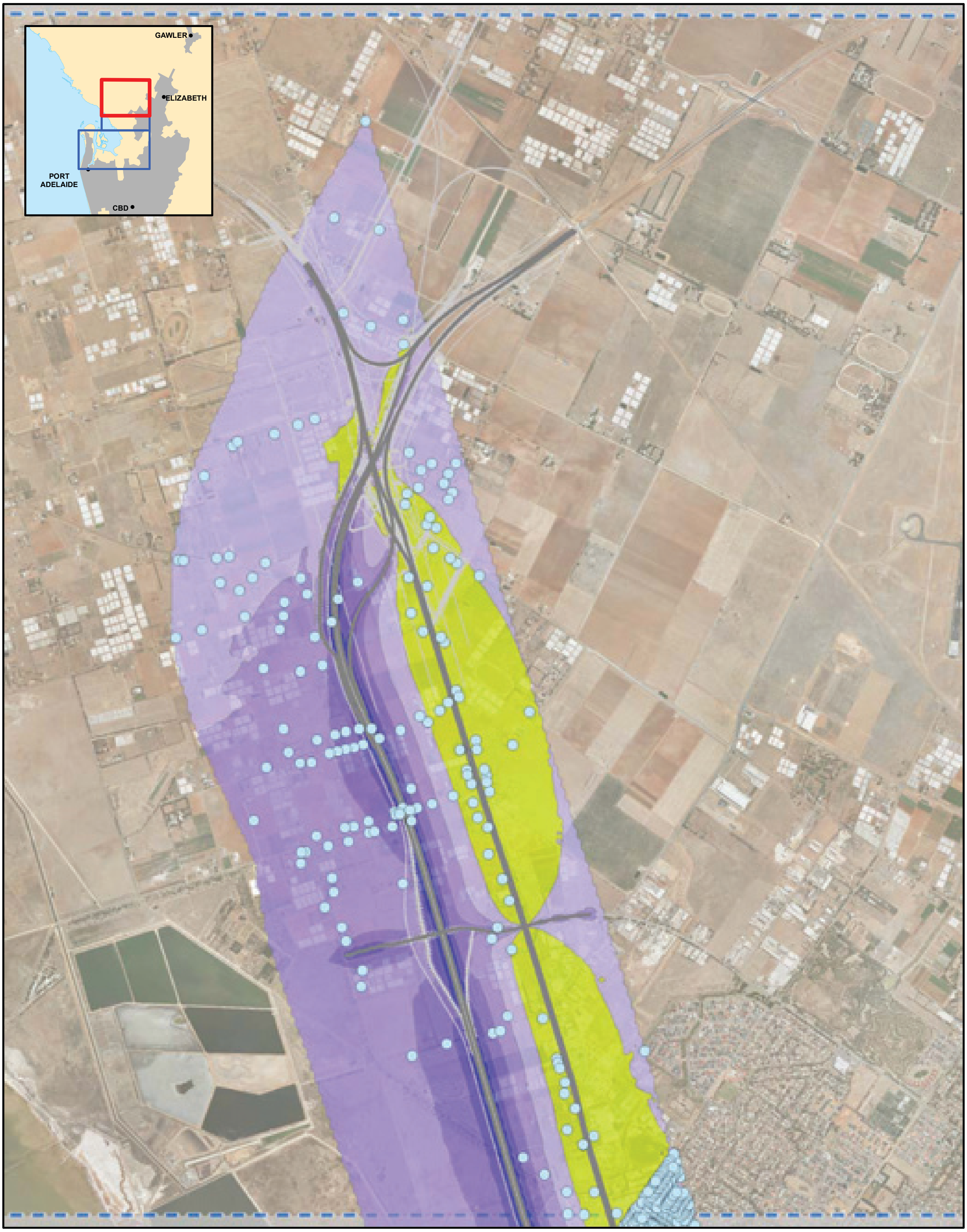
Figures 3.17 to 3.19 illustrate the change in road traffic noise levels between the pre-opening situation (2017) and future noise levels (2031). For properties close to the Port Wakefield Road corridor, reductions in noise levels of 5 to 10 dB(A) would be achieved. Properties near the Northern Connector corridor (typically those in St Kilda and Globe Derby Park) would be expected to experience increases of between 5 and 15 dB(A). A larger density of properties would experience reductions in noise levels due to their proximity to the Port Wakefield Road corridor than those receiving increases in road traffic noise from the Northern Connector.

Freight trains currently operate on the Salisbury rail line, passing a large number of residences through the areas of Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury and Salisbury North. Current freight rail movements to the LeFevre Peninsula also pass residential areas in Ottoway. Residences in these areas would benefit from the Northern Connector through reduced noise levels, although smaller passenger trains will continue to operate on the existing line. Residences in Globe Derby Park and St Kilda would be marginally impacted by rail noise from the Northern Connector.

Figures 3.20 to 3.21 illustrate the change in rail noise levels for the entire study area between the pre-opening situation (2017) and future situation with the Northern Connector (2027). The Figures indicate particularly significant day time and night time rail noise reductions for areas of Salisbury North, with considerable reductions of up to 5 dB(A) for day time and night time L_{eq} levels and 10 dB(A) for maximum L_{max} noise levels also predicted for the other areas.

Road and rail noise are traditionally assessed independently of each other. This is because the two noise sources have different characteristics, and are assessed using different noise criteria that have been specifically tailored. It is seldom that road and rail share the same transit corridor. The Northern Connector would have the benefit of keeping the two noise sources together, rather than separating and potentially creating a wider noise impact footprint.

For most residents, the noise environment would generally consist of the more constant hum of road traffic noise, with relatively infrequent freight rail pass-bys audible for brief periods of time. The overall day time and night time noise environment would be controlled by road traffic noise rather than rail noise.



Source: DEH, DTEI, DPLGDate: 09/03/11

NORTH

0 0.5 1
Kilometers

Figure 3.17 **Difference noise contours**
L_{eq} - Northern section

DECREASE **INCREASE**

< -20 dB	-20 to -15 dB	-15 to -10 dB	-10 to -5 dB	-5 to 0 dB	0 to 5 dB	5 to 10 dB	10 to 15 dB	15 to 20 dB	> 20 dB

House (receivers)

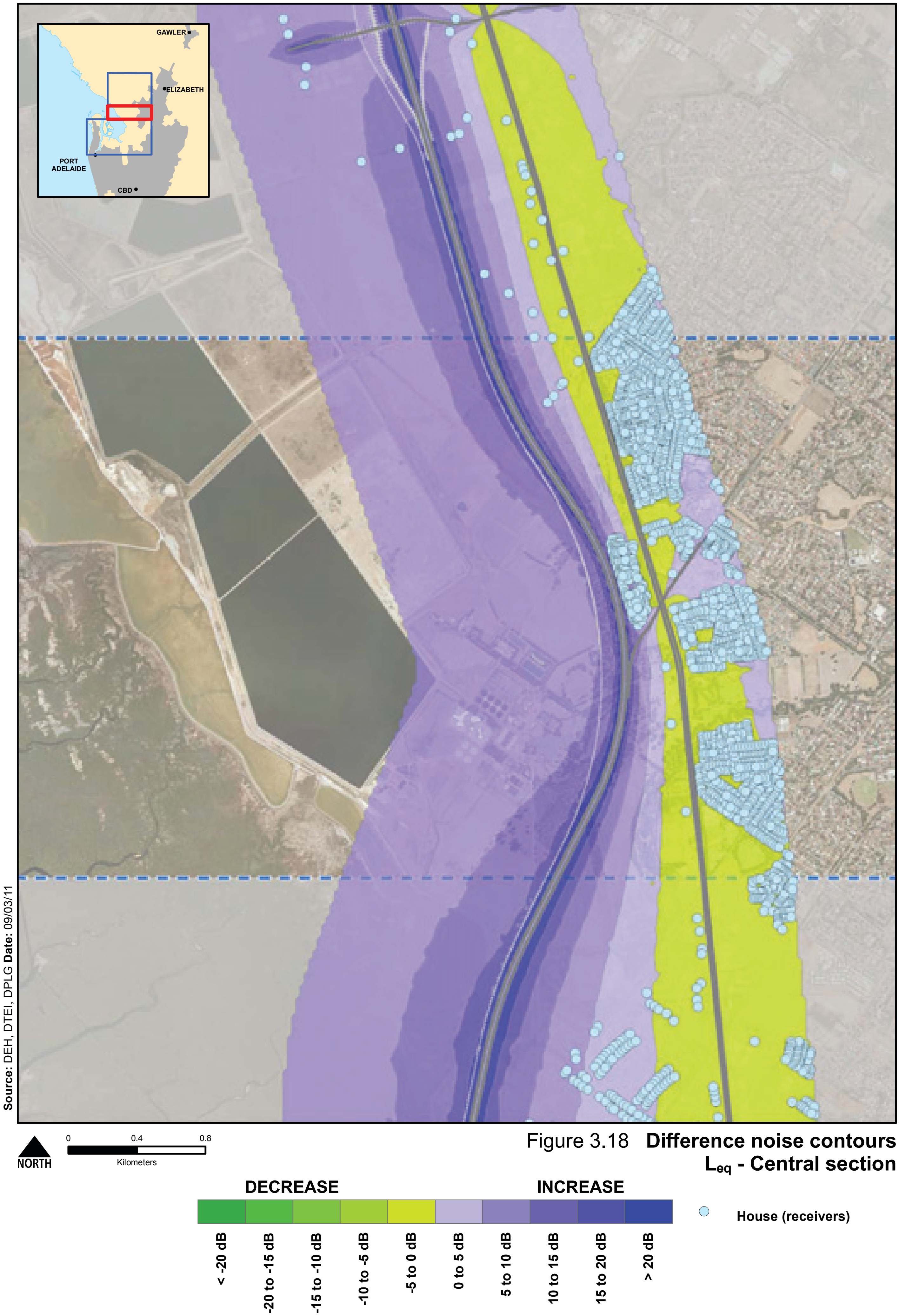


Figure 3.18 **Difference noise contours L_{eq} - Central section**

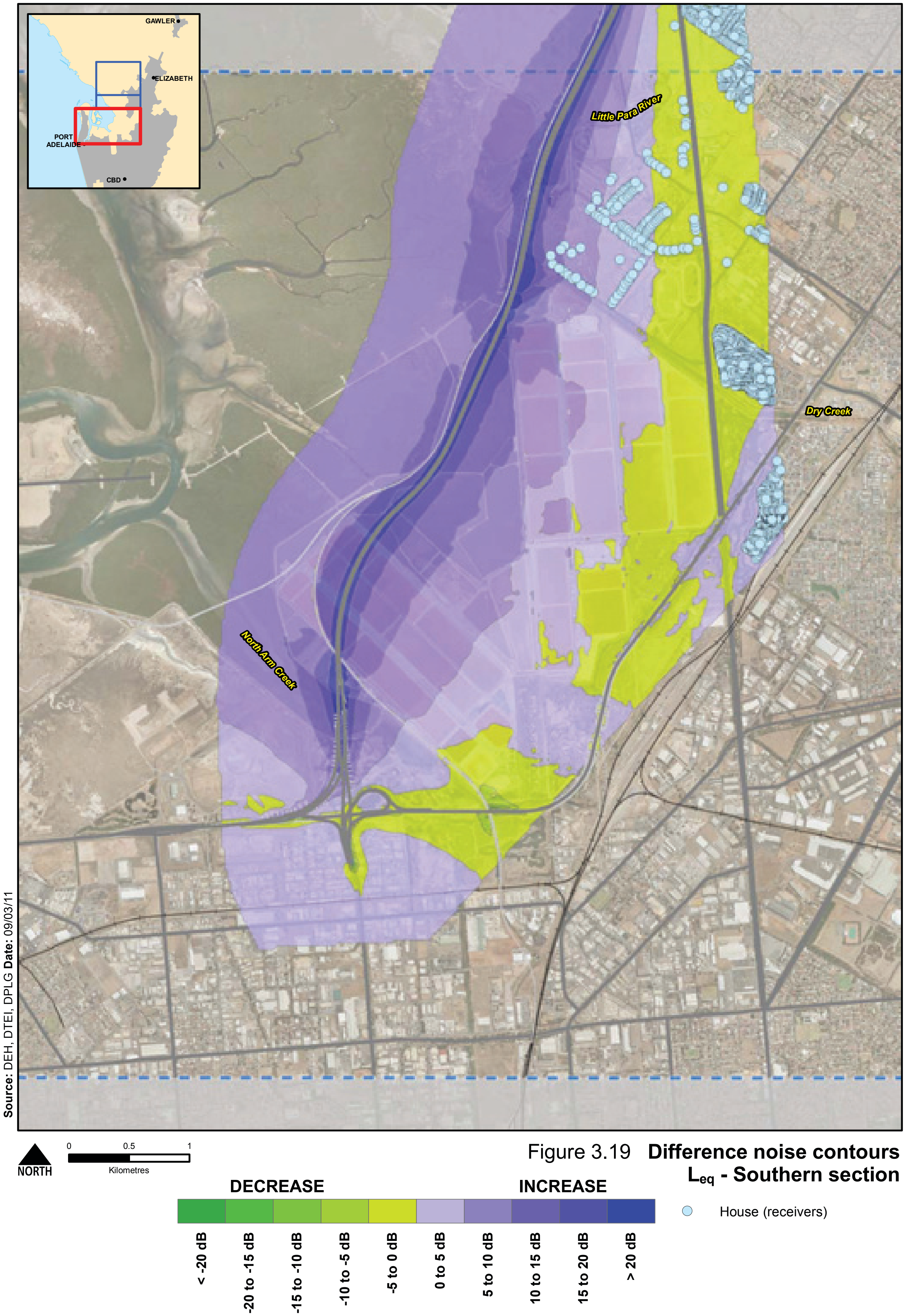


Figure 3.19 **Difference noise contours L_{eq} - Southern section**

Source: DEH, DTEI, DPLG **Date:** 09/03/11

NORTH

0 1 2
Kilometers

Figure 3.20 **Change in day time rail $L_{eq,15h}$ - Noise level**

DECREASE **INCREASE**

< -20 dB | -20 to -15 dB | -15 to -10 dB | -10 to -5 dB | -5 to 0 dB | 0 to 5 dB | 5 to 10 dB | 10 to 15 dB | 15 to 20 dB | > 20 dB

- House (receivers)
- Northern Connector road
- Northern Connector rail
- Spur line to Port Flat siding
- South Road Superway
- Northern Expressway

Source: DEH, DTEI, DPLGDate: 09/03/11

NORTH

0 1 2
Kilometers

Figure 3.21 **Change in night time rail $L_{eq,9h}$ - Noise level**

DECREASE **INCREASE**

< -20 dB | -20 to -15 dB | -15 to -10 dB | -10 to -5 dB | -5 to 0 dB | 0 to 5 dB | 5 to 10 dB | 10 to 15 dB | 15 to 20 dB | > 20 dB

House (receivers)

Northern Connector road

Northern Connector rail

Spur line to Port Flat siding

South Road Superway

Northern Expressway

3.5 Operational vibration

3.5.1 Road vibration

Upon opening of the Northern Connector, it is anticipated that the surface of the road would be relatively smooth. As the road ages, the condition of the road may deteriorate to a rough surface, leading to a marginal increase in the generated vibration levels.

The width of the proposed Northern Connector corridor means that no vibration sensitive receivers would be located within 30 m of the road edge. Based on the existing vibration levels measured adjacent to Port Wakefield Road, the ground vibration levels from road traffic at the nearest sensitive receivers to the preferred route are expected to comply with both human exposure and structural damage vibration criteria.

Properties on Port Wakefield Road within 20 m of the road edge would also experience a significant decrease in vibration events due to a decreased number of heavy vehicle pass-bys.

3.5.2 Rail vibration

The nearest sensitive receivers to the Northern Connector rail corridor are located approximately 50 metres away from the rail corridor. At these distances, vibration levels due to freight rail pass-bys are expected to comply with both human exposure and structural damage vibration criteria.

The project would also divert freight rail away from the residential areas of Mawson Lakes, Parafield Gardens, Salisbury Downs, Salisbury, Salisbury North and Ottoway. Although some residences in these areas would still be exposed to vibration from passenger rail pass-bys, vibration generated by passenger rail movements are not expected to exceed human exposure criteria whereas the vibration generated by existing freight rail movements may exceed the human exposure criteria at times. The Northern Connector would therefore significantly reduce the impact of vibration from rail pass-bys on those residences currently adjacent to the existing freight line

4 Management and mitigation

A number of different possible design strategies to reduce the noise impact of the Northern Connector during construction and after project opening. Specific noise mitigation measures will be determined in the detailed design phase of the project.

4.1 Measures to minimise impacts during planning and design

DTEI is committed to investigating all ‘reasonable and practicable’ mitigation measures to meet appropriate noise and vibration criteria. Mitigation measures will only be considered adjacent to new major project works. Specific noise mitigation measures will be determined in the detailed design phase of the project.

4.1.1 Controlling road and rail noise at the source

Ideally the most effective way of minimising noise from road and rail traffic is to control noise at the source, where feasible, by:

- making vehicles quieter
- installing ‘low noise’ road surfaces
- modifying the road gradient
- appropriate rail alignment design
- appropriate rail construction
- reducing the design speed
- introducing traffic management schemes and traffic calming devices.

Quieter vehicles

The reduction of noise from road vehicles is a major factor in reducing traffic noise. For maximum effectiveness vehicle noise management needs to include design, education and enforcement components.

DTEI actively supports and/or is involved in the following programs to achieve quieter vehicles:

- national processes for developing transport, vehicle or infrastructure noise standards or guidelines, particularly motor vehicle noise standards
- national processes for developing in-service transport vehicle noise standards, particularly those for motor vehicles (and champions the need to reflect improvements achieved in new vehicle noise standards).

‘Low noise’ road surfaces

For individual vehicles, road tyre noise begins to dominate over the power-train noise at vehicle speeds of 30–50 km/h for cars and 40–80 km/h for trucks. For traffic as a whole, road tyre noise appears to dominate at around 70 km/h. This means that in areas with posted speeds of 70 km/h or more, the reduction of road tyre noise can be a useful noise reduction treatment.

The type of road surface can have a significant effect on traffic noise generated by pavement surface/tyre interactions and using alternative road surfacing treatments can be an effective method of reducing road traffic noise at the source.

The Northern Connector is currently proposing to use SMA adjacent to existing sensitive receivers to reduce the pavement noise emissions. SMA reduces noise by the order of 1 dB(A) relative to DGA and 5 dB(A) relative to a concrete surface.

Modifying road and rail routes

The Northern Connector study area is a semi-rural environment, characterised by a variety of agricultural land uses with isolated dwellings and residential communities. A number of route options, for both road and rail, were considered during the route selection phase. The effect of noise and vibration on adjacent dwellings was a significant criterion during the route selection process.

Modifying the gradient

Reducing the road gradient can have a positive effect on road traffic noise levels, as acceleration noise and engine/exhaust brake noise are both reduced. A 5% reduction in road gradient will reduce L_{eq} traffic noise levels by about 1.5 dB(A). A similar reduction in the rail gradient will also reduce L_{eq} rail noise levels, depending on the power used by the locomotive to travel up or down a gradient.

Due to the relatively flat gradient over the preferred route, it is not practical to change the gradient of the Northern Connector.

Appropriate rail alignment design

The Northern Connector rail alignment has been designed in order to minimise the occurrence of wheel and brake squeal. Rail curves near sensitive receivers have been designed with a radius of greater than 400 metres to prevent maximum noise events from wheel squeal. Braking on the high speed, free-flowing rail alignment is also unlikely, reducing the chance of maximum noise events from brake squeal.

Freight train warning horns represent potential worst case maximum noise events and it is not possible to remove this noise source as the warning horns are required for safety reasons. However, the rail design significantly reduces the likelihood of warning horns being used by removing level crossings and locating the rail corridor near to a high-speed road.

Appropriate rail track construction

Track construction can have a considerable effect on the noise and vibration emitted by rail vehicle pass-bys. For example, the use of continuously welded rail rather than jointed rail can reduce the noise and vibration generated when vehicles pass across joints in the rail line. A track may also be fitted with resilient rail clips, baseplate pads or ballast mats to reduce ground-borne or structure-borne noise and vibration. However, this is normally only necessary where the rail line includes a tunnelled section or overpass structure near to sensitive receivers.

The Northern Connector freight rail line would be constructed from continuously welded rail that would help to reduce the noise and vibration effect of rail pass-bys. Due to the set back of the future rail line from residential locations, it is not proposed that vibration isolation measures would be incorporated as part of the design.

Reducing design speeds

On high-speed roads such as motorways, halving the average speed will reduce the traffic L_{eq} noise level by up to 5–6 dB(A). Similar reductions in both L_{eq} and L_{max} rail noise levels can be achieved by reducing the speed of rail pass-bys.

However, the Northern Connector would be part of the National Network and would be designed to a freeway standard with a maximum speed limit of 110 km/h for both road and rail. A reduction in design speed would negate part of the original purpose of the Northern Connector and is not proposed.

Traffic management schemes and traffic calming devices

Street closures can be beneficial in diverting traffic from local roads to arterial roads. Similarly, heavy vehicle access restrictions are an appropriate mechanism for reducing heavy vehicle noise. Heavy vehicle access restrictions adopted by local councils have included both weight and time restrictions. Traffic calming devices, such as roundabouts, speed humps, midblock platforms and chicanes, can all help reduce traffic noise on local roads. Research has shown that roundabouts provide the greatest benefit in noise reduction on local roads.

The Northern Connector would have both positive and negative effects: it would increase traffic volumes on new connector roads and reduce traffic volumes along the existing Port Wakefield Road alignment.

Traffic management schemes are not suitable for a freeway, which is designed to minimise traffic congestion and interruptions to flow and thus provide a more continuous noise source and reduce extraneous loud noise events such as exhaust braking, acceleration and deceleration noise.

Land-use planning and development controls

Future road traffic noise problems can be avoided through zoning mechanisms that do not permit noise-sensitive land uses along transport corridors, or those that have not been designed in accordance with good acoustic principles. Agricultural, recreational, commercial and light industrial land uses can provide effective buffer zones between busy roads and rail lines, and residential communities.

DTEI has no control over development approvals outside transport reserves, but takes an active role in advising other authorities during the preparation of planning instruments.

Roadside noise walls and mounds

Acoustic barriers provide immediate reductions in road and rail traffic noise at the shielded properties once barrier construction is complete. Traffic noise barriers, in the form of ‘noise walls’ or mounded earthworks, must break the lines-of-sight between road traffic noise sources — including reflections of noise from solid walls

— and the noise-sensitive receiver, to gain maximum effectiveness. However, barriers of a lower height can still reduce noise.

The acoustic effectiveness of a barrier depends on its density, height, length and location. The higher the barrier (compared to the direct line-of-sight from the source to the receiver) and the closer its location (to either the source or the receiver), the greater the noise attenuation provided. The barrier also needs to have a sufficient length.

Roadside barriers, as distinct from barriers close to dwellings, usually have to provide shielding along an appreciable length of road to be effective. They can therefore be efficient in providing attenuation to groups of residences, but will not be cost-effective for isolated single structures and maybe ineffective where openings are required for driveway access.

Noise walls can be constructed using timber, pre-cast concrete panels, lightweight aerated concrete, fibre cement panels, transparent acrylic panels and profiled steel cladding. Dense vegetation screen planting has visual and privacy benefits, but provides only minor acoustic attenuation — about 1 dB(A) for a 10 m depth. For significant noise attenuation, a solid barrier (e.g. earth mounding, noise wall, cutting) is required.

Noise walls will be considered during the detailed design stage for the more densely populated residential areas around Globe Derby Park. However, in other areas where sensitive receivers may be affected by the Northern Connector, noise barriers may not be considered an effective means of providing noise mitigation due to the lower density of residences.

4.1.2 Controlling noise and vibration at the receiver

Even with effective vehicle controls, road and rail traffic noise will still be emitted. Management strategies at the receiver include:

- careful environmental assessment to identify existing and potential road and rail traffic noise and vibration problems, and the most effective solutions
- noise mitigation treatments near and in existing noise-sensitive buildings, or their conversion to less sensitive uses.

Noise barriers close to sensitive receivers

As already indicated, noise barriers such as moundings and noise walls are most effective when located either close to the road traffic stream, or close to the affected dwelling(s) or other noise sensitive land uses.

With the consent of owners, acoustic barriers can sometimes be located within a residential property boundary, at those residences that exceed the noise criteria, so that they provide maximum shielding of the dwelling. They might be designed to form a courtyard, providing some benefit for an outdoor area near the dwelling.

This approach would reduce the extent of barriers otherwise required, and is the most cost-effective solution for isolated, noise-exposed residences.

Noise mitigation treatment of existing sensitive receivers

Individual dwelling treatments can be provided in lieu of, or in conjunction with, noise control measures such as low noise road surfaces, noise barriers and barriers near the dwellings. Any such acoustic architectural treatments would require extensive consultation with, and the agreement of, all affected parties.

Building treatments would generally be considered only when external road traffic or rail noise criteria cannot be achieved at the premises and other measures are impractical or not cost effective. The mitigation measures would be designed to achieve the internal noise levels that would have prevailed had the external road traffic or rail noise criteria been achievable. Most buildings will achieve an internal noise level 10–15 dB(A) below the external noise level with the windows open, without requiring additional treatment.

A range of treatment measures would be agreed with the owners of those properties considered eligible for noise treatment, during the design phase of the project.

4.2 Measures to minimise impacts during construction

4.2.1 Noise

A framework for construction noise and vibration management would be developed by DTEI which specifies the construction noise and vibration management requirements that the appointed contractor must adhere to. This framework would be required to receive endorsement from the EPA.

The appointed contractor would then be required to develop a detailed Construction Noise and Vibration Management Plan (CNVMP) in accordance with the framework and OI 21.7 before construction begins. The CNVMP would specify the noise and vibration mitigation measures that the contractor would adopt throughout the construction process.

During construction, proactive noise control strategies to minimise noise during construction may include temporary acoustic barriers, enclosures, silencers or the substitution of alternative construction processes. All reasonable and practicable noise mitigation methods would be identified by the site supervisor on a daily if not hourly basis during works, particularly any works outside of daytime hours.

Noise level emissions and potential annoyance depend significantly on the condition of equipment, type of operation, its duration and the time of day it is conducted. All major items of plant would be checked at the start of works on site and thereafter every six months and/or following a major service.

Generally, most residences identified as affected by construction noise would also be affected by operational traffic noise. Noise mitigation treatments for operational traffic noise would be implemented as early as possible during the construction phase in order to provide mitigation of both construction noise and traffic noise.

Although the actual noise mitigation measures adopted would depend on the staging and construction methods proposed by the appointed contractor, possible measures include the following:

Site management

- Location of noisy plant as far away from noise sensitive receivers as possible.
- Selection and location of site access roads as far away from noise sensitive receivers as possible.
- Schedule any night work that creates the most noise early in the night to minimise impact on noise sensitive receivers, where possible.
- Taking care not to drop materials to cause peak noise events, including materials from a height into a truck.
- Orientation of plant known to emit noise strongly in one direction so that the noise is directed away from noise sensitive areas (if practicable).
- Shutting down, or throttling down to a minimum, machines that are used intermittently in the intervening periods between works.
- Concentrating noisy activities at one location and moving to another as quickly as possible.
- Avoiding truck movements on residential streets where possible.
- Minimising the reversing of vehicles to reduce the noise from reversing signals.
- Minimising vehicles and equipment queuing and idling near noise sensitive receivers.
- Ensuring that truck operators clear tailgates and lock them at the point of unloading.
- Not using vehicle warning devices such as horns as signalling devices, unless it is necessary.
- Using two-way radios at the minimum effective volume.
- Implementing worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible, and avoid shouting and whistling.
- Installing temporary noise barriers, where practicable.
- Locating equipment to take advantage of the noise barriers provided by existing site features and structures.
- When work is complete, minimising the noise of packing up plant and equipment and departing from the site.

Equipment management

- Installing broadband reversing alarms to noisy items of plant that would be reversing regularly or at night time.
- Ensuring equipment has quality mufflers installed.

- Ensuring equipment is well maintained and fitted with adequately maintained silencers that meet the design specifications.
- Ensuring silencers and enclosures are intact, rotating plants are balanced, loose bolts are tightened, frictional noise is reduced through lubrication, and cutting noise reduced by keeping equipment sharp.
- Using only the necessary power to complete the task.
- Using traffic practice controllers to prevent vehicles and equipment queuing, idling or reversing near noise sensitive receivers.

Sensitive receiver noise control

- Installing any permanent noise barriers or building treatments required to minimise operational road traffic noise as early as possible in the construction process.
- Consulting with affected residents to help develop acceptable noise management strategies.
- Providing an easily accessible and well-publicised complaint hotline, and suitably developed complaint handling procedure to effectively deal with any issues raised during the work.

Mitigation measures in context

While the above measures may not necessarily result in meeting the construction noise targets at all times, they should serve to reduce effects to levels most noise sensitive receivers would find acceptable.

In some cases, the community may prefer a balance between higher acceptable noise levels in order to enable a faster construction process to ultimately reduce the perceived noise effect. That is, a shorter duration of higher noise levels may be better than a longer term lower construction noise level.

Consultation with affected receivers throughout the construction phase is an essential part of any mitigation plan. Clear communications with all affected residents of the envisaged duration and times of night time operation in particular would help alleviate the 'surprise' and 'when is it going to stop' concerns.

4.2.2 Vibration

The CNVMP that would be developed before construction begins would also outline the vibration mitigation measures to be implemented by the appointed contractor.

Construction vibration mitigation would typically include the following actions:

- Adoption of low-vibration construction processes where possible. This could include the adoption of CFA piling in preference to impact piling.
- Vibration monitoring at selected structures closer than 25 m (50 m for heritage-listed structures) to construction activities that are known to generate high ground vibration levels.
- Restriction of the times when construction activities that produce higher vibration levels can occur to avoid early morning and night time periods.
- Regular community updates advising when and where construction activities may generate perceptible levels of vibration.
- Minimising vibration energy (i.e. reduced piling hammer drop distance or compactor displacement setting) as necessary depending upon receiver distance.

Where construction activities, including pile driving, excavation by hammering or ripping, dynamic compaction or demolition of structures, may cause damage through vibration to nearby public utilities, structures, buildings and their contents, or if the items are located within the distance from the construction activity as specified in Table 4.1, a building condition inspection of these items would be undertaken before construction.

Table 4.1. Distance from construction work for building condition inspection

Activity	Distance(1)
Pile driving	100 m
Vibration compaction	>7 tonne plant: 50 m
Vibration compaction	<7 tonne plant: 25 m
Demolition of structures	50 m

Note:

(1) The distance for heritage-listed buildings would be double that specified.

Glossary

‘A’ weighted	Frequency filter applied to measured noise levels to represent how humans hear sounds.
dB	The decibel (dB) is a logarithmic unit of measurement used to quantify sound pressure levels. Typically, 0 dB is the threshold of hearing and 120 dB is the threshold of pain.
dB(A)	‘A’ weighted overall sound pressure level in decibels.
L_{90}	Noise level exceeded for 90% of the measurement period, often referred to as the ‘background’ noise level.
L_{90} day	Background noise level exceeded for 90% of the period from 7 a.m. to 7 p.m. Used for the assessment of construction noise.
L_{90} night	Background noise level exceeded for 90% of the period from 7 p.m. to 7 a.m. Used for the assessment of construction noise.
$L_{eq,T}$	Equivalent continuous noise level measured over a time period T, often referred to as the ‘ambient’ noise level. Represents an approximate average of the noise level over the period.
$L_{eq,15h}$	Equivalent continuous noise level measured over the 15 hour day time period (7 a.m. to 10 p.m.).
$L_{eq,9h}$	Equivalent continuous noise level measured over the 9 hour night time period (10 p.m. to 7 a.m.).
$L_{eq,24h}$	Equivalent continuous noise level measured over a 24 hour period. Used for the assessment of rail noise.
L_{max}	Maximum measured noise level within a given time period.
PPV	Peak Particle Velocity represents the rate at which a particle of ground is moving, i.e. a measure of ground vibration in millimetres per second. It is often used to assess vibration effects on a structure.
Sensitive receiver	Any noise sensitive land use as defined by the DTEI *Road Traffic Noise Guidelines*. These include: ▪ existing dwellings in a zone where dwellings are contemplated as defined by the relevant development plan ▪ existing nursing homes ▪ caravan parks accommodating long term residential use ▪ parks and educational institutions (considered on a case by case basis).

List of abbreviations

EPA	South Australian Environmental Protection Authority
EP Act	*Environment Protection Act 1993*
DTEI	Department for Transport, Energy and Infrastructure
RTNG	*Road Traffic Noise Guidelines*
GANRO	*Draft Guidelines for the Assessment of Noise from Rail Operations*
Noise EPP	*Environment Protection (Noise) Policy 2007*
OI 21.7	*Infrastructure Works At Night – Operational Instruction 21.7*
CoRTN	Calculation of Road Traffic Noise
AADT	Annual average daily traffic
CV	Commercial vehicles
DGA	Dense graded asphalt
SMA	Stone mastic asphalt
CFA	Continuous Flight Augured

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German Standard DIN 4150-1975, *Part 2 – Vibrations in Buildings – Influence on Persons in Buildings*.

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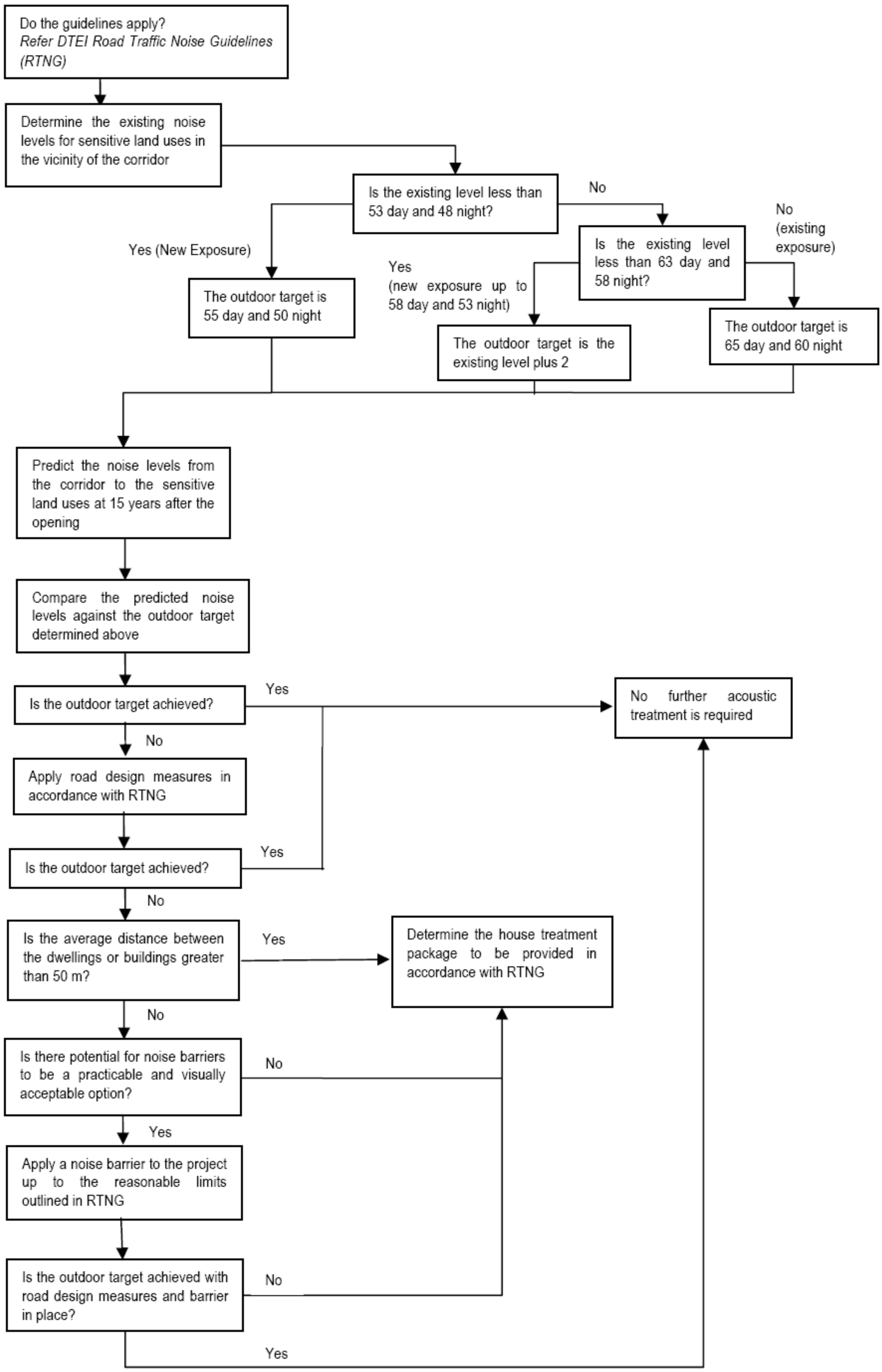
Attachment A

Noise criteria assessment flowchart


Do the guidelines apply?
Refer DTEI Road Traffic Noise Guidelines (RTNG)
Determine the existing noise levels for sensitive land uses in the vicinity of the corridor
Is the existing level less than 53 day and 48 night?
No
Yes (New Exposure)
The outdoor target is 55 day and 50 night
Is the existing level less than 63 day and 58 night?
No (existing exposure)
Yes (new exposure up to 58 day and 53 night)
The outdoor target is the existing level plus 2
The outdoor target is 65 day and 60 night
Predict the noise levels from the corridor to the sensitive land uses at 15 years after the opening
Compare the predicted noise levels against the outdoor target determined above
Is the outdoor target achieved?
Yes
No further acoustic treatment is required
No
Apply road design measures in accordance with RTNG
Is the outdoor target achieved?
Yes
No
Is the average distance between the dwellings or buildings greater than 50 m?
Yes
Determine the house treatment package to be provided in accordance with RTNG
No
Is there potential for noise barriers to be a practicable and visually acceptable option?
No
Yes
Apply a noise barrier to the project up to the reasonable limits outlined in RTNG
Is the outdoor target achieved with road design measures and barrier in place?
No
Yes

Attachment B

Predicted road traffic and rail volumes

Table B.1. Predicted traffic volumes for existing road network in 2017

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield Road	North Salisbury Highway	61260	52071	9.0%	9189	30.5%
	North Globe Derby Drive	44974	38228	9.9%	6746	33.5%
	North Ryans Road	37979	32282	10.4%	5697	35.3%
	North Bolivar Drive	35773	30407	12.3%	5366	41.8%
	North Waterloo Corner Road	36211	30779	10.8%	5432	36.8%
	North Northern Expressway	14750	12538	10.7%	2212	36.5%
Salisbury Highway / Port River Expressway	East Port Wakefield Road	45041	38285	7.4%	6756	25.3%
	East South Road	66067	56157	9.3%	9910	31.5%
	West South Road	34338	29187	9.9%	5151	33.8%
South Road	South Port River Expressway	48950	41608	10.7%	7342	36.3%
Bolivar Road	East Port Wakefield Road	10336	8786	2.4%	1550	8.3%
Waterloo Corner Road	East Port Wakefield Road	2159	1835	12.4%	324	42%
Northern Expressway	East Port Wakefield Road	21463	18244	9.6%	3219	32.6%

Table B.2. Predicted traffic volumes for proposed road network in 2017

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield Road	North Salisbury Highway	25112	21345	4.1%	3767	14%
	North Globe Derby Drive	15286	12993	1.8%	2293	6.3%
	North Ryans Road	16220	13787	1.8%	2433	6.3%
	North Bolivar Drive	8556	7273	4.0%	1283	13.5%
	North Waterloo Corner Road	12553	10670	2.8%	1883	9.5%
	North Northern Expressway	19382	16475	8.5%	2907	28.8%
Salisbury Highway / Port River Expressway	East Port Wakefield Road	42963	36519	5.4%	6444	18.3%
	East South Road	40031	34026	5.4%	6005	18.3%
	West South Road	38962	33118	5.4%	5844	18.3%
South Road	South Port River Expressway	59865	50885	7.4%	8980	25%
Bolivar Road	East Northern Connector	5903	5018	1.4%	885	4.8%
	East Port Wakefield Road	21875	18594	1.4%	3281	4.8%
Waterloo	West Northern Connector	1116	949	5%	167	17%

Corner Road	East Northern Connector	8461	7192	5%	1269	17%
	East Port Wakefield Road	9655	8207	5%	1448	17%
Northern Expressway	East Port Wakefield Road	23471	19950	6.1%	3521	20.8%
Northern Connector	North Port River Expressway	45452	38634	6%	6818	20.3%
	North Globe Derby Drive	45452	38634	6%	6818	20.3%
	North Bolivar Drive	39549	33617	7%	5932	23.8%
	North Waterloo Corner Road	30233	25698	7.3%	4535	24.8%

Table B.3. Predicted traffic volumes for proposed road network in 2031

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield Road	North Salisbury Highway	29065	24705	4.9%	4360	16.8%
	North Globe Derby Drive	28705	24399	3.1%	4306	10.5%
	North Ryans Road	25242	21456	3.1%	3786	10.5%
	North Bolivar Drive	20290	17247	5.4%	3044	18.3%
	North Waterloo Corner Road	22519	19141	4.6%	3378	15.8%
	North Northern Expressway	32639	27743	11.1%	4896	37.8%
Salisbury Highway / Port River Expressway	East Port Wakefield Road	63168	53693	4.9%	9475	16.8%
	East South Road	60307	51261	4.9%	9046	16.8%
	West South Road	54535	46355	4.9%	8180	16.8%
South Road	South Port River Expressway	108721	92413	7.4%	16308	25%
Bolivar Road	East Northern Connector	9900	8415	1.8%	1485	6.3%
	East Port Wakefield Road	32577	27690	2.4%	4887	8.3%
Waterloo Corner Road	West Northern Connector	9701	8246	7.4%	1455	25%
	East Northern Connector	14978	12731	7.4%	2247	25%
	East Port Wakefield Road	17304	14708	7.4%	2596	25%
Northern Expressway	East Port Wakefield Road	45592	38753	6.7%	6839	22.8%
Northern Connector	North Port River Expressway	78700	66895	6.3%	11805	21.5%
	North Globe Derby Drive	78700	66895	6.3%	11805	21.5%
	North Bolivar Drive	68800	58480	7.7%	10320	26.3%
	North Waterloo Corner Road	54970	46725	8.2%	8246	27.8%

Table B.4. Predicted freight train volumes for existing rail network in 2017

Rail line section		Day time volumes (7 am to 10 pm)		Night time volumes (10 pm to 7 am)	
From	**To**	**Up**	**Down**	**Up**	**Down**
Dry Creek	Salisbury	6	6	3	3
Salisbury	Virginia	6	5	2	3
Dry Creek	Gillman	6	6	2	2

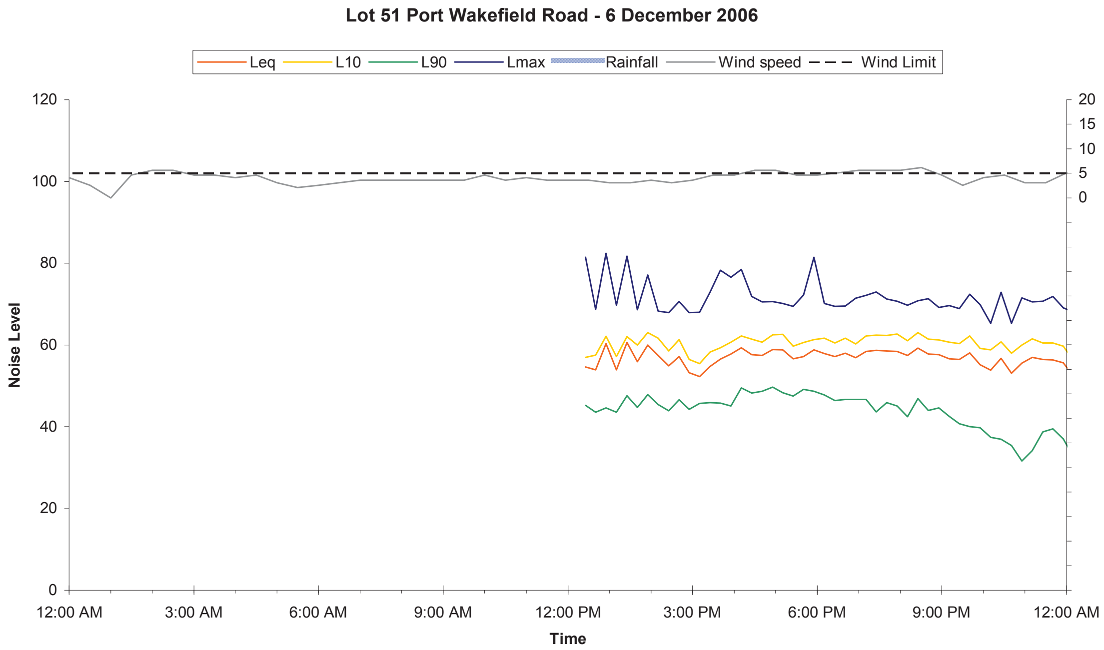
Table B.5. Predicted freight train volumes for proposed rail network in 2027

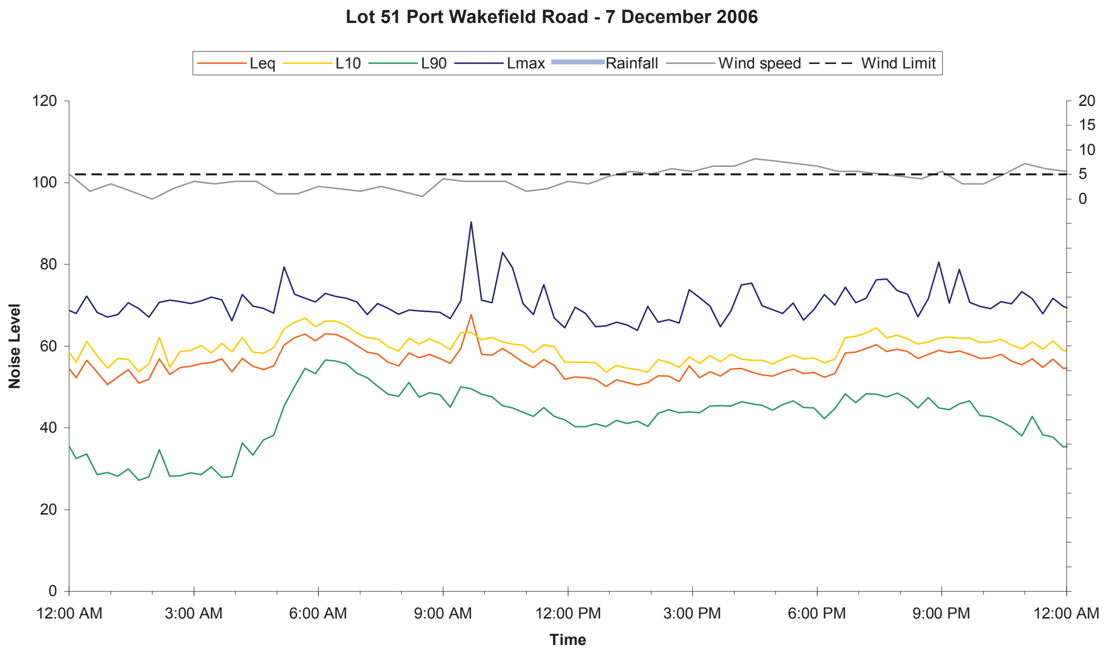
Rail line section		Day time volumes (7 am to 10 pm)		Night time volumes (10 pm to 7 am)	
From	**To**	**Up**	**Down**	**Up**	**Down**
Northern Connector	Virginia	9	8	4	5
Northern Connector	Gillman	9	8	2	3
Dry Creek	Salisbury	0	1	1	0
Salisbury	Virginia	0	0	0	0
Dry Creek	Gillman	6	6	2	2

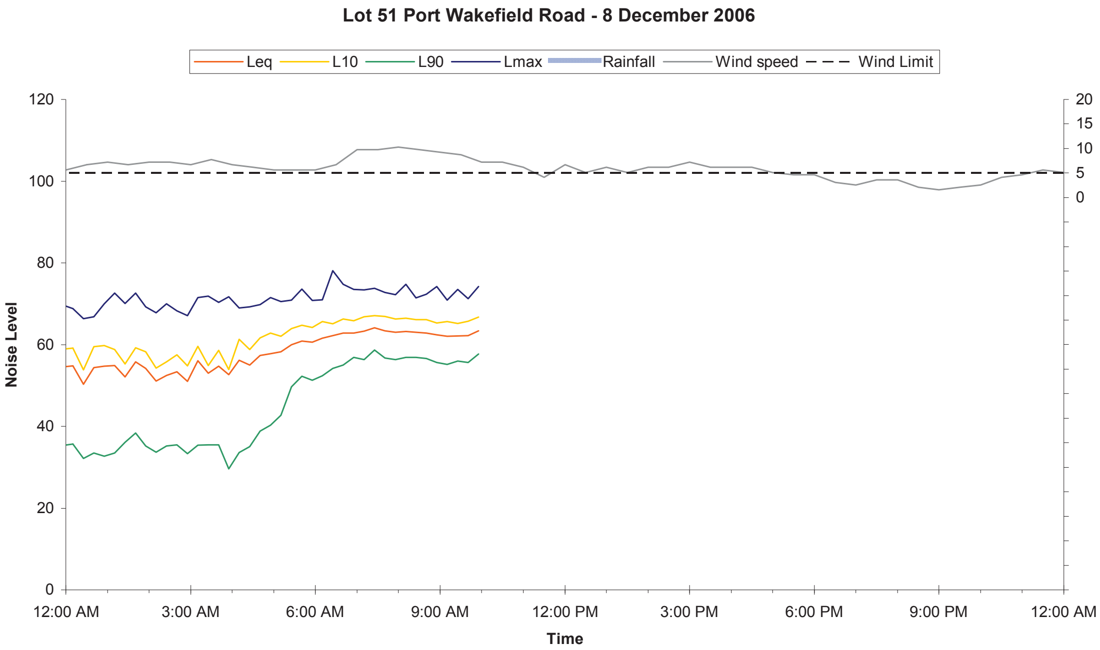
Attachment C

Noise logger measurements

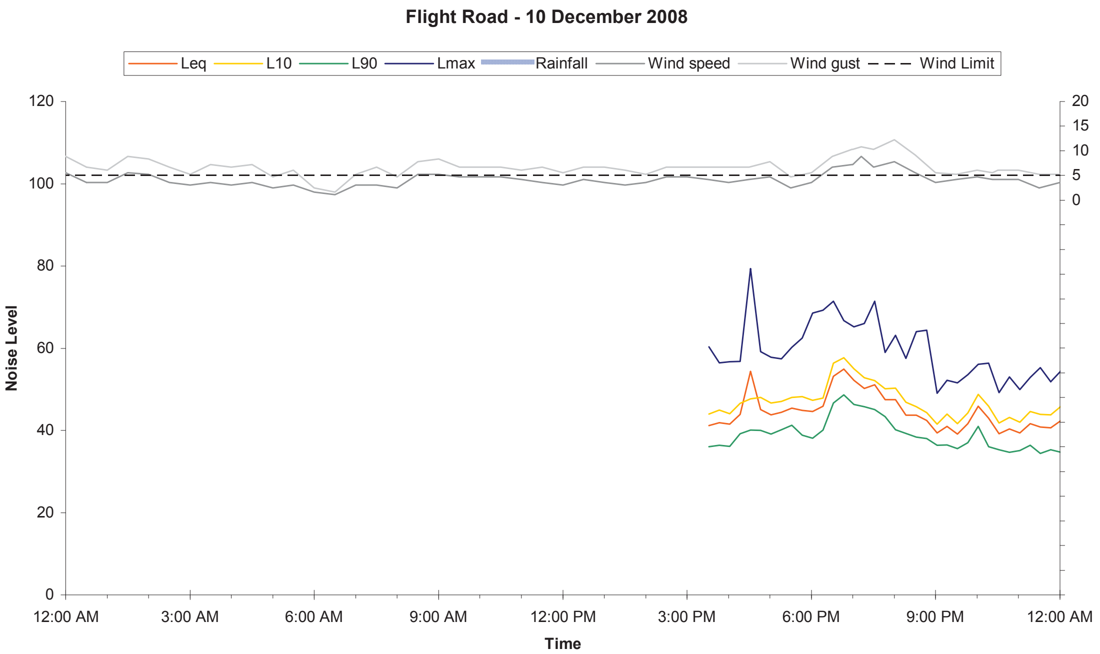
1 – Lot 51 Port Wakefield Road, Waterloo Corner

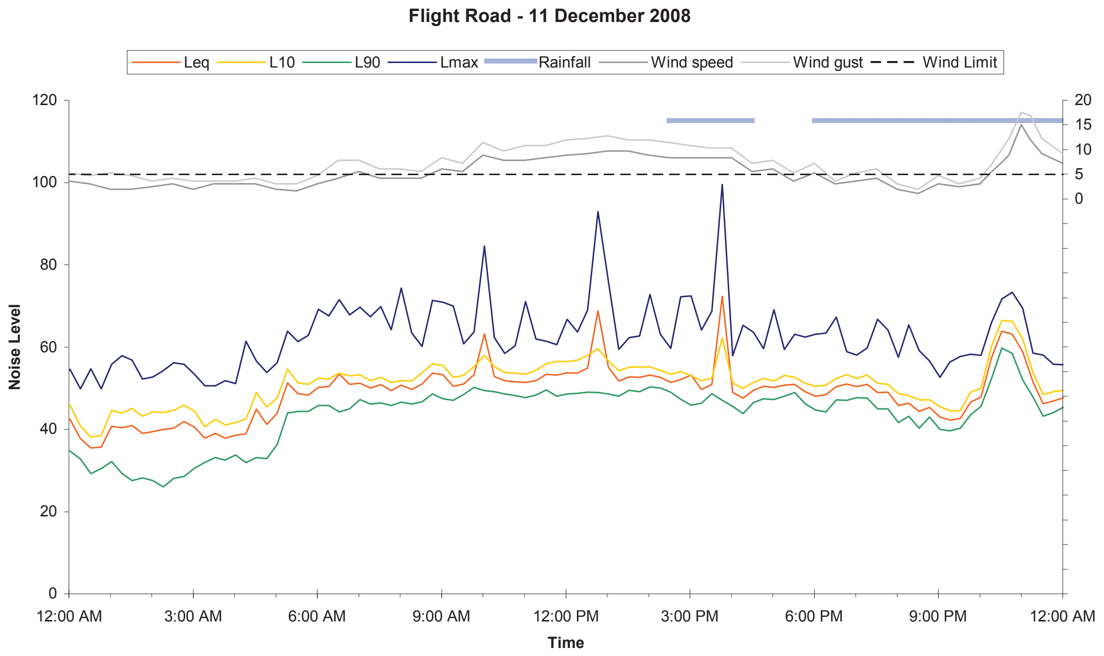


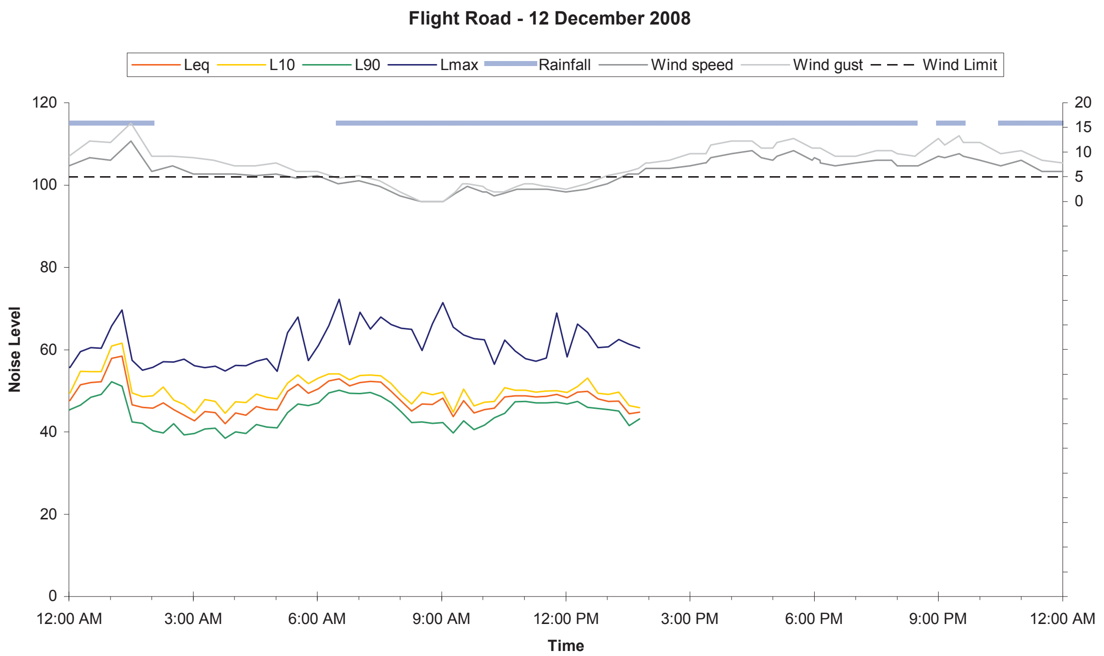




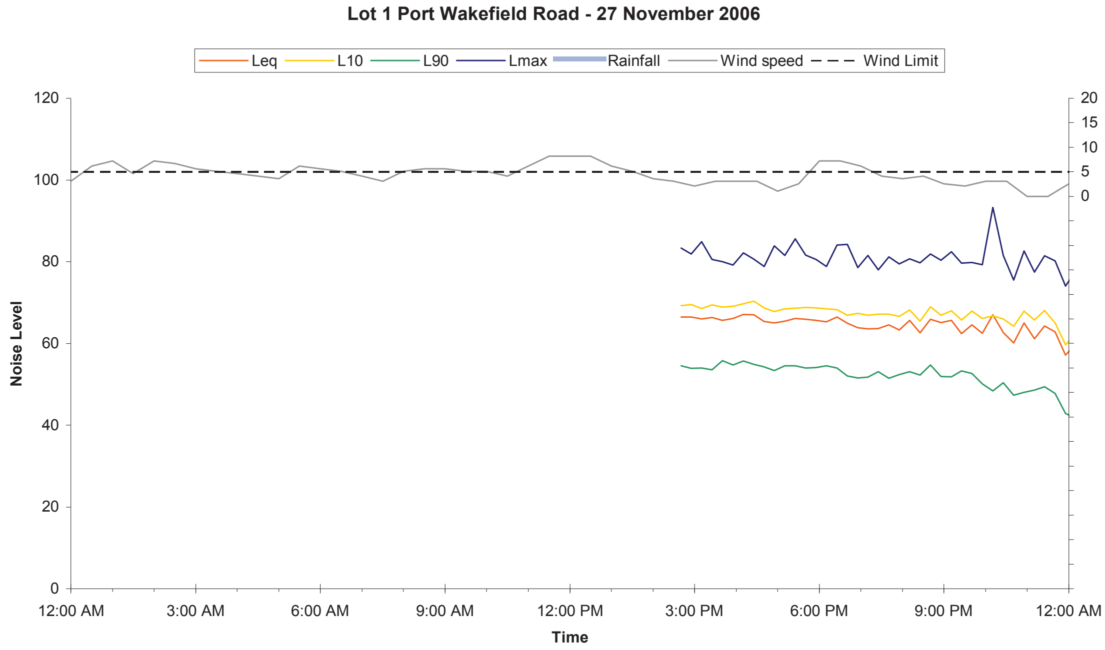
2 – Lot 8 Flight Road, Waterloo Corner

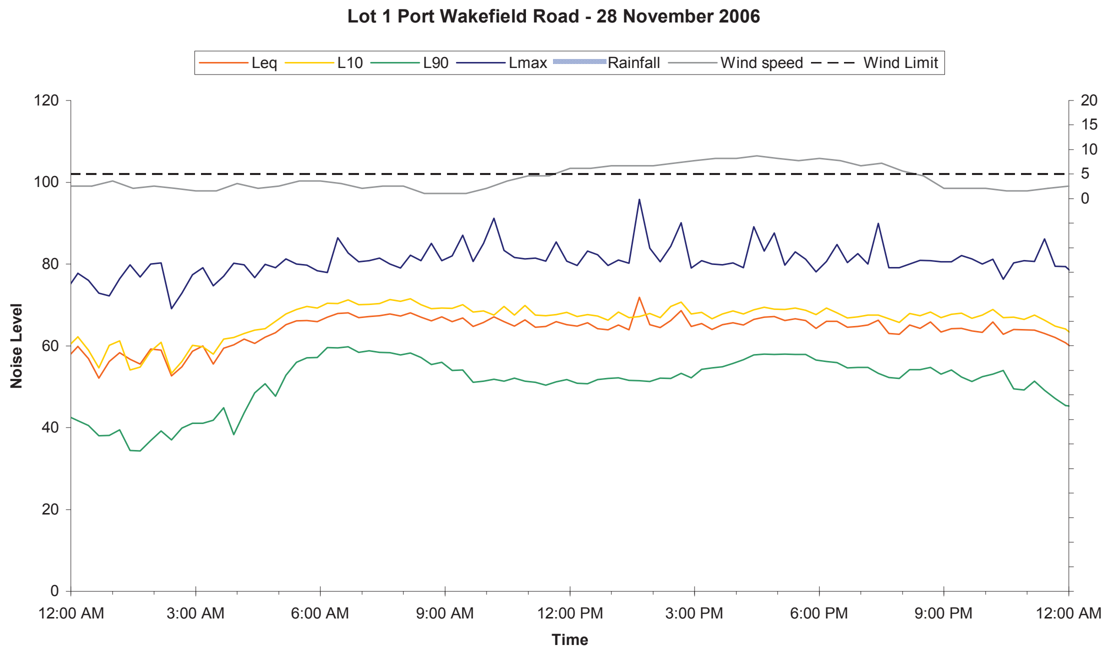


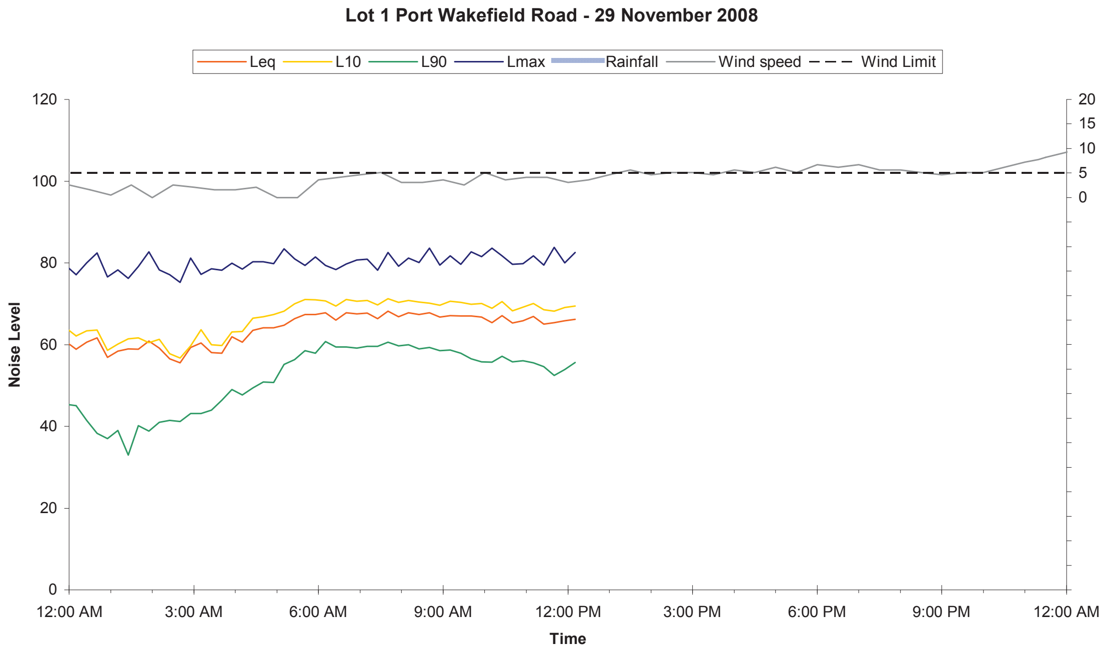

Flight Road - 11 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
120
100
80
60
40
20
0
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM


Flight Road - 12 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
120
100
80
60
40
20
0
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM

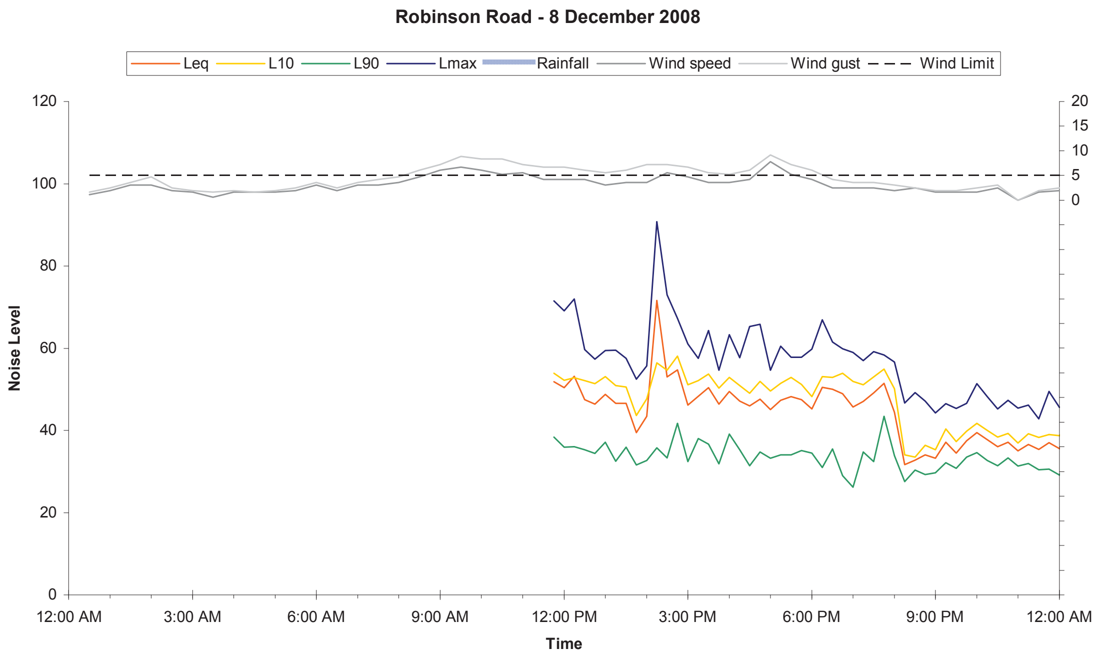
3 – Lot 1 Port Wakefield Road, Waterloo Corner

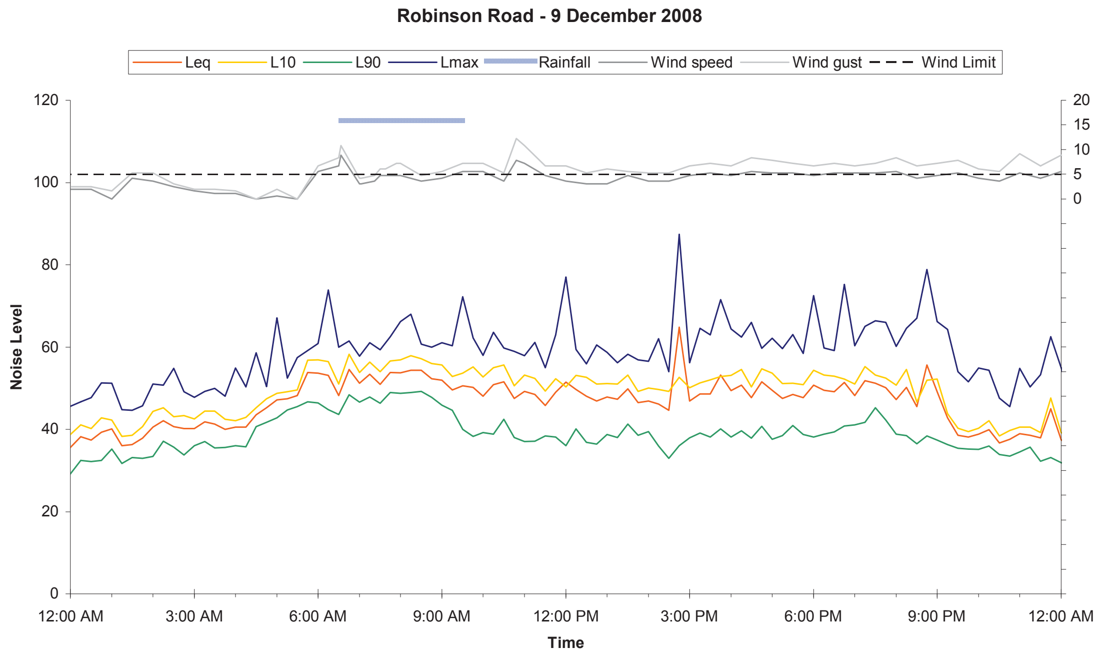


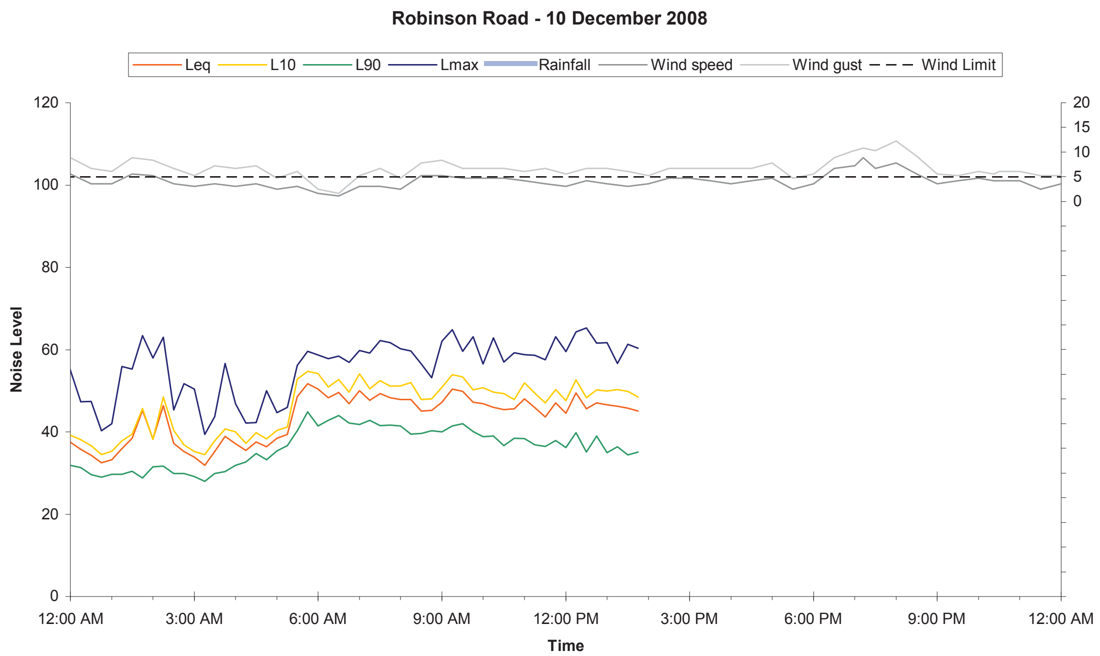




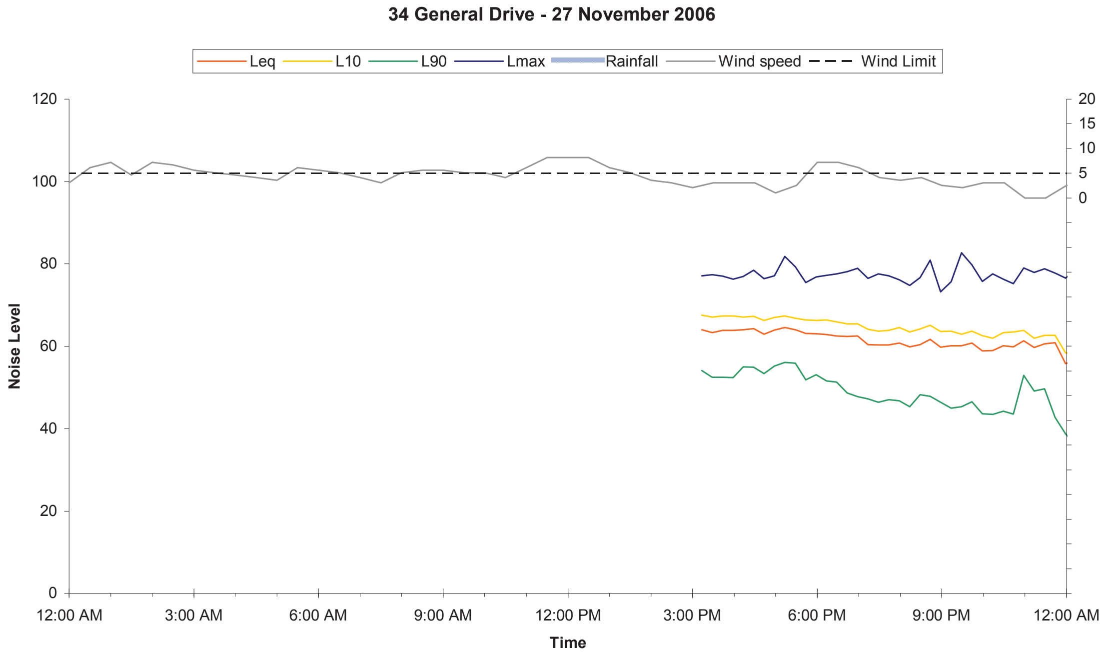
4 – Lot 2 Robinson Road, Waterloo Corner

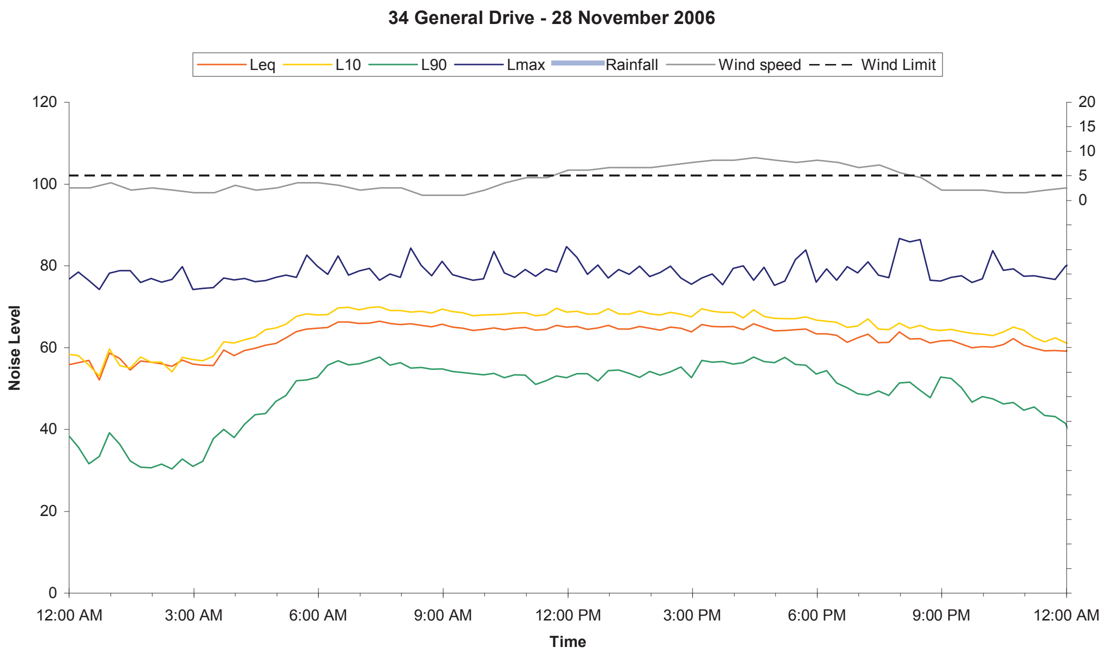


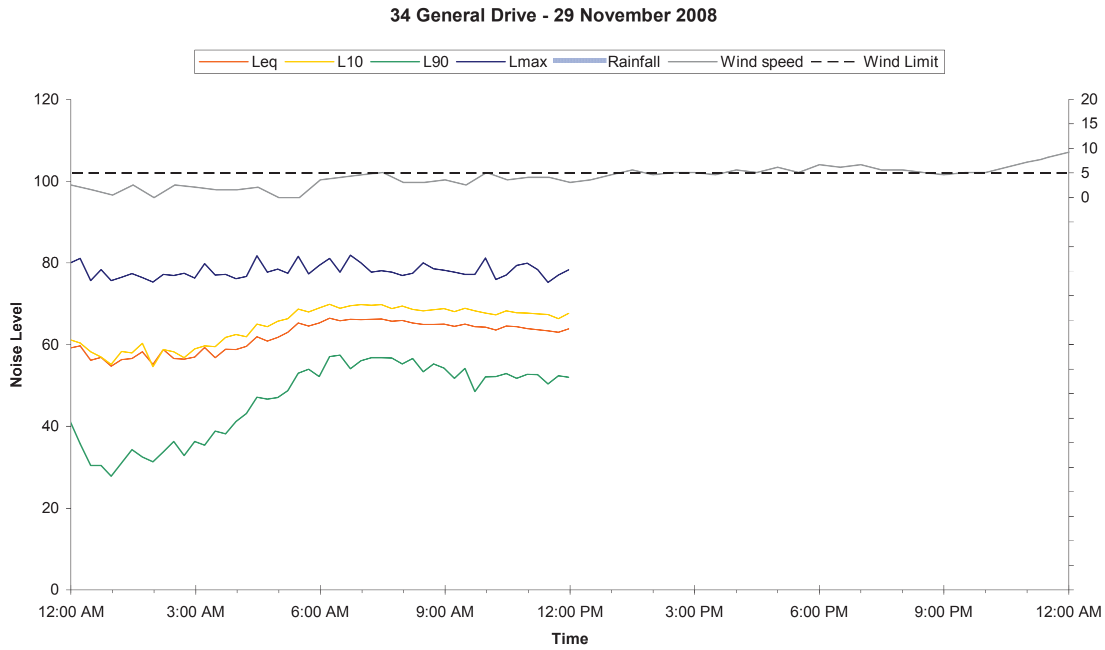

Robinson Road - 9 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
0
20
40
60
80
100
120
0
5
10
15
20
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM


Robinson Road - 10 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
0
20
40
60
80
100
120
0
5
10
15
20
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM

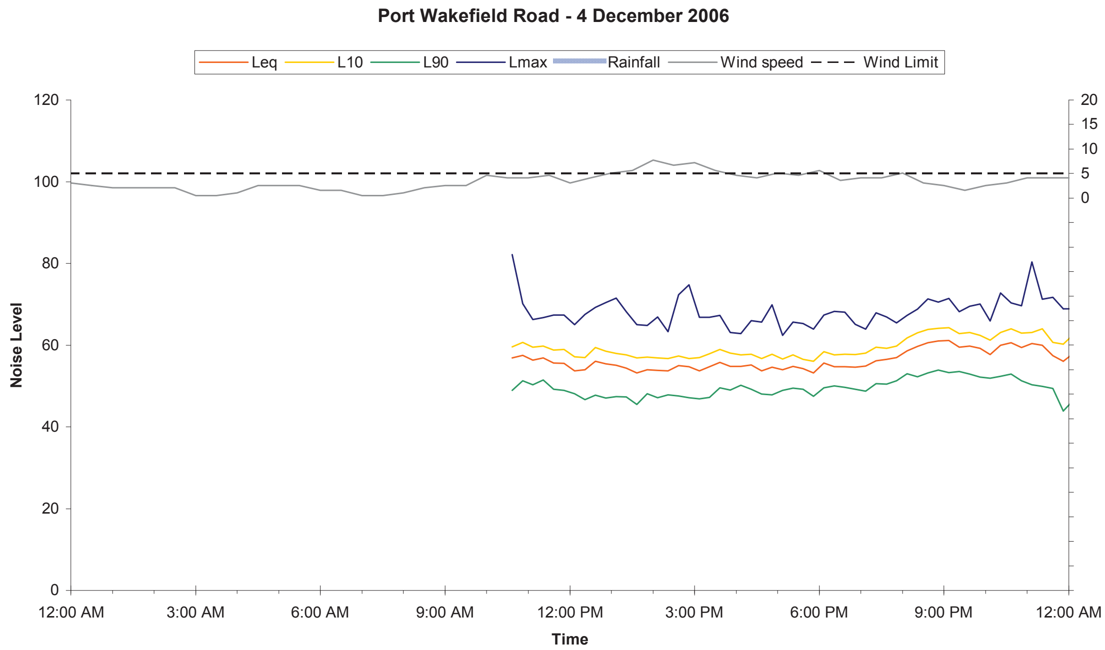
5 – 34 General Drive, Paralowie

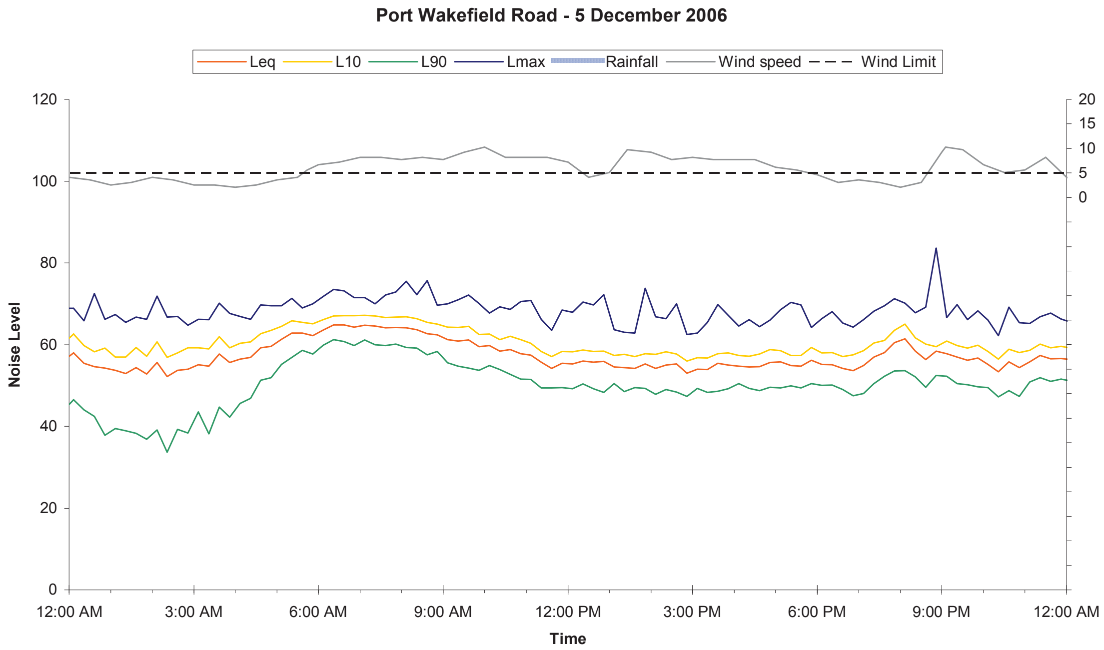


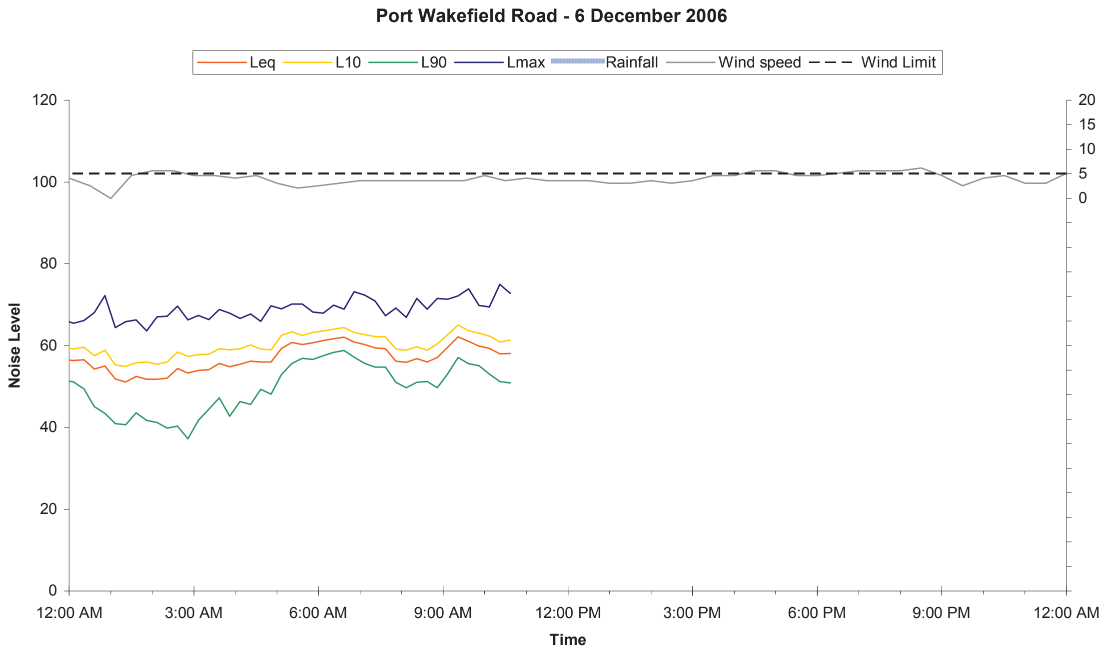




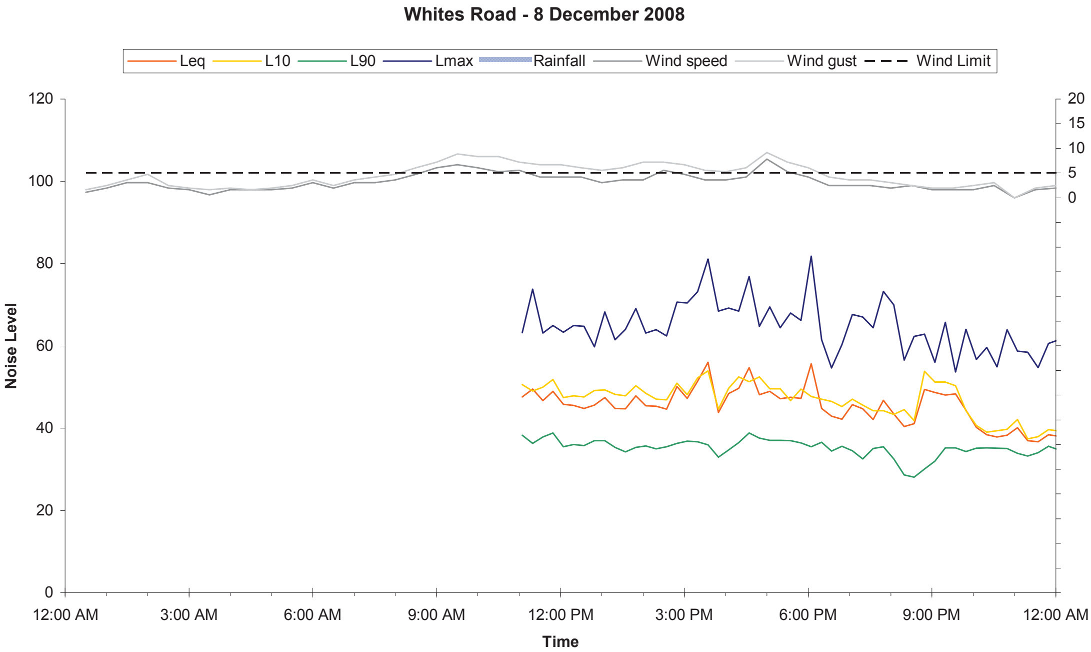
6 – Port Wakefield Road, Globe Derby Park

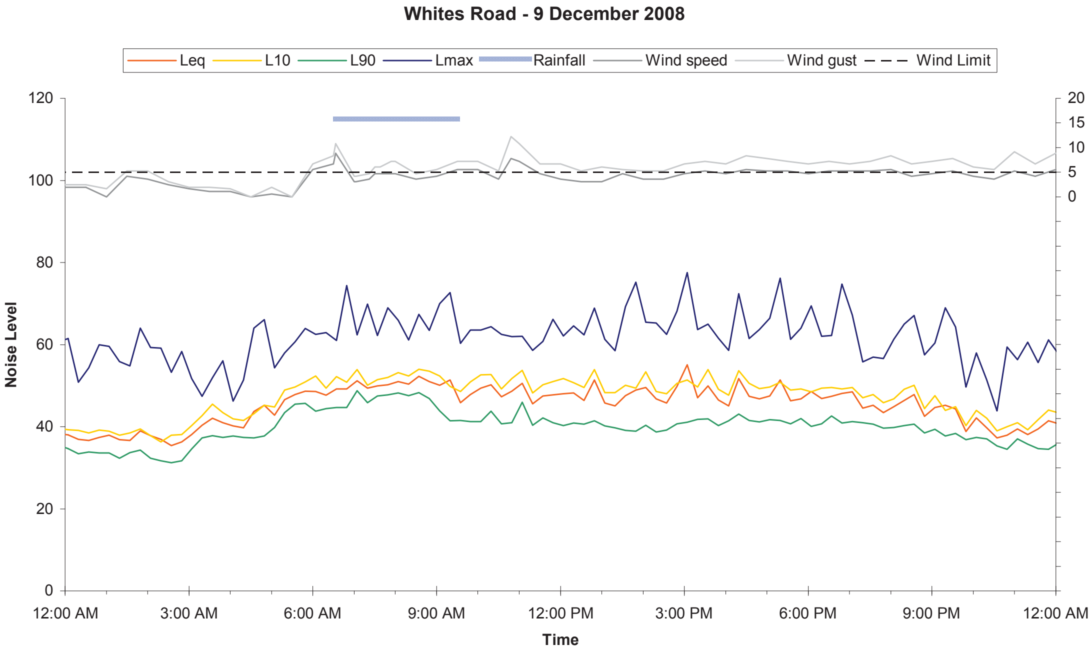


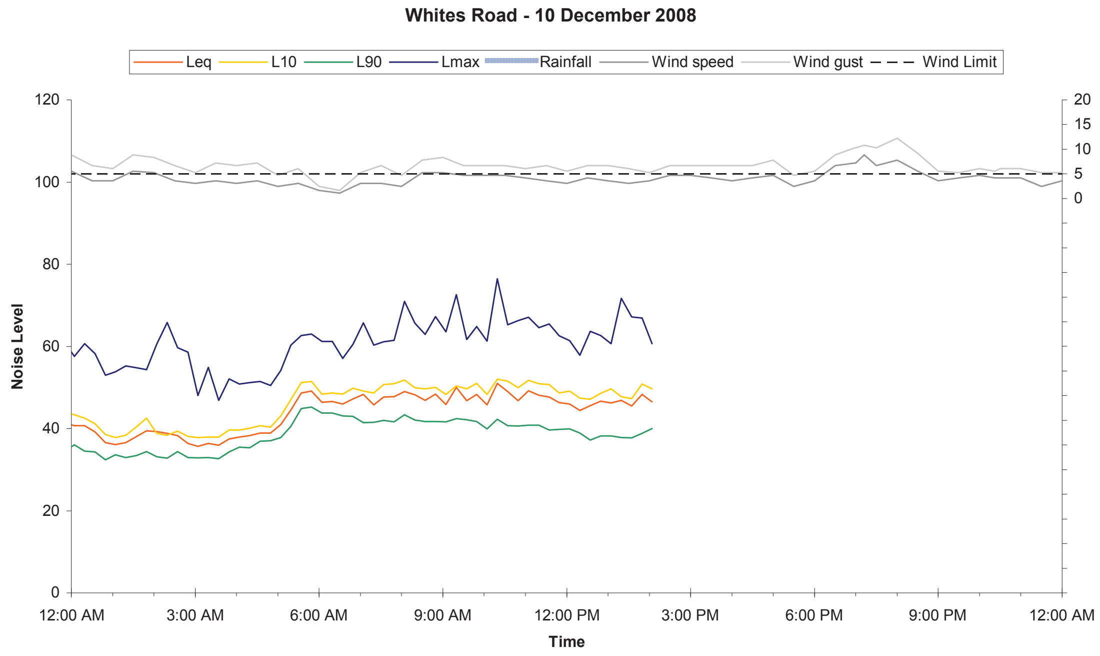

Port Wakefield Road - 5 December 2006
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind Limit
Noise Level
120
100
80
60
40
20
0
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time


Port Wakefield Road - 6 December 2006
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind Limit
Noise Level
120
100
80
60
40
20
0
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time

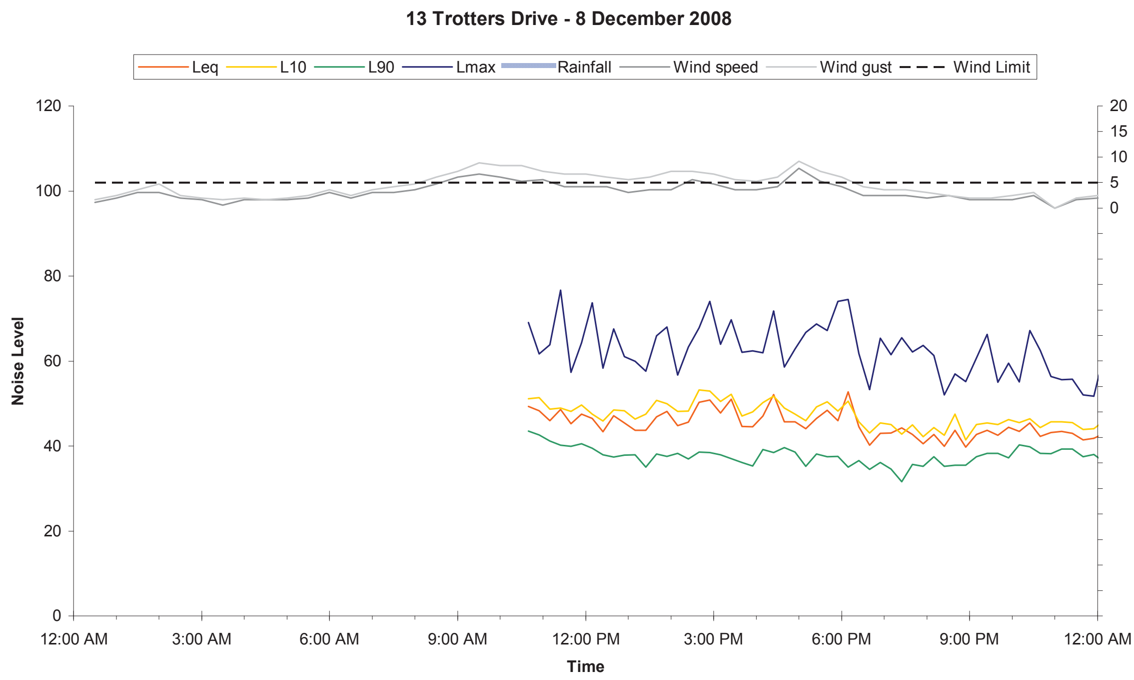
7 – Whites Road, Globe Derby Park

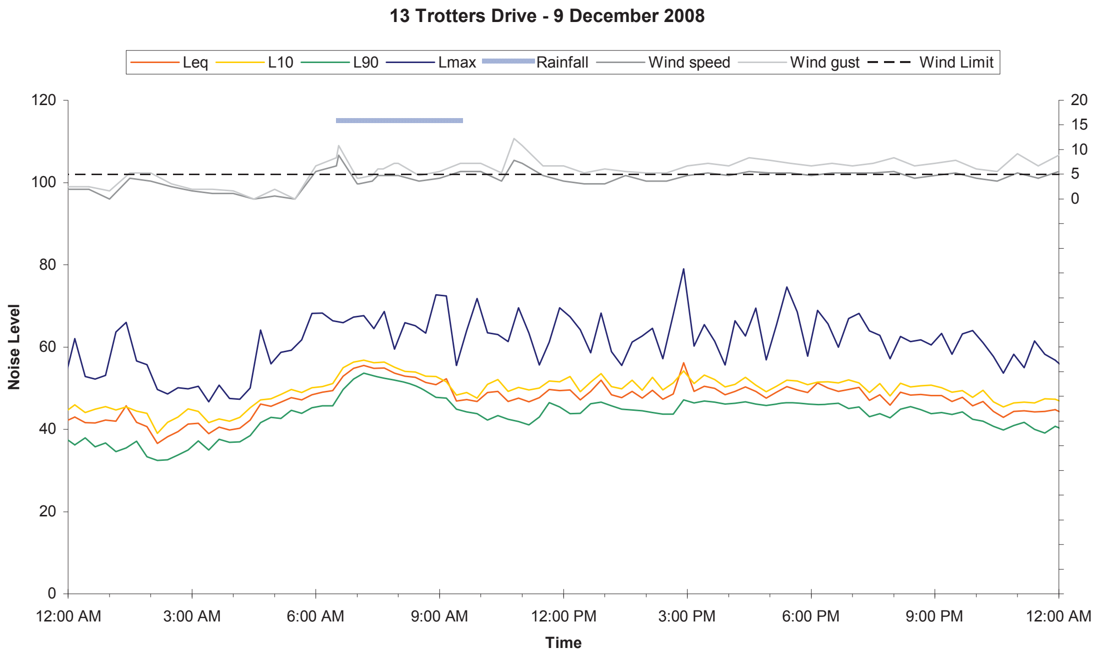


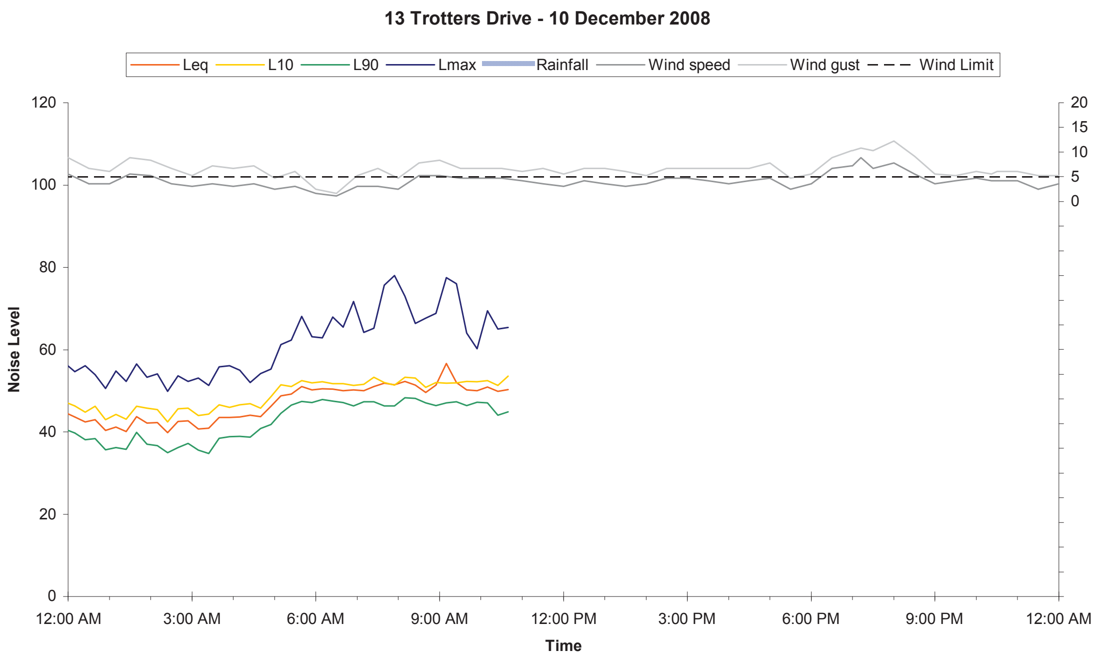




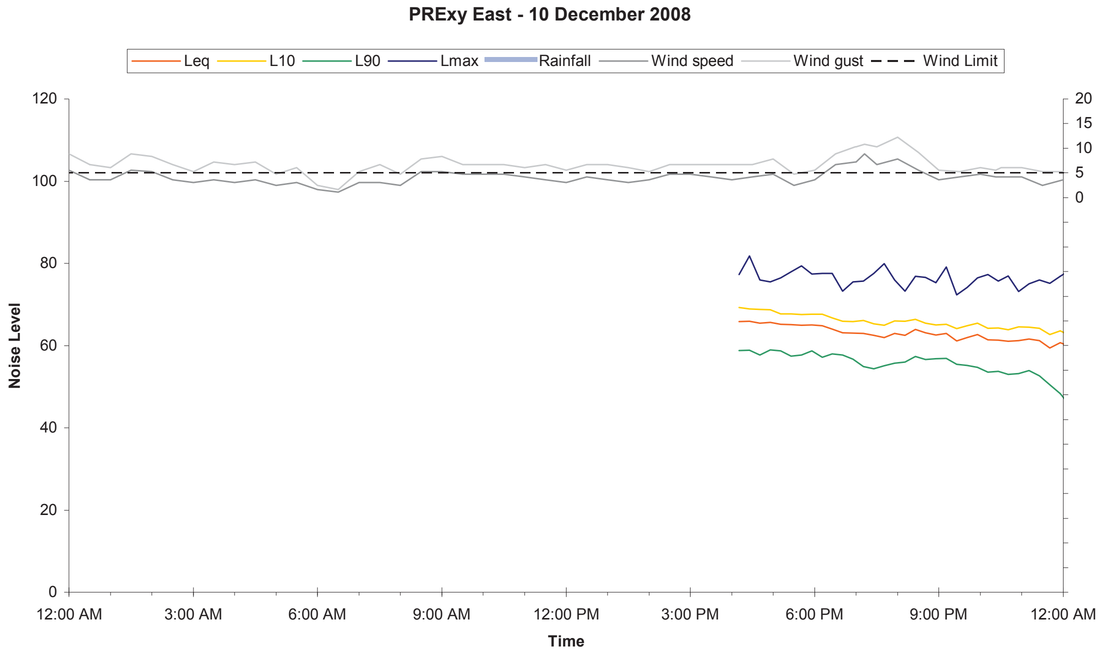
8 – 13 Trotters Drive

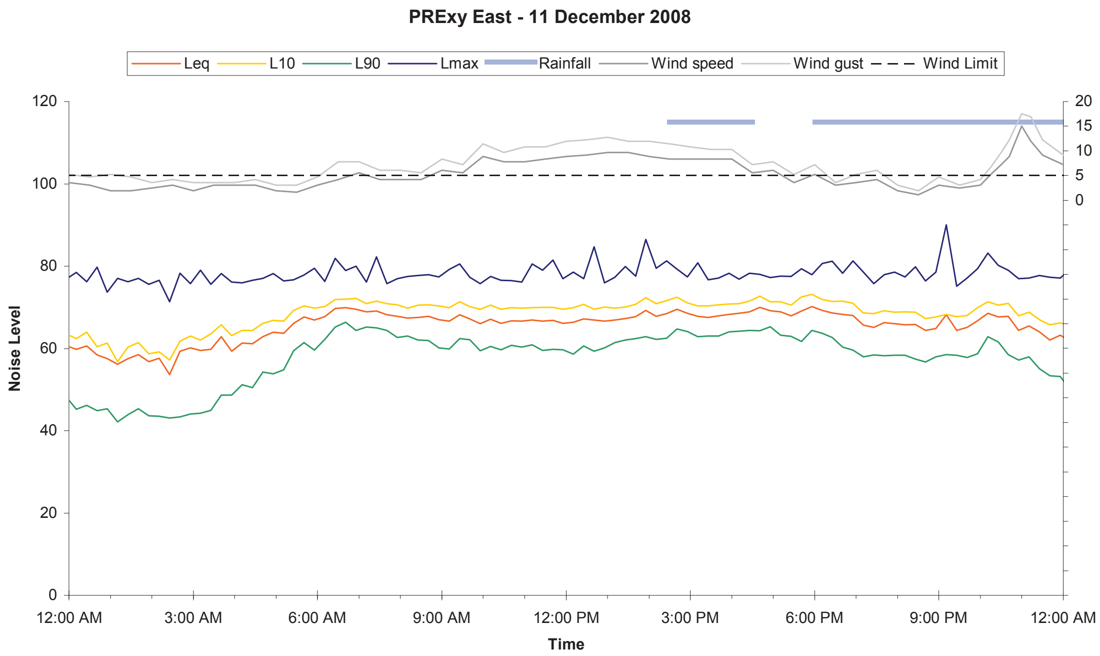


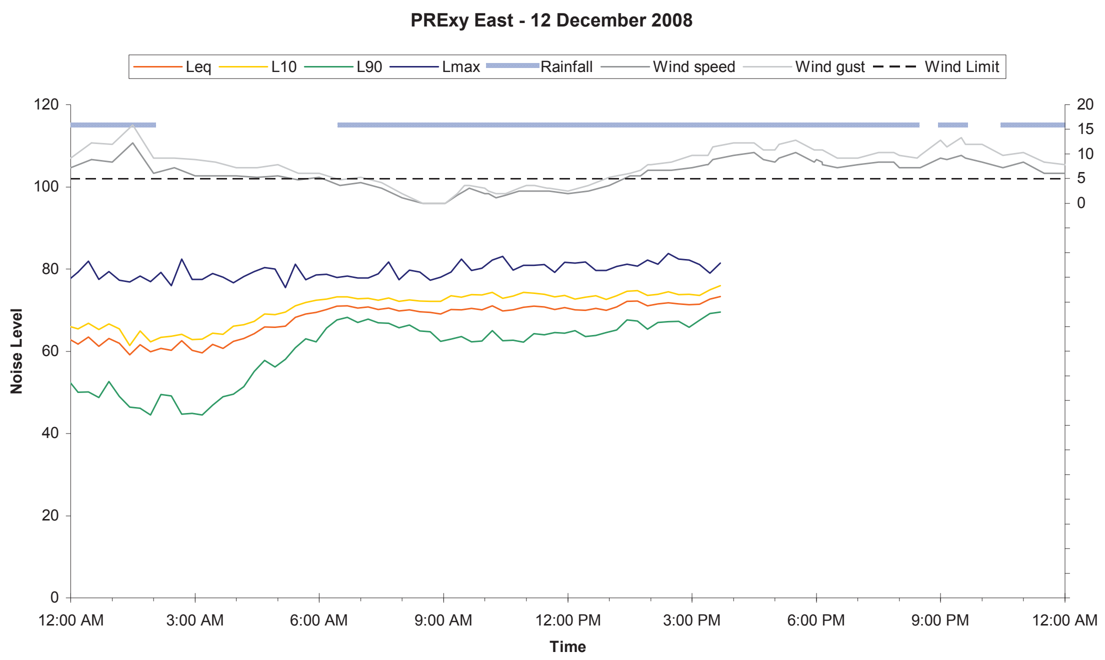

13 Trotters Drive - 9 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
0
20
40
60
80
100
120
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM


13 Trotters Drive - 10 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time
0
20
40
60
80
100
120
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM

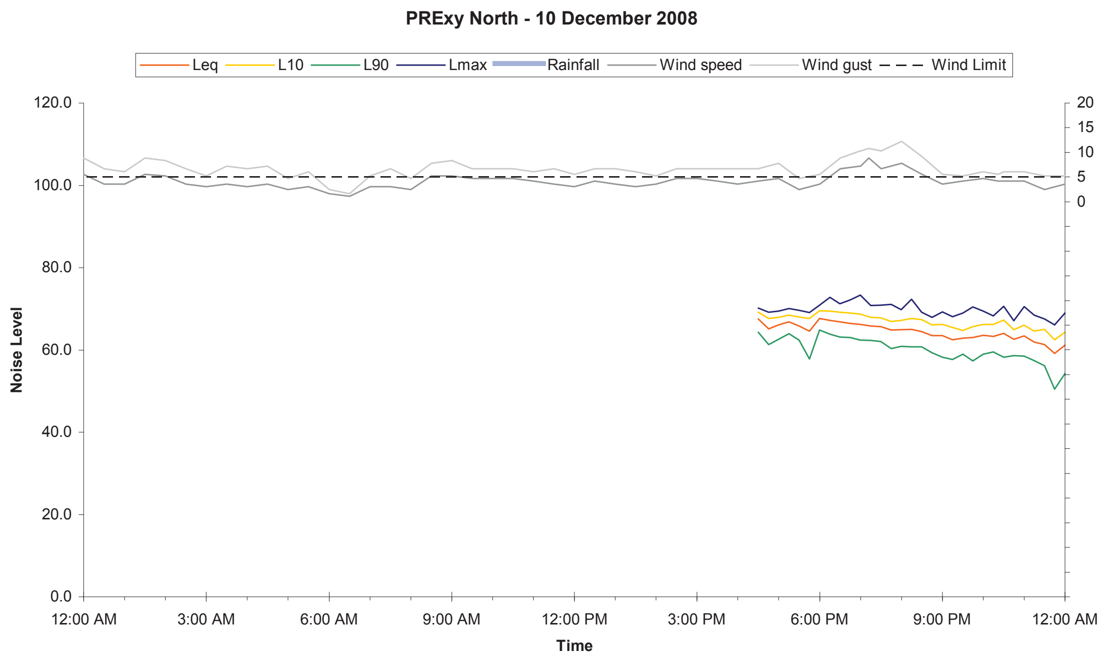
9 – Port River Expressway East

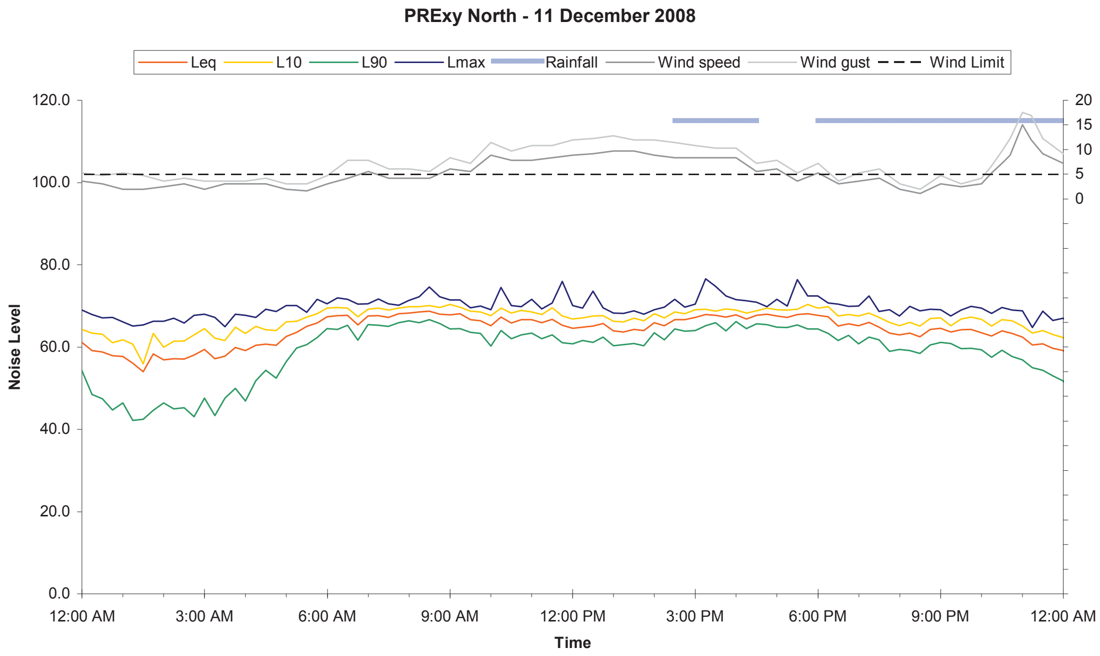


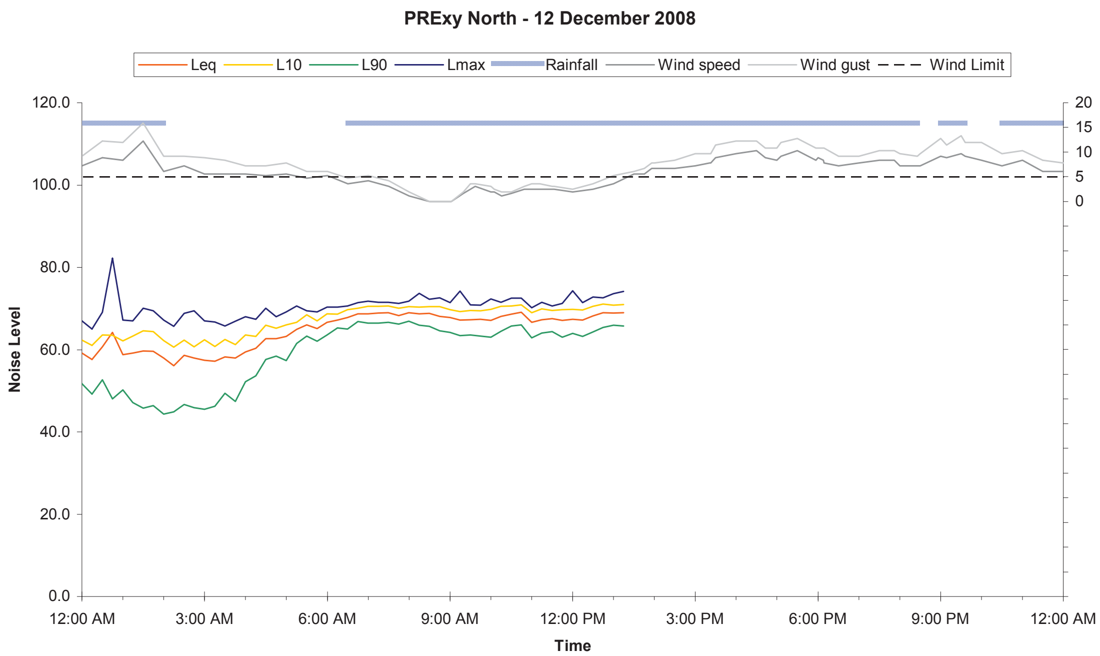




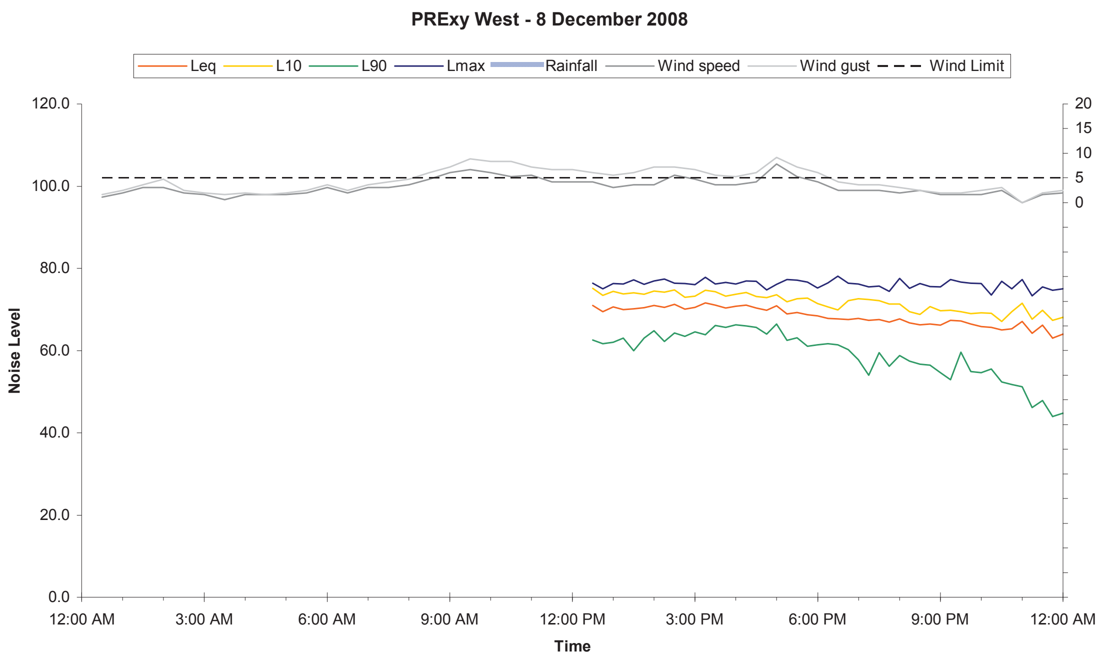
10 – Port River Expressway North

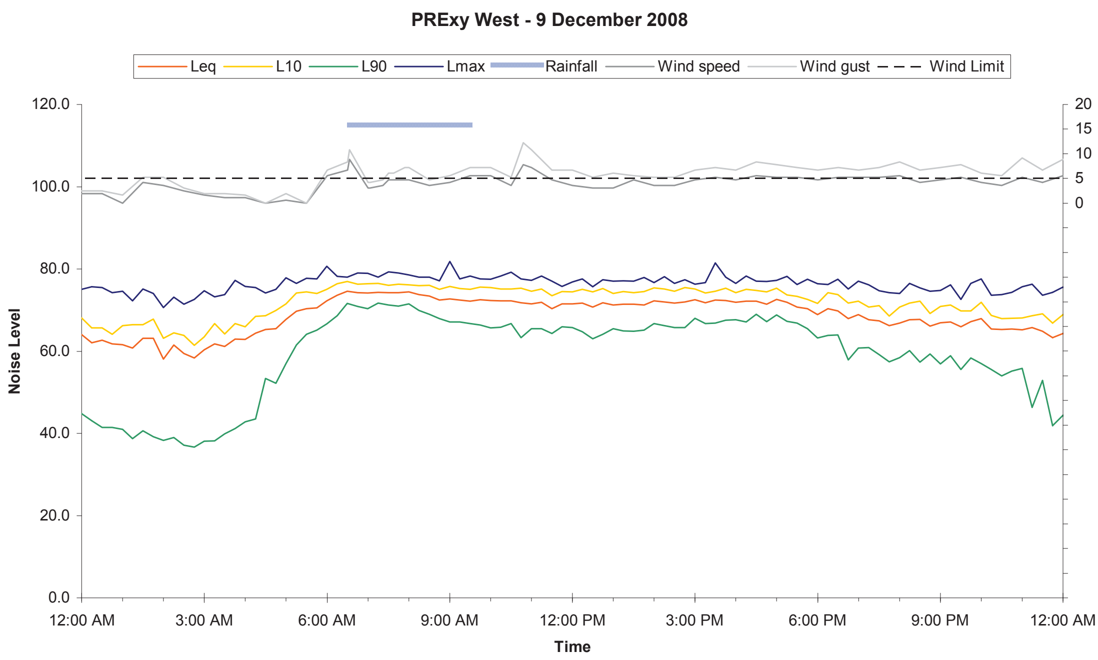


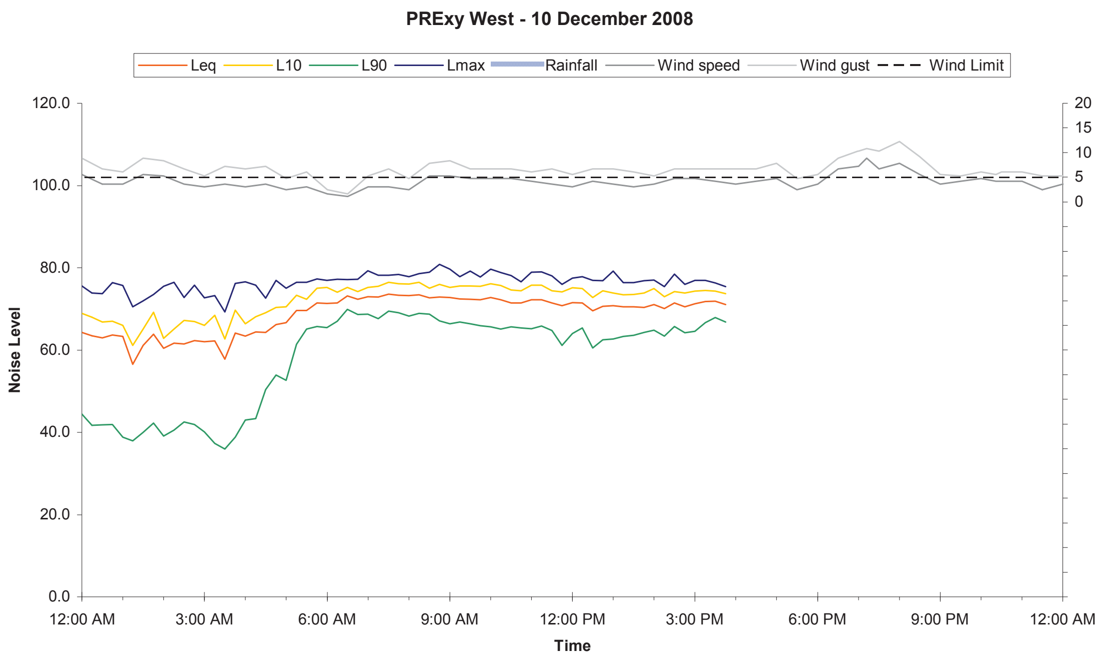

PRExy North - 11 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time


PRExy North - 12 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
Time

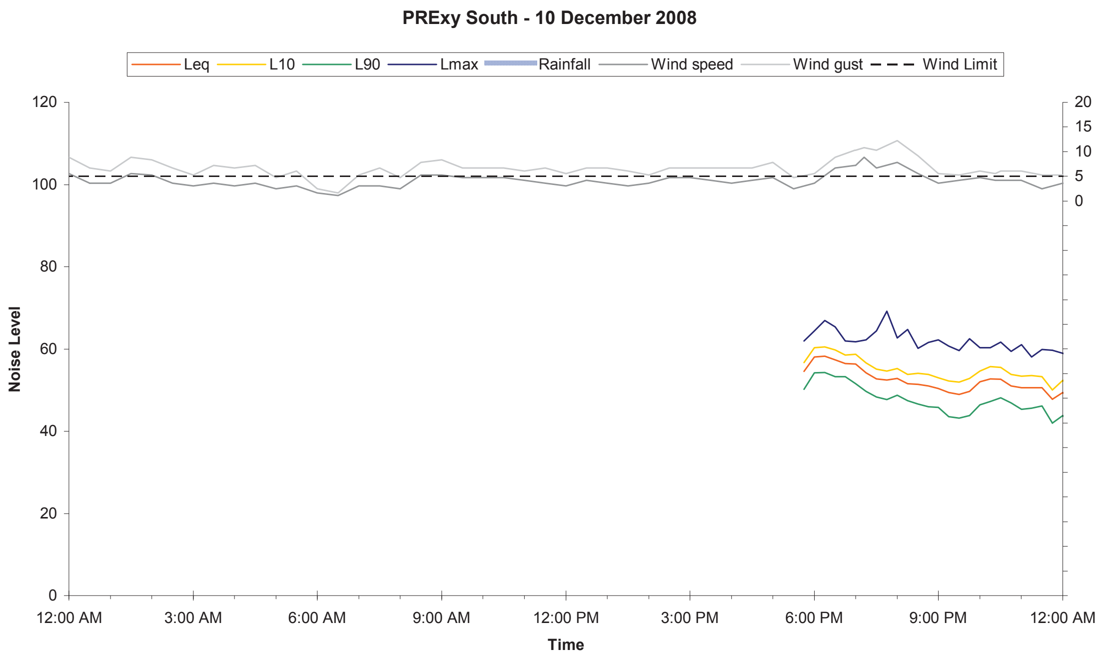
11 – Port River Expressway West

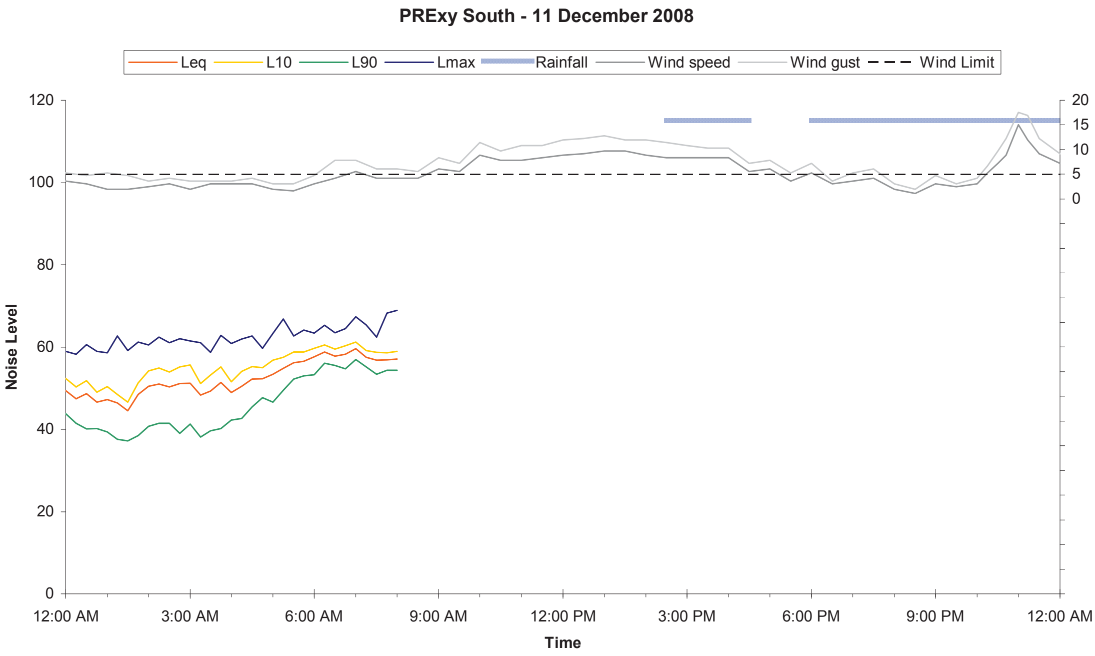






12 – Port River Expressway South




PRExy South - 11 December 2008
Leq
L10
L90
Lmax
Rainfall
Wind speed
Wind gust
Wind Limit
Noise Level
120
100
80
60
40
20
0
20
15
10
5
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time

Attachment D

Predicted noise levels versus adopted criteria at identified receiver locations

Table D.1. Identified receivers above adopted day time road traffic noise criteria with Northern Connector

Property ID	Catchment	Criteria, dB(A)	Predicted opening (2017) levels, dB(A)	Predicted future (2031) levels, dB(A)	2031 exceed, dB(A)
18	Northern	55	57	58	3
19	Northern	55	57	59	4
44	Northern	55	56	58	3
52	Northern	55	56	58	3
499	Northern	65	65	68	3
502	Northern	61	60	62	2
503	Northern	57	55	58	1
505	Northern	59	57	59	1
2452	Central	65	63	67	2
3843	Southern	55	54	57	2
3846	Southern	55	58	61	6
3847	Southern	55	58	61	6
3848	Southern	55	57	59	4
3849	Southern	55	55	58	3
3850	Southern	55	54	57	2
3851	Southern	55	54	56	1
3858	Southern	55	59	62	7
3859	Southern	55	60	63	8
3865	Southern	55	57	59	4
3866	Southern	55	56	58	3
3990	Central	58	57	60	2
3999	Central	63	62	65	2
4004	Central	56	59	62	6
4005	Central	57	57	60	3
4010	Northern	57	57	59	2
4012	Northern	55	60	62	7
4017	Northern	55	63	66	11
4018	Northern	58	56	59	1
4022	Northern	55	57	60	5
4023	Northern	65	63	67	2
4026	Northern	65	64	68	3
4037	Northern	55	59	62	7
4038	Northern	55	62	64	9
4042	Northern	55	56	59	4
4047	Northern	55	63	65	10
4049	Northern	55	57	60	5
4053	Northern	60	58	68	7
4055	Northern	65	63	66	1
4059	Northern	65	65	67	2
4066	Northern	55	62	64	9
4067	Northern	55	56	58	3
4068	Northern	55	55	57	2
4076	Northern	55	56	66	11
4117	Northern	55	56	58	3
4121	Northern	55	65	68	13
4125	Northern	55	58	61	6

4132	Northern	55	59	62	7
4135	Northern	55	63	65	10
4136	Northern	55	59	62	7
4137	Northern	55	57	60	5
4139	Northern	55	55	57	2
4143	Northern	55	54	56	1
4144	Northern	55	57	59	4
4145	Northern	55	60	63	8
4150	Northern	57	56	58	1
4152	Northern	65	66	69	4
4577	Southern	61	61	62	1
4578	Southern	61	61	63	1
4579	Southern	62	62	63	1
4580	Southern	62	61	63	1
4581	Southern	64	64	65	1
4582	Southern	62	61	63	1
4583	Southern	62	62	63	1
4585	Southern	62	62	63	1
4588	Southern	62	61	63	1
4604	Southern	60	59	61	1
4605	Southern	61	60	62	1
4606	Southern	60	59	61	1
4607	Southern	61	60	62	1
4609	Southern	62	61	63	1
4614	Southern	60	59	61	1
4616	Southern	62	62	63	1
4617	Southern	61	61	63	1
4619	Southern	62	61	63	1
4620	Southern	62	62	63	1
4621	Southern	62	62	64	1
8062	Southern	56	55	57	1
8152	Southern	64	64	65	1
8153	Southern	64	63	65	1
8294	Southern	61	61	62	1
8295	Southern	60	60	62	1
8296	Southern	60	60	62	1
8297	Southern	63	63	65	1
8298	Southern	62	62	64	1
8299	Southern	61	61	63	1
8300	Southern	62	61	63	1

Table D.2. Identified receivers above adopted night time road traffic noise criteria with Northern Connector

Property ID	Catchment	Criteria, dB(A)	Predicted opening (2017) levels, dB(A)	Predicted future (2031) levels, dB(A)	2031 exceed, dB(A)
7	Northern	60	58	61	1
15	Northern	50	48	51	1
18	Northern	50	52	55	5
19	Northern	50	52	55	5
21	Northern	50	49	52	2

43	Northern	50	48	51	1
44	Northern	50	51	54	4
52	Northern	50	51	54	4
499	Northern	60	64	67	7
513	Northern	60	58	61	1
517	Northern	60	59	63	3
2450	Central	60	59	63	3
2452	Central	60	61	65	5
2453	Central	60	58	62	2
2465	Central	60	59	63	3
2466	Central	60	58	62	2
2467	Central	60	59	63	3
2468	Central	60	59	63	3
2469	Central	60	58	62	2
2470	Central	60	58	62	2
2471	Central	60	58	62	2
2472	Central	60	58	62	2
2473	Central	60	59	63	3
2474	Central	60	59	63	3
2475	Central	60	59	63	3
2476	Central	60	59	63	3
2527	Central	60	58	62	2
2528	Central	60	59	63	3
2529	Central	60	58	63	3
2530	Central	60	58	62	2
2531	Central	60	59	63	3
2532	Central	60	59	63	3
2533	Central	60	59	63	3
2534	Central	60	59	63	3
2535	Central	60	59	63	3
2536	Central	60	59	63	3
2537	Central	60	59	63	3
2538	Central	60	59	63	3
2539	Central	60	59	63	3
2540	Central	60	59	63	3
2541	Central	60	58	63	3
2542	Central	60	59	63	3
2543	Central	60	59	63	3
2544	Central	60	59	63	3
2545	Central	60	59	63	3
2546	Central	60	59	63	3
2547	Central	60	58	63	3
2548	Central	60	58	63	3
2549	Central	60	58	63	3
3063	Central	60	58	62	2
3064	Central	60	58	62	2
3065	Central	60	58	62	2
3066	Central	60	58	62	2
3067	Central	60	58	62	2
3068	Central	60	58	62	2
3069	Central	60	57	61	1
3237	Central	60	58	61	1
3257	Central	60	59	61	1
3258	Central	60	58	61	1
3259	Central	60	58	61	1

3260	Central	60	58	61	1
3261	Central	60	58	61	1
3262	Central	60	58	61	1
3263	Central	60	58	61	1
3265	Central	60	58	61	1
3291	Central	60	59	62	2
3295	Central	60	60	62	2
3296	Central	60	59	61	1
3568	Central	60	60	63	3
3570	Central	60	60	63	3
3589	Central	60	60	62	2
3590	Central	60	60	63	3
3591	Central	60	60	63	3
3592	Central	60	60	63	3
3593	Central	60	60	63	3
3594	Central	60	60	63	3
3842	Southern	50	50	52	2
3843	Southern	50	53	55	5
3846	Southern	50	57	59	9
3847	Southern	50	57	59	9
3848	Southern	50	55	58	8
3849	Southern	50	54	56	6
3850	Southern	50	53	55	5
3851	Southern	50	52	54	4
3852	Southern	50	51	53	3
3853	Southern	50	50	52	2
3858	Southern	50	57	60	10
3859	Southern	50	59	61	11
3865	Southern	50	55	58	8
3866	Southern	50	54	56	6
3873	Southern	50	49	52	2
3874	Southern	50	49	52	2
3876	Southern	50	48	51	1
3878	Southern	50	49	52	2
3978	Southern	60	58	61	1
3979	Southern	60	59	62	2
3980	Southern	60	59	61	1
3981	Southern	60	58	61	1
3986	Central	60	60	62	2
3990	Central	57	56	58	1
3997	Central	60	58	61	1
3999	Central	60	60	63	3
4004	Central	55	58	60	5
4005	Central	57	56	59	2
4008	Central	60	58	62	2
4010	Northern	57	55	58	1
4011	Northern	50	51	54	4
4012	Northern	50	59	61	11
4017	Northern	51	62	65	14
4019	Northern	60	58	62	2
4022	Northern	55	56	59	4
4023	Northern	60	62	66	6
4026	Northern	60	63	67	7
4029	Northern	60	59	64	4
4030	Northern	60	58	62	2

4031	Northern	60	58	62	2
4032	Northern	60	58	62	2
4037	Northern	53	58	61	8
4038	Northern	51	60	63	11
4042	Northern	50	55	57	7
4047	Northern	51	61	64	13
4049	Northern	55	56	59	4
4053	Northern	60	63	67	7
4054	Northern	60	60	63	3
4055	Northern	60	61	64	4
4059	Northern	60	62	66	6
4060	Northern	60	57	61	1
4065	Northern	50	50	53	3
4066	Northern	50	60	63	13
4067	Northern	50	54	57	7
4068	Northern	50	53	56	6
4069	Northern	50	50	53	3
4075	Northern	50	44	54	4
4076	Northern	50	54	65	15
4077	Northern	50	44	52	2
4115	Northern	50	49	52	2
4116	Northern	50	50	53	3
4117	Northern	50	54	57	7
4121	Northern	51	63	66	15
4125	Northern	54	57	60	6
4127	Northern	60	59	62	2
4128	Northern	60	60	63	3
4129	Northern	60	60	63	3
4130	Northern	60	60	63	3
4132	Northern	52	57	60	9
4135	Northern	50	60	63	13
4136	Northern	50	57	59	9
4137	Northern	50	55	58	8
4139	Northern	50	52	55	5
4140	Northern	50	49	52	2
4143	Northern	50	51	54	4
4144	Northern	50	54	57	7
4145	Northern	50	57	60	10
4152	Northern	60	64	67	7
4577	Southern	60	59	61	1
4578	Southern	60	60	61	1
4579	Southern	60	60	62	2
4580	Southern	60	60	61	1
4581	Southern	60	62	64	4
4582	Southern	60	60	61	1
4583	Southern	60	60	61	1
4585	Southern	60	60	62	2
4588	Southern	60	60	61	1
4609	Southern	60	60	61	1
4616	Southern	60	60	62	2
4617	Southern	60	59	61	1
4619	Southern	60	60	61	1
4620	Southern	60	60	62	2
4621	Southern	60	60	62	2
8152	Southern	60	62	64	4

8153	Southern	60	62	63	3
8294	Southern	60	59	61	1
8295	Southern	60	59	60	1
8296	Southern	59	59	60	1
8297	Southern	60	61	63	3
8298	Southern	60	61	62	2
8299	Southern	60	59	61	1
8300	Southern	60	60	61	1

Table D.3. Identified receivers above adopted day time rail noise criteria with Northern Connector

Property ID	Catchment	Criteria, dB(A)	Predicted future (2027) levels, dB(A)	2027 exceed, dB(A)
4135	Northern	60	61	1

Table D.4. Identified receivers above adopted night time rail noise criteria with Northern Connector

Property ID	Catchment	Criteria, dB(A)	Predicted future (2027) levels, dB(A)	2027 exceed, dB(A)
4066	Northern	55	59	4
4135	Northern	55	60	5
4145	Northern	55	56	1

Table D.5. Identified receivers above adopted maximum rail noise criteria with Northern Connector

Property ID	Catchment	Criteria, dB(A)	Predicted future (2027) levels, dB(A)	2027 exceed, dB(A)
19	Northern	80	81	1
4066	Northern	80	88	8
4135	Northern	80	89	9
4136	Northern	80	81	1
4145	Northern	80	83	3

For more information

For more information, to make an enquiry or join the mailing list contact the Northern Connector project team.
Phone: 1300 793 458 (interpreter service available)
Email: dtei.northernconnector@sa.gov.au
Visit the website: www.infrastructure.sa.gov.au and then follow the prompts.

Για περισσότερες πληροφορίες γι’ αυτό το πρόγραμμα οδοποιίας τηλεφωνήστε στο **1300 793 458**. Διαθέτουμε και διερμηνείς.

Se desiderate altre informazioni su questo progetto stradale telefonate al **1300 793 458**. Ci sono interpreti a disposizione.

Để có thêm thông tin về công trình đường bộ này xin hãy gọi điện thoại số **1300 793 458**. Sẽ có phiên dịch viên.

បើចង់ទទួលព័ត៌មានបន្ថែមទៀតអំពីគំរោងផ្លូវថ្នល់នេះ៖ សូមទូរស័ព្ទមកលេខ **1300 793 458** មានអ្នកបកប្រែភាសាជូន។

www.infrastructure.sa.gov.au 1300 793 458