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Transport for New South Wales
01 August 2017

New Intercity Fleet - Springwood to Lithgow Rail Corridor Modifications

Noise and Vibration Impact Assessment

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Noise and Vibration Impact Assessment

Client: Transport for New South Wales
ABN: 18 804 239 602

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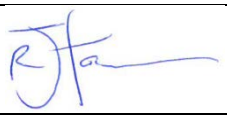
01-Aug-2017

Job No: 60538110

Quality Information

Document	New Intercity Fleet - Springwood to Lithgow Rail Corridor Modifications – Noise and Vibration Impact Assessment
Ref	60538110
Date	01-Aug-2017
Prepared by	Geoff Lucas
Reviewed by	Gayle Greer

Revision History

Revision	Revision Date	Details	Authorised Name/Position	Signature
1	24-May-2017	Draft	Richard Farmer Project Manager	Signed in original
2	12-Jul-2017	Updated to incorporate TfNSW comments	Richard Farmer Project Manager	Signed in original
3	01-Aug-2017	Updated to incorporate TfNSW comments	Richard Farmer Project Manager	

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Executive summary

AECOM Australia Pty Ltd (AECOM) has been commissioned by Transport for NSW (TfNSW) to undertake a Noise and Vibration Impact Assessment for the New Intercity Fleet - Springwood to Lithgow Rail Corridor Modifications (the Project). Nearby noise and vibration sensitive receivers were identified and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish construction noise management levels. As operational noise levels are expected to remain largely unchanged with the introduction of the new fleet, no quantitative modelling of operational noise impacts was undertaken.

Construction activity noise

Ten distinct construction stages have been developed in consultation with TfNSW, consisting of a number of construction activities, and used in a computer-based noise model to determine the potential changes to noise levels. Construction noise impacts were then assessed at 53 representative residential receivers at various locations along the length of the rail line between Springwood Station and Lithgow Station. These locations were selected to understand the potential noise impacts within areas with likely similar background noise levels. Noise impacts were also assessed at representative nearby non-residential sensitive receivers (e.g. schools, churches etc.).

During standard construction hours, results show that noise levels at 44 representative receivers are predicted to exceed noise management levels (NMLs) during some stage of construction during standard construction hours. Exceedances of up to 20 decibels (dB) are predicted, with the largest exceedances predicted during track slewing activities. One representative receiver was predicted to be ‘highly affected’ with noise levels predicted to be above 75 dB(A).

Results show that noise levels at all but one representative receiver are predicted to exceed NMLs during some stage of construction during the daytime and evening outside of standard construction hours. Noise levels at all representative receivers are predicted to exceed NMLs during the evening and night-time periods.

Exceedances of up to 25 dB, 27 dB and 45 dB are predicted during the day, evening and night-time respectively, with the largest exceedances predicted during track slewing activities, where almost all representative receivers are predicted to exceed NMLs. Noise levels during track slewing works are mostly in part due to the use of jackhammers.

Predicted noise levels at two non-residential sensitive receivers (school receivers) - N1 (Children's House Montessori, 585 Great Western Hwy, Faulconbridge) and N10 (Mid Mountains Neighbourhood Centre, 2 Lowden Ln, Lawson) are predicted to exceed NMLs during the track slewing works.

The sleep disturbance assessment results show the noise levels at the majority of representative receivers are predicted to exceed both sleep disturbance screening criteria and sleep awakening criteria during two of the three stages of night-time works. Significant exceedances of sleep awakening criteria are predicted, with highest predicted impacts of 88 dB(A) predicted at receiver R36 (141A Station Street, Blackheath), representing an exceedance of 23 dB above awakening criteria. Night-time works are anticipated to take place during up to ten 48 hour possessions, which will be spread over a two year period. This will provide respite periods between track possessions, with the longest period of consecutive night-works being limited to two nights.

Mitigation measures have been recommended in line with TfNSW’s *Construction Noise Strategy*. The implementation of these mitigation measures where reasonable and feasible would minimise and manage noise impacts.

Construction vibration

Safe working distances to nearby structures have been recommended for nominated plant. If the safe working distances are maintained then no adverse impact from the vibration intensive works are likely in terms of human response or cosmetic damage. Should vibration intensive activities be required within the safe working distances, the additional mitigation measures provided would be implemented.

Based on the construction activities assessed for the Project, it is likely that works would occur within the safe working distances for heritage listed stations. Vibration monitoring is recommended for works which occur within the safe working distances.

Operational impacts

Environmental noise emissions from the operation of the stations are not expected to change significantly as a result of the Project, as such an assessment under the *Industrial Noise Policy* (EPA, 2000) is not required.

The New Intercity Fleet is expected to be quieter than the existing intercity trains, in particular wheel squeal and engine noise is likely to be lower. Slewing will only modify the horizontal rail alignment by a maximum of 25 centimetres, therefore operational noise from rail movements is expected to remain the same or be reduced from the current situation. Therefore an assessment under the *Rail Infrastructure Noise Guideline* (EPA, 2003) is not required.

1 Introduction

AECOM Australia Pty Ltd (AECOM) has been commissioned by Transport for New South Wales (TfNSW) to undertake a Noise and Vibration Impact Assessment for the New Intercity Fleet - Springwood to Lithgow Rail Corridor Modifications (the Project).

The Project would involve essential enabling works to facilitate the safe and reliable operation of the New Intercity Fleet between Sydney and Lithgow on the Blue Mountains Line. The New Intercity Fleet would provide a better experience for public transport customers by delivering an accessible, modern, safe and comfortable travel experience.

Subject to approval, construction is expected to commence in 2018 and take around two years to complete. Works would be undertaken during standard daytime construction hours and also out-of-hours (such as during rail possessions). Up to ten 48 hour possessions are likely to be required over the two year construction period.

1.1 Background information

This Noise and Vibration Impact Assessment has been prepared in support of a Review of Environmental Factors report, which has been prepared to assess the environmental impacts associated with the construction and operation of the Project under the provisions of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The following policies and guidelines are relevant for this assessment:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *Rail Infrastructure Noise Guideline* (RING), NSW Environmental Protection Authority (EPA), 2013
- *NSW Industrial Noise Policy* (INP), Environment Protection Authority (EPA), 2000
- *Construction Noise Strategy* (CNS), TfNSW, 2016
- DIN Standard 4150: *Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999
- British Standard 6472: Part 1 2008 *Evaluation of Human Exposure to Vibration in Buildings*, 2008
- Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010
- Australian Standard AS 1055.1-1997 – *Acoustics – Description and measurement of environmental noise, Part 1: General procedures*, 1997
- UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*, 2006.

Definitions for acoustic terminology used within this report can be found in Appendix A.

1.2 Scope

The scope of this Noise and Vibration Impact Assessment is to:

- establish the existing background noise levels in the vicinity of the Project
- establish construction noise management levels and vibration limits which would apply to the Project
- predict construction noise and vibration levels at nearby residential and other sensitive receivers due to the Project
- predict noise impacts from additional off-site construction traffic generated by the Project
- recommend mitigation measures where necessary to reduce and manage noise and vibration impacts from the Project
- consider operational noise levels at nearby residential and other sensitive receivers due to the Project.

1.3 Proposed works

The Project would include the following key elements:

- extension of platforms at Katoomba Station and Lithgow Station
- modifications to station platform edges (also known as platform coping)
- re-positioning of rail tracks (track slewing) along the length of the rail corridor
- modification of the existing platform canopy at Faulconbridge Station
- signalling works to accommodate the new track position and platform modifications
- adjustment of the overhead wiring system and supporting structures as required.

The works assessed in this report occur between Springwood Station and Lithgow Station. Works at Mount Victoria Station and Zig Zag Station have not been assessed in this report.

1.4 Site description

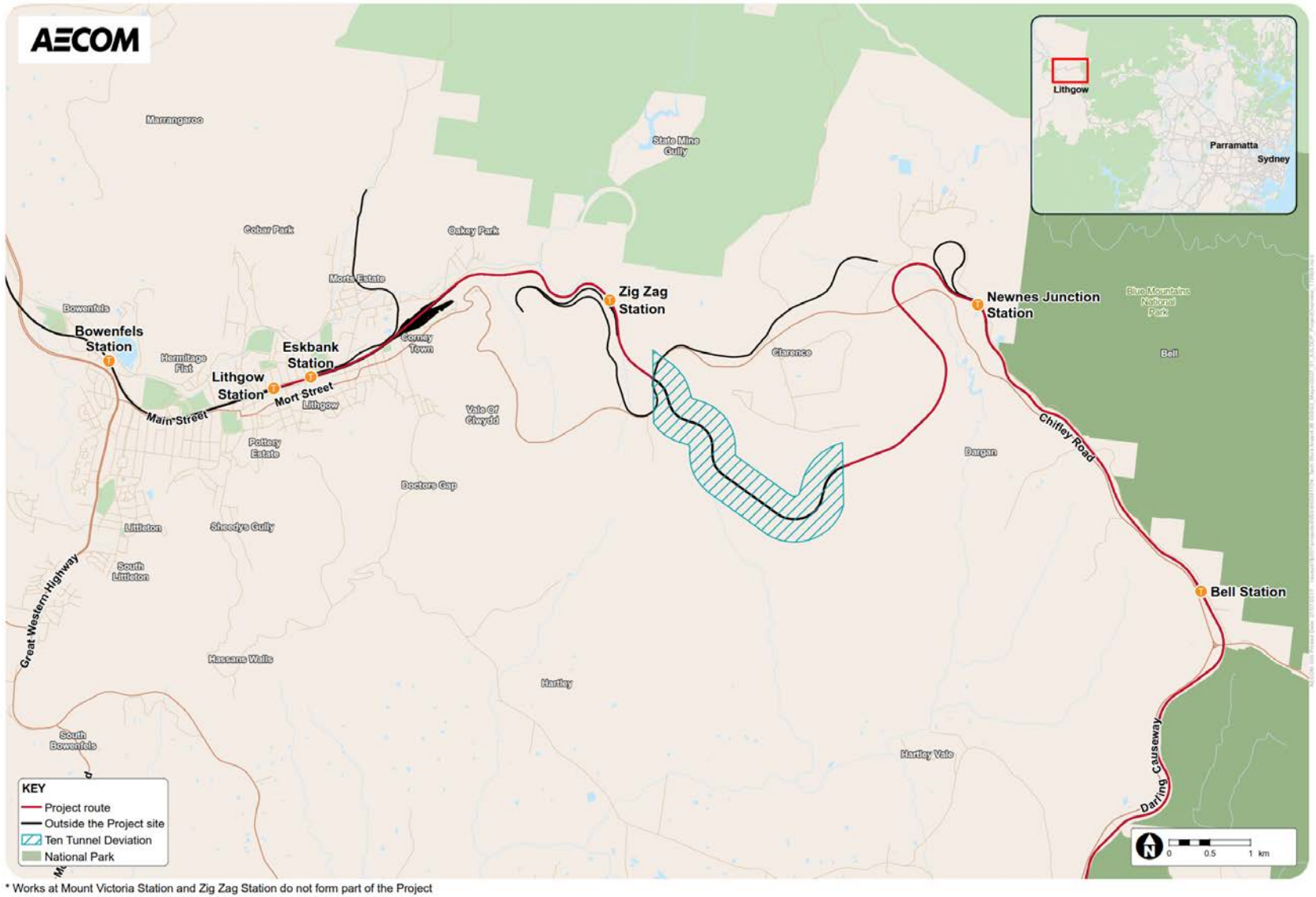
The Project site, which includes the rail corridor and ancillary facilities (refer Figure 1 and Figure 2) between Springwood Station and Lithgow Station follows the Great Western Highway until Mount Victoria. Up to this point suburban residential properties mainly surround the Project site on both sides, along with some commercial properties at the stations.

The Blue Mountains National Park also adjoins the rail corridor around Linden Station and either side of Medlow Bath Station. To the north of Mount Victoria Station, the Project site is surrounded mainly by the Blue Mountains National Park, with some isolated rural properties.

Beyond Newnes Junction Station, the Project site passes through a series of tunnels (Ten Tunnels Deviation) before arriving at Lithgow Station where a mix of residential and commercial properties surrounds the Project site. The Great Western Highway is considered to be an arterial road, as per the categories within the Environment Protection Authority's (EPA) *NSW Road Noise Policy*.

* Works at Mount Victoria Station and Zig Zag Station do not form part of the Project

Figure 1 Project site overview (part 1 of 2)



* Works at Mount Victoria Station and Zig Zag Station do not form part of the Project

Figure 2 Project site overview (part 2 of 2)

1.5 Receivers

1.5.1 Noise catchment areas

To assist in determining noise criteria for the receivers surrounding the Project, four noise catchment areas (NCA) were identified as described in Table 1. The noise environment at each of the residential receivers within each NCA is considered to be comparable and these definitions can be used to develop assessment / management criteria for similar existing environments. The NCAs are shown in Figure 3.

Table 1 Noise catchment areas

NCA	Description
1	Residences in suburban locations near the rail line and Great Western Highway
2	Residences in Katoomba
3	Rural residences in remote locations between Mount Victoria and Lithgow
4	Residences in Lithgow

1.5.2 Representative receivers

In order to simplify the assessment methodology, 53 representative residential receivers were selected to describe the noise impacts within areas considered likely to have similar background noise levels. These residences are listed in Table 2.

Noise impacts were also assessed at 24 representative non-residential receivers; these are listed in Table 3.

The locations of the residential and non-residential receivers identified for use in the assessment are presented in Appendix B. It is noted that other residential and non-residential receivers which could potentially be affected are scattered around the vicinity of the Project site.

Table 2 Representative receivers - residential

Receiver ID	Receiver address	NCA	Distance to Project (metres)
R1	1 Clarinda Avenue, Faulconbridge	1	26
R2	621 Great Western Highway, Faulconbridge	1	43
R3	26 Sir Henrys Parade, Faulconbridge	1	32
R4	789 Great Western Highway, Linden	1	47
R5	778 Great Western Highway, Linden	1	74
R6	9 Burke Road, Linden	1	46
R7	1 Numantia Road, Linden	1	26
R8	764 Great Western Highway, Linden	1	65
R9	4 Buena Vista Road, Woodford	1	41
R10	18 Railway Parade, Woodford	1	43
R11	8 Station Street, Woodford	1	107
R12	56 Great Western Highway, Woodford	1	61
R13	44 Railway Parade, Hazelbrook	1	27
R14	3 Falcon Street, Hazelbrook	1	73

Receiver ID	Receiver address	NCA	Distance to Project (metres)
R15	4 Burford Street, Hazelbrook	1	84
R16	285B Great Western Highway, Lawson	1	44
R17	1 Badgery Crescent, Lawson	1	66
R18	11 Loftus Street, Lawson	1	70
R19	353 Great Western Highway, Bullaburra	1	56
R20	35 Railway Parade, Bullaburra	1	36
R21	15 Railway Parade, Bullaburra	1	39
R22	14 Railway Parade, Wentworth Falls	1	51
R23	170 Great Western Highway, Wentworth Falls	1	44
R24	2 Railway Parade, Wentworth Falls	1	35
R25	87 Railway Parade, Leura	1	38
R26	70 Railway Parade, Leura	1	41
R27	14 Great Western Highway, Leura	1	29
R28	5 Lurline Street, Katoomba	2	91
R29	2-4 Murri Street, Katoomba	2	144
R30	11 Penault Avenue, Katoomba	2	31
R31	7 Whitton Street, Katoomba	2	54
R32	10 Railway Parade, Medlow Bath	1	73
R33	40 Great Western Highway, Medlow Bath	1	42
R34	26 Railway Parade, Medlow Bath	1	37
R35	22-24 Coachhouse Lane, Medlow Bath	1	49
R36	141A Station Street, Blackheath	1	12
R37	142 Wentworth Street, Blackheath	1	123
R38	132 Station Street, Blackheath	1	38
R39	27 Sandham Road, Bell	3	208
R40	20 Sandham Road, Bell	3	171
R41	18 Sandham Road, Bell	3	52
R42	12A Sandham Road, Bell	3	124
R43	97 Chifley Road, Bell	3	227
R44	567 Sandham Road, Clarence	3	61
R45	576 Sandham Road, Clarence	3	76
R46	588-602 Sandham Road, Clarence	3	91
R47	2 Hayley Street, Lithgow	4	40
R48	1 Young Street, Lithgow	4	43
R49	183 Mort Street, Lithgow	4	170
R50	4 Clarice Street, Lithgow	4	82
R51	17 John Street, Lithgow	4	133
R52	40 Maple Crescent, Lithgow	4	245
R53	2 Church Street, Lithgow	4	290

Table 3 Representative receivers – non-residential

Receiver ID	Receiver address	Use	Distance to Project (metres)
N1	Children's House Montessori - 585 Great Western Highway, Faulconbridge	School	44
N2	68 Great Western Highway, Woodford	Commercial	66
N3	40 Railway Parade, Hazelbrook	Commercial	26
N4	2 Rosedale Avenue, Hazelbrook	Commercial	35
N5	Unnamed Reserve - 6 Loftus Street, Lawson	Active Recreation	18
N6	Blue Mountains Hotel, 286 Great Western Highway, Lawson	Commercial	38
N7	Lawson Library - Joseph Lane, Lawson	Library	80
N8	Emmanuel Anglican Church - 13 Honour Avenue, Lawson	Place of Worship	117
N9	Lawson Bowling Club - 2 Loftus Street, Lawson	Active Recreation	16
N10	Mid Mountains Neighbourhood Centre - 2 Lowden Lane, Lawson	School / Childcare	76
N11	351A Great Western Highway, Bullaburra	Commercial	55
N12	13 Station Street, Wentworth Falls	Commercial	46
N13	174 Great Western Highway, Wentworth Falls	Commercial	59
N14	129 Leura Mall, Leura	Commercial	34
N15	134 Leura Mall, Leura	Commercial	61
N16	2 Katoomba Street, Katoomba	Commercial	29
N17	1A Goldsmith Place, Katoomba	Commercial	34
N18	1 Railway Parade, Medlow Bath	Commercial	33
N19	Blackheath Library - 265 Great Western Highway, Blackheath	Library	46
N20	255 Great Western Highway, Blackheath	Commercial	35
N21	Lithgow Anglican Church - 2 Roy Street, Lithgow	Place of Worship	43
N22	132 Main Street, Lithgow	Commercial	20
N23	1 Railway Parade, Lithgow	Commercial	52
N24	59 Bridge Street, Lithgow	Commercial	115

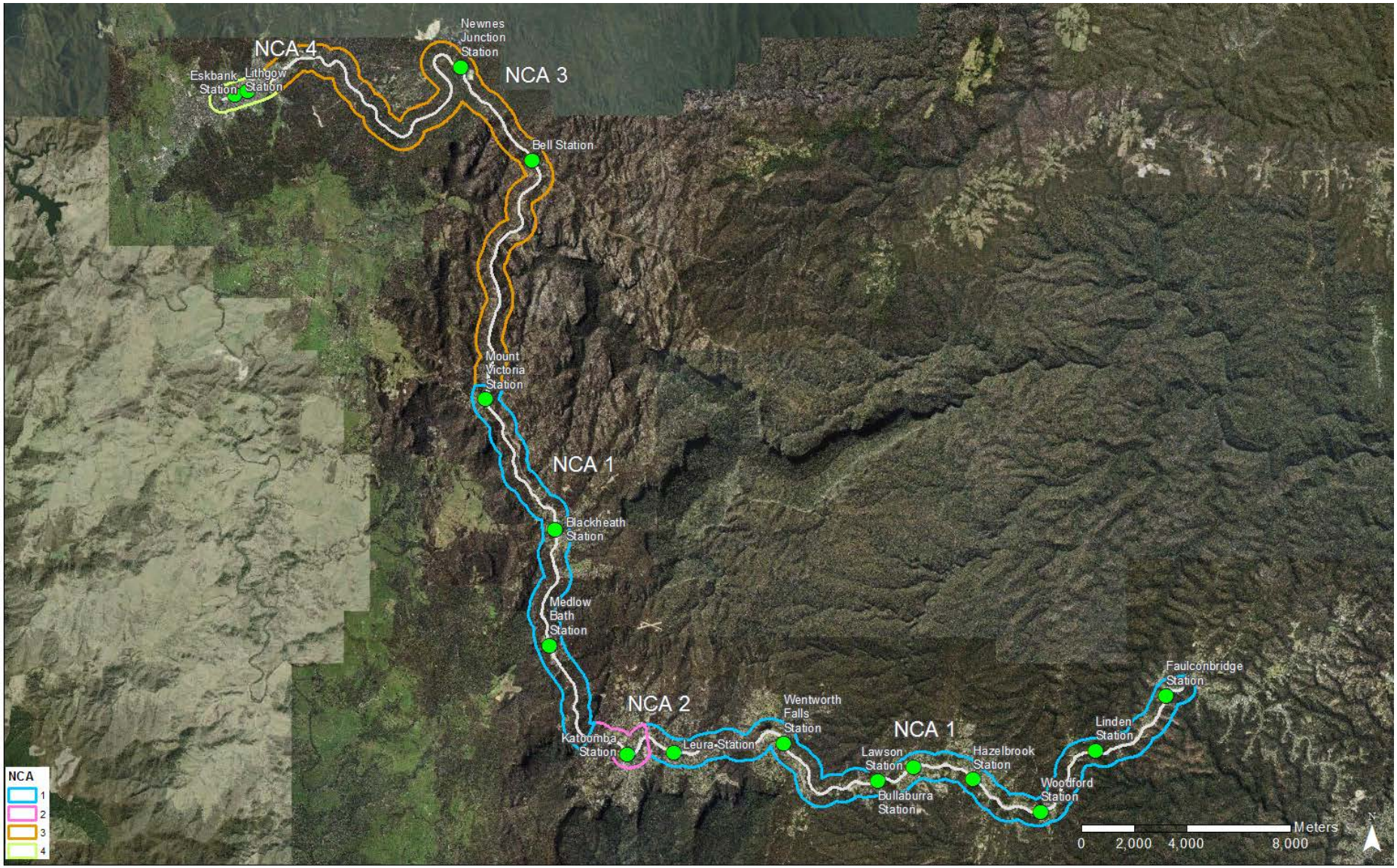


Figure 3 Regional context and NCA locations

1.5.3 Heritage items

There are a number of stations between Springwood and Lithgow that are listed within heritage registers including the State Heritage Register, RailCorp's Section 170 Heritage and Conservation Register and Blue Mountains and Lithgow Local Environment Plans (LEP) heritage registers. These stations and there heritage listings are detailed in Table 4.

Table 4 Stations with heritage listings within the Project area

Station	Heritage listings
Faulconbridge	• RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Linden	• RailCorp's Section 170 Heritage and Conservation Register
Woodford	• RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Hazelbrook	• RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Lawson	• State Heritage Register • RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Bullaburra	• RailCorp's Section 170 Heritage and Conservation Register
Wentworth Falls	• RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Leura	• RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Katoomba	• State Heritage Register • RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Medlow Bath	• State Heritage Register • RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Blackheath	• State Heritage Register • RailCorp's Section 170 Heritage and Conservation Register • Blue Mountains LEP
Bell	• RailCorp's Section 170 Heritage and Conservation Register
Newnes Junction	• RailCorp's Section 170 Heritage and Conservation Register
Eskbank	• State Heritage Register • RailCorp's Section 170 Heritage and Conservation Register • Lithgow LEP
Lithgow	• State Heritage Register, • RailCorp's Section 170 Heritage and Conservation Register • Lithgow LEP

2 Existing acoustic environment

2.1 Noise measurement methodology

Long-term unattended noise measurements were undertaken at six locations between 31 March 2017 and 11 April 2017 to establish the existing ambient and background noise environment at potentially affected receivers in the vicinity of the Project site. At least one noise logger was placed within each NCA at a representative location as shown in Appendix D (due to its size three loggers were placed in NCA 1). NCA descriptions are provided in Section 1.5.1. The noise loggers were calibrated prior to and after the monitoring period with a drift in calibration not exceeding ± 0.5 db(A). The details of the unattended noise monitoring conducted can be found in Table 5.

All the acoustic instrumentation employed during the noise measurements comply with the requirements of the *Australian Standards International Electrotechnical Commission 61672.1-2004 Electroacoustics - Sound level meters - Specifications* (AS IEC, 2004) and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

Table 5 Unattended noise monitoring details

NCA	Rating Background Level[2]			Ambient noise levels[3]		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NCA1	50 dB(A)	48 dB(A)	30 dB(A)	60 dB(A)	59 dB(A)	56 dB(A)
NCA2	41 dB(A)	39 dB(A)	31 dB(A)	54 dB(A)	53 dB(A)	43 dB(A)
NCA3	31 dB(A)	30 dB(A)	30 dB(A)	45 dB(A)	44dB(A)	43 dB(A)
NCA4	42 dB(A)	40 dB(A)	30 dB(A)	59 dB(A)	58 dB(A)	52 dB(A)

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.
2. Rating Background Level (RBL) (L_{A90}) represents the noise level exceeded for 90 per cent of the monitoring period.
3. Ambient noise level represents the average noise level over the monitoring period.

The noise environment at each of the residential receivers within a NCA is considered to have a similar noise environment to the unattended monitoring location within that NCA. As such each of these residential receivers is assigned the same background noise level.

In accordance with the EPA's *NSW Industrial Noise Policy* (INP), noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The INP advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data were acquired from the Bureau of Meteorology's Mount Boyce and Penrith weather stations (station ID 063292 and ID 067113).

2.2 Unattended noise measurements

The loggers measured the noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The $L_{A1,}$ L_{A10} and L_{A90} noise levels are the levels exceeded for 1 per cent, 10 per cent and 90 per cent of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level for each day, evening and night period in accordance with the INP for each monitoring location. The assessment background level is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 6 presents individual ABLs for each day's assessment periods. The background noise level or rating background level representing the day, evening and night-time assessment periods is based on the median of individual assessment background levels determined over the entire monitoring period.

Table 6 also presents the existing L_{Aeq} ambient noise level selected for each day, evening and night-time period, in accordance with the INP. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

Graphical noise logging results are presented in Appendix B.

Table 6 Unattended noise measurement results in dB(A) – NCA 1a

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	49	28	-	60	57
Saturday 01 April	52	47	31	60	58	52
Sunday 02 April	-	49	-	-	60	-
Monday 03 April	-	50	-	-	61	-
Tuesday 04 April	54	50	32	63	61	58
Wednesday 05 April	53	48	29	62	60	57
Thursday 06 April	52	47	34	61	60	57
Friday 07 April	52	51	36	61	60	56
Saturday 08 April	49	48	28	60	58	54
Sunday 09 April	-	-	-	-	-	-
Monday 10 April	-	49	38	-	60	57
Tuesday 11 April	-	-	-	-	-	-
Log Average				61	60	56
RBL	52	49	31			

Notes:

1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 7 Unattended noise measurement results in dB(A) – NCA 1b

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	49	24	-	63	61
Saturday 01 April	51	46	29	60	57	54
Sunday 02 April	-	49	-	-	60	-
Monday 03 April	-	48	-	-	60	-
Tuesday 04 April	51	51	29	60	59	60
Wednesday 05 April	50	49	32	59	58	60
Thursday 06 April	52	50	32	62	59	61
Friday 07 April	52	52	33	60	60	62
Saturday 08 April	-	-	-	-	-	-
Log Average				60	60	60
RBL	51	49	30			

Notes:
1. Day is defined as 700 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 8 Unattended noise measurement results in dB(A) – NCA 1c

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	49	31	-	62	56
Saturday 01 April	49	46	26	59	57	51
Sunday 02 April	-	47	-	-	59	-
Monday 03 April	-	48	-	-	59	-
Tuesday 04 April	50	50	39	60	59	58
Wednesday 05 April	51	49	31	60	60	58
Thursday 06 April	49	48	32	60	59	58
Friday 07 April	50	49	33	60	59	57
Saturday 08 April	49	47	27	59	58	54
Sunday 09 April	-	-	-	-	-	-
Monday 10 April	-	45	33	-	58	55
Tuesday 11 April	-	-	-	-	-	-
Log Average				60	59	56
RBL	50	48	32			

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 9 Unattended noise measurement results in dB(A) – NCA 2

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	40	31	-	50	43
Saturday 01 April	42	39	30	54	52	42
Sunday 02 April	40	39	-	54	49	-
Monday 03 April	-	39	31	-	57	43
Tuesday 04 April	41	-	-	54	-	-
Wednesday 05 April	41	41	33	55	52	44
Thursday 06 April	-	-	-	-	-	-
Log Average				54	53	43
RBL	41	39	31			

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 10 Unattended noise measurement results in dB(A) – NCA 3

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	26	17	-	46	45
Saturday 01 April	32	28	22	45	44	41
Sunday 02 April	36	29	-	46	45	-
Monday 03 April	-	30	27	-	46	43
Tuesday 04 April	33	-	-	44	-	-
Wednesday 05 April	31	24	17	45	44	41
Thursday 06 April	27	26	17	43	41	41
Friday 07 April	30	26	17	46	44	42
Saturday 08 April	29	25	22	45	43	43
Sunday 09 April	-	-	-	-	-	-
Monday 10 April	-	-	-	-	-	-
Log Average				45	44	43
RBL	31	30[2]	30[2]			

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.
2. Where the rating background noise level is found to be less than 30 dB(A), the RBL is set to 30 dB(A) in accordance with the INP.

Table 11 Unattended noise measurement results in dB(A) – NCA 4

Measurement date (2017)	Background noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 31 March	-	38	29	-	58	52
Saturday 01 April	40	40	-	58	55	-
Sunday 02 April	40	-	-	57	-	-
Monday 03 April	-	40	30	-	59	53
Tuesday 04 April	42	-	-	59	-	-
Wednesday 05 April	43	41	30	60	61	52
Thursday 06 April	42	39	28	60	59	52
Friday 07 April	42	42	32	60	58	52
Saturday 08 April	40	39	29	59	56	51
Sunday 09 April	-	-	-	-	-	-
Monday 10 April	-	-	-	-	-	-
Log Average				59	58	52
RBL	42	40	30			

Notes:

4. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

2.3 Existing noise environment summary

The acoustic environment of NCA 1 is characterised by a mixture of local and highway traffic (The Great Western Highway). Trains were operating during the installation of the monitoring equipment and therefore contribute to the acoustic environment. Noise monitoring results indicated lower noise levels during the night, compared to day and evening periods. This is typical of a suburban environment.

The acoustic environment of NCA 2 is characterised by a mixture of natural sounds and local traffic. Similarly to NCA 1 the noise monitoring results indicated lower noise levels during the night, compared to day and evening periods. This is typical of a suburban environment.

The acoustic environment of NCA 3 is characterised mainly by natural sounds with some distant highway noise. Trains were also operating during the installation of the noise monitoring equipment and contribute to the acoustic environment. Night-time noise levels are very quiet, typical of a rural environment.

The acoustic environment of NCA 4 is characterised by local traffic, particularly Railway Parade. Trains were also operating during the installation of the noise monitoring equipment and contribute to the acoustic environment. The noise monitoring results indicated lower noise levels during the night, compared to day and evening periods. This is typical of a suburban environment.

3 Construction noise and vibration criteria

3.1 Construction activity noise criteria

3.1.1 Interim Construction Noise Guideline

The *Interim Construction Noise Guideline* (ICNG) is the principal guideline for the assessment and management of construction noise in NSW. The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the Environmental Impact Assessment (EIA) processes'*. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and compared to the levels provided in Section 4 of the ICNG.

Where an exceedance of the management levels is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The ICNG defines what is considered to be feasible and reasonable as follows:

- "Feasible

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- Reasonable

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

The construction noise management levels (NML) for the residential and non-residential receivers are detailed in Table 12, Table 13 and Table 14.

Table 12 ICNG residential noise management levels

Time of day	NML, LAeq,15min, dB(A)1	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• a strong justification would typically be required for works outside the recommended standard hours • the proponent should apply all feasible and reasonable work practices to meet the noise affected level • where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community • for guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Notes:
1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 13 presents the NMLs applicable to residential receivers nearby to the Project.

Table 13 Construction noise management levels – Residential receivers

NCA	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
1[1]	Day	50	60	55
	Evening	48	-	53
	Night	30	-	35
2	Day	41	51	46
	Evening	39	-	44
	Night	31	-	36
3	Day	31	41	36
	Evening	30	-	35
	Night	30	-	35
4	Day	42	52	47
	Evening	40	-	45

NCA	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
	Night	30	-	35

Notes:
1. For NCA1 the lowest recorded RBLs were used from unattended noise measurements 1a, 1b or 1c.

Table 14 presents the NMLs applicable to other non-residential noise sensitive receivers such as educational facilities and places of worship and to industrial and commercial receivers.

Table 14 Construction noise management levels – non-residential receivers

Land use	Noise management levels, $L_{Aeq,15min,}$ dB(A) (applies when properties are in use)
Classrooms at schools and other educational institutions	55 dB(A)[1]
Places of worship	55 dB(A)[1]
Childcare centres	55 dB(A)[1]
Medical	55 dB(A)[1]
Active recreation	65 dB(A)
Library	55 dB(A)[1]
Commercial premises (including offices, retail outlets)	70 dB(A)
Industrial premises	75 dB(A)

Notes:

1. These external management levels are based upon a 45 dB(A) internal noise management level and a 10 dB reduction from outside to inside through an open window.

3.1.2 Sleep disturbance criteria

The ICNG requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. On the basis of the ambient noise environment during the night-time period, the predicted L_{A1} noise levels and number of expected L_{A1} noise events should be predicted in order to determine the likelihood of potential sleep disturbance. The ICNG makes reference to the NSW *Environment Criteria for Road Traffic Noise* (ECRTN), now superseded by the *Road Noise Policy* (RNP), for guidance in assessing the potential for sleep disturbance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min),}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is exceeded, a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, *'Maximum internal noise levels below 50 to 55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides around 10 dB in noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 15.

Table 15 Sleep disturbance criteria

NCA	Background noise level (L_{A90}), dB(A)	Sleep disturbance criteria, dB(A)	$L_{A1(1\ minute)}$, dB(A)
		Screening level	Awakening reaction
1	30	45	65
2	31	46	65
3	30	45	65
4	30	45	65

3.2 Construction traffic noise criteria

Noise from construction traffic on public roads is not covered by the ICNG. However the ICNG does refer to the ECRTN, now superseded by the RNP, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic, an initial screening test should be undertaken by evaluating whether existing road traffic noise levels will increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is equal to or greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

3.3 Construction vibration criteria

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 16.

Table 16 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard *DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures* (DIN 4150)
Human comfort (tactile vibration)	*Assessing Vibration: A Technical Guideline* (AVATG)[1]

Note:

1. This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

3.3.1 Structural damage

At present, no Australian Standard exists for the assessment of building damage caused by vibration.

The German Standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 17. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. In this assessment of DIN 4150 limited have been adopted for residential, non-residential and heritage structures.

Table 17 Structural damage safe limits (DIN 4150) for building vibration

Group	Type of structure	At foundation – Less than 10 Hz	At foundation - 10 Hz to 50 Hz	At foundation - 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:
1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.

3.3.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 18. The VDV criteria are based on the likelihood that a person would comment adversely on the level of vibration over the entire assessment period.

Table 18 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$) for daytime (7am – 10pm) and night time (10pm – 7am)

Location	Daytime Preferred	Daytime Max	Night time Preferred	Night time Max
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above.
2. Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.

4 Construction noise assessment

4.1 Construction stages and scheduling

Ten distinct construction stages consisting of a number of construction activities have been assumed to be required for the enabling works. These would be confirmed by the construction contractor prior to construction commencing and further assessment would be undertaken if required. Proposed construction stages for the works are described in Table 19. The construction stages that have been modelled (i.e. those that represent a worst case for noise impacts) are highlighted in blue in the table. The proposed timing of the works is also presented.

It is likely that up to 10 48 hour track possessions would be required, likely during the weekends. This would also include up to five shutdown periods of up to 12 day shutdowns for the section between Newnes Junction Station and Lithgow Station, providing five day closures of one line either side of a weekend possession period.

For construction stages 1- site establishment, 3 – platform demolition and 5 - platform construction, any works outside of standard hours are likely to be low impact site establishment works. As a result the noise impacts from these works, outside standard hours, are expected to be minimal.

Table 19 Construction assessment stages and scheduling

Construction stage	Description	Location[1]	Timing
1 Site establishment	Establishment of site compounds, establishment of temporary facilities, site surveys of all track, platform, overhead wiring and signalling infrastructure, utility locating.	All Stations – Faulconbridge to Lithgow	Standard hours or during possession / shutdown
2 Utilities disconnection	Disconnecting utility services or installing protection measures for cable routes as required	All Stations – Faulconbridge to Lithgow	Standard hours
3 Platform coping modifications	Removing or widening the platform edges (coping) of platforms 1 and 2 at all stations and removing a portion of the existing platform awning at Faulconbridge Station, reinstate finishes such as tactile pavers and/or yellow and white line markers	All Stations – Faulconbridge to Lithgow	Standard hours or during possession / shutdown
4 Reinstate utilities	Reinstate utility services where required	All Stations – Faulconbridge to Lithgow	Standard hours
5 Platform extension	Constructing platform extension at Katoomba and Lithgow stations	Katoomba and Lithgow	Standard hours or during possession / shutdown
6 Communications installation	Installation of CCTV, lighting, public announcement systems, and spark gaps to service platform extensions	Katoomba and Lithgow	Standard hours or during possession / shutdown
7 Track slewing	Track slewing	All Track – Springwood to Lithgow	48 hour possession
8 Signalling	Relocation of electrical equipment at Woodford Station, Hazelbrook Station, Lawson Station and Eskbank Station. Minor signal infrastructure adjustments along the rail corridor at Hazelbrook Station and Woodford Station to accommodate new track positions as a result of the slewing	Hazelbrook, Woodford, Lawson and Eskbank	48 hour possession
9 Overhead wiring	Relocating and replacing of overhead wire structures at Katoomba Station to accommodate the extended platform, at Bell Station and Eskbank Station to accommodate the crossover replacements and at Leura Station, Medlow Bath Station and Blackheath Station to accommodate track slewing	Katoomba, Bell, Eskbank, Leura, Medlow Bath and Blackheath	48 hour possession
10 Testing and commissioning	Testing and commissioning	All Track	Standard hours or during possession / shutdown

Notes:
1. Mount Victoria Station and Zig Zag Station are excluded from the works.
2. Modelled construction stages are highlighted in blue .

4.2 Construction noise sources

Construction noise sources and their respective L_{Aeq} sound power levels for each stage are shown in Table 20. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites* noise database and assume equipment is modern and in good working order.

Table 20 Equipment sound power levels per construction stage

Equipment	Sound Power Level, dB(A)	Stage
Bobcat	104	1
Concrete pump	106	3, 5
Concrete truck	106	3, 5
Coring machine	113	8, 9
Demolition saw	110	3, 5
Excavator	98	2, 4, 5, 7, 8, 9
Excavator (road header)	110	3
Franna crane	93	3, 5
Generator	93	1, 3, 5, 7, 8, 9
Hand tools	94	1, 2, 3, 4, 5, 7, 8, 9
Hydrema and /or hi-rail dumper	98	3, 5
Jack hammer	108	3, 5, 7
Lighting tower	95	3, 5
Mobile crane	104	7, 9
Bored piling rig	103	3, 5
Trucks[1]	98	1, 2, 3, 4, 5, 7, 8, 9

Note

1. Sound powers are time weighted (i.e. weighted for 'on time' during a typical 15 minute period).

It is noted that Stage 6 is likely to experience noise levels less than other stages and therefore no specific construction noise assessment has been undertaken for Stage 6.

4.3 Modelling and conditions

In order to assess noise impacts during construction, a noise model was created to represent 'reasonable' worst periods of upgrade works. The construction of the Project has been modelled in SoundPLAN Version 7.3 with the following features included in the noise model:

- ground topography (the level and shape of the surrounding land)
- ground absorption and reflection
- buildings (including shielding of noise)
- residential and non-residential receivers (as shown in Table 2 and Table 3)
- construction noise sources for the Project (as listed in Table 20).

Noise emissions from the construction sites have been modelled using an implementation of the ISO 9613 propagation algorithm with neutral metrological conditions.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures would also vary as the construction equipment moves around the site.

Construction noise levels at the identified residential and non-residential receivers have been assessed against the NMLs for standard hours, daytime, evening and night-time out-of-hours (as shown in Table 13 and Table 14). However, the level of impact may change depending on the final construction methodology which would be developed by the contractor, and further assessment would be undertaken if required.

During construction not all equipment would be operating simultaneously at all times and in the one location (as assumed in the modelling), which would result in a reduction in predicted noise levels.

Mitigation measures for receivers have been specified in Section 4.8. These measures are considered to be feasible and reasonable and would reduce the impact of these exceedances.

Noise results for construction stage 5 – platform construction are presented in Appendix E as noise contour layers over aerial maps.

4.4 Construction stages 1, 3, 7, 8 and 9

4.4.1 Noise impacts at residential receivers

Standard working hours

The predicted construction noise levels at residential receivers during standard hours are shown in Table 21.

Table 21 Predicted noise impacts at representative residential receivers – standard hours in dB(A)

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 – Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R1	26	60	55	64	73	< 30	64
R2	43	60	50	59	67	< 30	60
R3	32	60	46	55	68	< 30	57
R4	47	60	45	54	64	< 30	53
R5	74	60	40	49	58	< 30	48

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 – Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R6	46	60	35	44	64	< 30	44
R7	26	60	34	43	74	< 30	42
R8	65	60	19	28	57	< 30	28
R9	41	60	57	66	69	64	65
R10	43	60	52	61	68	58	59
R11	107	60	50	59	60	62	63
R12	61	60	50	59	65	60	61
R13	27	60	54	63	68	67	68
R14	73	60	53	62	60	51	52
R15	84	60	44	53	58	53	54
R16	44	60	52	61	66	61	62
R17	66	60	42	51	62	49	50
R18	70	60	51	60	62	63	64
R19	56	60	47	56	57	< 30	58
R20	36	60	48	57	69	< 30	67
R21	39	60	37	46	63	< 30	54
R22	51	60	48	57	60	< 30	62
R23	44	60	48	57	67	< 30	56
R24	35	60	47	56	65	< 30	55
R25	38	60	43	52	68	< 30	59
R26	41	60	44	53	64	< 30	55
R27	29	60	41	50	73	< 30	52
R28	91	51	39	48	63	< 30	43
R29	144	51	30	39	50	< 30	39
R30	31	51	37	46	70	< 30	33
R31	54	51	42	51	57	< 30	38
R32	73	60	52	61	61	< 30	63
R33	42	60	56	65	67	< 30	65
R34	37	60	43	52	69	< 30	51
R35	49	60	41	50	66	< 30	50
R36	12	60	57	66	**80**	< 30	63
R37	123	60	46	55	56	< 30	58
R38	38	60	48	57	69	< 30	60
R39	208	41	39	48	50	< 30	49
R40	171	41	44	53	52	< 30	55
R41	52	41	55	64	65	< 30	66
R42	124	41	35	44	55	< 30	50
R43	227	41	40	49	50	< 30	51
R44	492	41	49	58	65	< 30	68
R45	536	41	51	60	61	< 30	61
R46	150	41	46	55	56	< 30	55
R47	40	52	52	61	69	38	57

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 – Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R48	43	52	43	52	68	37	45
R49	170	52	32	41	41	30	38
R50	82	52	36	45	58	39	42
R51	133	52	44	53	52	48	49
R52	245	52	37	46	51	35	37
R53	290	52	41	50	50	38	39

Notes:
1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above NML.
2. Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

Results show that noise levels at 44 of the representative residential receivers are predicted to exceed NMLs during some stage of construction during standard construction hours. Exceedances of up to 20 dB are predicted, with the largest exceedances predicted during track slewing activities. Noise levels during track slewing works are due to the use of jackhammers, whereas the high noise levels during signalling works are attributed to the use of a coring machine.

The most affected receivers are scattered along the length of the Project site, and noise levels correlate with their proximity to the rail line. The worst affected representative receiver, R36 - 141A Station Street, Blackheath within NCA 1, is located around 12 metres from the rail line.

Representative receiver R36 is the only residential receiver predicted to be 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, due predominantly to the operation of jackhammers associated with track slewing works (i.e. construction stage 7). However, while this is a major noise source, the duration of operation of this equipment is likely to be short, and the resulting impacts, though high, will be short-term only as the works would be conducted during a 48 hour weekend possession period.

Outside of standard hours

The predicted construction noise levels at residential receivers outside of standard hours are shown during for the daytime, evening and night-time periods in Table 22, Table 23 and Table 24 respectively.

Table 22 Predicted noise impacts at representative residential receivers – daytime outside of standard hours in dB(A)

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 - Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R1	26	55	55	64	73	< 30	64
R2	43	55	50	59	67	< 30	60
R3	32	55	46	55	68	< 30	57
R4	47	55	45	54	64	< 30	53
R5	74	55	40	49	58	< 30	48
R6	46	55	35	44	64	< 30	44
R7	26	55	34	43	74	< 30	42
R8	65	55	19	28	57	< 30	28
R9	41	55	57	66	69	64	65

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 - Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R10	43	55	52	61	68	58	59
R11	107	55	50	59	60	62	63
R12	61	55	50	59	65	60	61
R13	27	55	54	63	68	67	68
R14	73	55	53	62	60	51	52
R15	84	55	44	53	58	53	54
R16	44	55	52	61	66	61	62
R17	66	55	42	51	62	49	50
R18	70	55	51	60	62	63	64
R19	56	55	47	56	57	< 30	58
R20	36	55	48	57	69	< 30	67
R21	39	55	37	46	63	< 30	54
R22	51	55	48	57	60	< 30	62
R23	44	55	48	57	67	< 30	56
R24	35	55	47	56	65	< 30	55
R25	38	55	43	52	68	< 30	59
R26	41	55	44	53	64	< 30	55
R27	29	55	41	50	73	< 30	52
R28	91	46	39	48	63	< 30	43
R29	144	46	30	39	50	< 30	39
R30	31	46	37	46	70	< 30	33
R31	54	46	42	51	57	< 30	38
R32	73	55	52	61	61	< 30	63
R33	42	55	56	65	67	< 30	65
R34	37	55	43	52	69	< 30	51
R35	49	55	41	50	66	< 30	50
R36	12	55	57	66	**80**	< 30	63
R37	123	55	46	55	56	< 30	58
R38	38	55	48	57	69	< 30	60
R39	208	36	39	48	50	< 30	49
R40	171	36	44	53	52	< 30	55
R41	52	36	55	64	65	< 30	66
R42	124	36	35	44	55	< 30	50
R43	227	36	40	49	50	< 30	51
R44	492	36	49	58	65	< 30	68
R45	536	36	51	60	61	< 30	61
R46	150	36	46	55	56	< 30	55
R47	40	47	52	61	69	38	57
R48	43	47	43	52	68	37	45
R49	170	47	32	41	41	30	38
R50	82	47	36	45	58	39	42
R51	133	47	44	53	52	48	49
R52	245	47	37	46	51	35	37

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	1 - Site establish.	3 - Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R53	290	47	41	50	50	38	39

Notes:
1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above NML
2. Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher

Table 23 Predicted noise impacts at representative residential receivers – evening outside of standard hours in dB(A)

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R1	26	53	73	< 30	64
R2	43	53	67	< 30	60
R3	32	53	68	< 30	57
R4	47	53	64	< 30	53
R5	74	53	58	< 30	48
R6	46	53	64	< 30	44
R7	26	53	74	< 30	42
R8	65	53	57	< 30	28
R9	41	53	69	64	65
R10	43	53	68	58	59
R11	107	53	60	62	63
R12	61	53	65	60	61
R13	27	53	68	67	68
R14	73	53	60	51	52
R15	84	53	58	53	54
R16	44	53	66	61	62
R17	66	53	62	49	50
R18	70	53	62	63	64
R19	56	53	57	< 30	58
R20	36	53	69	< 30	67
R21	39	53	63	< 30	54
R22	51	53	60	< 30	62
R23	44	53	67	< 30	56
R24	35	53	65	< 30	55
R25	38	53	68	< 30	59
R26	41	53	64	< 30	55
R27	29	53	73	< 30	52
R28	91	44	63	< 30	43
R29	144	44	50	< 30	39
R30	31	44	70	< 30	33
R31	54	44	57	< 30	38
R32	73	53	61	< 30	63
R33	42	53	67	< 30	65

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R34	37	53	69	< 30	51
R35	49	53	66	< 30	50
R36	12	53	**80**	< 30	63
R37	123	53	56	< 30	58
R38	38	53	69	< 30	60
R39	208	35	50	< 30	49
R40	171	35	52	< 30	55
R41	52	35	65	< 30	66
R42	124	35	55	< 30	50
R43	227	35	50	< 30	51
R44	492	35	65	< 30	68
R45	536	35	61	< 30	61
R46	150	35	56	< 30	55
R47	40	45	69	38	57
R48	43	45	68	37	45
R49	170	45	41	30	38
R50	82	45	58	39	42
R51	133	45	52	48	49
R52	245	45	51	35	37
R53	290	45	50	38	39

Notes:
1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above NML.
2. Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

Table 24 Predicted noise impacts at representative residential receivers – night-time outside of standard hours in dB(A)

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R1	26	35	73	< 30	64
R2	43	35	67	< 30	60
R3	32	35	68	< 30	57
R4	47	35	64	< 30	53
R5	74	35	58	< 30	48
R6	46	35	64	< 30	44
R7	26	35	74	< 30	42
R8	65	35	57	< 30	28
R9	41	35	69	64	65
R10	43	35	68	58	59
R11	107	35	60	62	63
R12	61	35	65	60	61
R13	27	35	68	67	68

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R14	73	35	60	51	52
R15	84	35	58	53	54
R16	44	35	66	61	62
R17	66	35	62	49	50
R18	70	35	62	63	64
R19	56	35	57	< 30	58
R20	36	35	69	< 30	67
R21	39	35	63	< 30	54
R22	51	35	60	< 30	62
R23	44	35	67	< 30	56
R24	35	35	65	< 30	55
R25	38	35	68	< 30	59
R26	41	35	64	< 30	55
R27	29	35	73	< 30	52
R28	91	36	63	< 30	43
R29	144	36	50	< 30	39
R30	31	36	70	< 30	33
R31	54	36	57	< 30	38
R32	73	35	61	< 30	63
R33	42	35	67	< 30	65
R34	37	35	69	< 30	51
R35	49	35	66	< 30	50
R36	12	35	**80**	< 30	63
R37	123	35	56	< 30	58
R38	38	35	69	< 30	60
R39	208	35	50	< 30	49
R40	171	35	52	< 30	55
R41	52	35	65	< 30	66
R42	124	35	55	< 30	50
R43	227	35	50	< 30	51
R44	492	35	65	< 30	68
R45	536	35	61	< 30	61
R46	150	35	56	< 30	55
R47	40	35	69	38	57
R48	43	35	68	37	45
R49	170	35	41	30	38
R50	82	35	58	39	42

Receiver ID	Nearest distance to rail alignment (metres)	NML, dB(A)	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R51	133	35	52	48	49
R52	245	35	51	35	37
R53	290	35	50	38	39

Notes:
1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above NML.
2. Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

Results show that noise levels at all but one representative receiver are predicted to exceed NMLs during some stage of construction during the daytime and evening outside of standard construction hours. Noise levels at all representative receivers are predicted to exceed NMLs during the night-time periods.

Exceedances of up to 25 dB, 27 dB and 45 dB are predicted during the day, evening and night-time respectively, with the largest exceedances predicted during track slewing activities.

One receiver, R36, is predicted to be 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, due to the track slewing activities, similarly to during standard construction hours. As noted previously, the jackhammer is anticipated to operate for short periods of time, so periods of high noise impacts are expected to be short-term only.

The most affected receivers are scattered along the length of the Project, and generally lie within a close proximity to the rail line. The worst affected representative receiver, R36 - 141A Station Street, Blackheath within NCA 1, is located around 12 metres from the rail line.

4.4.2 Noise impacts at non-residential receivers

Construction noise levels at representative non-residential receivers are shown in Table 25. It should be noted that NMLs for non-residential receivers apply whenever the premises are in use; therefore no separate assessment for daytime, evening and night-time periods is required.

Table 25 Predicted noise impacts at representative non-residential receivers in dB(A)

Receiver ID	Use	Nearest distance to rail alignment (metres)	NML	1 - Site establish	3 – Platform coping mods	7 - Track slewing	8 - Signalling	9 - Overhead wiring
N1	School	44	55	44	53	67	< 30	53
N2	Commercial	66	70	42	51	63	51	52
N3	Commercial	26	70	57	66	70	70	71
N4	Commercial	35	70	47	56	65	54	55
N5	Active Recreation	18	65	54	63	77	68	69
N6	Commercial	38	70	53	62	68	67	68
N7	Library	80	55	47	56	59	59	60
N8	Place of Worship	117	55	45	54	55	56	57
N9	Active Recreation	16	65	55	64	77	62	63
N10	School / Childcare	76	55	44	53	60	53	54
N11	Commercial	55	70	49	58	59	< 30	58
N12	Commercial	46	70	52	61	66	< 30	66
N13	Commercial	59	70	50	59	63	< 30	58
N14	Commercial	34	70	62	71	68	< 30	68
N15	Commercial	61	70	50	59	63	< 30	63
N16	Commercial	29	70	58	67	73	< 30	51
N17	Commercial	34	70	59	68	71	< 30	58
N18	Commercial	33	70	55	64	71	< 30	65
N19	Library	46	55	54	63	66	< 30	67
N20	Commercial	35	70	50	59	68	< 30	63
N21	Place of Worship	43	55	62	71	71	48	57
N22	Commercial	20	70	48	57	76	33	57
N23	Commercial	52	70	55	64	65	58	58
N24	Commercial	115	70	50	59	61	48	49

Notes:

1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above NML.

During track slewing works, noise levels at receiver N21 (Lithgow Anglican Church, 2 Roy St, Lithgow) are predicted to exceed NMLs by 16 dB. This is on the basis that all identified construction activities, except for signalling works and overhead wiring services, will occur along the nearest location on the rail corridor which is likely to be a conservative estimate, as the actual activities may not include all items of equipment assumed in the calculations. The noisiest equipment during the track slewing works is the jackhammer. While this is a major noise source, the duration of operation of this equipment is likely to be short, and the resulting

impacts, though high, will be short-term only as they would be undertaken during the possession periods.

Predicted noise levels at school receivers, N1 (Children's House Montessori, 585 Great Western Hwy, Faulconbridge) and N10 (Mid Mountains Neighbourhood Centre, 2 Lowden Lane, Lawson) are predicted to exceed NMLs during track slewing works, with exceedances of up to 12 dB predicted.

Recommended mitigation measures are presented in Section 4.8.

4.4.3 Sleep disturbance assessment

As there are several construction stages which are proposed to incorporate out-of-hours works, consideration must also be given to the potential for sleep disturbance to residential receivers during night-time works. The results for predicted noise impacts for sleep disturbance are shown in Table 26.

Sleep disturbance results are based on the predicted night time $L_{A1(1\ minute)}$ dB(A) noise levels for construction equipment, assumed to be 8 dB higher than L_{eq} noise levels.

Table 26 Predicted $L_{A1(1min)}$ noise impacts at representative residential receivers – sleep disturbance – Night-time in dB(A)

Receiver ID	Nearest distance to rail alignment (metres)	Sleep disturbance screening level	Sleep awakening level	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R1	26	45	65	**81**	< 30	**72**
R2	43	45	65	**75**	< 30	**68**
R3	32	45	65	**76**	< 30	**65**
R4	47	45	65	**72**	< 30	61
R5	74	45	65	**66**	< 30	56
R6	46	45	65	**72**	< 30	52
R7	26	45	65	**82**	< 30	50
R8	65	45	65	**65**	< 30	36
R9	41	45	65	**77**	**72**	**73**
R10	43	45	65	**76**	**66**	**67**
R11	107	45	65	**68**	**70**	**71**
R12	61	45	65	**73**	**68**	**69**
R13	27	45	65	**76**	**75**	**76**
R14	73	45	65	**68**	59	60
R15	84	45	65	**66**	61	62
R16	44	45	65	**74**	**69**	**70**
R17	66	45	65	**70**	57	58
R18	70	45	65	**70**	**71**	**72**
R19	56	45	65	**65**	< 30	**66**
R20	36	45	65	**77**	< 30	**75**
R21	39	45	65	**71**	< 30	62
R22	51	45	65	**68**	< 30	**70**
R23	44	45	65	**75**	< 30	64
R24	35	45	65	**73**	< 30	63
R25	38	45	65	**76**	< 30	**67**
R26	41	45	65	**72**	< 30	63

Receiver ID	Nearest distance to rail alignment (metres)	Sleep disturbance screening level	Sleep awakening level	7 - Track slewing	8 - Signalling	9 - Overhead wiring
R27	29	45	65	**81**	< 30	60
R28	91	46	65	**71**	< 30	51
R29	144	46	65	58	< 30	47
R30	31	46	65	**78**	< 30	41
R31	54	46	65	65	< 30	46
R32	73	45	65	**69**	< 30	**71**
R33	42	45	65	**75**	< 30	**73**
R34	37	45	65	**77**	< 30	59
R35	49	45	65	**74**	< 30	58
R36	12	45	65	**88**	< 30	**71**
R37	123	45	65	64	< 30	**66**
R38	38	45	65	**77**	< 30	**68**
R39	208	45	65	58	< 30	57
R40	171	45	65	60	< 30	63
R41	52	45	65	**73**	< 30	**74**
R42	124	45	65	63	< 30	58
R43	227	45	65	58	< 30	59
R44	492	45	65	**73**	< 30	**76**
R45	536	45	65	**69**	< 30	**69**
R46	150	45	65	64	< 30	63
R47	40	45	65	**77**	46	65
R48	43	45	65	**76**	45	53
R49	170	45	65	49	38	46
R50	82	45	65	**66**	47	50
R51	133	45	65	60	56	57
R52	245	45	65	59	43	45
R53	290	45	65	58	46	47

Notes:
1. Items shaded in GREY indicate predicted noise impact at this receiver during this work stage is above sleep disturbance screening level.
2. Items in **BOLD RED** indicate predicted noise impact at this receiver during this work stage is above sleep awakening level.

Results in Table 26 show the majority of representative receivers are predicted to exceed both sleep disturbance screening criteria and sleep awakening criteria during two of the three stages of night-time works. Significant exceedances of sleep awakening criteria are predicted, with highest predicted impacts of 88 dB(A) predicted at receiver R36, representing an exceedance of 23 dB above awakening criteria.

Night-time works are anticipated to take place during up to ten 48 hour possessions, which will be spread over a two year period. This will provide respite periods between track possessions, with the longest period of consecutive night-works being limited to two nights.

4.5 Construction stage 5 – Platform extension works

Platform extension works are planned at Katoomba Station and Lithgow Station. A more comprehensive assessment of the stage 5 platform extension works at these stations has therefore been conducted in order to assess construction noise impacts in more detail. A total of 404 receivers, including both residential and non-residential receivers, were modelled around Katoomba Station and 586 receivers were modelled around Lithgow Station.

A summary of modelling results at both stations is presented in Table 27 and

Table 28. Noise contour maps for construction stage 5 works at both stations are presented in Appendix E, with exceedances presented on building maps presented in Appendix F.

Table 27 Predicted noise impacts during construction stage 5 at Katoomba and Lithgow Stations – residential receivers

Station	Total number of modelled receivers	Number of receivers exceeding				Highly affected, >75 dB(A)
		Standard hours		Daytime outside standard of hours		
		NML	NML+10	NML	NML+10	
Residential						
Katoomba Station	342	17	0	80	1	0
Lithgow Station	444	57	12	116	24	1

Table 28 Predicted noise impacts during construction stage 5 at Katoomba Station and Lithgow Station – non-residential receivers

Station	Total number of modelled receivers	Number of receivers exceeding	
		Standard hours	
		NML	NML+10
Non-residential			
Katoomba Station	62	1 - Commercial	0
Lithgow Station	142	6 - Commercial	1 - Commercial

Results show that during standard construction hours, noise levels at up to 17 residential receivers are predicted to exceed NMLs at Katoomba Station and 57 receivers at Lithgow Station. Noise levels are not expected to exceed NMLs by more than 10 dB at any residential receivers around Katoomba Station. Noise levels at 12 residential receivers are predicted to exceed the NML by more than 10 dB at Lithgow Station.

Outside of standard construction hours, noise levels at up to 80 residential receivers are predicted to exceed NMLs at Katoomba Station and 116 at Lithgow Station. Noise levels at only one is predicted to exceed by more than 10 dB at Katoomba Station, and 24 at Lithgow Station.

During stage 5 works at both stations, up to six commercial receivers are predicted to exceed NMLs at any time, with noise levels at one receiver predicted to exceed NMLs by more than 10 dB. All other non-residential receivers are predicted to comply with NMLs. It should be noted, the ‘highly affected’ descriptor does not apply to non-residential receivers.

The most affected receivers are located adjacent to the stations. During works at Katoomba Station, receivers to the north of the works are predicted to be most affected due largely to ground topography and shielding from surrounding buildings. At Lithgow Station, receivers along Railway Parade and Main Street are predicted to be the most affected.

Noise levels during the stage 5 platform extension works are controlled generally by demolition equipment, i.e. demolition saw and jackhammers. These are expected to operate sporadically and for short periods of time throughout the 48 hour possession period with only up to five possessions over the 10 months assumed to complete the works at both Katoomba and Lithgow stations, therefore predicted noise levels are only expected to occur for short durations.

It should also be noted that predicted noise levels assume all plant is operating simultaneously, which provides a conservative assessment. Noise levels experienced by the community are likely to be lower than those predicted for significant periods of time.

4.6 Construction traffic assessment

Construction traffic volumes are anticipated to be up to 10 heavy vehicles supplying plant and equipment at the beginning and end of each possession and closedown, plus a number of light / medium vehicle movements to service personnel and small equipment / material requirements.

During the platform works, less than five medium / heavy vehicle movements are anticipated per site per possession, with a small number of light vehicle movements to access both during possessions and during normal hours.

In order for construction traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along construction traffic routes would need to increase by around 60 per cent.

On-site observations noted that the existing traffic flow was substantially greater than the proposed construction traffic numbers. Based on a Traffic and Transport Impact Assessment prepared by AECOM (AECOM, 2017), additional construction traffic movements would be less than 10 per cent of the existing total daily movements. Therefore, the construction vehicles would have a negligible impact on existing road traffic noise in the area. As a result of the low volume of traffic generated by the construction works, the Project is considered to comply with the *Road Noise Policy* criteria.

4.7 Construction vibration assessment

Vibration-intensive works may include the use of the following items of equipment:

- bored piling
- jackhammer
- rail tamping.

The safe working distances of these items of equipment from off-site receivers are shown in Table 29 which is based on recommendations of the TfNSW *Construction Noise Strategy* (CNS) and AECOM's previous project experience. If these safe working distances are complied with no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

Based on the indicative construction activities assessed for the Project, it is unlikely that works would occur within the safe working distances for offsite receivers. If vibration-intensive works are required within these safe working distances, mitigation measures to control excessive vibration would be implemented as outlined in Section 4.8.

The following stations contain heritage structures and have modification works scheduled:

- Faulconbridge
- Linden
- Woodford
- Hazelbrook
- Lawson
- Bullaburra
- Wentworth Falls
- Leura
- Katoomba
- Medlow Bath
- Blackheath
- Bell
- Newnes Junction
- Eskbank
- Lithgow.

It is likely that works will be undertaken within the safe working distances to the station buildings, structures and platforms. The safe working distances for cosmetic damage are generally considered to be conservative and working within them would not necessarily result in damage. However as factors such as work practices and intervening structures can affect vibration levels, vibration monitoring is recommended within these distances and should be undertaken at the beginning of vibration intensive works in order to refine the safe working distances for site specific conditions.

The station buildings, structures and platforms should be demarcated as constraint areas during construction to avoid potential impacts from vibration. For vibration-generating activities adjacent to vibration sensitive station buildings, structures and platforms, it is recommended that attended measurements are undertaken when work commences, to determine site specific safe working distances.

Table 29 Safe working distances of vibration intensive equipment to be used during the Project

Plant	Rating/ Description	Cosmetic damage – residential/commercial	Cosmetic damage - heritage	Human response
Bored piling	≤ 800 mm	2 m (nominal)	2 m (nominal)	2 m (nominal)
Jack hammer	Hand held	1 m (nominal)	1 m (nominal)	Avoid contact with structure
Rail tamping	-	5 m (nominal)	5 m (nominal)	5 m (nominal)

There are no residential receivers for which the cosmetic damage or human response safe working distances are encroached by proposed construction activities for the Project. Although some works may be undertaken during standard hours when the stations are open to the public, those affected by intermittent construction vibrations would be in transit and only subject to vibration effects temporarily. No significant issues to the public are considered likely as a result.

The Project would be undertaken in the close vicinity of the heritage-listed station buildings, structures and platforms, particularly at Katoomba and Lithgow where the platforms are being extended. Works may potentially be required within the safe working distances and human response thresholds of these structures. The station buildings, structures and platforms may also be at risk from indirect impacts during construction, and would be demarcated as a constraint area during construction to avoid potential impacts from vibration. For vibration-generating activities adjacent to the station buildings, structures and platforms, it is recommended that attended vibration measurements are undertaken as required when work commences, to determine site specific safe working distances.

It is also noted that piling is proposed within construction stages 3 and 5. However, as this is proposed to be bored piling (rather than impact piling), vibration generated by this process is very low, and is not expected to cause cosmetic damage or human response issues for any

receiver location other than potentially the station building itself. As identified above, it is recommended that attended vibration measurements are undertaken when piling commences, to determine site-specific safe working distances. Piling work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed.

4.8 Construction mitigation measures

4.8.1 Construction Noise and Vibration Management Plan

It has been identified that potential construction noise impacts at residences within the vicinity of the Project may exceed the 75 dB(A) highly affected construction noise threshold. A Construction Noise and Vibration Management Plan (CNVMP) would be developed and implemented prior to commencement of construction activities. The CNVMP would include all reasonable and feasible safeguards to manage the noise emissions from the site and manage any complaints which may occur due to construction noise. The CNVMP should include, as a minimum, the following:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work
- description and identification of all construction activities, including work areas, equipment and duration
- description of work practices (generic and specific) which would be applied to minimise noise and vibration
- a complaints handling process
- noise and vibration monitoring procedures
- overview of community consultation required for identified high impact works.

Construction works should be planned and carried out during standard construction hours wherever possible. For works which are required to be undertaken out of hours (during possessions) due to the need to retain the operational status of the station, the use of those items of equipment or processes which have been identified in Section 4.4 as generating the highest noise levels should be minimised as far as is possible, and confined to the earlier portions of the evening and night-time periods as far as is practical to minimise the risk of sleep disturbance throughout the night.

Table 30 presents the standard mitigation measures contained within the *Construction Noise Strategy* (CNS) which should be considered as mitigation measures as part of the CNVMP.

Table 30 TfNSW's *Construction Noise Strategy* standard mitigation measures

Action required	Safeguard details
Management measures	
Implement any project specific mitigation measures required	In addition to the measures set out in this table, any project specific mitigation measures identified in this report.
Implement community consultation measures	Periodic notification (monthly letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.

Action required	Safeguard details
Noise monitoring	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	High noise and vibration generating activities may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block.
Equipment selection	Use quieter and less vibration emitting construction methods where feasible and reasonable.
Maximum noise levels	The noise levels of plant and equipment must have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions should be considered as part of the selection process.
Use and siting of plant	Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Plant and vehicles to be turned off when not in use. Noise-emitting plant to be directed away from sensitive receivers.
Plan works site and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as “City” Model Rammer Hammers Air Parking brake engagement is silenced
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

In addition to the standard mitigation measures identified in the CNS, the following specific mitigation measures have been developed as a result of the predicted impacts associated with the Project:

- Noisy work should be scheduled to be undertaken during the standard construction hours where possible. However, noisy activities that cannot be undertaken during standard construction hours should be scheduled as early as possible during the evening and / or night-time periods. Where out-of-hours works is required, an out-of-hours works application form must be submitted to TfNSW for approval on a case-by-case basis.
- Respite periods should be considered to mitigate construction noise impacts to any identified highly affected.
- Alternative works methods, such as use of hydraulic or electric-controlled units in place of diesel units, and/or the use of alternative plant which performs the same function (e.g. rubber wheeled instead of steel tracked plant) should be considered and implemented where feasible and reasonable.
- Equipment should be regularly inspected and maintained to ensure it is in good working order.
- Truck drivers should be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (e.g. minimising the use of engine brakes, and no extended periods of engine idling). Construction sites should be arranged to limit the need for reversing associated with regular / repeatable movements (e.g. trucks transporting spoil) to minimise the use of reversing alarms. Where feasible and reasonable, non-tonal reversing alarms should be used, taking into account the requirements of the Workplace Health and Safety legislation.
- The noise monitoring program should be implemented to assist in confirming and controlling the site-specific potential for disturbance at particularly sensitive localities at the commencement of activities and periodically during the construction program as the works progress. The results should be reviewed to determine if additional mitigation measures are required. All measurements should be undertaken in accordance with Australian Standard *1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures.*
- For vibration-intensive work scheduled to occur near a heritage buildings, structures or platform , within the safe working distance for human response but outside the safe working distance for cosmetic damage, it is considered that the additional measures highlighted in Section 4.8.3 would be sufficient to mitigate the vibration impact at nearby receivers. Therefore vibration monitoring would not be required at these properties.

For vibration-intensive activities which occur within the safe working distance for cosmetic damage for heritage station buildings, structures or platforms, as presented in Table 29, management methods to mitigate these impacts should include, as a minimum, the following:

- The use of less vibration-intensive methods of construction or equipment is preferred where possible to reduce annoyance and potential for cosmetic damage. All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts.
- It is recommended that attended vibration measurements are undertaken when work commences, to determine site-specific safe working distances. Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed around one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are

approaching the peak particle velocity objective. It is also advisable to carry out condition surveys of sensitive heritage structures before construction works begins.

4.8.2 Community consultation and complaints handling

All residents and sensitive receivers impacted by noise and vibration from the proposed works which are expected to exceed the NML should be consulted about the Project prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents / building occupants should include:

- programmed times and locations of construction work
- the hours of proposed works
- construction noise and vibration impact predictions
- construction noise and vibration mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration should be detailed in a Community and Stakeholder Engagement Plan for the construction of the Project and should include a 24 hour hotline and complaints management process.

4.8.3 TfNSW's *Construction Noise Strategy* - Additional mitigation measures

Where exceedances in airborne noise are still expected to occur after standard mitigation measures have been applied, the CNS recommends the implementation of additional mitigation measures. These mitigation measures are specified within TfNSW's CNS and presented in Table 31.

The provision of additional mitigation is based on the predicted exceedances above RBLs and when the exceedances occur. The RBLs can be found in Table 13.

The following abbreviations have been used (refer to Table 32 for further details):

- AA: Alternative accommodation
- M: Monitoring
- IB: Individual briefings
- LB: Letter box drops
- RO: Project specific respite offer
- PC: Phone calls
- SN: Specific notifications.

Table 31 Additional mitigation measures matrix for airborne construction noise

		Mitigation measures			
		$L_{Aeq(15minute)}$ noise level above the background			
		Qualitative assessment of noise levels[1]			
	Time period	0 to 10 dBA Noticeable	10 to 20 dBA Clearly audible	20 to 30 dBA Moderately intrusive	>30 dBA Highly intrusive
Standard	Mon-Fri (7am-6pm) Sat (8am-1pm) Sun/Pub Hol (Nil)	-	-	LB, M	LB, M
OOHW[3] Period 1	Mon-Fri (6pm-10pm) Sat (7-8am) & (1pm-10pm) Sun/Pub Hol (8am-6pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN, RO[2]
OOHW[3] Period 2	Mon-Fri (10pm-7am) Sat (10pm-8am) Sun/Pub Hol (6pm-7am)	LB	M, LB, RO[2]	M, IB, LB PC, SN, RO[2]	AA, M, IB, LB, PC, SN, RO

Notes:

1. For some types of construction activities, a qualitative assessment of the potential noise impacts can be undertaken in lieu of detailed noise modelling. For these activities, noise mitigation measures should be evaluated on the basis of the noise levels being noticeable, clearly audible, moderately intrusive or highly intrusive. The qualitative assessment should consider the type of equipment being used, the character of the noise emissions, time of day, the location of the nearest receivers and the noise sensitivity of the nearest receivers. Where a qualitative assessment is being undertaken, this will need to be approved by the Environmental Management Representative.
2. Respite Offers identified in Period 2 for clearly audible (10 to 20dBA) and moderately intrusive (20 to 30dBA) work shall only apply if works are expected to continue for more than 3 consecutive evenings for Period 1 or more than 2 consecutive nights for Period 2.
3. OOH – Outside of standard hours.

Table 32 outlines the additional mitigation measures, as outlined in the CNS.

Table 32 Description of additional mitigation measures

Abbreviation	Mitigation measure	Explanation
LB	Letter Box Drops	All residences should be notified as a minimum by letterbox drop seven days ahead of construction activities.
M	Monitoring	Attended noise monitoring is to be undertaken as follows: At the commencement of out-of-hours works (within the first two nights), where out-of-hours works activities change; and Noise measurements shall be undertaken in accordance with the procedure documented in AS1055.1-1997 Acoustics - Description and Measurement of Environmental Noise - General Procedures.
IB	Individual Briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that would be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
RO	Project Specific Respite Offer	Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis.
PC	Phone Calls	Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific Notifications	Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise management levels. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
AA	Alternative Accommodation	Alternative accommodation options should be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level.

5 Operational noise assessment

Environmental noise emissions from the operation of the modified stations are not expected to change significantly as a result of the Project, as such an assessment under the *Industrial Noise Policy* is not required.

The New Intercity Fleet is expected to be quieter than the existing intercity trains, in particular wheel squeal and engine noise is likely to be lower. Slewing will only modify the horizontal rail alignment by a maximum of 25 centimetres, therefore operational noise from rail movements is expected to remain the same or be reduced from the current situation. Therefore an assessment under the *Rail Infrastructure Noise Guideline* is not required.

Appendix A Acoustic terminology

The following is a brief description of acoustic terminology used in this report.

Terminology	***Description***
Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: 0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period

Terminology	*Description*
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10 per cent of the measurement period. For 10 per cent of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90 per cent of the measurement period. For 90 per cent of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Industrial Noise Policy and Road Noise Policy.

Appendix B Graphical noise logging results

Linden - 31/03/17 - 11/04/17

Logger Setup

Logger Type: 957

Serial No : 23855

Address: 778 Great Western Highway , Linden

Location: On rock plateau on private property

Facade / Free Field: Free Field

Environment: Bushland next to great western highway. Wind in trees and birds chirping contributing to environment slightly. Traffic noise clearly audible and dominant with engine brakes once every 5 mins or so.

Logger Setup Photo

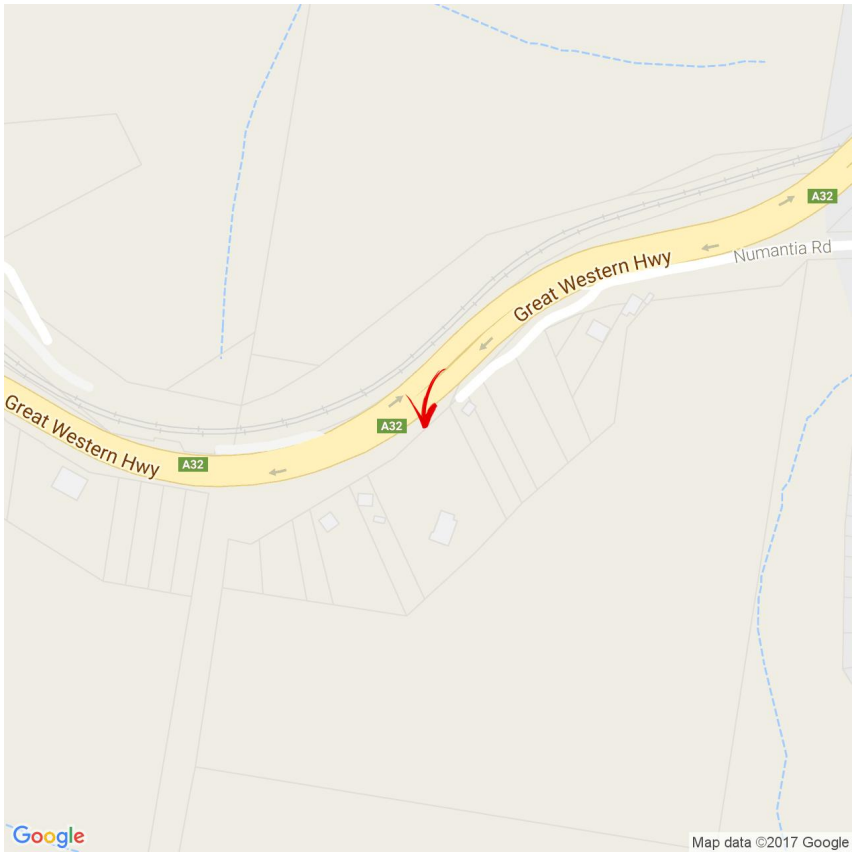
INP Noise Level, dB(A)

	Log Average	RBL
Day	61	52
Evening	60	49
Night	56	31

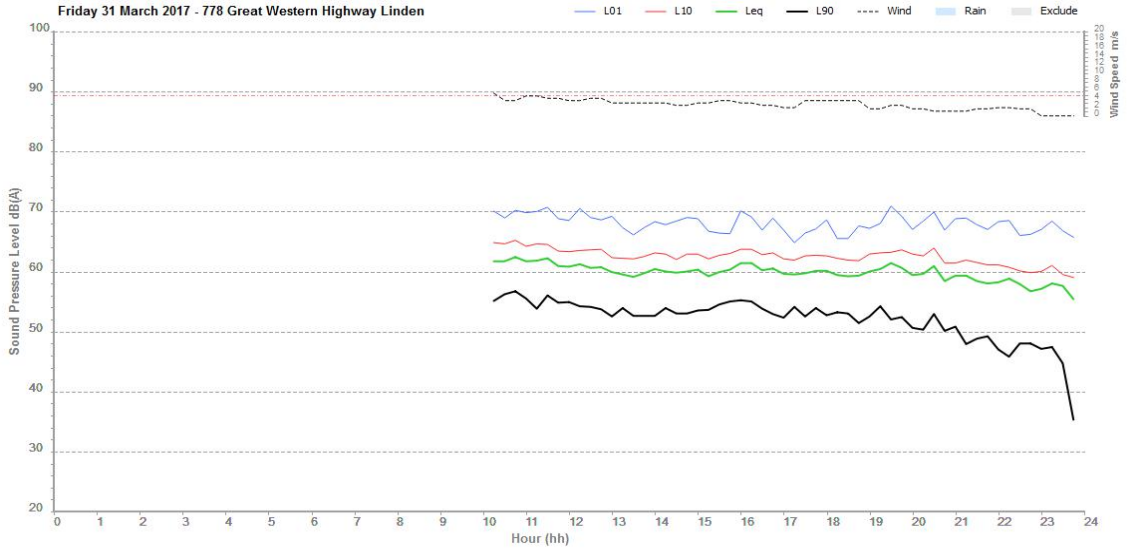
RNP Noise Level, dB(A)

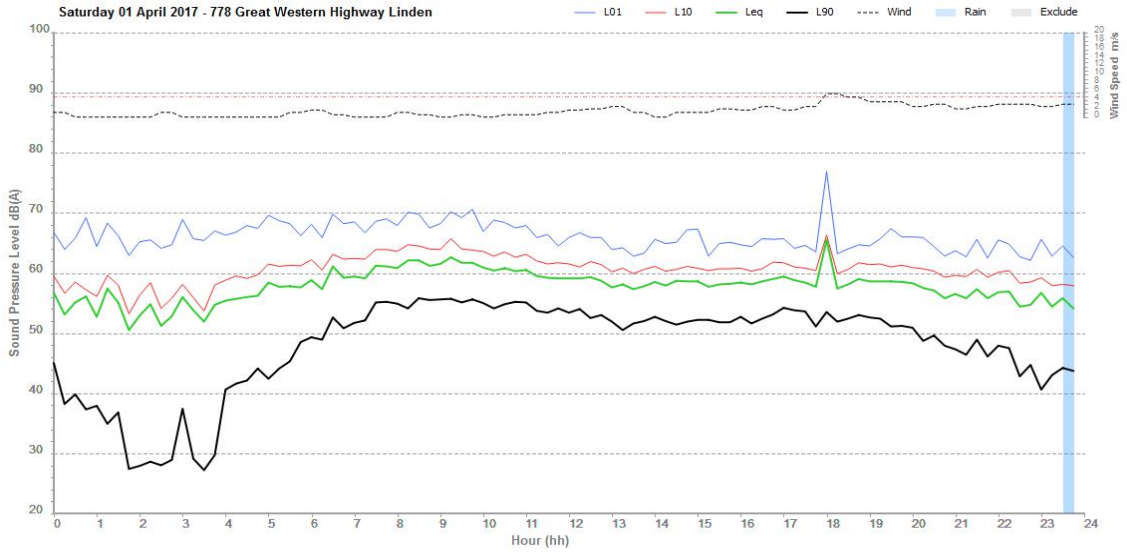
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

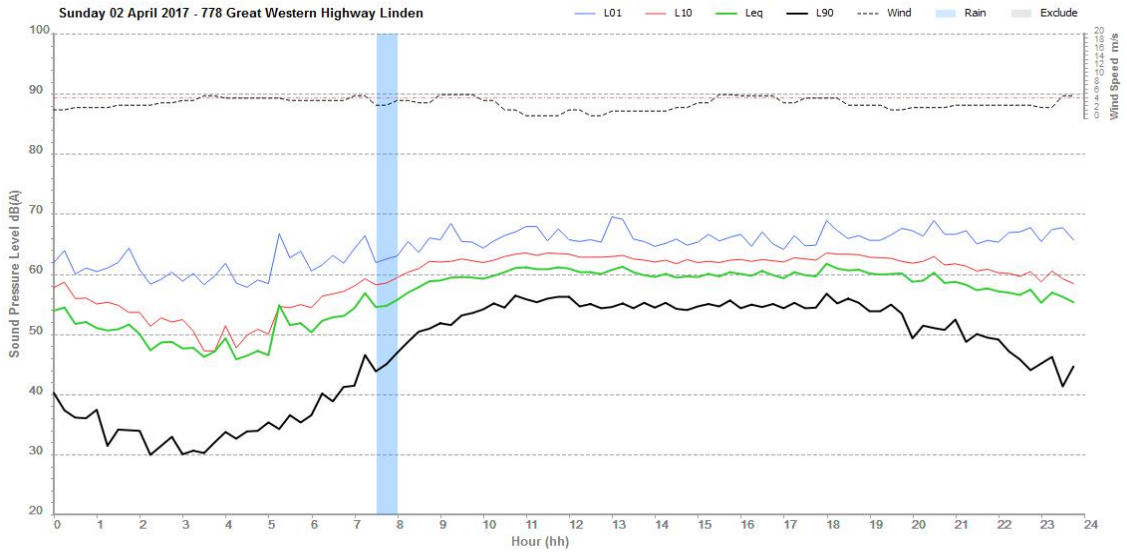
Logger Location Map



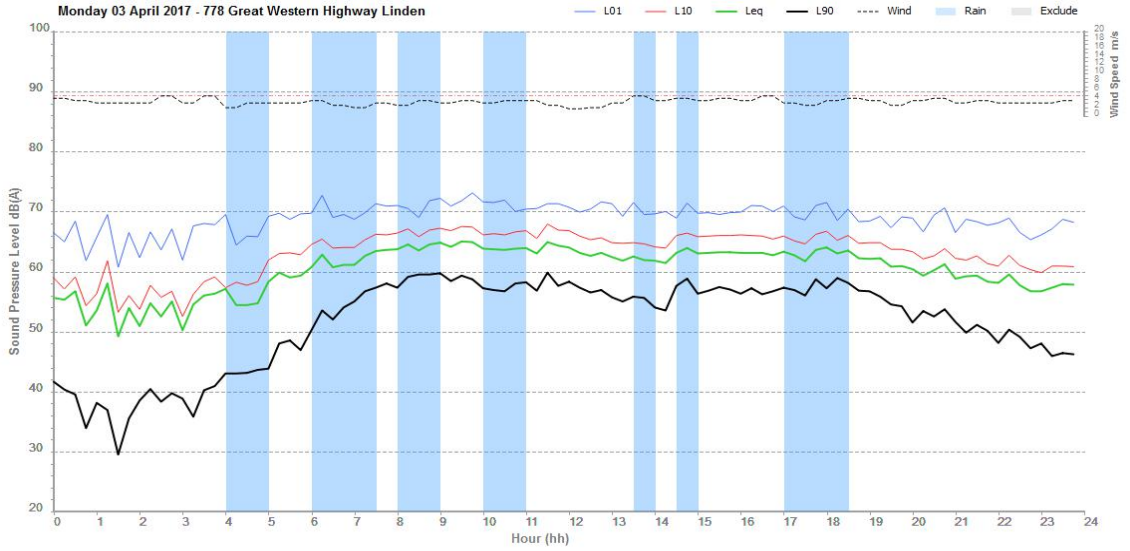
Logger Graphs

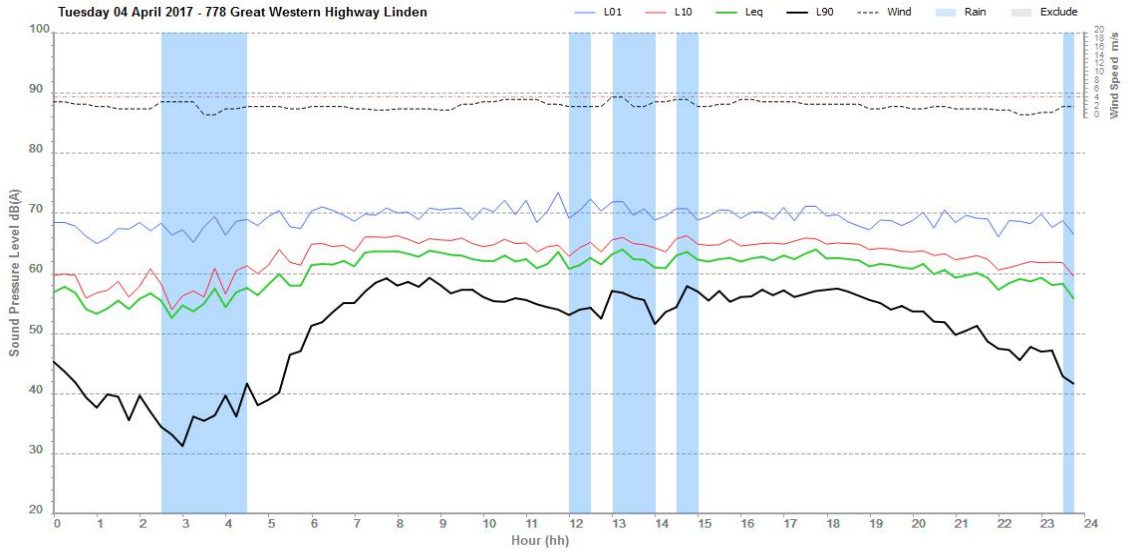


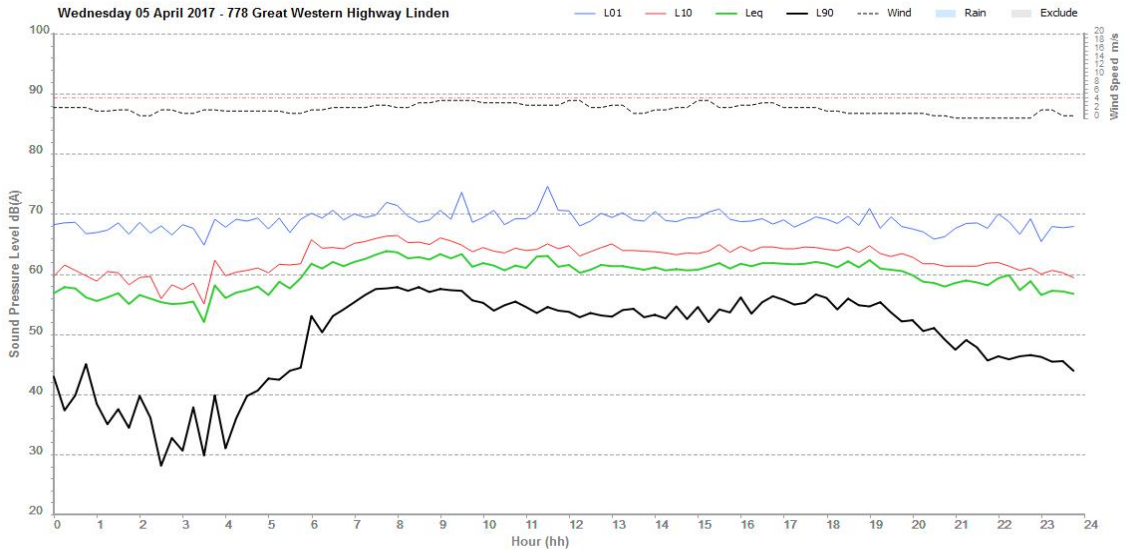




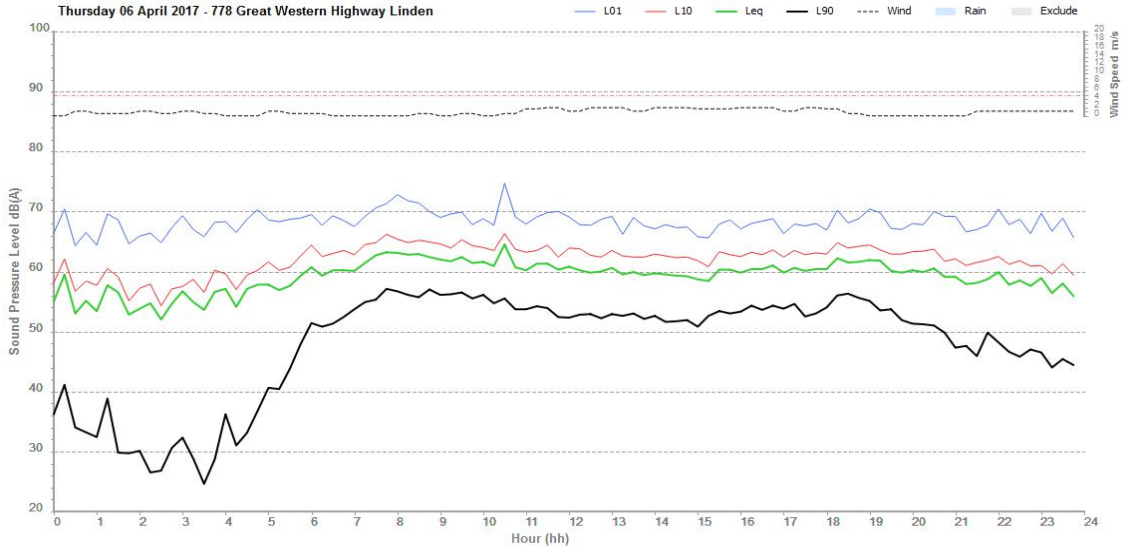
Logger Graphs

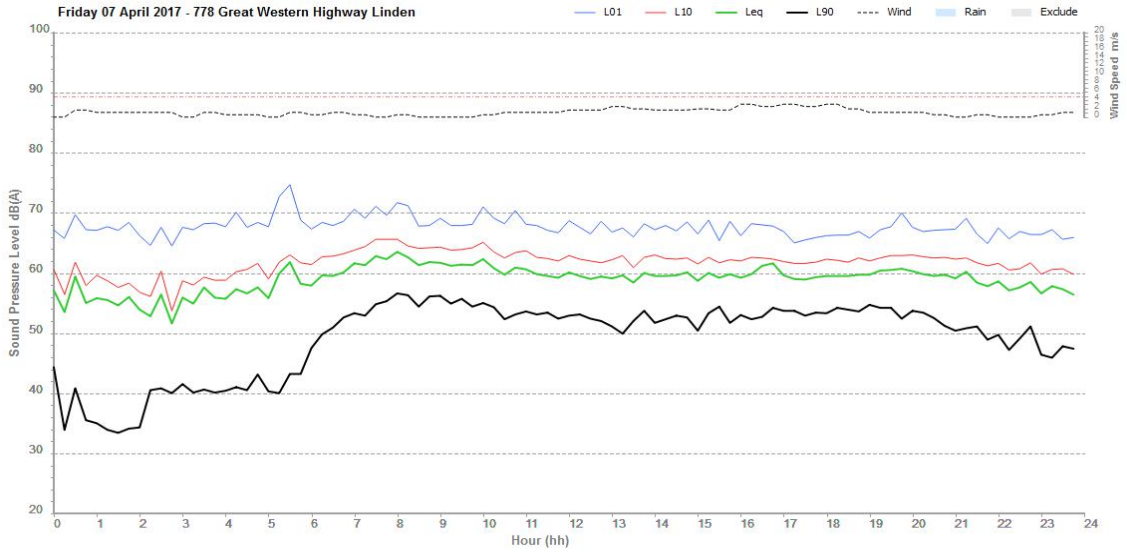


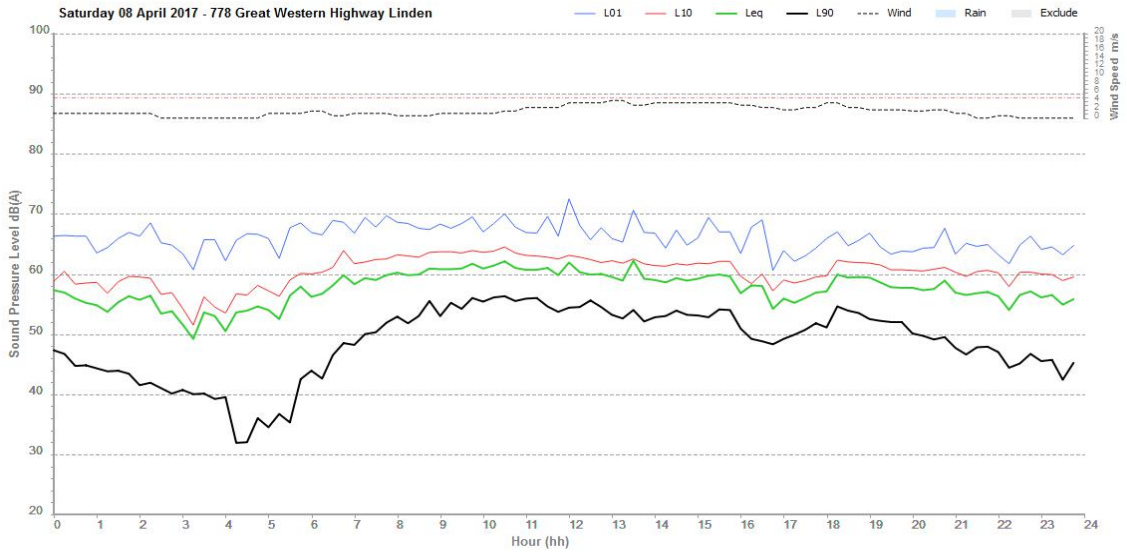




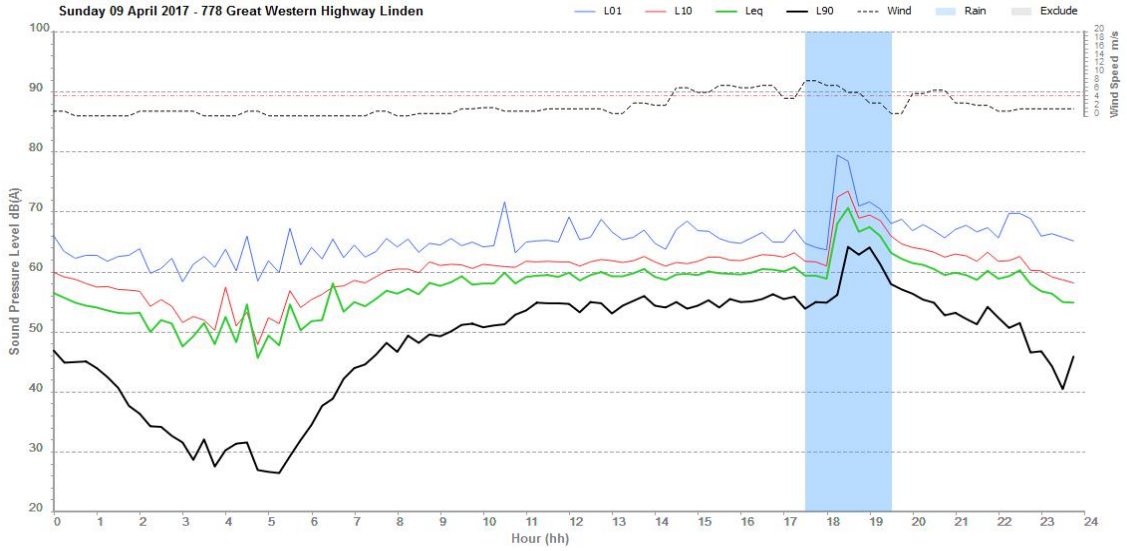
Logger Graphs

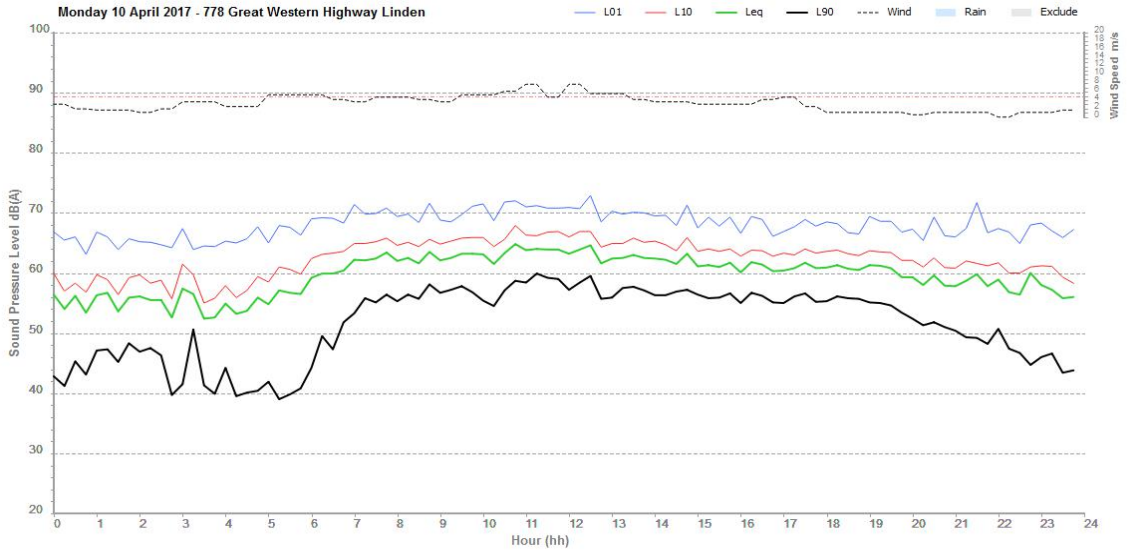


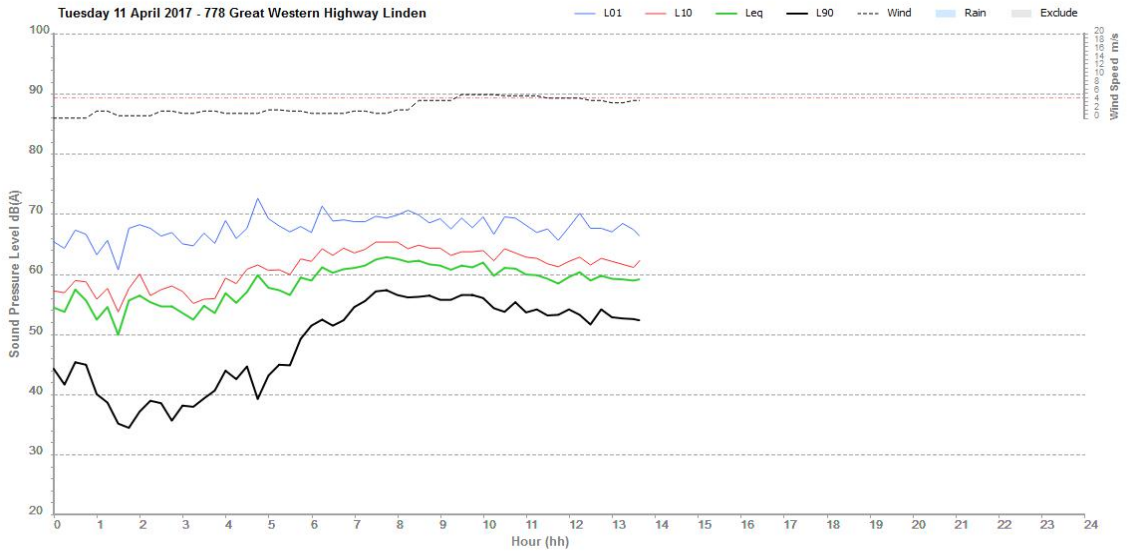




Logger Graphs







Woodford - 31/03/17 - 08/04/17

Logger Setup

Logger Type: 957

Serial No : 27542

Address: 25 Railway Parade , Woodford

Location: In back yard on top of cliff face

Facade / Free Field: Free Field

Environment: Houses on cliff overlooking railway line and partial line of sight to great western highway. Attended measurement taken on road below cliff due to whipper snipper. Engine braking events on great western highway, mixture of passenger and freight rail, but no events during attended measurement.

Logger Setup Photo

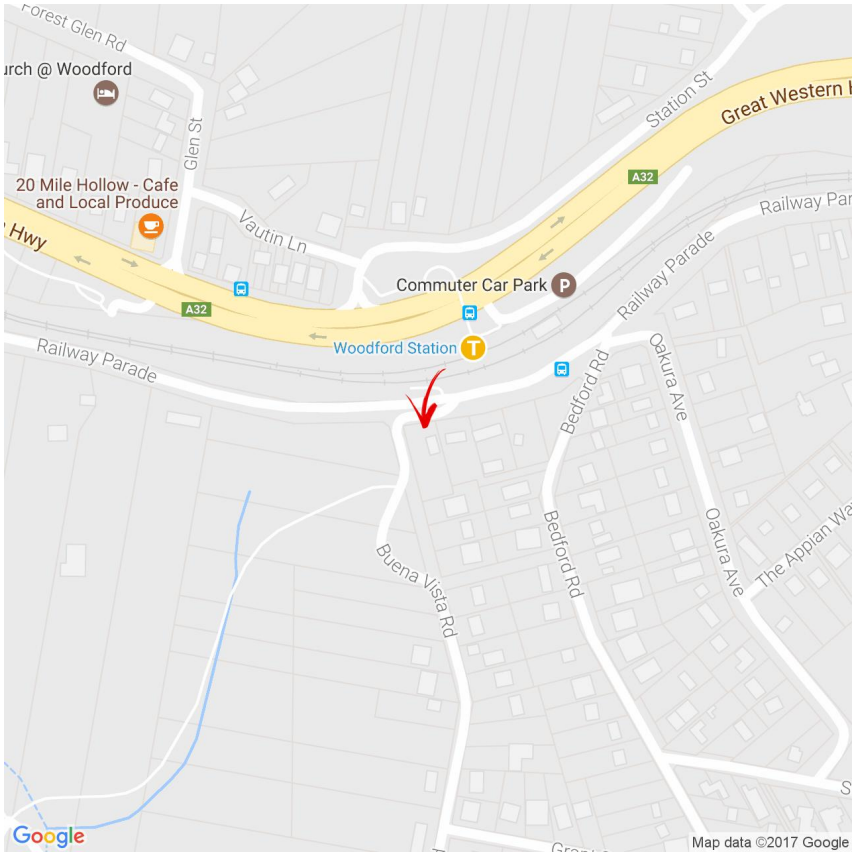
INP Noise Level, dB(A)

	Log Average	RBL
Day	60	51
Evening	60	49
Night	60	30

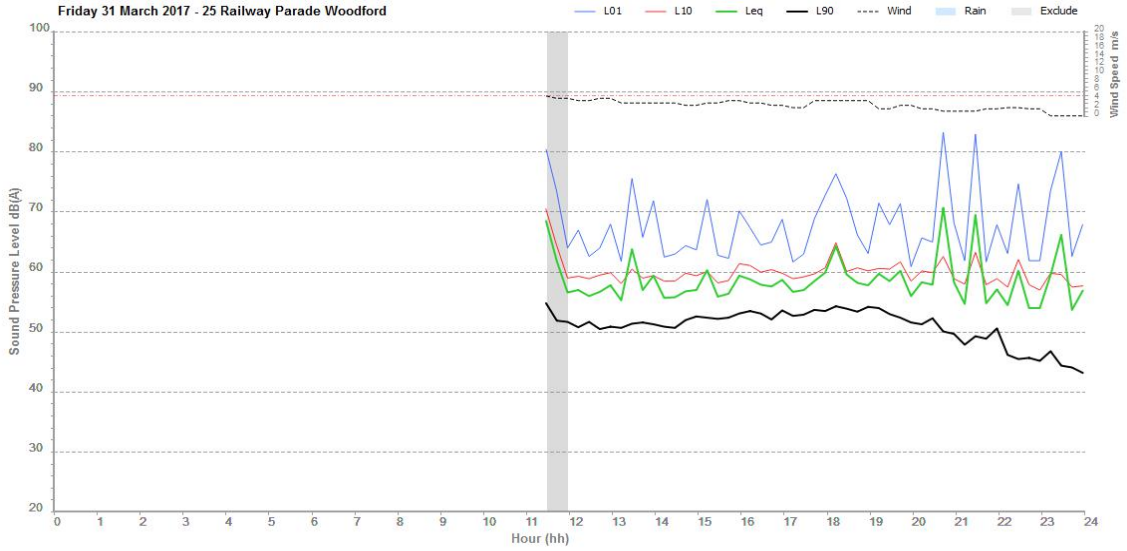
RNP Noise Level, dB(A)

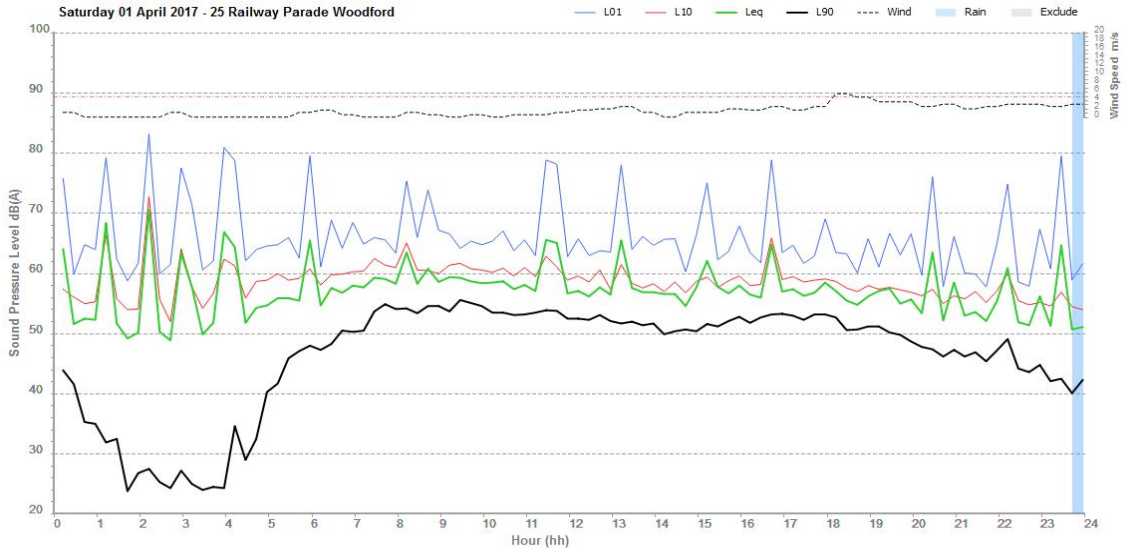
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

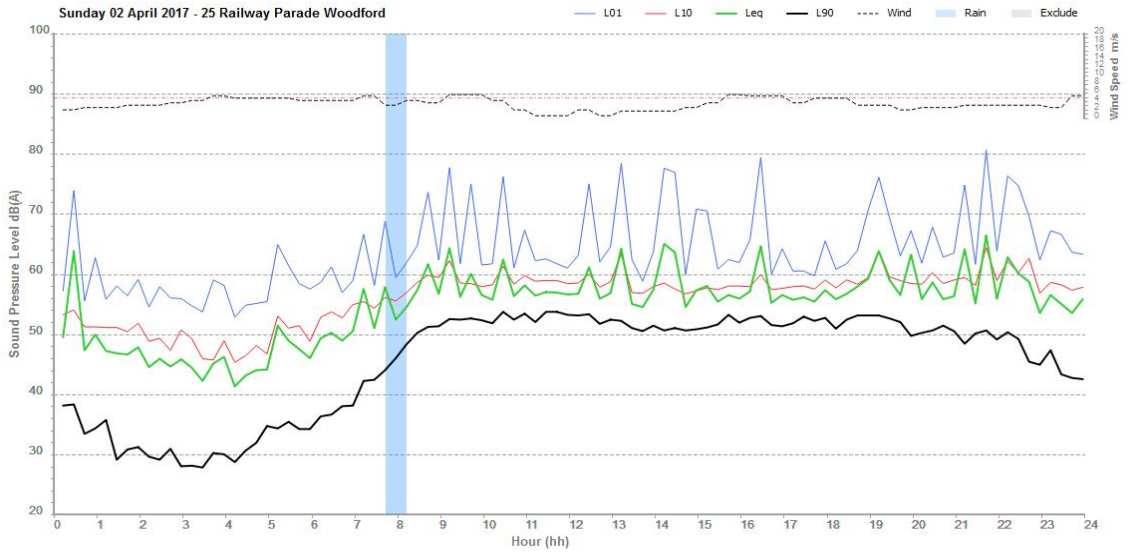
Logger Location Map



Logger Graphs







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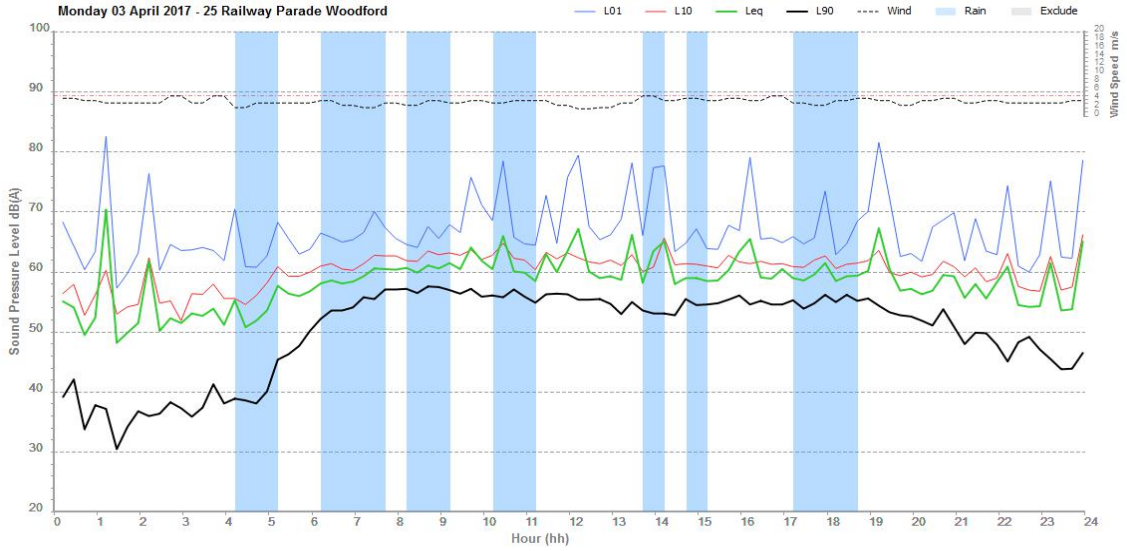
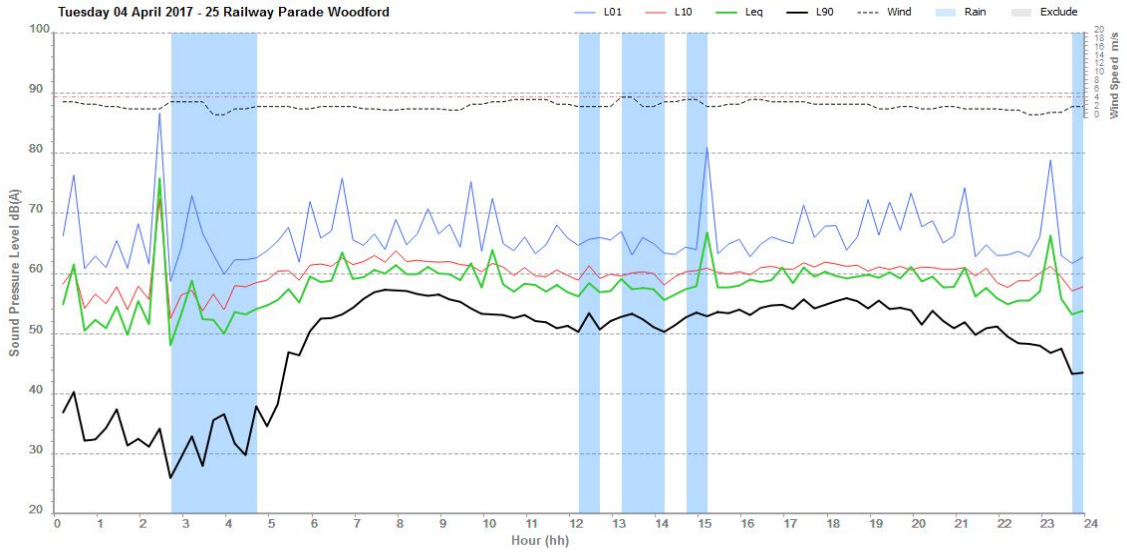
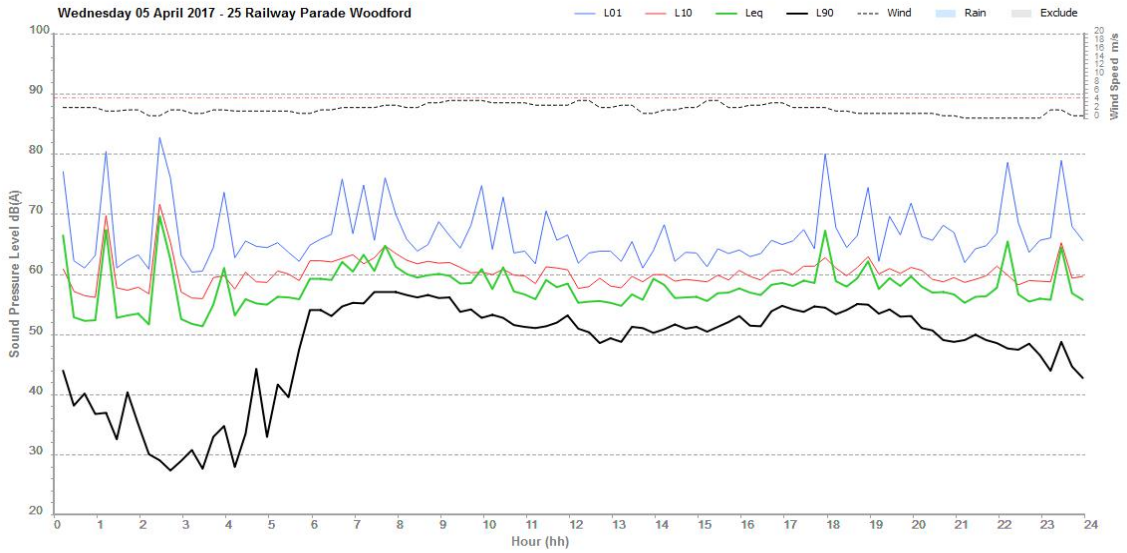
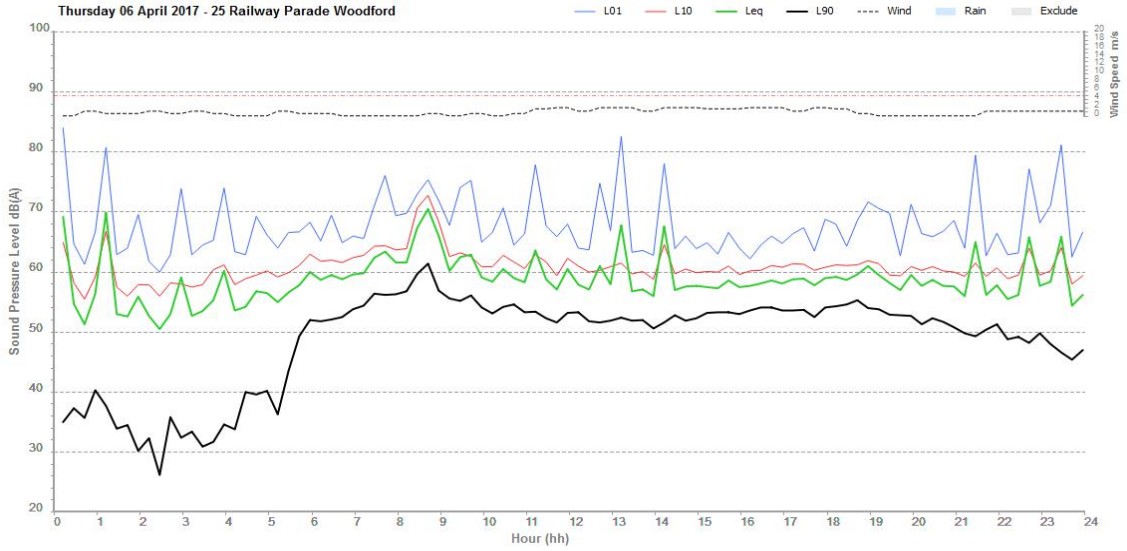
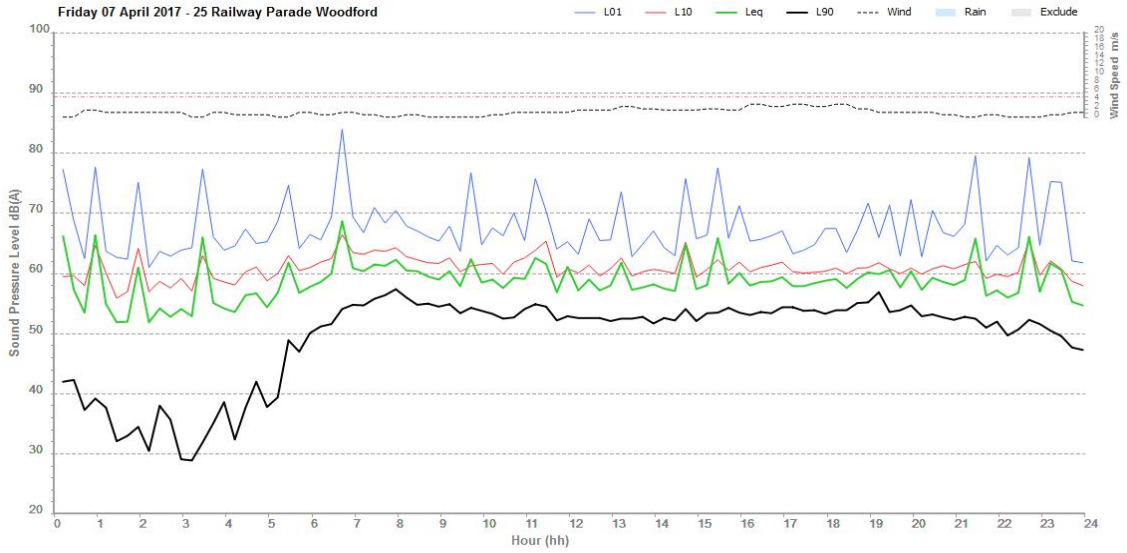


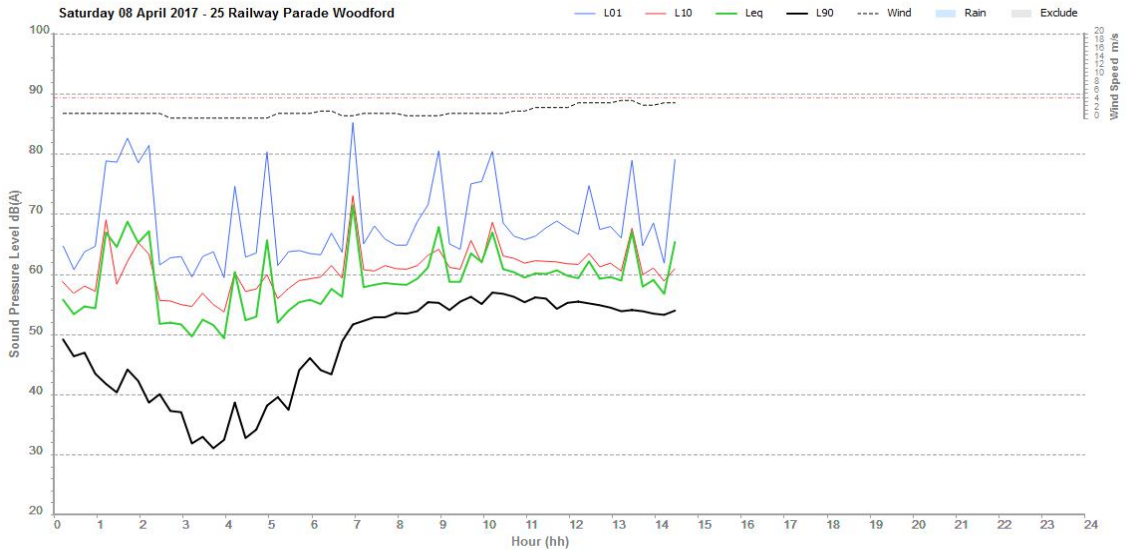




Logger Graphs







Hazelbrook - 31/03/17 - 11/04/17

Logger Setup

Logger Type: Rion NL21

Serial No : 00765701

Address: 40 Railway Parade , Hazelbrook

Location: Front yard

Facade / Free Field: Free Field

Environment: Mmixture of commercial and residential properties. Next to railway line and station. Some pedestrian noise and whipper snipper in background contributing somewhat to the environment. Traffic noise just audible from Great Western Highway with engine brakes clearly audible.

Logger Setup Photo

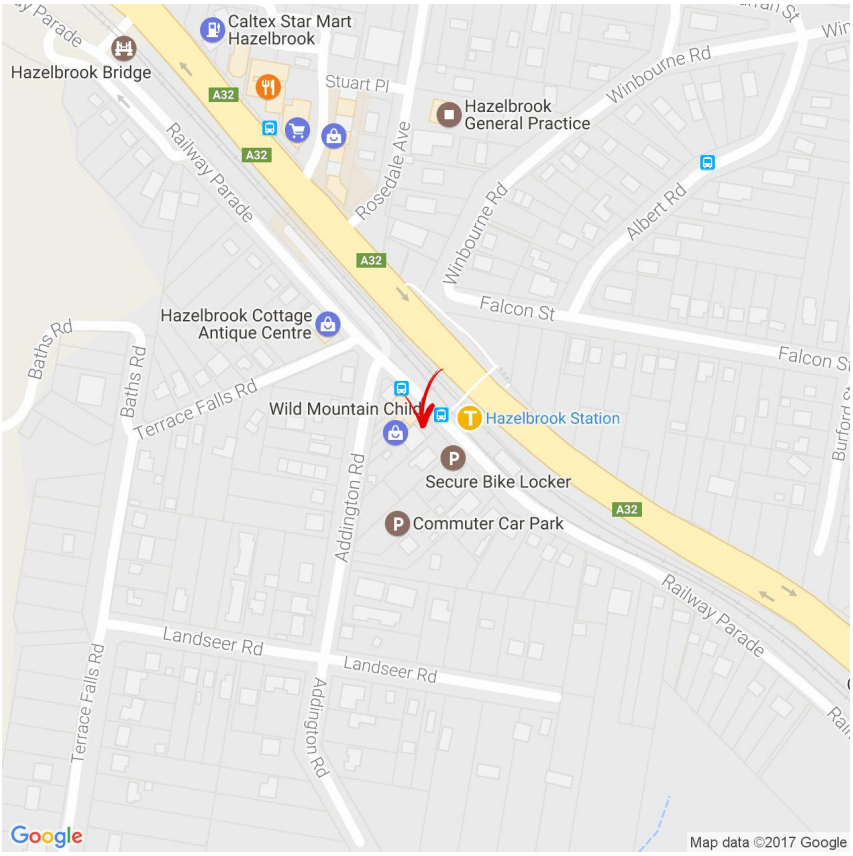
INP Noise Level, dB(A)

	Log Average	RBL
Day	60	50
Evening	59	48
Night	56	32

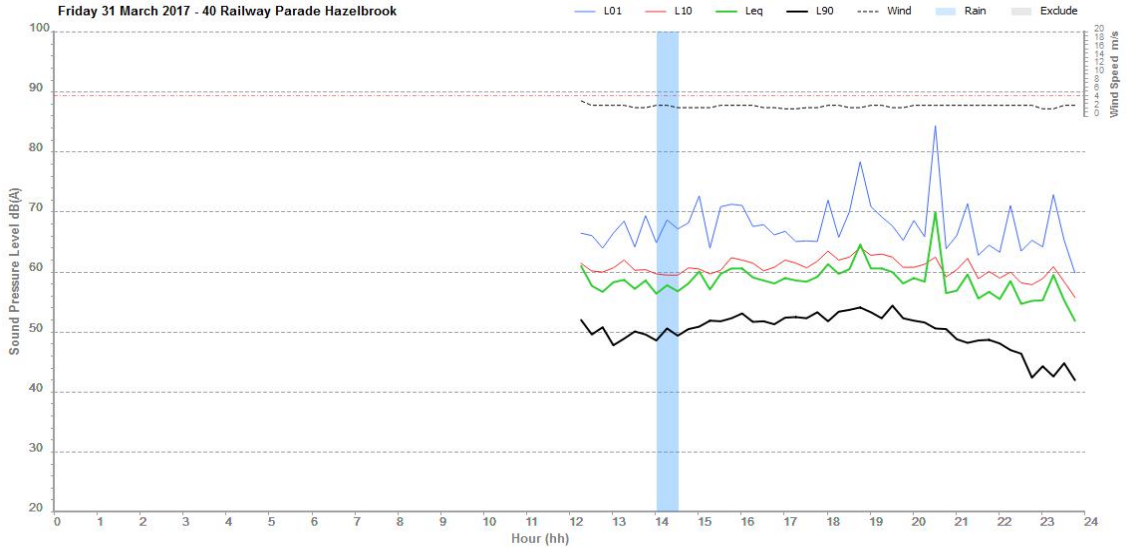
RNP Noise Level, dB(A)

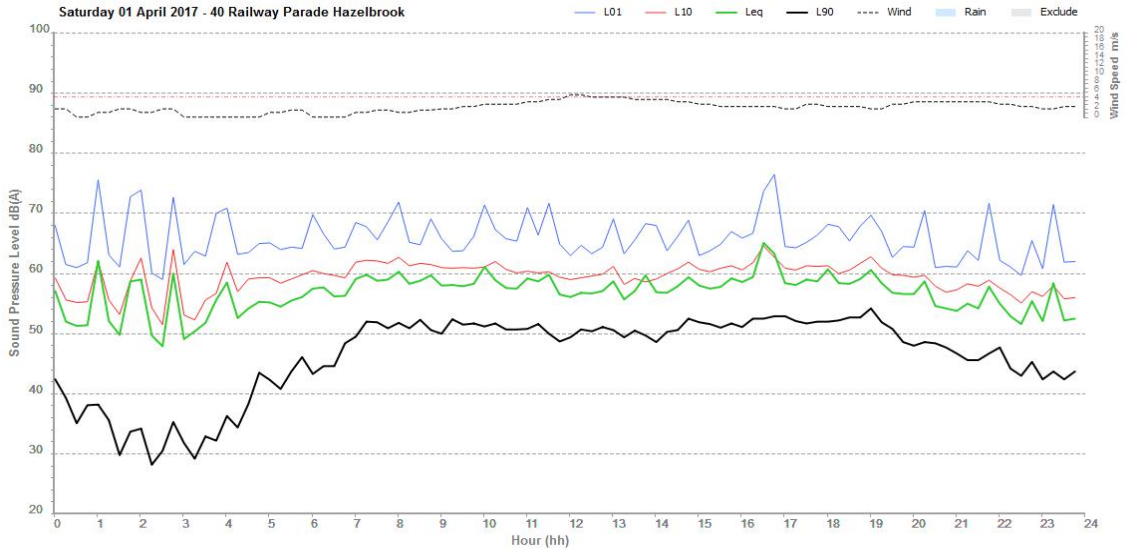
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

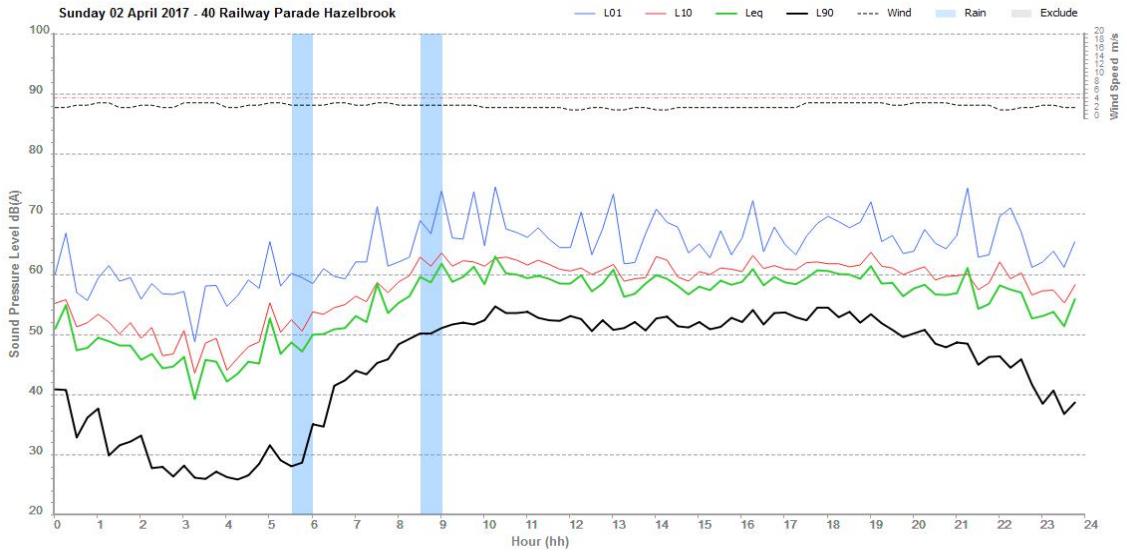
Logger Location Map



Logger Graphs







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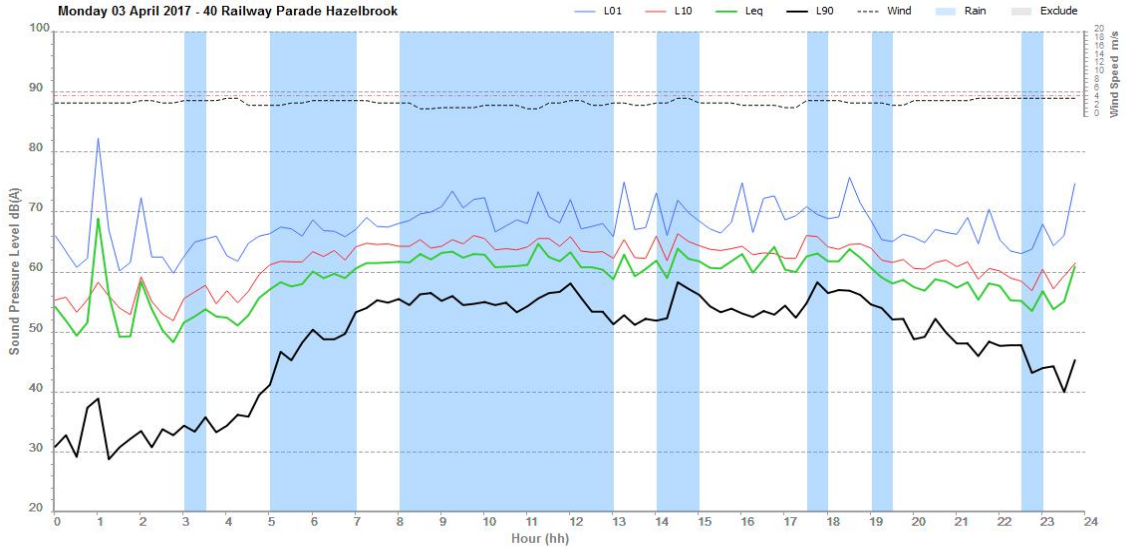
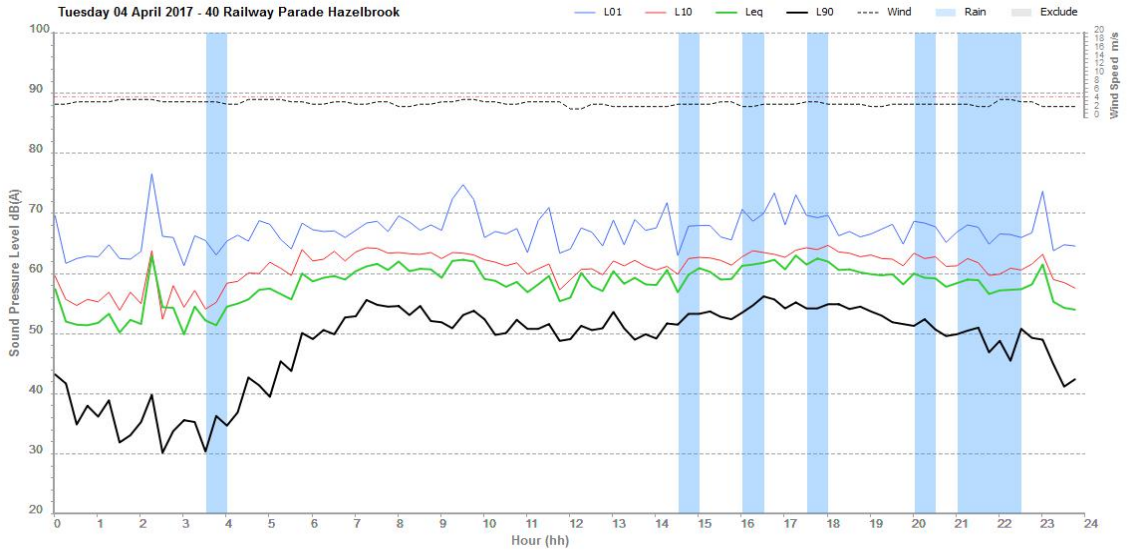
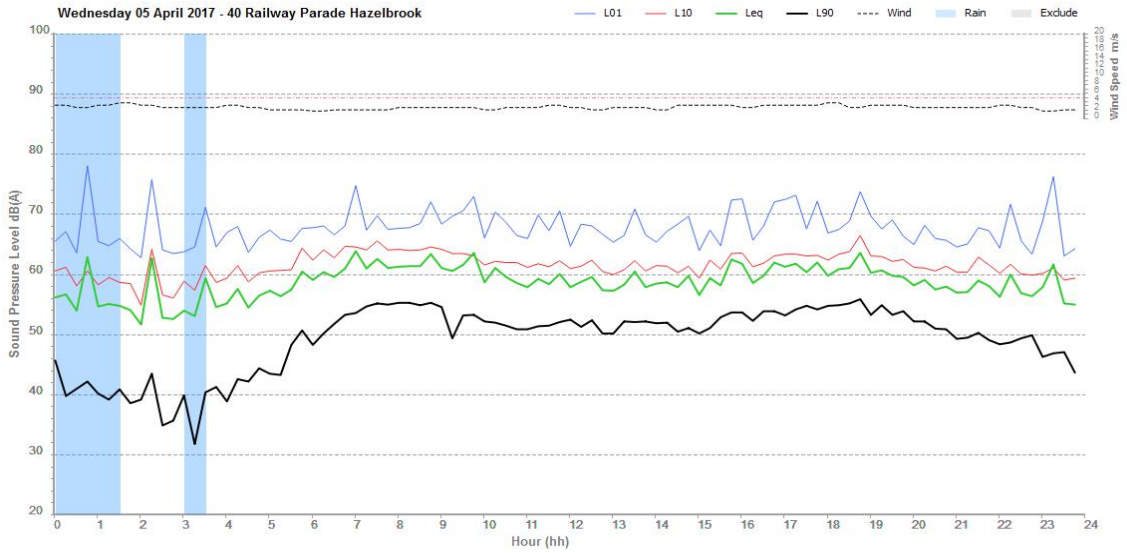
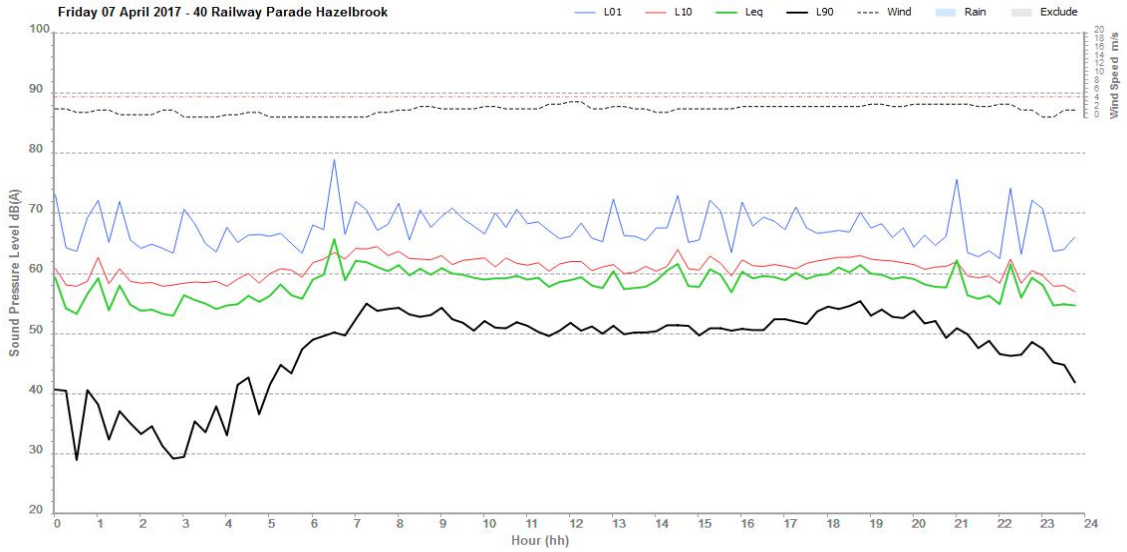
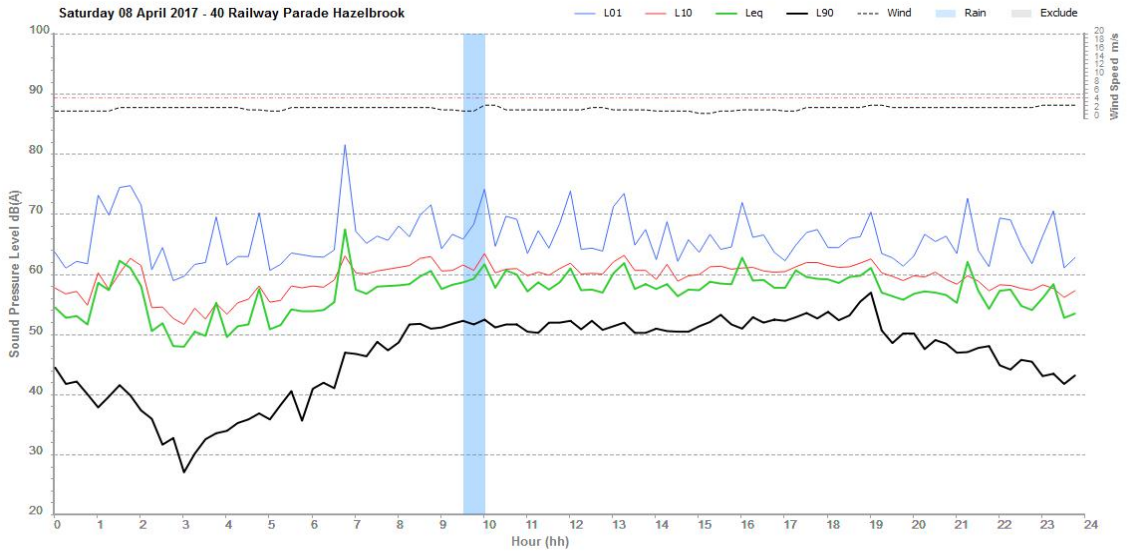






Logger Graphs





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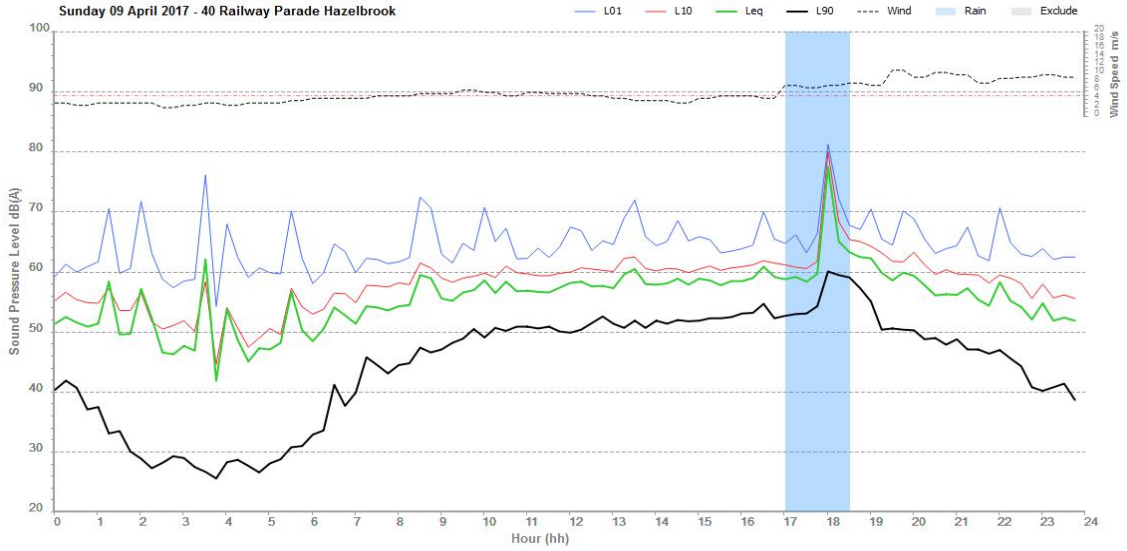
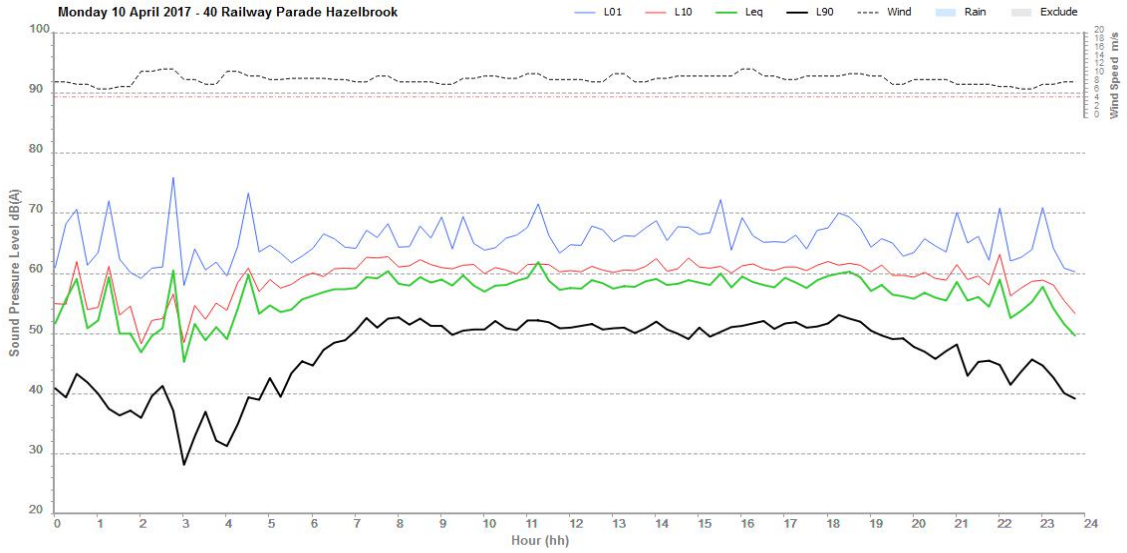
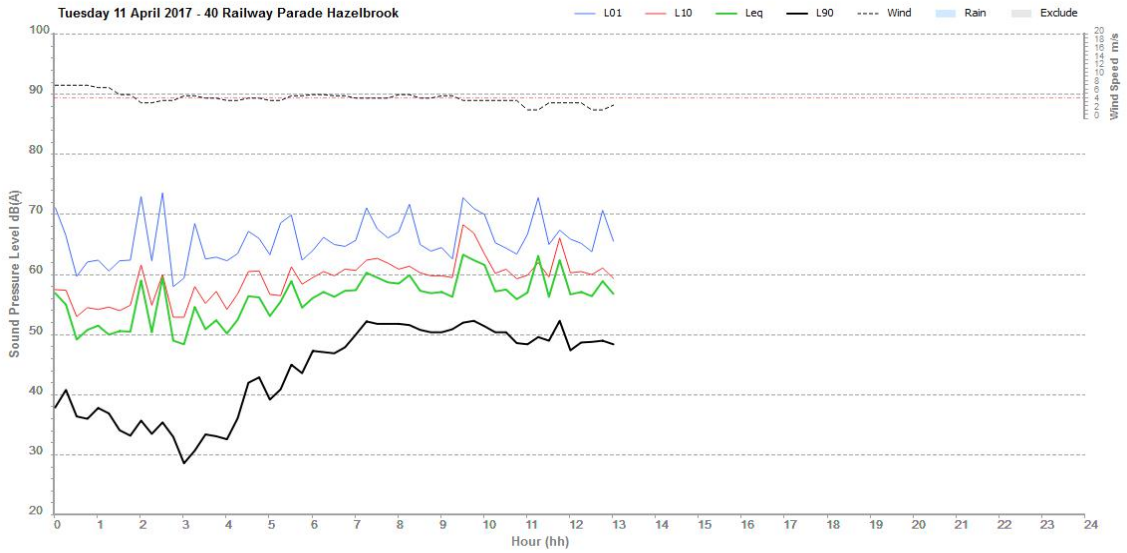






Katoomba - 31/03/17 - 06/04/17

Logger Setup

Logger Type: Cirus 171

Serial No : G061710

Address: 2-4 Murri Street , Katoomba

Location: Front Yard

Facade / Free Field: Free Field

Environment: Local traffic noise dominant mostly cars. Fairly quiet suburban street. Opposite fire station. Some wind noise and bird noise.

Logger Setup Photo

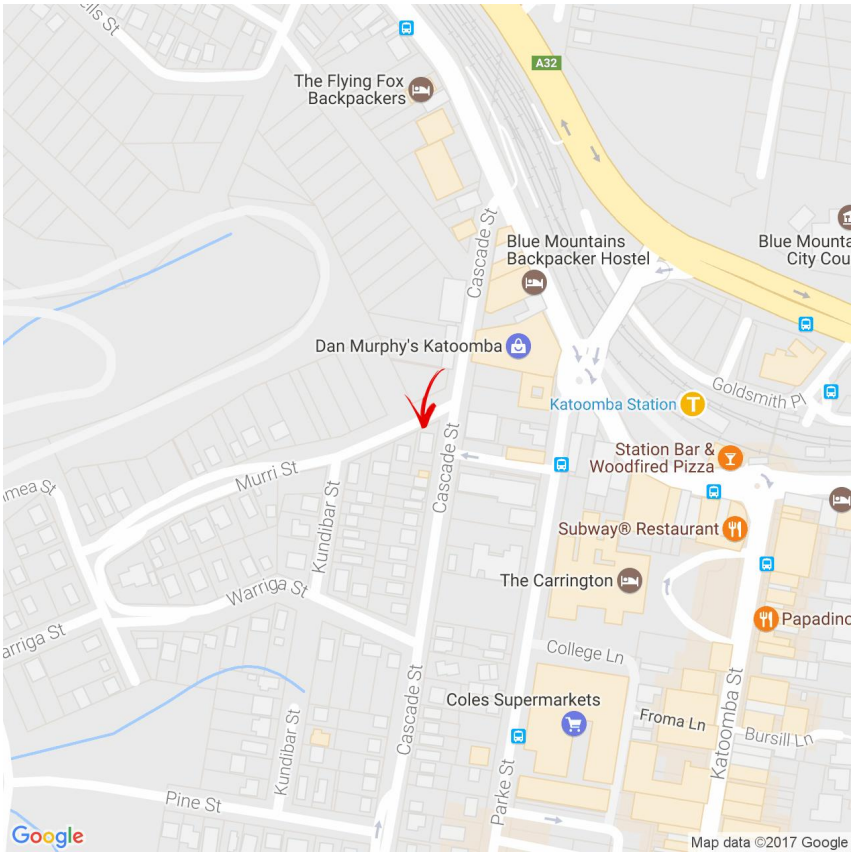
INP Noise Level, dB(A)

	Log Average	RBL
Day	54	41
Evening	53	39
Night	43	31

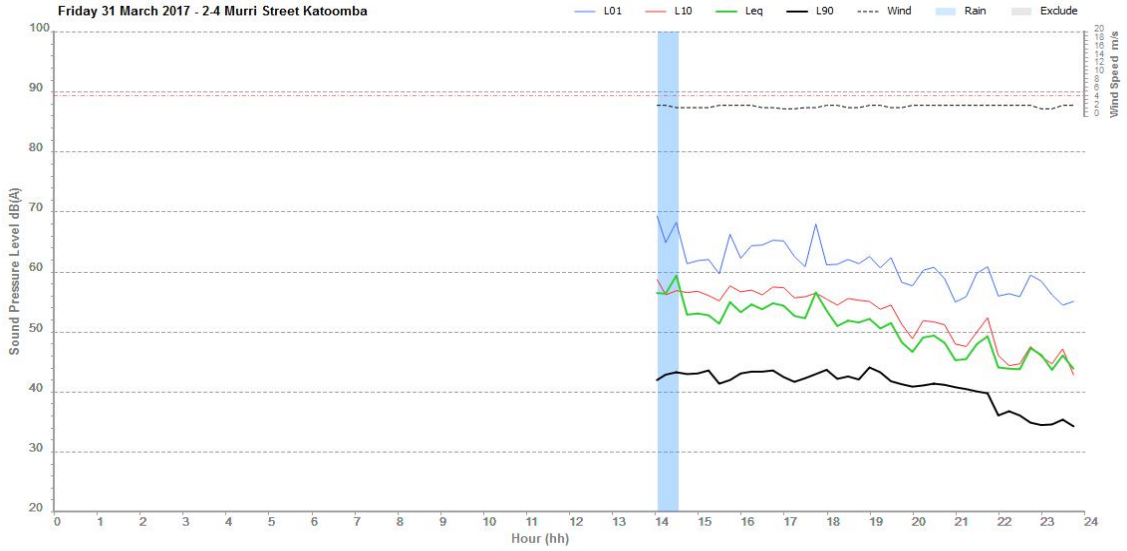
RNP Noise Level, dB(A)

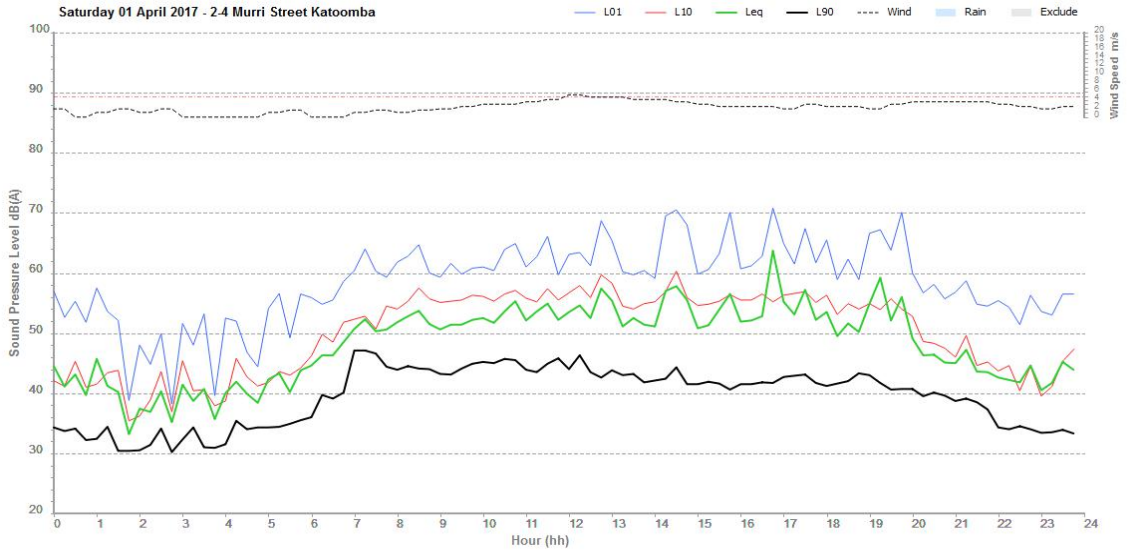
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

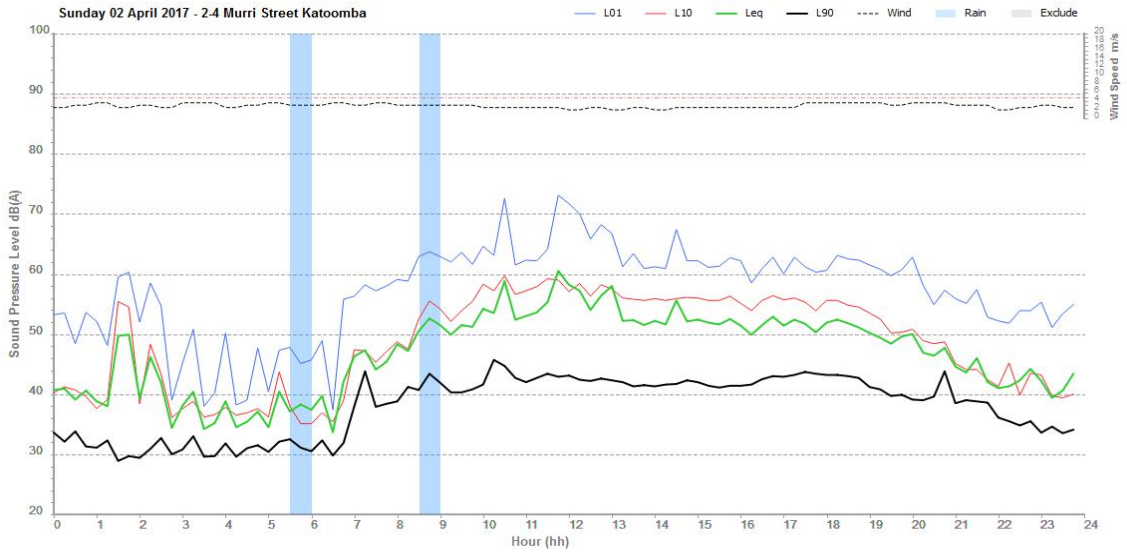
Logger Location Map



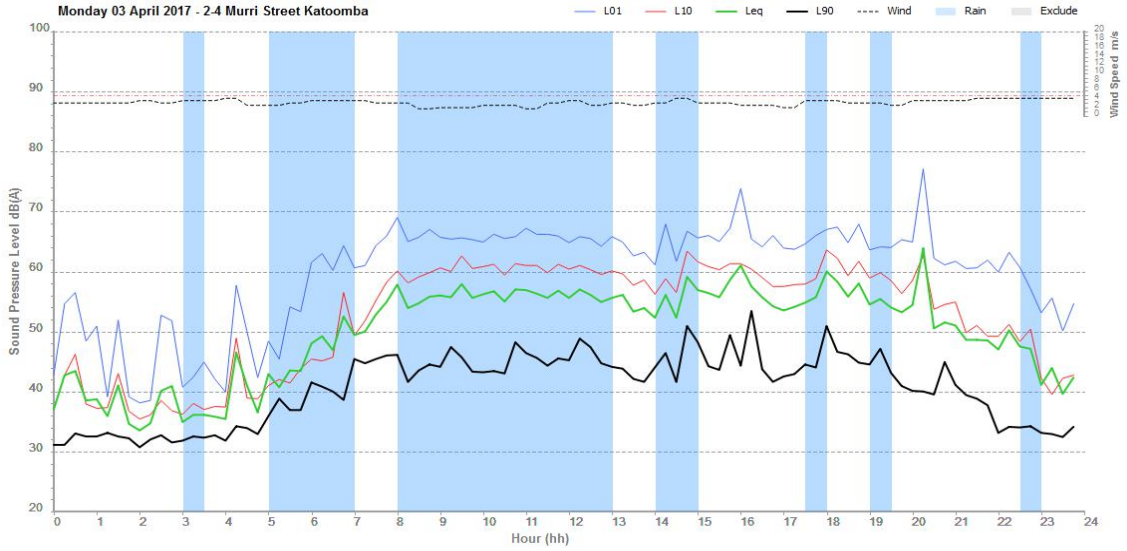
Logger Graphs

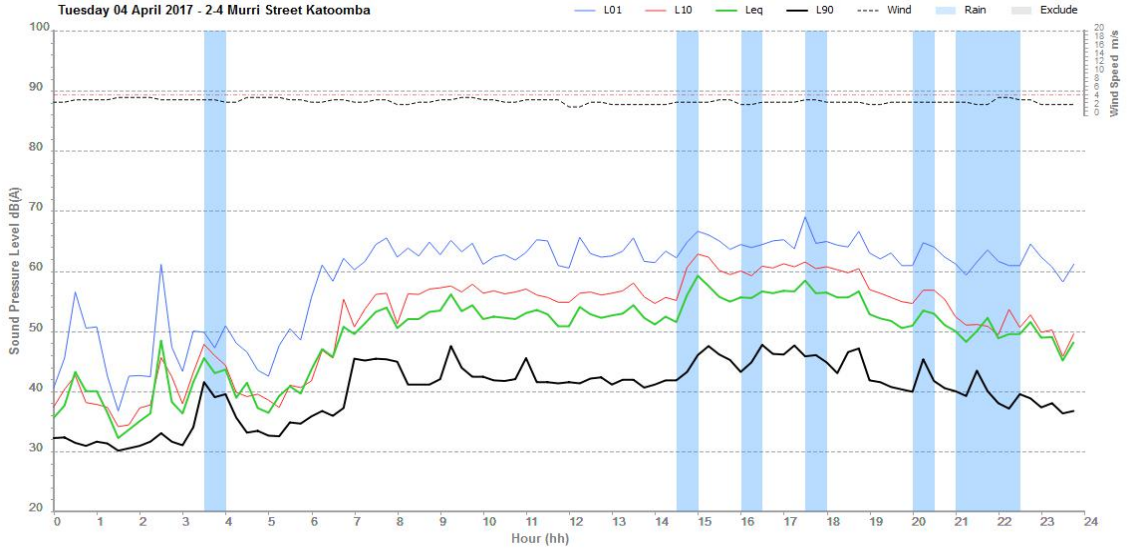


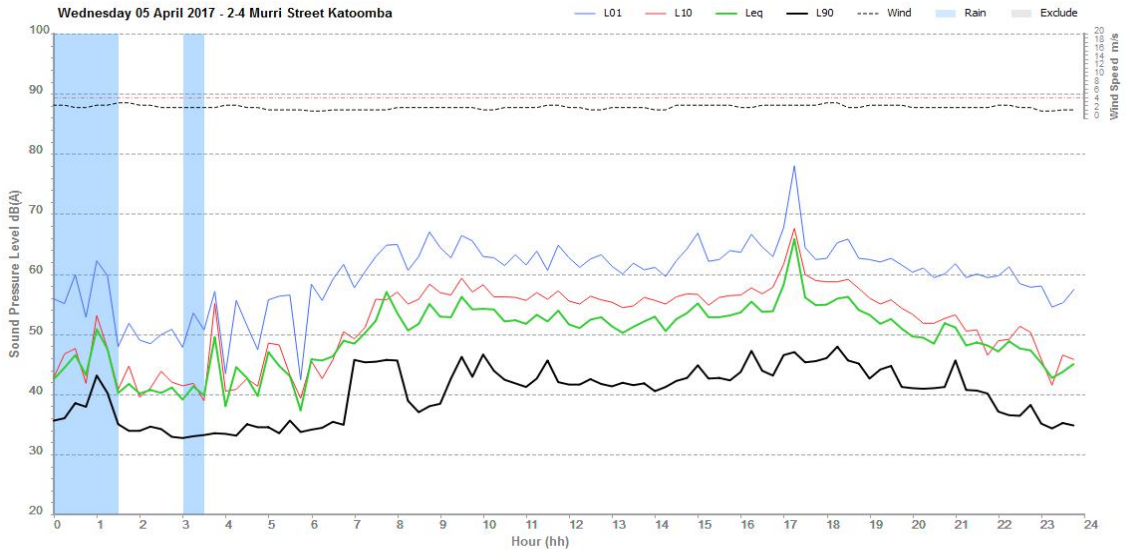




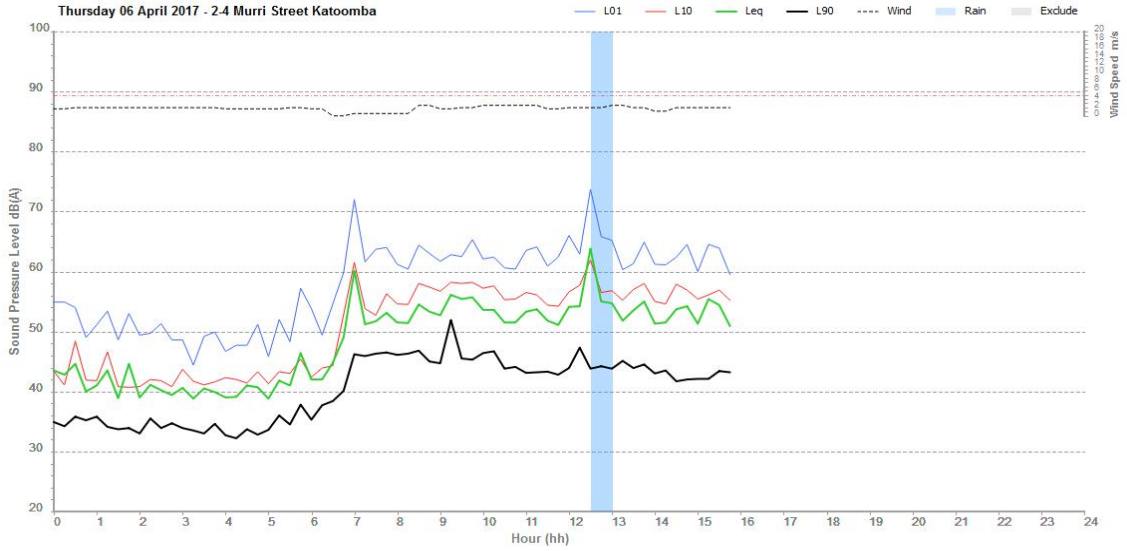
Logger Graphs







Logger Graphs



Bell - 31/03/17 - 10/04/17

Logger Setup

Logger Type: Rion NL52

Serial No : 1043455

Address: 20 Sandham Road , Bell

Location: Front Yard

Facade / Free Field: Free Field

Environment: Next to the rail line. Wind noise dominant. Distant sound of highway in background. Train passed during attended measurement, 76dBA.

Logger Setup Photo

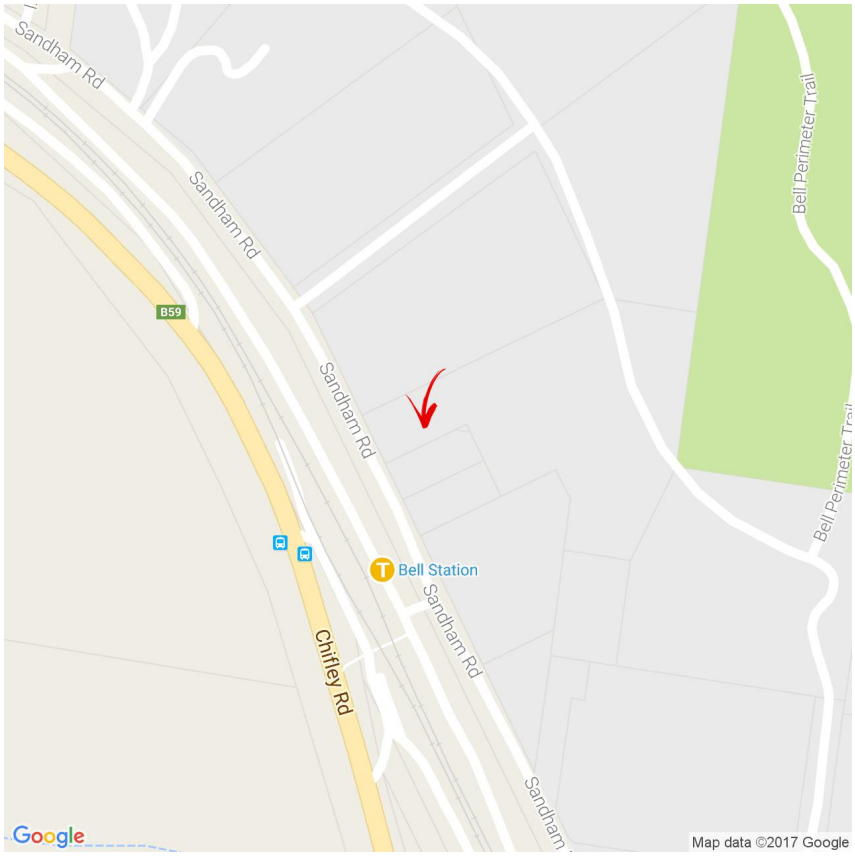
INP Noise Level, dB(A)

	Log Average	RBL
Day	45	31
Evening	44	26
Night	43	17

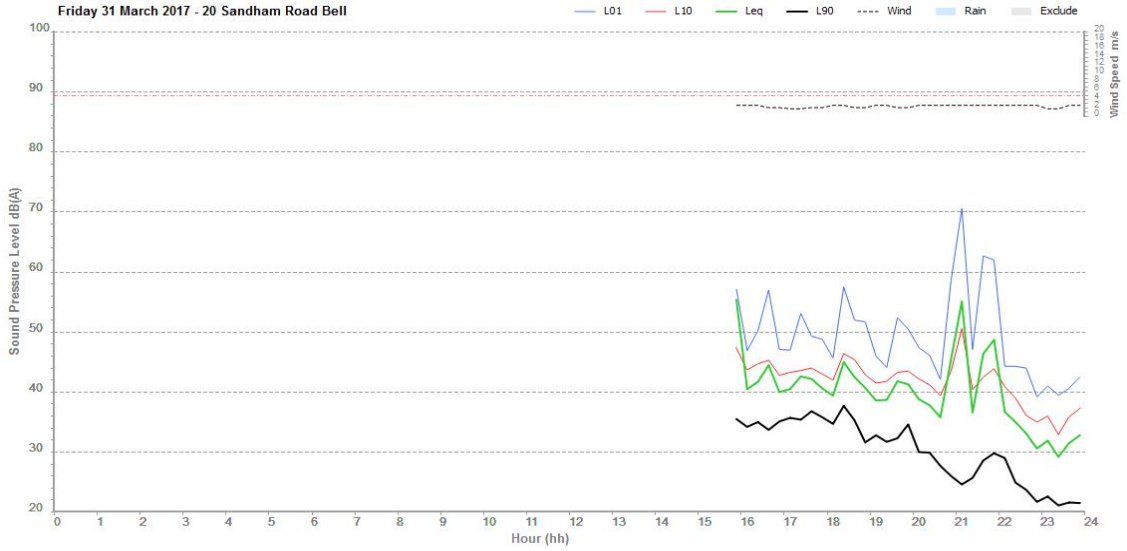
RNP Noise Level, dB(A)

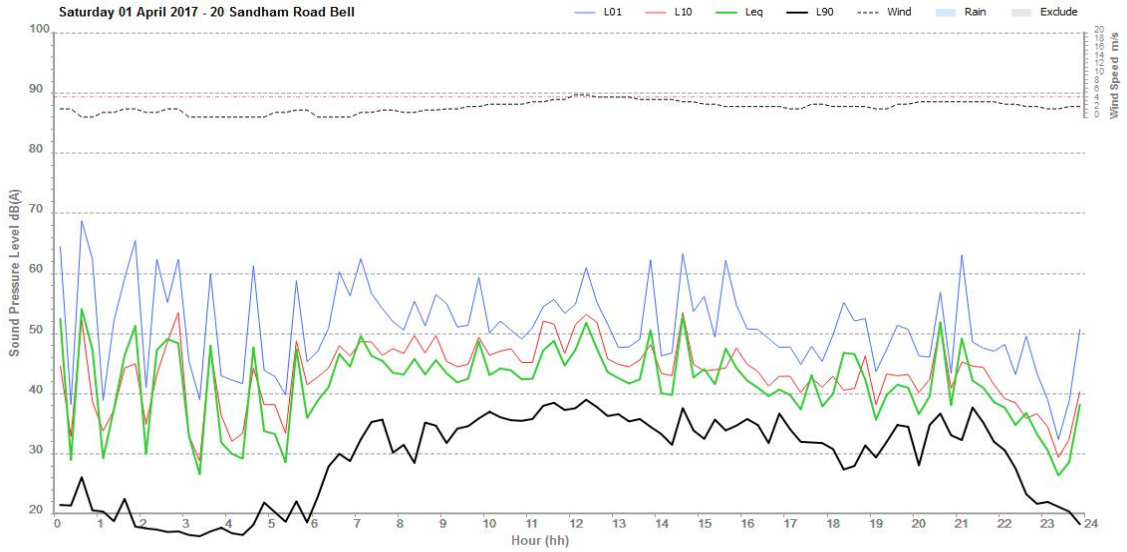
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

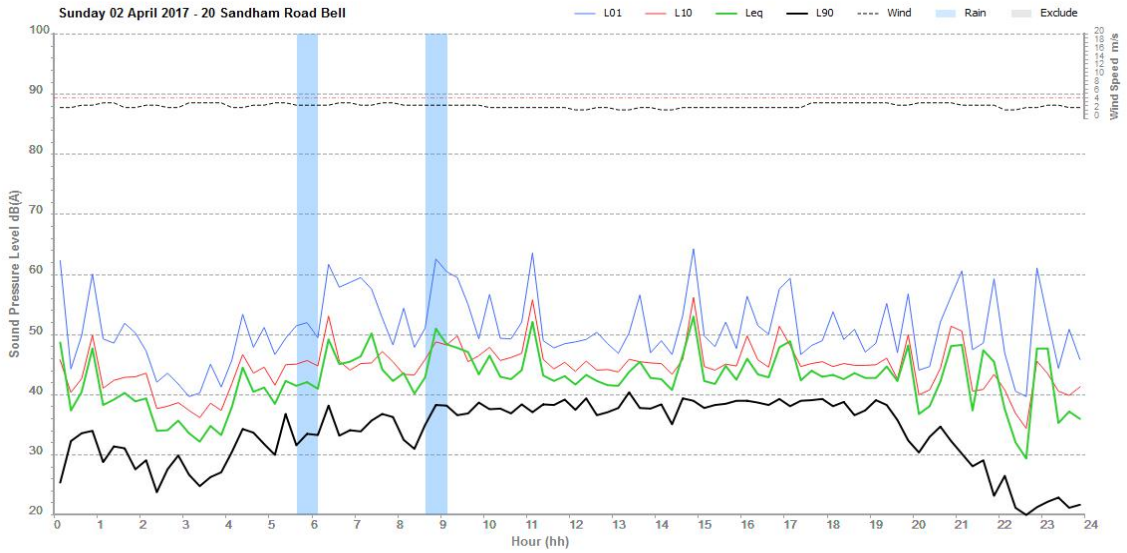
Logger Location Map



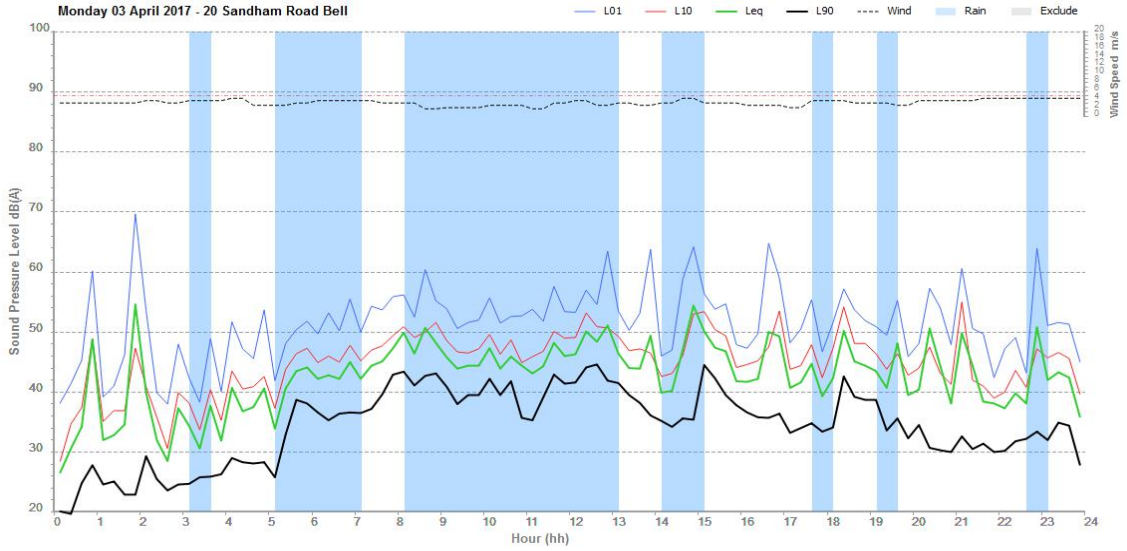
Logger Graphs

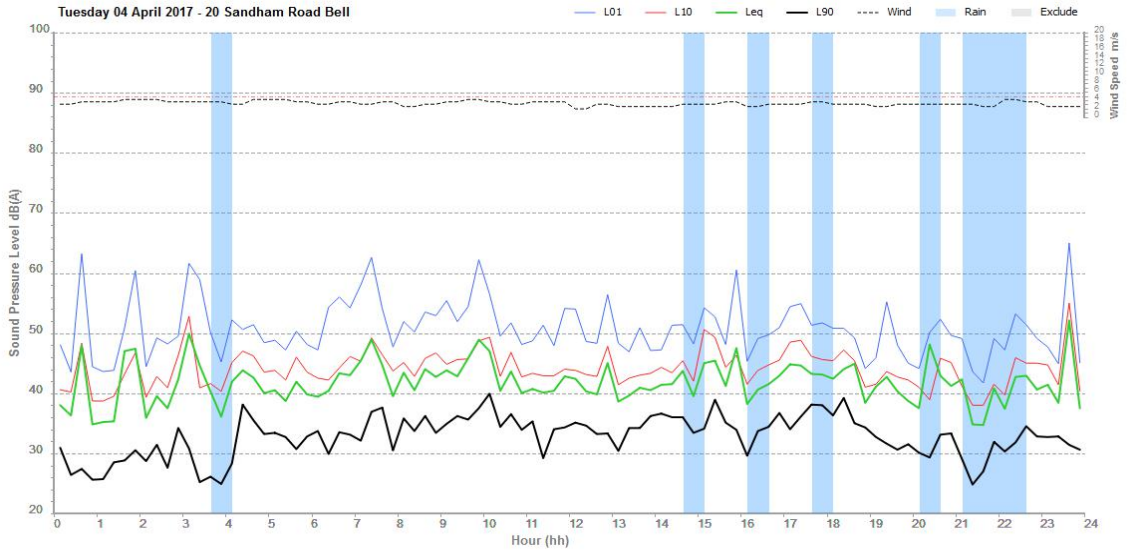


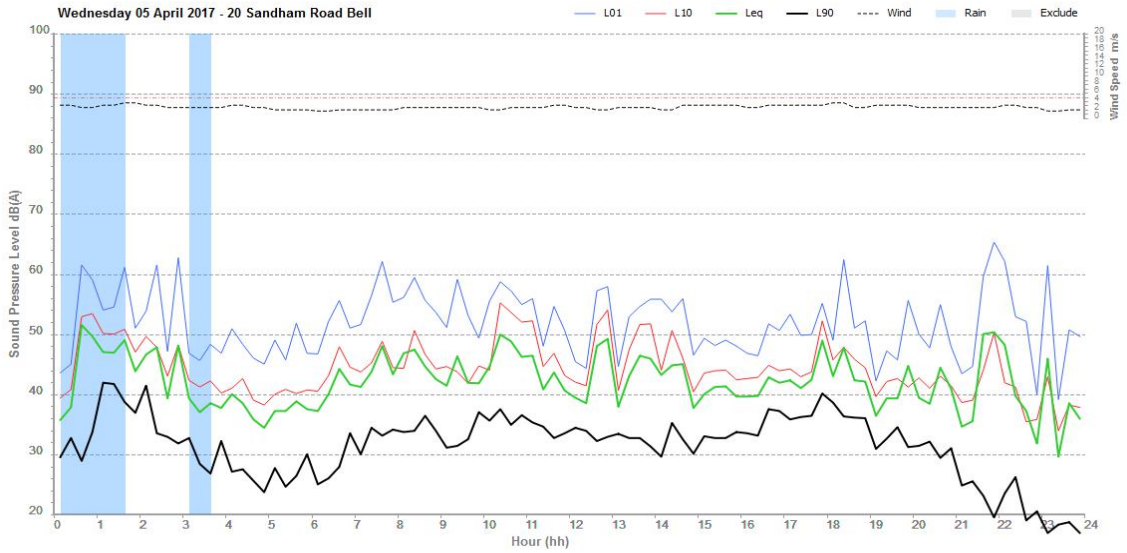




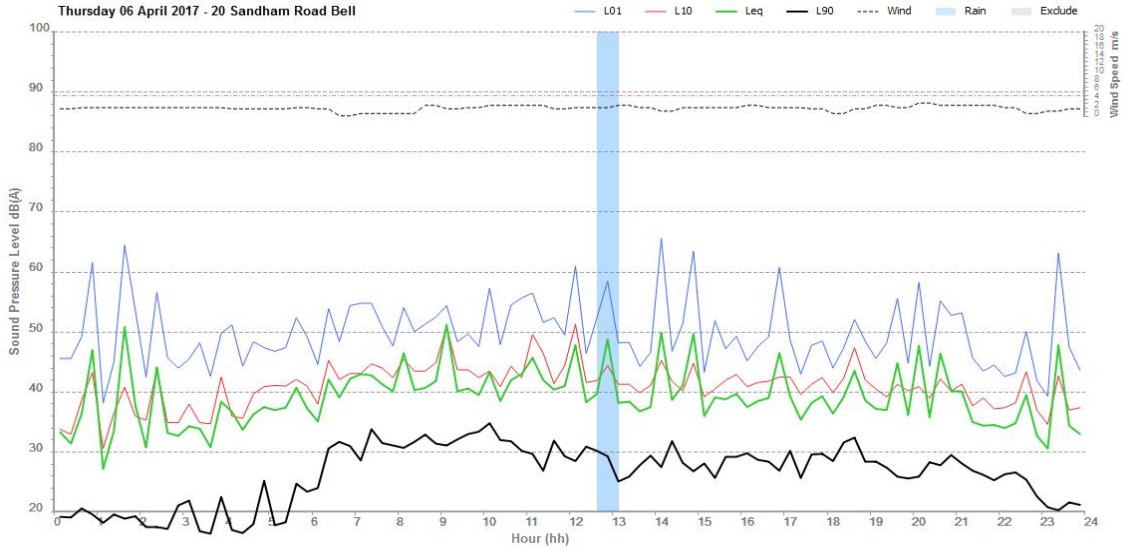
Logger Graphs

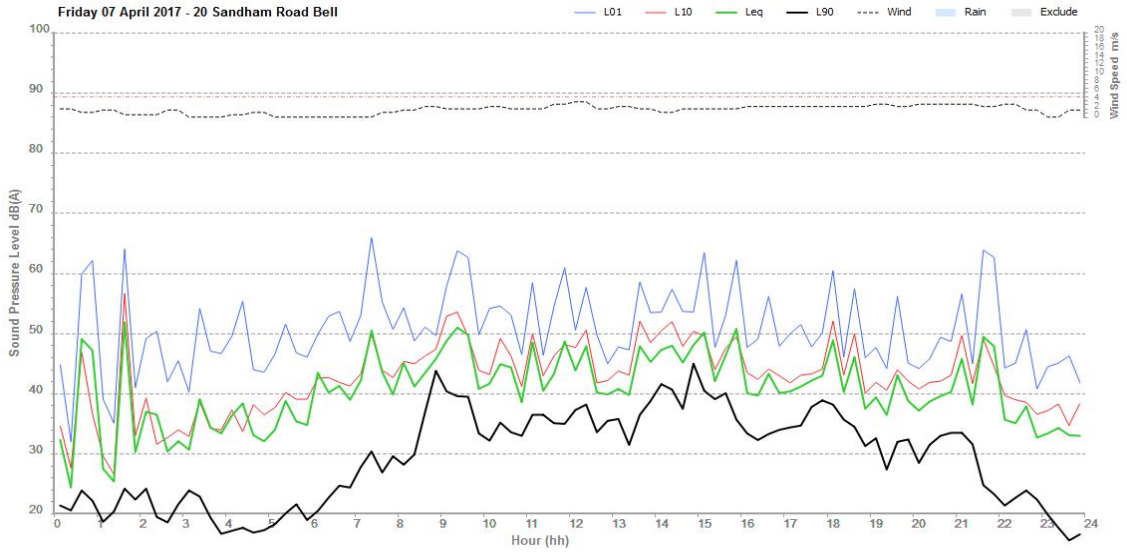


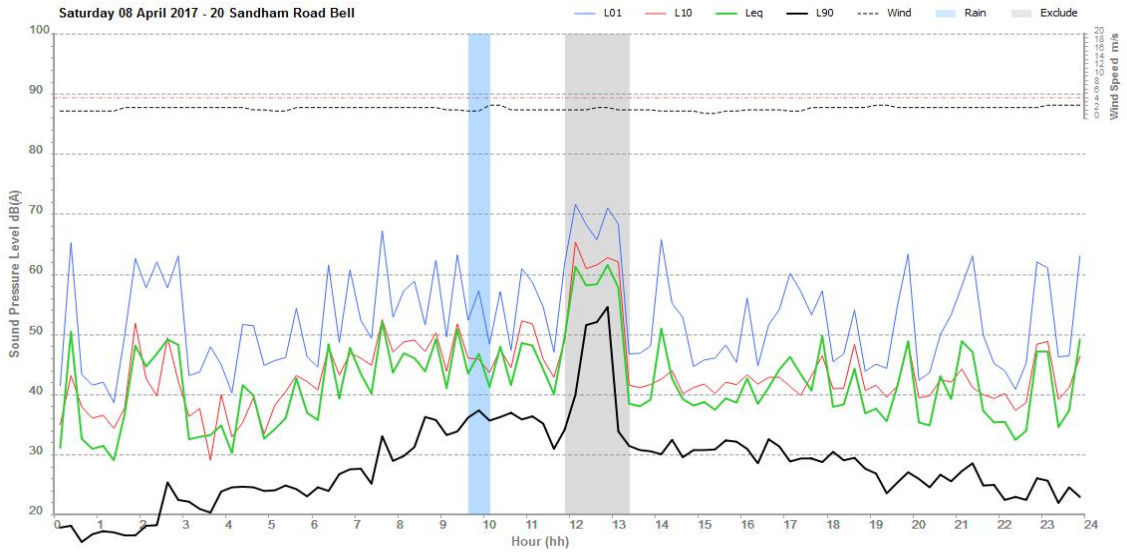




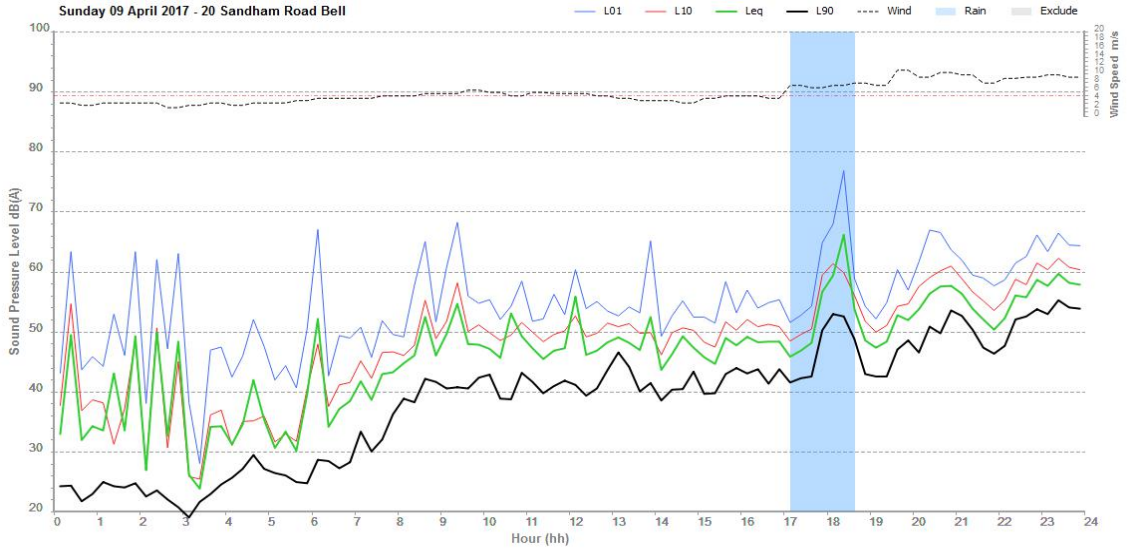
Logger Graphs

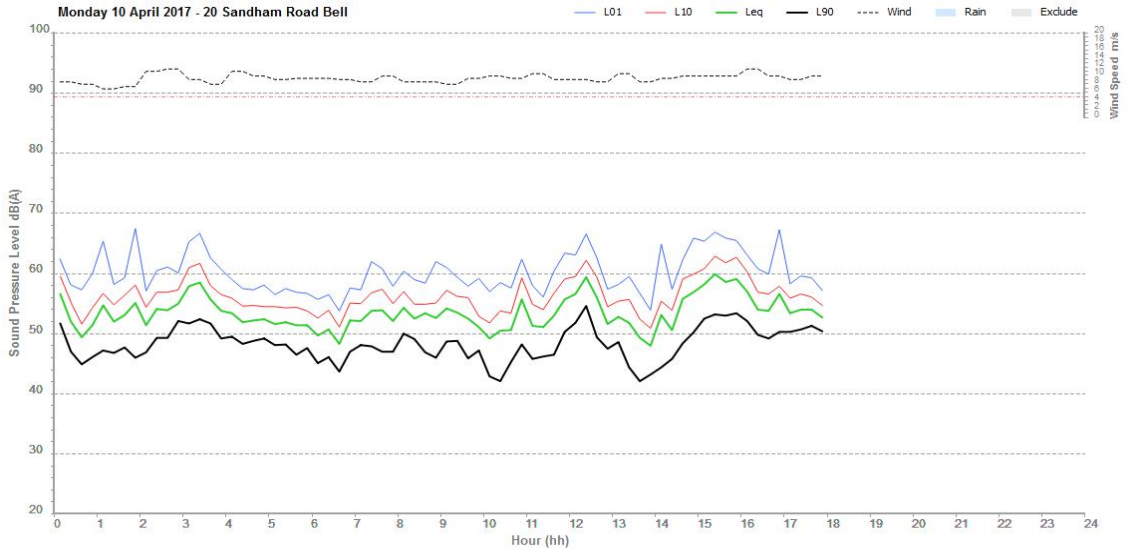






Logger Graphs





Lithgow - 31/03/17 - 11/04/17

Logger Setup

Logger Type: Rion NL52

Serial No : 164395

Address: 41 Railway Parade , Lithgow

Location: Front yard

Facade / Free Field: Free Field

Environment: Local road traffic dominant 65dBA. Aircraft flyover occasional buses from the station. Crickets

Logger Setup Photo

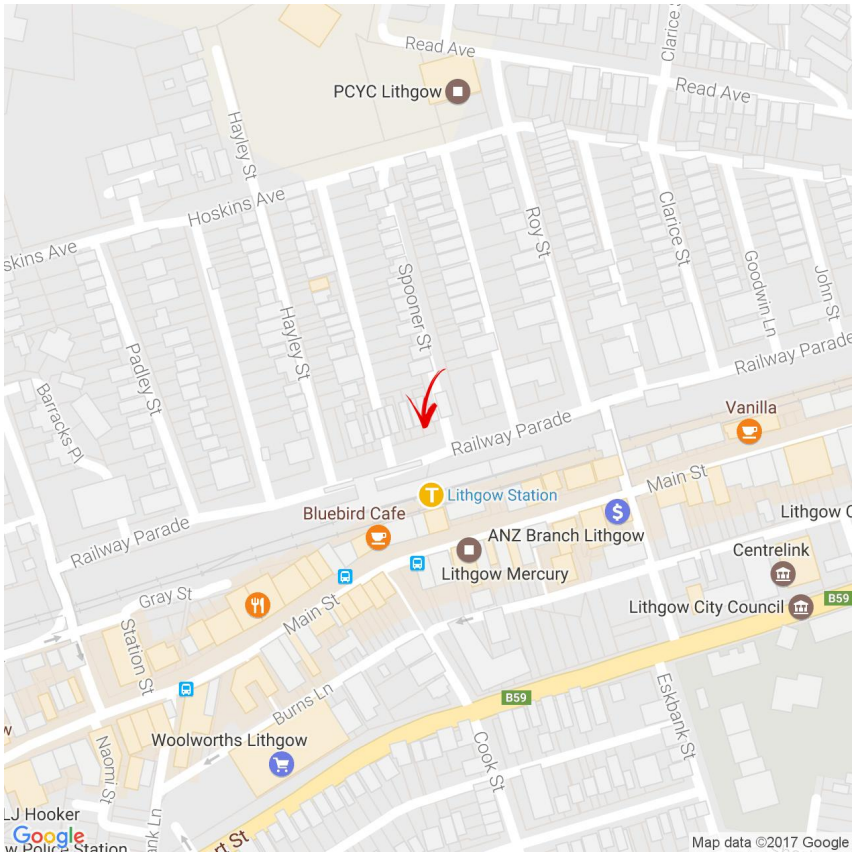
INP Noise Level, dB(A)

	Log Average	RBL
Day	59	42
Evening	58	40
Night	52	30

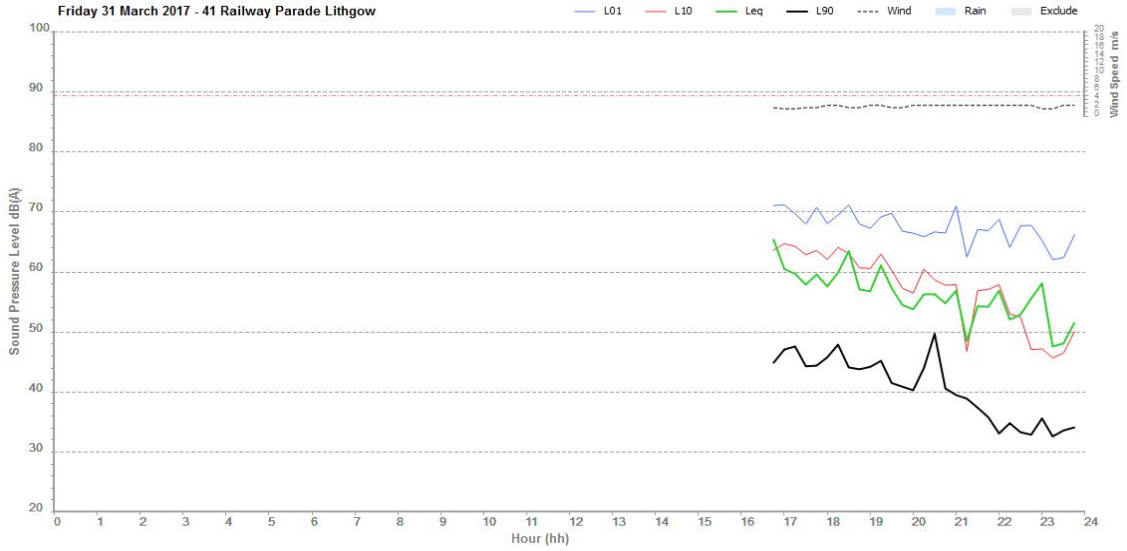
RNP Noise Level, dB(A)

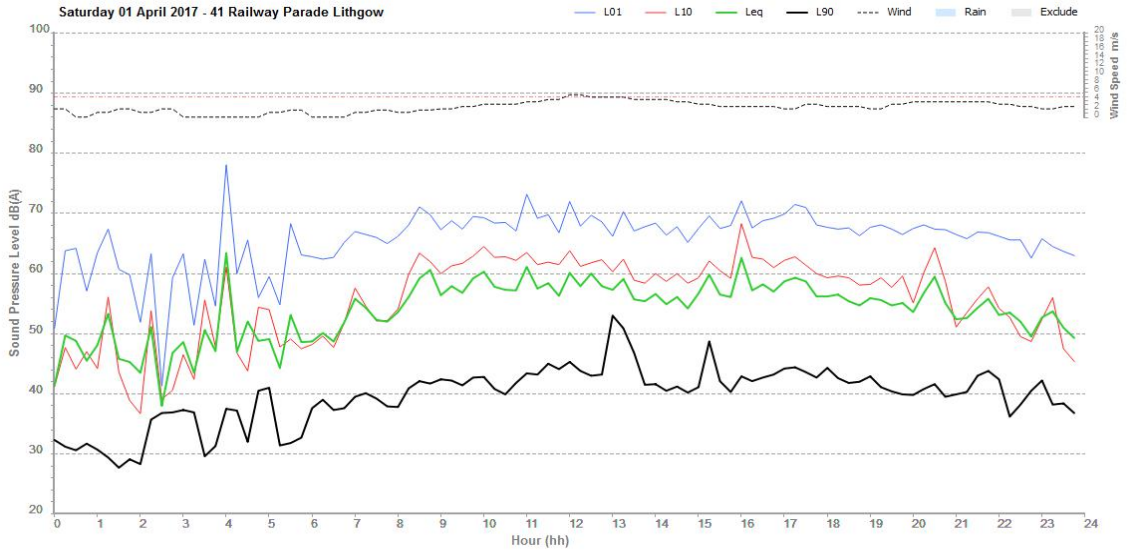
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

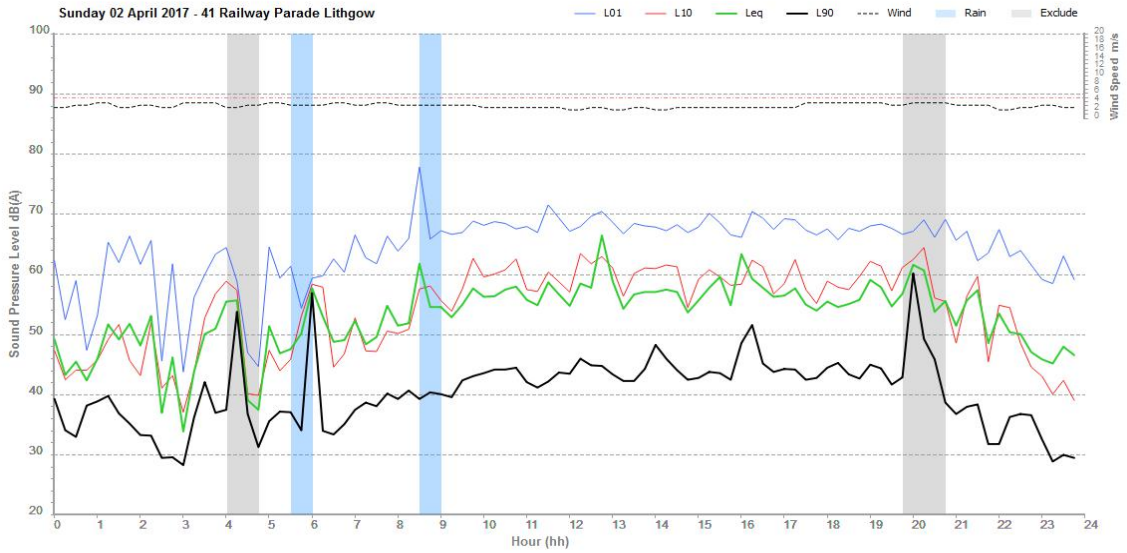
Logger Location Map



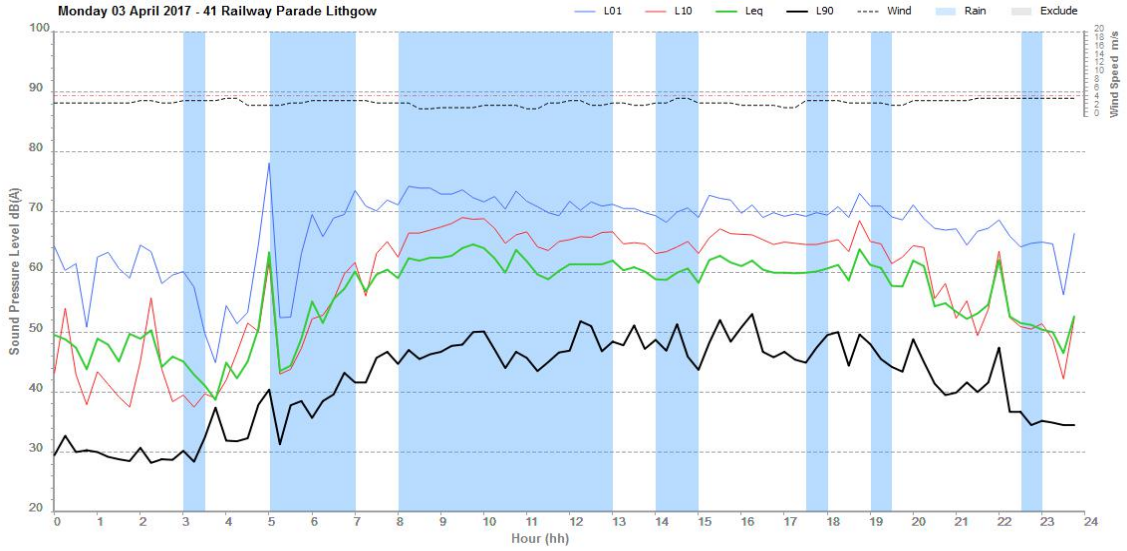
Logger Graphs

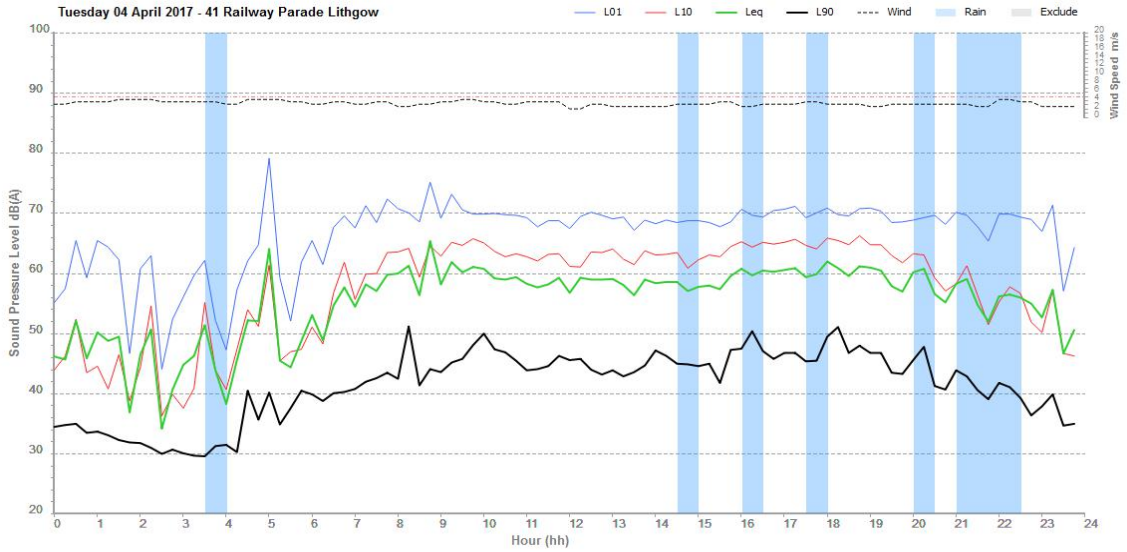


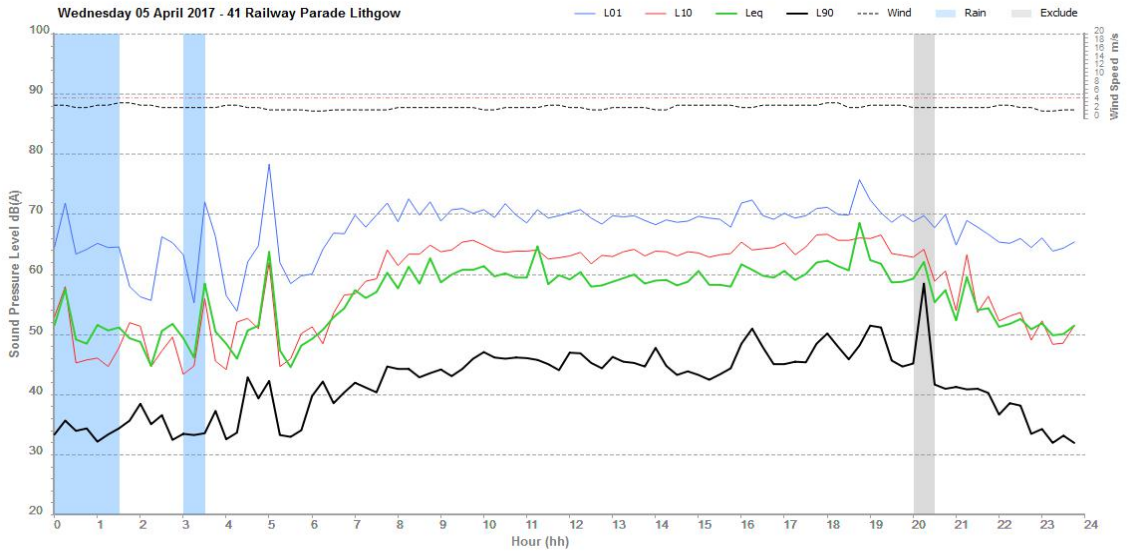




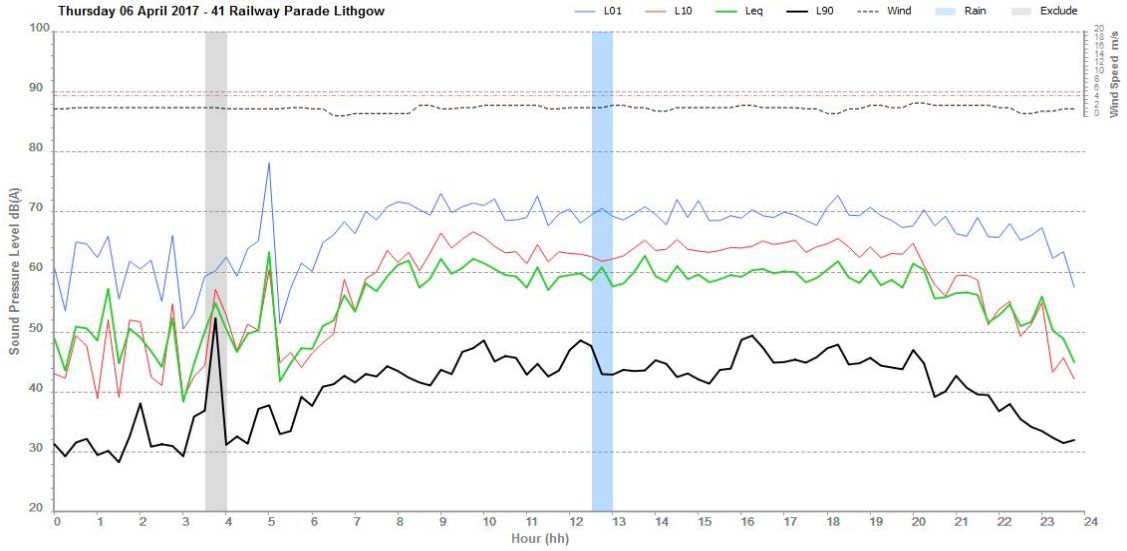
Logger Graphs

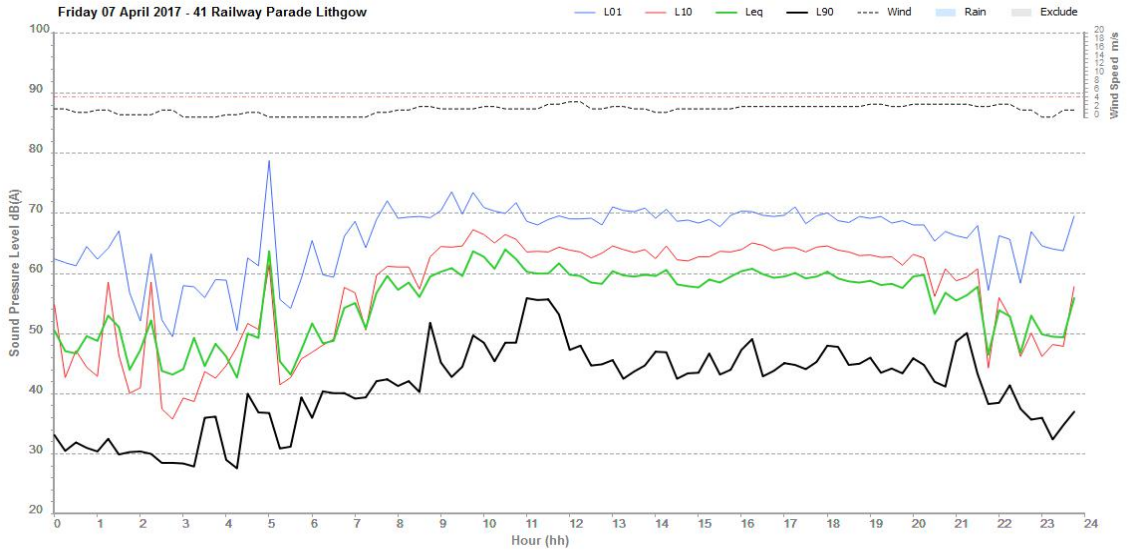


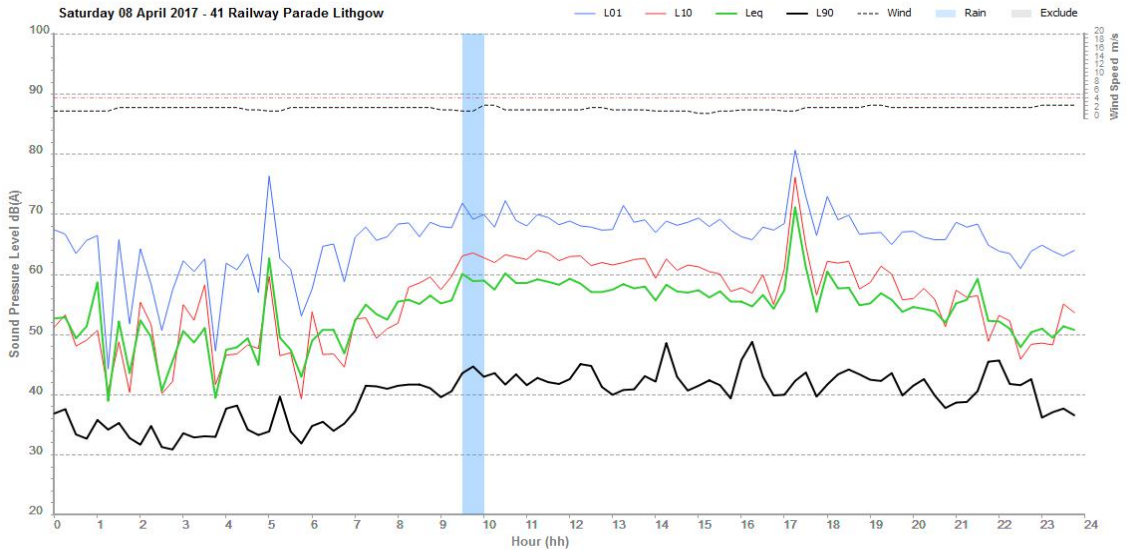




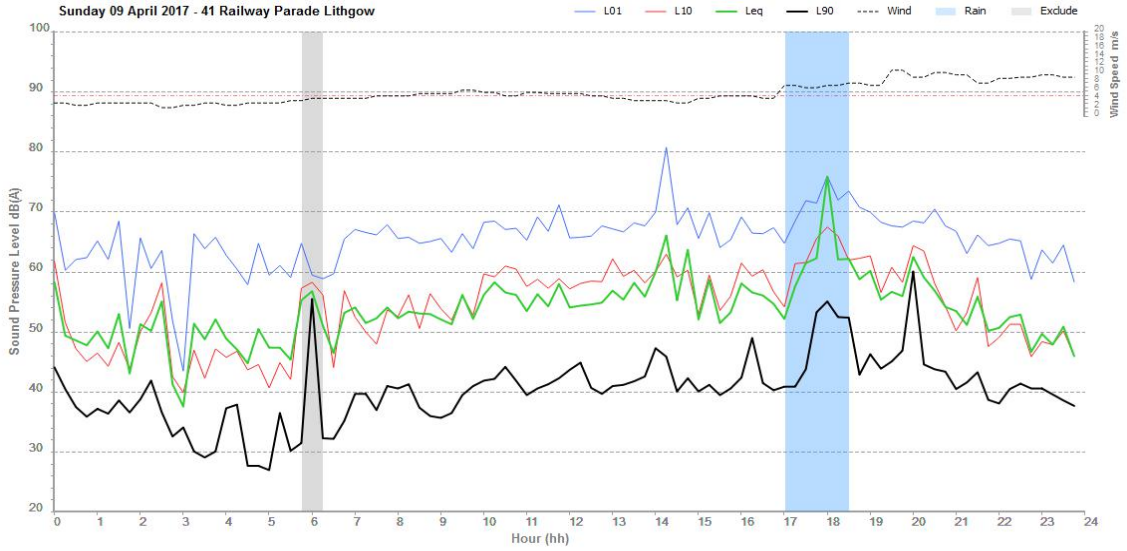
Logger Graphs

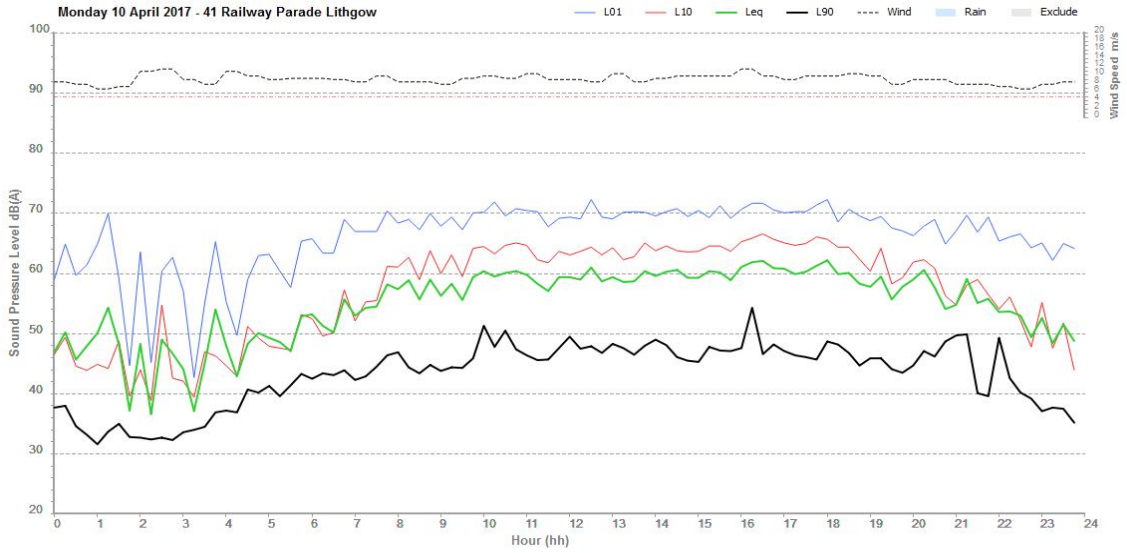






Logger Graphs





Appendix C Representative receiver locations

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Faulconbridge Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **1**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Linden Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **2**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Woodford Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **3**

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Hazelbrook Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **4**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Lawson Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **5**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Bullaburra Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **6**

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Wentworth Falls Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **7**

- Active Recreation
- Commercial
- Library
- Place of Worship
- Residential
- School

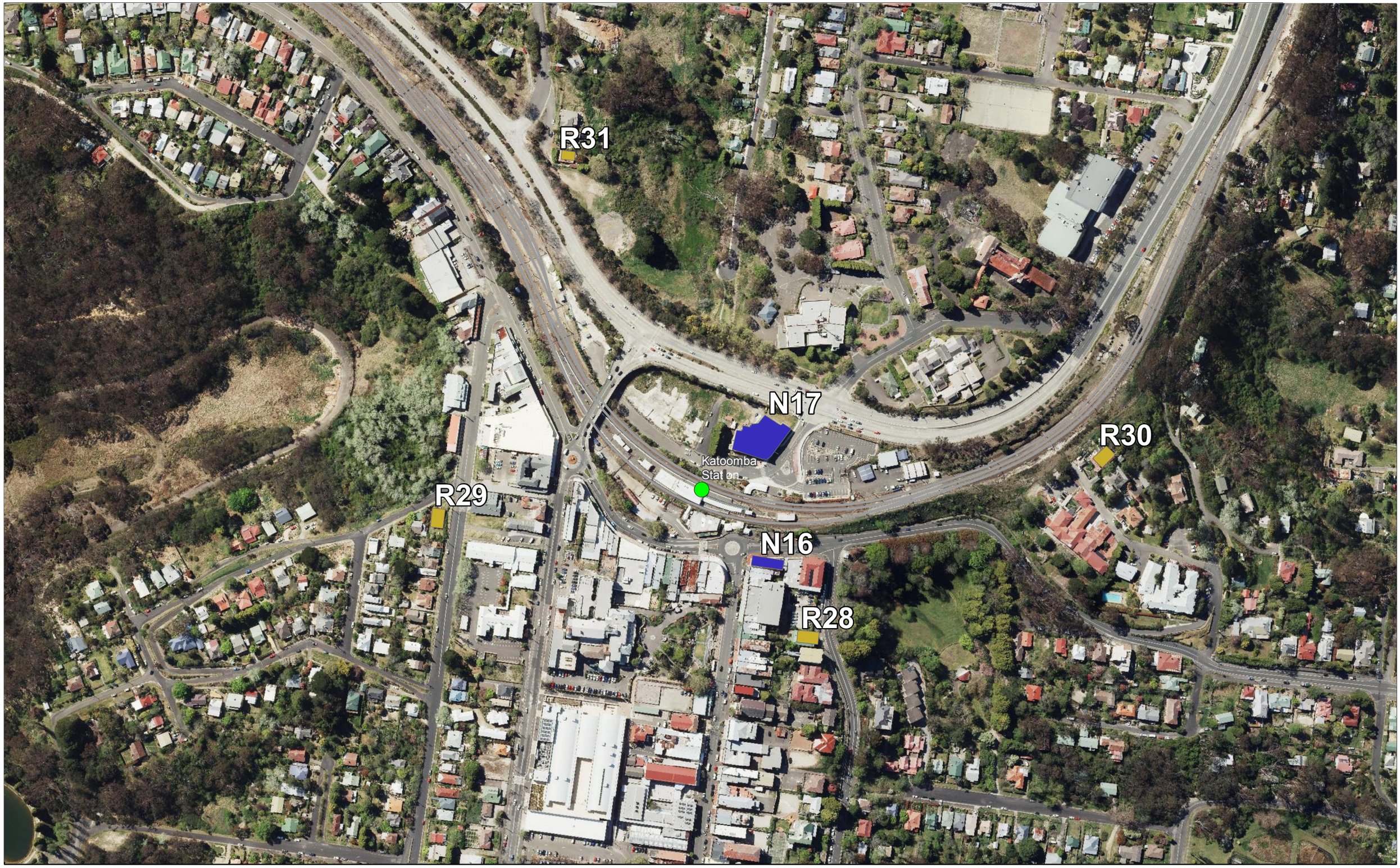
New Intercity Fleet – Route Clearance Works
Leura Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **8**

AECOM



Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Katoomba Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **9**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Medlow Bath Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **10**

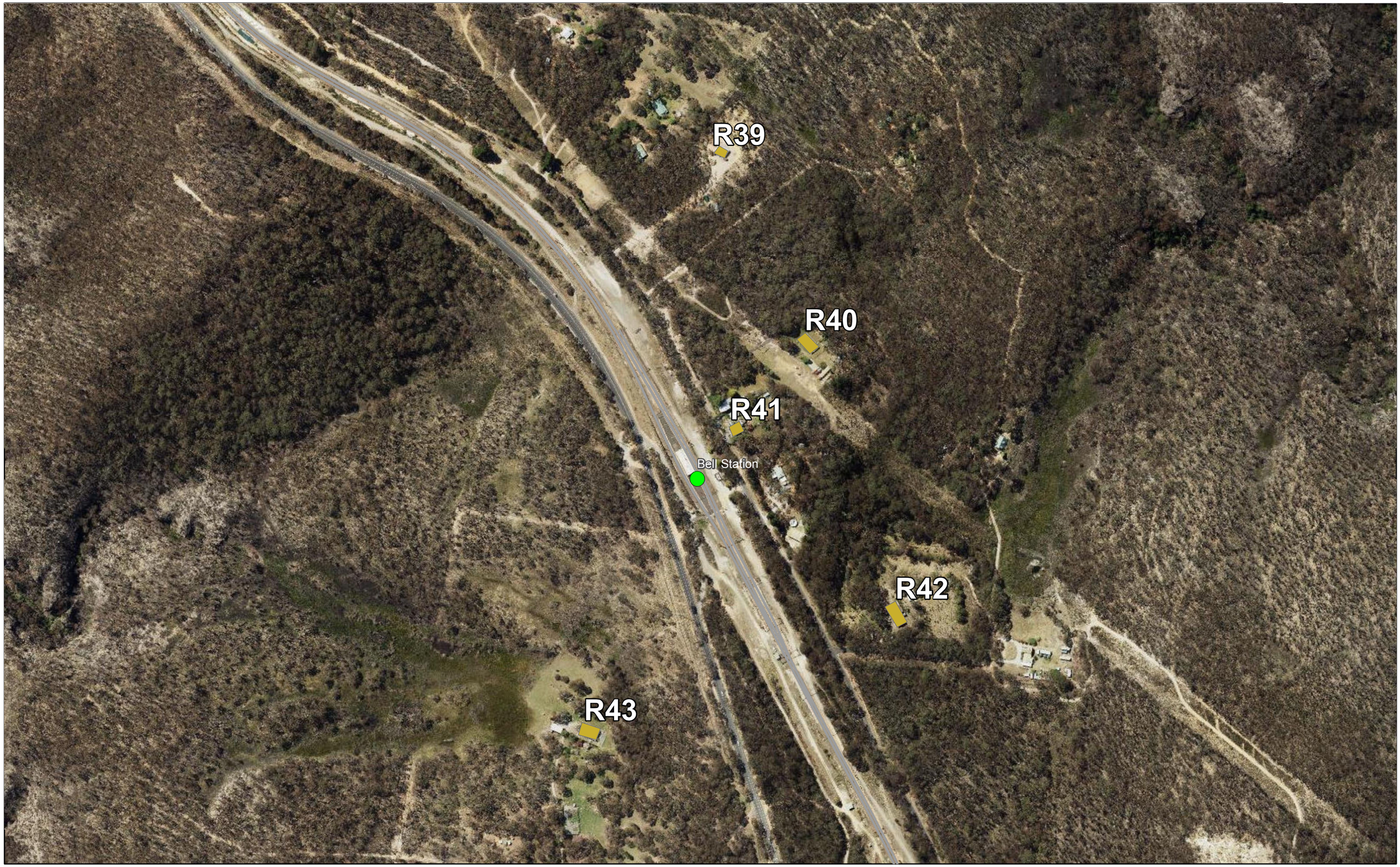
Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Blackheath Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **11**



Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Bell Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **12**

AECOM

Active Recreation
Commercial
Library
Place of Worship
Residential
School

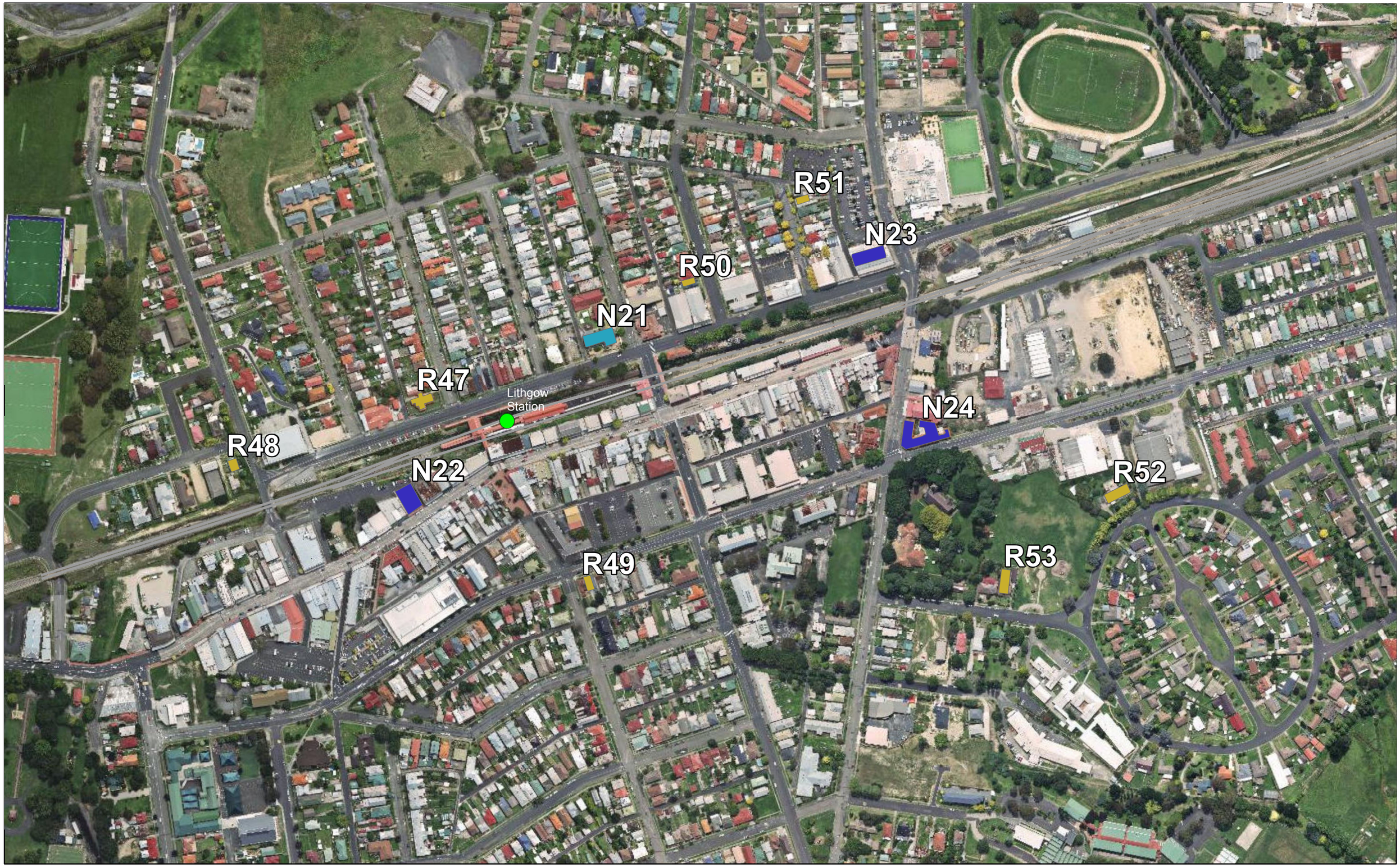
New Intercity Fleet – Route Clearance Works
Newnes Junction Station

Jul 2017
60528375

0 50 100 200 Meters

Fig. **13**

AECOM



Active Recreation
Commercial
Library
Place of Worship
Residential
School

New Intercity Fleet – Route Clearance Works
Lithgow Station

Jul 2017
60528375

Meters
0 50 100 200

Fig. **14**

Appendix D Noise logging locations

AECOM

Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Linden

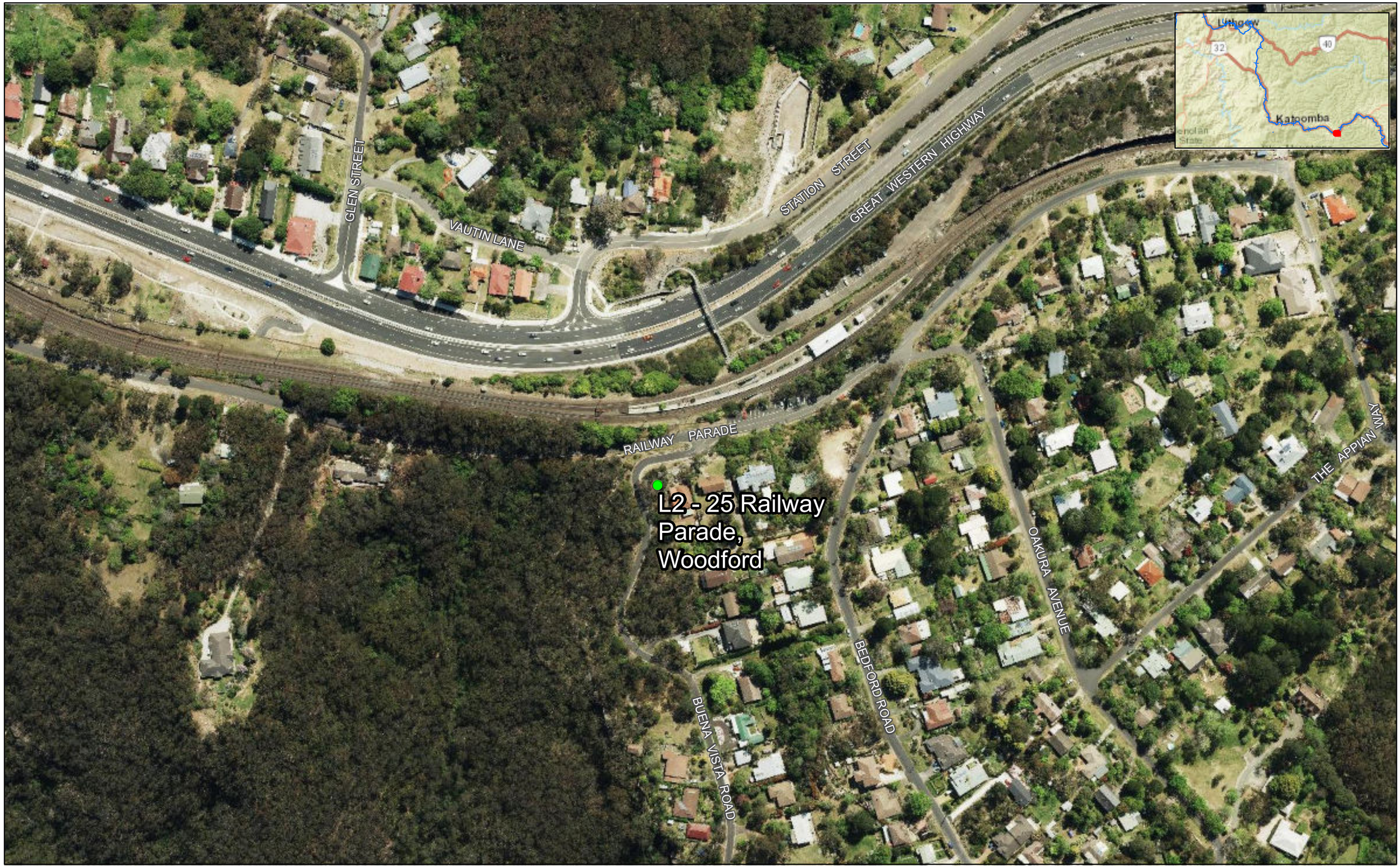
Jun 2017
60528375

N

Meters
0 50 100 200

Fig. **1**

AECOM



Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Woodford

Jun 2017
60528375

N

0 50 100 200 Meters

Fig. **2**

AECOM

Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Hazelbrook

Jun 2017
60528375

N

0 50 100 200 Meters

Fig. **3**

AECOM

Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Katoomba

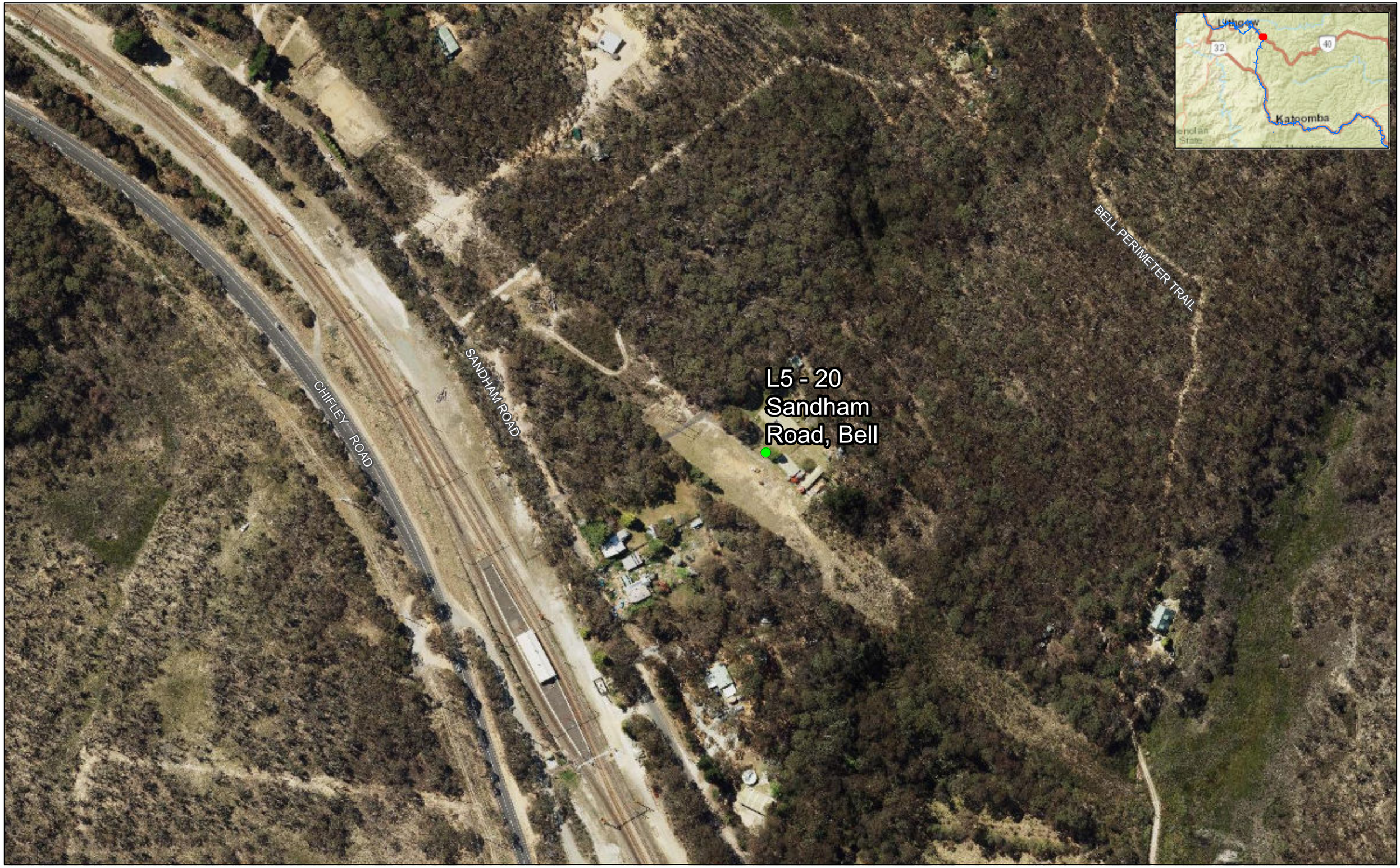
Jun 2017
60528375

N

0 50 100 200 Meters

Fig. **4**

AECOM



Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Bell

Jun 2017
60528375

N

0 50 100 200 Meters

Fig. **5**

AECOM

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS

● Logger Locations

New Intercity Fleet – Route Clearance Works
Noise Monitoring Location - Lithgow

Jun 2017
60528375

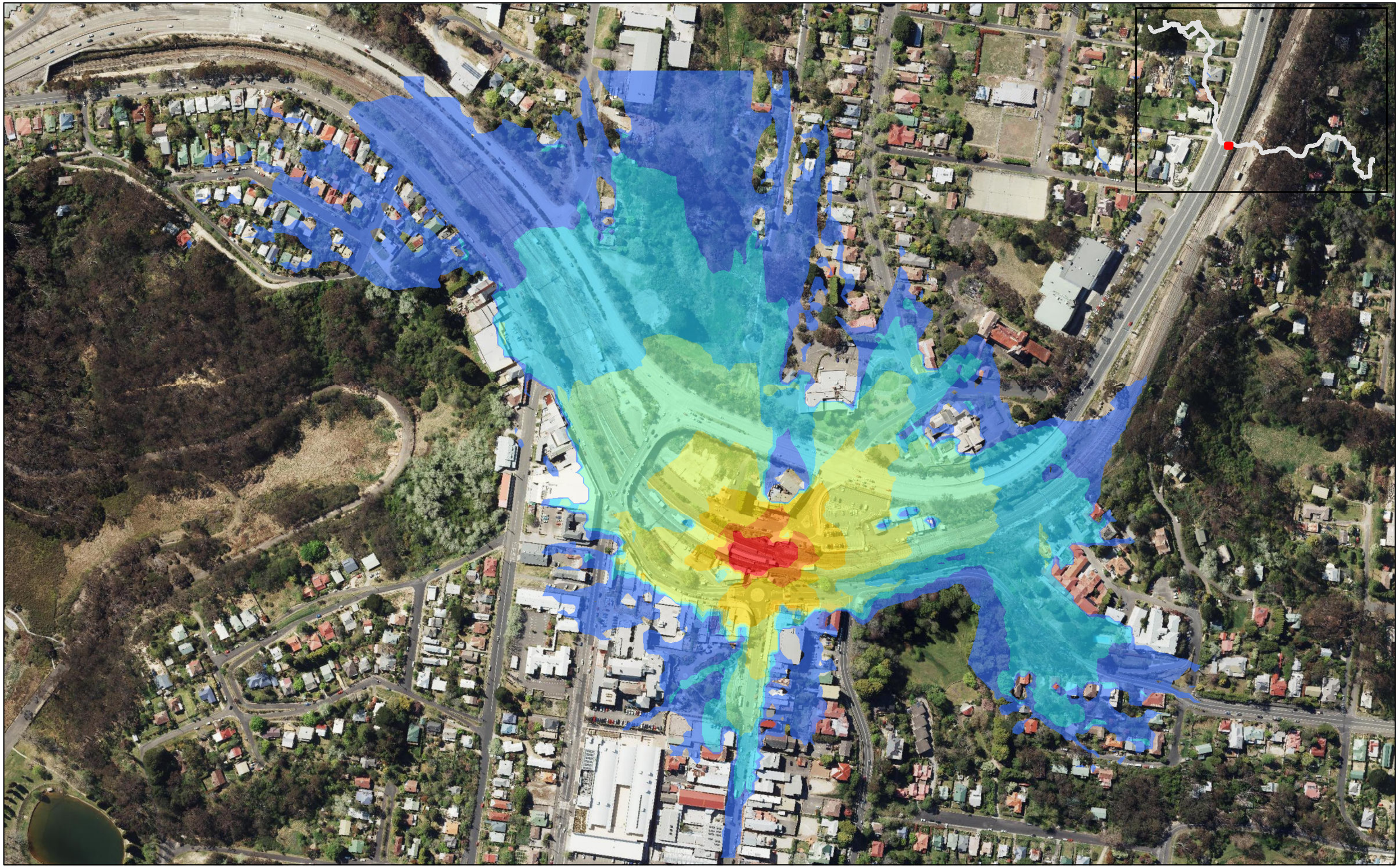
N

0 50 100 200 Meters

Fig. **6**

Appendix E Noise contour maps

AECOM



Sound Pressure Level, L_{Aeq} dB(A)

< 46 | 46 - 51 | 51 - 56 | 56 - 61 | 61 - 66 | 66 - 71 | 71 - 76 | > 76

New Intercity Fleet – Route Clearance Works

Noise Contours - Platform Extension - Katoomba Station

May 2017

60528375

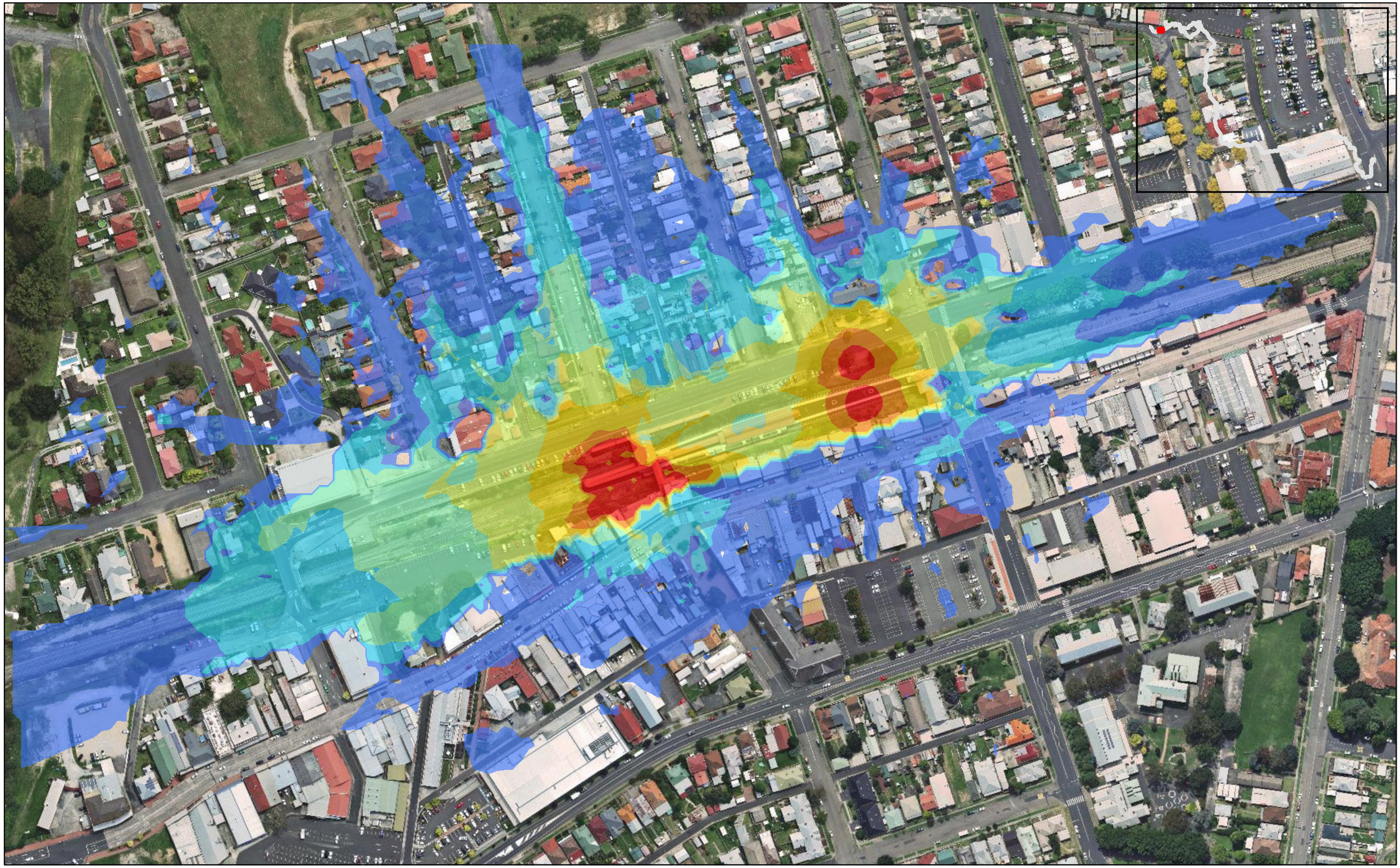
Meters

0 50 100 200

N

Fig. **1**

AECOM



Service Layer Credits: © Land and Property Information 2015

Sound Pressure Level, L_{Aeq} dB(A)

< 47	47 - 52	52 - 57	57 - 62	62 - 67	67 - 72	72 - 77	> 77

New Intercity Fleet – Route Clearance Works

Noise Contours - Platform Extension - Lithgow Station

May 2017

60528375

0 50 100 200 Meters

N

Fig. **2**

Appendix F Building exceedance maps

AECOM

Exceedance of the NML

1 - 10 dB

New Intercity Fleet – Route Clearance Works

Exceedances of the NML Standard Hours at Residential Buildings - Platform Extension - Katoomba Station

Jun 2017

60528375

Meters

0 50 100 200

N

Fig. 1

AECOM

Exceedance of the NML

- < 0 dB
- 1 - 10 dB
- 11 - 20 dB
- 30 dB

New Intercity Fleet – Route Clearance Works

Exceedances of the NML Outside Standard Hours Daytime at Residential Buildings - Platform Extension - Lithgow Station

Jun 2017

60528375

0 50 100 200 Meters

N

Fig. **2**