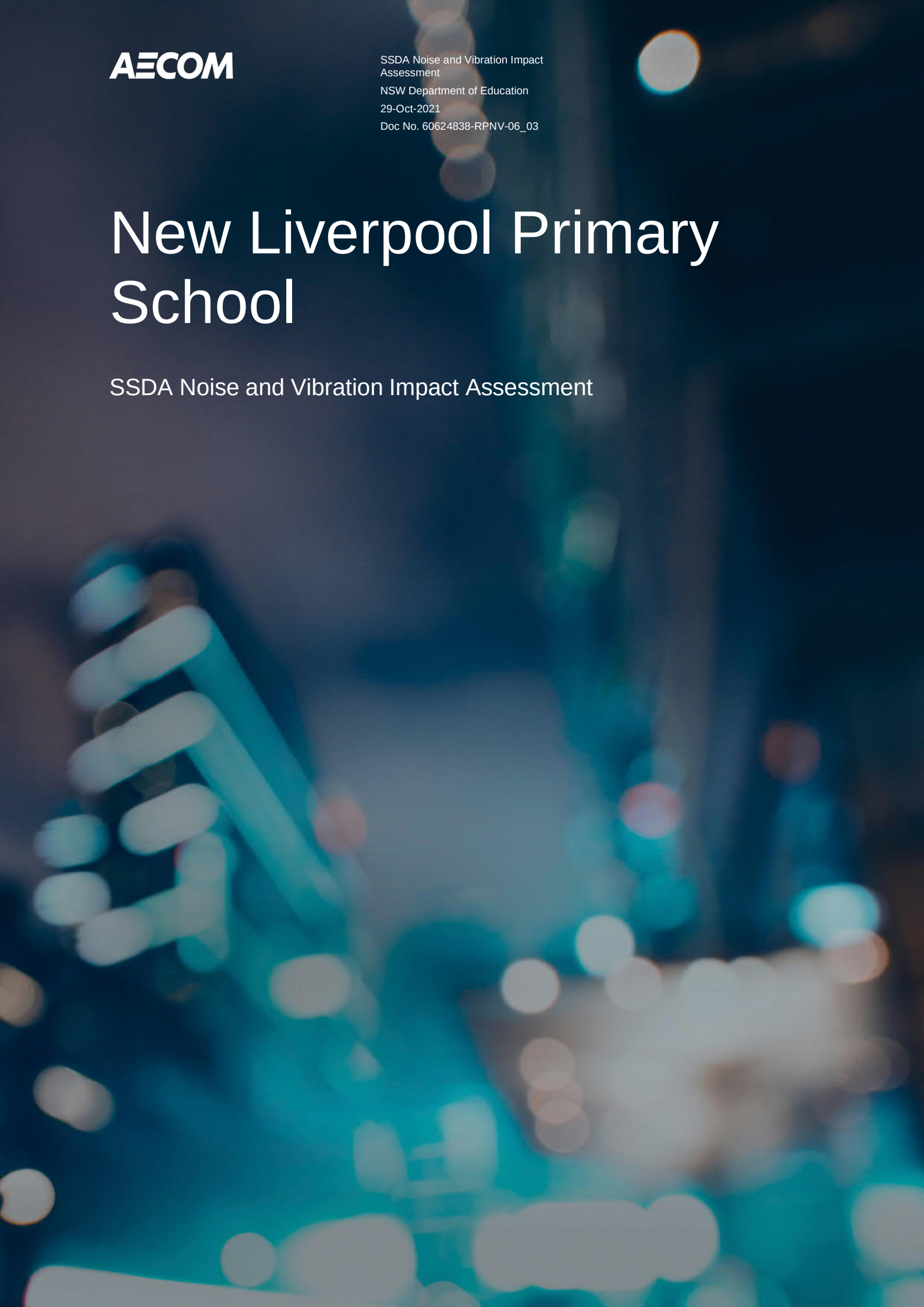
AECOM

SSDA Noise and Vibration Impact Assessment
NSW Department of Education
29-Oct-2021
Doc No. 60624838-RPNV-06_03

New Liverpool Primary School

SSDA Noise and Vibration Impact Assessment



New Liverpool Primary School

SSDA Noise and Vibration Impact Assessment

Client: NSW Department of Education

ABN: 40 300 173 822

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

29-Oct-2021

Job No.: 60624838

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Quality Information

Document New Liverpool Primary School

Ref 60624838

Date 29-Oct-2021

Prepared by Laura Keen

Reviewed by Gayle Greer

Revision History

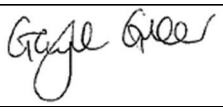
Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
00	28-Apr-2021	Draft for Comment	Laura Keen Principal Acoustic Engineer	LK
01	12-May-2021	Revision 01	Laura Keen Principal Acoustic Engineer	LK
02	10-Jun-2021	Revision 02	Laura Keen Principal Acoustic Engineer	LK
03	29-Oct-2021	Revision 03	Gayle Greer Technical Director - Acoustics	

Table of Contents

1.0 Introduction

1.1 Background

AECOM Australia Pty Ltd (AECOM) has been engaged by the NSW Department of Education, School Infrastructure NSW to provide acoustic consultancy services for the proposed New Liverpool Primary School (NLPS) located at the corner of Lachlan Street and Burnside Drive, Liverpool.

This Noise and Vibration Impact Assessment (NVIA) has been prepared on behalf of the NSW Department of Education and presents the assessment of operational and construction noise and vibration for project. The assessment has been prepared in support of an Environmental Impact Statement (EIS), which has been prepared to assess the environmental impacts associated with the project.

The Secretary's Environmental Requirements (SEARS) issued 9 January 2020 states that the EIS must include the following:

Noise and Vibration

- *Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
- *Identify and assess operational noise, including consideration of any public address system, school bell, mechanical services (eg air conditioning plant), use of any school hall for concerts etc (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to mitigate the potential noise impacts on surrounding occupiers of land.*

Relevant Policies and guidelines:

- *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority)*
- *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)*
- *Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006)*
- *Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning, 2008)*
- *Australian Standard 2363:1999 Acoustics – Measurement of noise from helicopter operations*

Operational noise management levels and vibration criteria have been established using:

- *Noise Policy for Industry* (NPfI), Environment Protection Authority (EPA), 2017
- *State Environment Protection Policy (SEPP) (Infrastructure*), 2007
- *Development Near Rail Corridors and Busy Roads – interim guideline*, Department of Planning, 2008
- *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
- *Australian Standard AS 2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction*

Construction noise management levels and vibration criteria have been established using:

- *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.

The operational and construction noise and vibration impact assessment is presented in this report along with noise and vibration mitigation treatments and strategies. The scope of the assessment includes:

- Operational noise and vibration
  - Major noise emitting plant
  - Traffic noise generation
  - Design of building envelope to attenuate traffic noise intrusion
  - Noise emission from indoor spaces, such as the school hall
  - Noise emission from outdoor spaces, such as outdoor play and sport
  - Recommendations for noise control measure to be incorporated into the architectural and services design strategies
- Construction noise and vibration
  - Noise predictions for construction scenarios
  - Noise impact assessment
  - Recommendations for construction noise control measures to be incorporated into a construction noise management strategy.

1.2 Site description

The New Liverpool Primary School (NLPS) is located within the grounds of the existing Liverpool Boys and Girls High School in the Liverpool Central Business District (CBD), at 18 Forbes Street, Liverpool. The proposed New Liverpool Primary School is located in the eastern portion of the existing school grounds (refer to Figure 1.)

The site is legally described as Lot 1 in DP 1137425. Land use to the north of the site is predominantly residential and Hart Park which is passive recreation area. To the east of the site are rail lines with industrial land uses beyond. South of the site are Liverpool hospital with Liverpool TAFE and Bigge Park (passive and active recreation areas) on the other side of the hospital. To the west of the site are Liverpool Boys High School and Liverpool Girls High School and on the far side of Forbes Street, are a mix of residential, commercial properties and a place of worship.

Figure 1 NLPS Site Plan

1.3 Works description

The application seeks consent for the construction and operation of a New Liverpool Primary School. This would include construction of a new school building for core school facilities, teaching spaces, support units, preschools as well as associated landscaping and open space improvements. A detailed description of development is provided by Ethos Urban within the EIS.

1.4 Proposed activities

The development is proposed to be used for both school activities and community use as follows:

- School use
  - Accommodation of up to 1200 students.
  - Outdoor play for the entire student body for morning tea and lunch
  - Indoor teaching within classrooms, libraries and other school buildings
  - Outdoor teaching and sports
  - School assemblies, concerts and dances within the school hall
- Community use
  - Community use would be limited to the library, hall and outdoor play areas

- Concerts and dances within the hall
- Sport on unencumbered play areas

1.5 Document purpose

This Noise and Vibration Impact Assessment is intended to provide a reference for the policies, guidelines and standards that apply to the treatment and management of operational and construction noise and vibration associated with a large building project.

The Noise and Vibration Impact Assessment also sets out the applicable criteria, standard noise and vibration mitigation measures and monitoring, reporting and complaint management requirements.

1.6 SEARs requirements

Table 1 presents a guide to where the noise and vibration SEARs requirements have been addressed in this report.

Table 1 SEARs requirements

SEARs Requirements		Relevant Section of the Report
12 Noise and Vibration		
Construction Noise	Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.	Section 4.0 Section 6.0 Appendix D
	Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.	Section 7.0
Operational Noise	Identify and assess operational noise, including consideration of any public address system, school bell, mechanical services (eg air conditioning plant), use of any school hall for concerts etc (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to mitigate the potential noise impacts on surrounding occupiers of land.	Section 3.0 Section 5.0 Appendix C

2.0 Noise Monitoring

Long-term unattended measurements at three locations were undertaken to establish the existing ambient and background noise environment at potentially affected receivers in the vicinity of the proposed site. AECOM conducted noise monitoring from Wednesday 9 September to Thursday 24 September 2020 to establishing existing background noise levels. Three noise loggers were placed at Liverpool Boys' High School, refer to Figure 2. The project area was divided into three noise catchment areas (NCAs), as shown in Figure 2. The NCAs were determined by reviewing existing land use and identifying groups of noise sensitive receivers which are likely to be exposed to a similar noise environment. The noise environment at each of the residential receivers within an NCA is considered to have a similar noise environment to the unattended monitoring location applicable to that NCA. As such each of these residential receivers is assigned the same background and ambient noise levels.

A description of the NCAs developed for this project are presented in Table 2.

Table 2 Noise catchment areas and description

NCA	Description of noise catchment area
1	NCA 1 mostly comprises residential apartment buildings, to the west of Forbes Street. There is also a church and Health services building within the noise catchment area. Applicable noise logging location: Location 1
2	NCA 2 comprises 2 to 4 storey residential apartment buildings, to the north of Lachlan Street. Applicable noise logging location: Location 2
3	NCA 3 comprises a few single residential buildings, to the east of Burnside Drive. The area is mostly an industrial precinct along with a railway station to the east of Burnside Drive. Applicable noise logging location: Location 3

It is recognised that, where possible, the most, or potentially, most affected receiver should be adopted as a monitoring location. However, it is also noted that in accordance with Note 3 of Table A1 of the NPfI "*where it is impractical or not possible to monitor at the reasonably most- or potentially most affected location(s), the location selected should be fully justified as being representative of background noise levels".*

The environmental noise monitoring was conducted at such a time, that in consultation with NSW Schools Infrastructure Communications Representatives and consideration of public health measures, contact with residents and the accessing of private residential property was to be avoided. The most- or potentially most- affected receiver has been determined to be residences located along the northern side of Lachlan Street.

Two long-term noise monitoring locations were selected on the southern side of Lachlan Street to provide measurements representative of those at the residences on Lachlan Street. One of these locations is located within 25 metres of residences, the other approximately 70 metres from residences. Both of the measurements locations were sufficiently far from stationary noise sources associated with the existing Liverpool Boys High School (such as mechanical plant) and close enough to the residences that the measured background L_{A90}, noise levels would not differ from the background noise levels at the Lachlan Street residences. It is also noted that the monitoring locations are a similar set back from Lachlan Street as the residential buildings such that measured traffic noise levels would be applicable to the residences. It is therefore considered that the locations are justified as being representative of the most- or potentially most- affected receivers and in compliance with the NPfI Table A1 Note 3.

Figure 2 Noise monitoring locations and noise catchment areas (NCAs)

2.1 Instrumentation

The equipment used for the noise measurements is detailed in Table 3.

Table 3 Environmental noise monitoring equipment

NCA	Location	Equipment	Serial number
1	Location 1: Liverpool Boys High School (Forbes Street)	Rion NL52	00898334
2	Location 2: Liverpool Boys High School (Lachlan Street)	Rion NL52	00876010
3	Location 3: Liverpool Boys High School (Burnside Drive)	ARL315	15299444

Calibration of the meters was checked on site with a Rion Sound Calibrator NC-74 (Serial Number 34667836) at the beginning and end of the measurement periods, with a drift in calibration not exceeding ± 0.5 dB.

All the acoustic instrumentation employed during the noise measurements comply with the requirements of Australian/New Zealand Standard AS/NZS IEC 61672.1:2019 *Electroacoustics - Sound level meters – Part 1: Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

In accordance with the EPA's Noise Policy for Industry (NPfI), noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data was acquired from the Bureau of Meteorology's Holsworthy weather station (station ID 066161).

2.2 Noise monitoring methodology

The microphones of all loggers were 1.5 metres above ground level. The loggers were set for sample periods of 15 minutes. The loggers measured the noise levels over the sample period and then determined L_{A10}, L_{A90}, L_{Amax}, and L_{Aeq} levels of the noise environment. The L_{A10} and L_{A90} levels are the levels exceeded for 10% and 90% of the sample period respectively. The L_{Amax} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{A90} is taken as the background noise level. 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 background noise level is defined by the EPA as 'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed'. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is considered to be represented by the L_{A90} descriptor. The noise levels measured at the proposed development site were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the EPA's NPfI, for each monitoring location. The ABL is established by determining the lowest ten percentile level of the L_{A90} noise data acquired over each period of interest. A summary of the measurement data is presented in Table 4. Noise levels are also graphically presented in Appendix B.

Table 4 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

Measurement date	L_{A90} Background noise levels, dB(A)			L_{Aeq} Ambient noise levels, dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NCA 1 – Location 1: Forbes Street, Liverpool						
Wed Sep 9 2020	-	44	-	64	58	55
Thu Sep 10 2020	-	44	41	62	59	55
Fri Sep 11 2020	48	44	42	60	58	55
Sat Sep 12 2020	45	44	40	55	56	53
Sun Sep 13 2020	43	42	40	56	55	53
Mon Sep 14 2020	47	43	41	60	57	55
Tue Sep 15 2020	47	43	39	60	59	56
Wed Sep 16 2020	47	44	40	60	56	55
Thu Sep 17 2020	46	-	41	60	56	56
Fri Sep 18 2020	47	41	40	61	56	56
Sat Sep 19 2020	-	44	39	56	56	53
Sun Sep 20 2020	45	44	40	58	57	54
Mon Sep 21 2020	48	43	41	62	57	55
Tue Sep 22 2020	-	42	40	58	56	56
Wed Sep 23 2020	47	42	40	60	57	56
Thu Sep 24 2020	-	-	-	61	-	55
RBL/Log Average	**47**	**44**	**40**	**60**	**57**	**55**
NCA 2 – Location 2: Lachlan Street, Liverpool						
Wed Sep 9 2020	-	44	-	64	59	54
Thu Sep 10 2020	-	46	41	60	59	56
Fri Sep 11 2020	47	45	42	60	59	57
Sat Sep 12 2020	44	45	42	57	56	56
Sun Sep 13 2020	44	42	40	57	56	55
Mon Sep 14 2020	47	45	42	59	57	56
Tue Sep 15 2020	48	44	41	60	58	56
Wed Sep 16 2020	47	44	42	59	56	57
Thu Sep 17 2020	-	-	42	59	57	57
Fri Sep 18 2020	48	43	40	60	58	58
Sat Sep 19 2020	-	45	38	57	56	54
Sun Sep 20 2020	46	43	40	59	58	55
Mon Sep 21 2020	48	44	41	59	58	56
Tue Sep 22 2020	-	43	39	57	56	56
Wed Sep 23 2020	47	42	39	59	58	56
Thu Sep 24 2020	-	-	-	61	-	56
RBL/Log Average	**47**	**44**	**41**	**60**	**58**	**56**

Measurement date	L_{A90} Background noise levels, dB(A)			L_{Aeq} Ambient noise levels, dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NCA 3 – Location 3: Burnside Drive, Liverpool						
Wed Sep 9 2020	-	46	-	67	60	58
Thu Sep 10 2020	-	48	44	63	60	58
Fri Sep 11 2020	47	47	46	60	60	58
Sat Sep 12 2020	43	47	45	58	59	57
Sun Sep 13 2020	45	44	44	58	60	57
Mon Sep 14 2020	48	46	46	61	60	58
Tue Sep 15 2020	47	46	44	64	60	58
Wed Sep 16 2020	46	46	45	60	59	58
Thu Sep 17 2020	46	-	48	64	63	61
Fri Sep 18 2020	48	45	43	65	59	60
Sat Sep 19 2020	-	46	41	59	58	55
Sun Sep 20 2020	47	46	43	61	58	56
Mon Sep 21 2020	48	46	44	60	58	58
Tue Sep 22 2020	0	46	43	58	59	57
Wed Sep 23 2020	47	45	43	59	59	59
Thu Sep 24 2020	-	-	-	60	-	57
RBL/Log Average	**47**	**46**	**44**	**62**	**60**	**58**

Notes:

1. *Day is defined as 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.*

   Evening is defined as 6pm to 10pm Monday to Sunday and Public Holidays.

   Night is defined as 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

3.0 Operation Noise and Vibration Criteria

3.1 Noise Policy for Industry – Operational Noise Trigger Levels

Under the NSW Protection of the Environment (Operations) Act 1997, the Environment Protection Authority (EPA) document Noise Policy for Industry (NPfI) provides guidance in relation to acceptable noise trigger levels for industrial noise emissions.

The Secretary's Environmental Assessment Requirements (SEARs) indicates that the EPA's NPfI should be used to assess noise emission from this development.

The NPfI provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The NPfI applies to all noise emission from permanent operations fixed facilities for the project. The assessment procedure for industrial noise sources has two components that must be considered:

- Controlling intrusiveness noise impacts in the short term for residences; and
- Maintaining noise level amenity for residences and other land uses.

3.1.1 Intrusiveness noise impacts

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the background noise level measured by more than 5 dB. The Rating Background Levels (RBLs) and resultant project intrusiveness noise levels are presented in Table 5.

Table 5 NPfI recommended $L_{Aeq,15\ minute}$ intrusiveness noise levels from industrial noise sources

Location		Period[4]	RBL (L_{A90}), dB(A)	Intrusiveness noise level (RBL + 5), ($L_{Aeq\ 15\ minutes}$), dB(A)
Residential Receivers	NCA1[1]	Day	47	52
		Evening	44	49
		Night	40	45
	NCA2[2]	Day	47	52
		Evening	44	49
		Night	41	46
	NCA3[3]	Day	47	52
		Evening	46	51
		Night	44	49

Notes:

1. *Based upon measured noise levels at Liverpool Boys High School (Forbes Street).*
2. *Based upon measured noise levels at Liverpool Boys High School (Lachlan Street).*
3. *Based upon measured noise levels at Liverpool Boys High School (Burnside Drive).*
4. *Day is defined as 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.*

   Evening is defined as 6pm to 10pm Monday to Sunday and Public Holidays.

   Night is defined as 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

As per the NPfI, intrusiveness noise levels are only applied to residential receivers. For other receivers, only the amenity levels apply.

3.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the recommended amenity noise levels specified in Table 2.2 of the NPfI. As per the definitions of receiver types within the NPfI, residences are classified as being in an urban area.

Table 6 NPfI recommended L_{Aeq} amenity noise levels from industrial sources

Type of receiver	Noise amenity area	Time of day	Recommended noise level ($L_{Aeq, period}$), dB(A)
Residential	Urban	Day	60
		Evening	50
		Night	45
School Classroom – Internal	All	Noisiest 1-hour period when in use	35[1]
Hospital Ward – Internal	All	Noisiest 1-hour	35
Hospital Ward – External	All	Noisiest 1-hour	50
Place of Worship – Internal	All	When in use	40
Area specifically reserved for passive recreation	All	When in use	50
Active recreation area	All	When in use	55
Commercial Premises	All	When in Use	65
Industrial Premises	All	When in use	70
Industrial Interface (only applicable to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes:

1. *In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB L_{Aeq1hr}.*

The amenity level applicable to the project is equal to the recommended level minus 5 dB(A). This takes into account the cumulative impacts from other industrial noise sources in the area.

As per the NPfI, the project amenity level is converted to a 15 minute period by adding 3 dB.

3.1.3 Project noise trigger levels

Table 7 presents the applicable project noise trigger levels.

Table 7 NPfI project noise trigger levels

Type of receiver		Time of day	Intrusiveness noise level (RBL+5) ($L_{Aeq, 15\ minutes}$), dB(A)	Project amenity level ($L_{Aeq, 15\ minutes}$), dB(A)	Project noise trigger level ($L_{Aeq\ 15\ minutes}$), dB(A)
Residential Receivers	NCA1	Day	52	58	52
		Evening	49	48	48
		Night	45	43	43
	NCA2	Day	52	58	52
		Evening	49	48	48
		Night	46	43	43
	NCA3	Day	52	58	52
		Evening	51	48	48
		Night	49	43	43
School Classroom – Internal		Noisiest 1-hour period when in use	-	38[1]	38[1]
Hospital Ward – Internal		Noisiest 1-hour	-	33	33
Hospital Ward – External		Noisiest 1-hour	-	48	48
Place of Worship – Internal		When in use	-	38	38
Area specifically reserved for passive recreation		When in use	-	48	48
Active recreation area		When in use	-	53	53
Commercial Premises		When in Use	-	63	63
Industrial Premises		When in use	-	68	68

Notes:

1. *Amenity noise level has been adjusted due to existing industrial noise levels at the project site in accordance with Section 2.4 of the Noise Policy for Industry.*

Adjustments to the level of noise predicted at the assessment location may be applied in accordance with Fact Sheet C of the NPfI to account for the subjective effects of specific noise characteristics including tonality, low frequency content, intermittency, impulsiveness and duration.

3.1.4 Sleep disturbance trigger levels

The NPfI requires the potential for sleep disturbance to be assessed by considering maximum noise level events during the night-time period.

Where night-time noise levels from the proposed development at a residential location exceed the following screening levels, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq, 15\ minute}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is greater; and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance trigger levels for the noise sensitive residential receivers are presented in Table 8.

Table 8 Night-time sleep disturbance trigger levels

Type of receiver	NCA	Measured night period RBL ($L_{Aeq, 15\ minute}$), dB(A)	Sleep disturbance screening trigger levels	
			$L_{Aeq, 15\ minutes}$, dB(A)	L_{AFmax}, dB(A)
Residential	1	40	45	55
	2	41	46	56
	3	44	49	59

3.2 Noise from road traffic generation – Road Noise Policy

Land use developments with the potential to create additional traffic on surrounding roads should be assessed using the EPA's Road Noise Policy (RNP). The external noise criteria are applied at 1 metre from the affected external building façade.

Table 9 Road traffic noise assessment criteria for existing residences affected by additional traffic

Period	Parameter	Criterion
Lachlan Street, Forbes Street, Goulburn Street, Campbell Street and Hart Street (Sub-Arterial)		
Day (7am – 10pm)	$L_{Aeq\ (15hr)}$	60 dB(A)
Night (10pm – 7am)	$L_{Aeq\ (9hr)}$	55 dB(A)
Drummond Street and Burnside Drive (Local roads)		
Day (7am – 10pm)	$L_{Aeq\ (1hr)}$	55 dB(A)
Night (10pm – 7am)	$L_{Aeq\ (1hr)}$	50 dB(A)

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

To assess noise impacts from additional traffic generated by the project, an initial screening test is undertaken to determine if existing road traffic noise levels would 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 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 Road and rail traffic noise intrusion

3.3.1 Development Near Rail Corridors and Busy Roads – Interim Guideline

The NSW Department of Planning document Development Near Rail Corridors and Busy Roads – Interim Guideline, presents noise criteria for sensitive receivers. Criteria relevant to the NLPS development are outlined in Table 10.

Table 10 Traffic noise intrusion – Development Near Rail Corridors and Busy Roads – Interim Guideline

Type of occupancy	Noise criteria, dB(A)
Educational Institutions including child care centres	40

3.4 Air traffic noise intrusion

3.4.1 Australian Standard AS 2021:2015

Australian Standard AS 2021:2015 contains guidelines for assessing maximum levels of aircraft noise intrusion based on the location of a building with respect to the Australian Noise Exposure Forecast (ANEF) contours. The suitability of the site of a given building type is ranked as either “Unacceptable”, “Conditionally Acceptable” or “Acceptable”.

Air operations in the vicinity of the project site are generated from the use of the helipads located at Liverpool Hospital. Due to the irregularity and emergency nature of these movements, ANEF contours are not available for the project site and this portion of AS 2021 is not considered applicable to apply the “land use planning” function for the NLPS project.

The building envelope would however be designed to meet the AS 2021:2015 guideline criteria for aircraft noise intrusion.

Table 11 presents a summary of the recommended aircraft noise intrusion indoor design sound levels applicable to this project.

Table 11 AS 2021:2015 recommended aircraft noise intrusion indoor design sound levels

Type of occupancy/activity	Aircraft noise intrusion indoor design sound level, dB(A)
Private offices, conference rooms	55
General office areas	65
Classrooms	55
Libraries, study areas	50
Workshops, gymnasia	75

Australian Standard AS 2363:1999 *Acoustics – Measurement of noise from helicopter operations* describes methods of measuring noise emission from helicopter operations. This Standard has been withdrawn by Standards Australia and does not provide direction on the assessment of aircraft noise intrusion to buildings and the treatment thereof. Sound power level data and offset from the Liverpool Hospital helipad approach and departure paths have been used to determine external design noise levels at the project site and AS 2021:2015 has been utilised for the assessment of aircraft noise intrusion to NLPS buildings.

4.0 Construction Noise and Vibration Criteria

Construction of the proposed development has the potential to temporarily contribute to the existing external noise environment. Noise is expected to be generated by construction works as well as construction traffic movements. This section presents construction noise and vibration management levels in order to address the following acoustical issues:

- Construction noise and vibration impacts

4.1 Construction noise management levels

The risk of adverse impact of construction noise on a community is determined by the extent of its emergence above the existing background noise level, the duration of the event and the characteristics of the noise.

The NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG) is a NSW Government document that sets out ways to deal with the impacts of construction noise on residences and other sensitive land uses. It presents assessment approaches tailored to the scale of the construction project and identifies practices to minimise noise impacts. The ICNG recommends that a quantitative assessment is carried out for all major construction proposals that are typically subject to the environmental impact assessment processes. A quantitative assessment, based on the likely construction scenarios, has been carried out for this project.

Predicted construction noise levels at nearby noise sensitive receivers (e.g. residences, schools, hospitals, places of worship, passive and active recreation areas) are compared to the levels provided in 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 (NMLs) for the residential and other sensitive land uses in proximity to the site are detailed below.

4.1.1 Residential receivers

Guidance for setting construction noise management levels for residential receivers are summarised in Table 12.

Table 12 Construction noise management levels – residential receivers

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours[2]:	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise.

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays		• Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 (ICNG).

Notes:

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

2. *As noted, standard construction hours are Monday to Friday 7 am to 6 pm and Saturday 8 am to 1 pm*

The above guidance has been utilised to define NMLs applicable to residences adjacent to the development. The project specific NMLs are summarised in Table 13.

Table 13 Construction noise management levels – Residential receivers

Residential receiver locations	Recommended standard hours RBL	Recommended standard hours noise management levels L_{Aeq} dB(A)	Highly noise affected level L_{Aeq} dB(A)
NCA1	47	57	75
NCA2	47	57	75
NCA3	47	57	75

4.1.2 Other sensitive land uses and commercial receiver noise management levels

Noise management levels for non-residential receivers located adjacent to the site have been determined using the recommended levels in the ICNG for other sensitive land uses and commercial buildings. The NMLs are presented in Table 14.

Table 14 Noise at sensitive land uses (other than residences) and commercial buildings

Land use	External noise levels, $L_{Aeq,15min}$ (Applies when properties are in use)
Educational institutions	65 dB(A)[1]
Hospital	65 dB(A)[1]
Place of worship	65 dB(A)[1]

Notes:

1. Assumes an external to internal noise level reduction through a closed window of 20 dB(A)

4.2 Vibration criteria

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.

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 15.

Table 15 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	Heritage structures – German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150) Non-heritage structures – Evaluation and Measurement for Vibration in Buildings Part 2, (British Standard (BS) 7385:Part 2-1993) (BS 7385)
Human comfort (tactile vibration)	Assessing Vibration: A Technical Guideline (AVATG)[1]

Notes:

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. However, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

4.2.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 and BS 7385-2 provide recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 16 and Table 17. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. Structural damage criteria for heritage items have been taken from DIN 4150, whilst criteria for commercial/residential items have been taken from BS 7385.

Table 16 Structural damage safe limits (DIN 4150) for building vibration (Vibration peak particle velocity)

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*

Table 17 BS 7385-2: Transient vibration guide values for cosmetic damage

Group	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

4.2.2 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/s1.75)

Location	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
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.*

5.0 Operational Noise and Vibration Assessment

The operational noise assessment, including assessment of noise emission and noise intrusion, is detailed in this section of the report with regard to the established criteria presented in Section 3.0. The acoustic assessment is based on the architectural drawings issued by Fitzpatrick and Partners detailed below:

- 22102-NLPS-AR-SD-0001 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-0201 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-0202 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1101 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1102 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1103 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1104 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1201 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1202 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1301 Issue 02 19/04/2021
- 22101-NLPS-AR-SD-1302 Issue 02 19/04/2021

5.1 Building services noise emission assessment

5.1.1 Equipment selections and noise levels

Details of proposed major plant items have been provided by Steensen Varming. The plant items and indicative associated sound power levels are provided in Table 19.

Table 19 Major plant items and associated sound power levels, dB

Location	Plant item	Octave band centre frequency, Hz						
		63	125	250	500	1k	2k	4k
CUPR01 Ground	Condenser Unit (5 units)	96	92	91	87	85	81	79
CUPR02 Ground	Condenser Unit (6 units)	96	92	91	87	85	81	79
CUPR03 Ground	Condenser Unit (3 units)	96	92	91	87	85	81	79
CUPR01 Level 1	Condenser Unit (7 units)	96	92	91	87	85	81	79
CUPR02 Level 1	Condenser Unit (6 units)	96	92	91	87	85	81	79
CUPR01 Level 2	Condenser Unit (4 units)	96	92	91	87	85	81	79
CUPR02 Level 2	Condenser Unit (6 units)	96	92	91	87	85	81	79
Northern Boundary	Padmount Substation	Overall 66 dB(A)[1]						

Notes:

1. In accordance with AS/NZS 60076

For the purposes of this noise and vibration impact assessment, the following scenarios have been considered for noise emission from the mechanical condenser units:

- Day (7am to 6pm): All condenser units operating simultaneously

- Evening (6pm to 10 pm): Condenser units located in CUPR01 Ground and CUPR03 Ground operating simultaneously
- Night (10 to 7am): Two units located in CUPR01 Ground or CUPR03 operating.

5.1.2 Acoustic treatments

The following acoustic treatments would be incorporated into the NLPS design:

- Acoustic louvres to all condenser plant rooms. Acoustic louvres are to have the minimum transmission loss presented in Table 20.
- Internally lined ductwork comprising minimum 2 metres straight duct and one bend to be applied to each condenser unit discharge. Internal lining to be minimum 50 mm thick.
- External plant room walls and roofs, with the exception of acoustic louvred area, to have a minimum R_w 40 acoustic performance

Table 20 Minimum acoustic louvre transmission loss, dB

Louvre location	Indicative depth, mm	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
Plant room	300	4	7	9	13	14	12	12	8

Incorporation of the above treatments results in building services meeting the applicable project trigger noise levels presented in Section 3.0 with the exception of Liverpool Boys High School.

The NPfI project noise trigger level for schools classrooms is assessed as an internal noise level. Based on a worst-case-scenario of open classroom windows at Liverpool Boys High School and a 10 dB noise reduction through an open window, it is predicted that the project noise trigger level would be exceeded within the eastern-most classrooms. However, it is noted that:

- Exceedances within the classrooms with the windows open are predicted to be less than 2 dB. A noise level difference of up to 2 dB is considered to imperceptible to the human ear and therefore this exceedance is considered minor.
- Compliance with the NPfI project noise trigger level can be achieved by closing the east facing windows of the classrooms
- Only a very small number of Liverpool Boys High School classrooms are affected.

In consideration of the above, the predicted minor exceedance of criteria at Liverpool Boys High School should not preclude the development from proceeding.

Operational noise contours for building services noise emission are presented in Appendix C

5.2 Outdoor area usage noise emission assessment

Outdoor areas of the proposed school grounds would be utilised for the following activities:

- Outdoor play, including morning tea and lunch breaks
- Physical education
- After-school sports
- Out of School Hours Care (OSHC).

Assessed scenarios that are considered representative of the worst-case for the above activities are as follows:

- Outdoor Play
  - 1,200 students total
  - 200 students located in the courtyard
  - 1,000 students located in the unencumbered play areas
  - $L_{Aeq,15min}$ 10 children: 87 dB(A)
  - Occurs during the day (7am to 6pm) period only
- Physical education and after-school sports
  - 160 students total
  - All students located on the unencumbered play areas
  - $L_{Aeq,15min}$ 10 children: 87 dB(A)
  - Occurs during the day (7am to 6pm) and evening (6pm to 10pm) periods
- Out of School Hours Care
  - 200 students located in the courtyard
  - Other OSHC (over and above 200) located within the school buildings such as the hall and library
  - $L_{Aeq,15min}$ 10 children: 87 dB(A)
  - Occurs during the day (7am to 6pm) and evening (6pm to 10pm) periods

It is considered that some outdoor teaching activities would occur in addition to the above, such as single class, teacher led learning, however these activities are expected to produce significantly lower noise levels than those outlined above.

It is predicted that the outdoor play scenario would comply with the relevant NPfI criteria at residences, however would result in exceedances at the sensitive receivers outlined in Table 21.

Table 21 Outdoor play noise emission criteria exceedances

Location	Project noise trigger level (external), dB(A)	Predicted outdoor play noise level, dB(A)	Predicted exceedance, dB	Comment
Liverpool Boys High School (Windows open)	48[1]	54	6	Compliance with internal criteria would be met with east facing windows closed. NLPS outdoor play breaks would likely coincide with breaks at Liverpool Boys High School minimising disturbance to the classrooms. Only a small number of classrooms are affected.
Liverpool Girls High School (Windows open)	48[1]	56	8	Compliance with internal criteria would be met with east facing windows closed. NLPS outdoor play breaks would likely coincide with breaks at Liverpool Girls High School minimising disturbance to the classrooms. Only a small number of classrooms are affected.
Liverpool Hospital Brain Injury Unit	48	54	6	Design of the hospital building facade to control air ambulance noise intrusion and rail traffic noise intrusion is likely to be sufficient to attenuate outdoor play noise to meet the internal criteria of 33 dB(A).

Notes:

1. External project noise trigger level has been based on a 10 dB noise reduction through an open window

The physical education and sports scenario and OSHC scenario noise emissions are predicted to comply with the NPfI criteria for both the day and evening periods.

It is noted that the NPfI is not applicable to noise emission from the use of outdoor play areas and sports fields and therefore compliance with these criteria is not mandatory. The NPfI criteria however has been used in this case as a benchmark to determine whether use of the outdoor areas is likely to cause disturbance to nearby sensitive receivers.

In consideration of the above, it is unlikely that the use of outdoor areas will cause significant disturbance to nearby noise sensitive receivers.

Operational noise contours for outdoor area use noise emission are presented in Appendix C.

5.3 Indoor area usage noise emission assessment

The use of the NLPS hall for both school and community activities has the potential to generate significant noise levels at nearby sensitive receivers.

5.3.1 Building envelope construction

The NLPS hall building envelope design has not yet been finalised, however, directions from Fitzpatrick and Partners are that the hall building envelope would include the following construction:

- Lower half of façade would comprise panelised brick
- Upper half of façade would comprise a mixture of
  - Lightweight wall construction
  - Operable windows
  - Fixed windows
- Metal Deck roof
- Roof top ventilation (whirlybirds)
- Large hangar doors to the southern façade
- Single person access doors to the northern facade

For the purposes of this noise impact assessment, the following limitations to areas and minimum acoustic performances in Table 22 apply.

Table 22 Hall building envelope

Façade/roof	Element	Notes
Northern façade	Panelised brickwork wall	Ground to 4.2 m above ground Minimum R_w 45
	Lightweight wall	From 4.2 m above ground to roof level Minimum R_w 45
	Door	Maximum area of 5.5 m^2 Minimum R_w 28
	Fixed glazing	Maximum area of 17 m^2 Minimum R_w 35
	Operable glazing	Maximum area of 17 m^2 Minimum R_w 35
Eastern façade	Panelised brickwork wall	Ground to 4.2 m above ground Minimum R_w 45
	Lightweight wall	From 4.2 m above ground to roof level Minimum R_w 45
	Fixed glazing	Maximum area of 19 m^2 Minimum R_w 35
	Operable glazing	Maximum area of 19 m^2 Minimum R_w 35

Façade/roof	Element	Notes
Southern façade	Panelised brickwork wall	Ground to 4.2 m above ground Minimum R_w 45
	Lightweight wall	From 4.2 m above ground to roof level Minimum R_w 45
	Door	Maximum area of 30 m^2 Minimum R_w 28
	Fixed glazing	Maximum area of 17 m^2 Minimum R_w 35
	Operable glazing	Maximum area of 17 m^2 Minimum R_w 35
Western façade	Panelised brickwork wall	Ground to 4.2 m above ground Minimum R_w 45
	Lightweight wall	From 4.2 m above ground to roof level Minimum R_w 45
	Door	Maximum area of 3 m^2 Minimum R_w 28
	Fixed glazing	Maximum area of 19 m^2 Minimum R_w 35
	Operable glazing	Maximum area of 19 m^2 Minimum R_w 35
Roof	Metal deck with lining under	Minimum R_w 45
	Rooftop ventilators	4 ventilators evenly distributed across roof Each ventilator maximum 600x600 mm

5.3.2 Hall operation scenarios

The hall would be utilised for a wide range of activities. These have been split into two categories for the purposes of the acoustic impact assessment:

- Category 1: High noise level activities
  - Activities involving live and/or amplified music
  - Maximum internal reverberant noise level of 95 dB(A)
  - School concerts, school dances/discos, community use
- Category 2: Low noise level activities
  - Maximum reverberant noise level of 80 dB(A)
  - Indoor sports, OSHC, school assemblies.

5.3.3 Acoustic treatments

Noise emission from the operation of the NLPS hall can be controlled to meet the relevant criteria presented in Section 3.0 with the closure of windows and doors dependent on the time of day and the type of activity to be held within the space. The operation of openable elements of the façade is outlined in Table 23.

Table 23 Hall noise emission control

Activity	Time	Control measures
Category 1	Day	Operable windows in northern, eastern and western façade closed Northern and western access doors closed Southern hangar door open Operable windows in southern façade open
	Evening	All operable windows closed All doors closed
Category 2	Day	All operable windows open Southern hangar door open Western access door open
	Evening	Operable windows in northern and western façade closed Operable windows in southern and eastern façade open Southern hangar door open

Notes:

1. It is not envisaged that the NLPS hall would be utilised during the night

It is noted that the NPfI is not applicable to noise emission from the use of the school hall and therefore compliance with these criteria is not mandatory. The NPfI criteria however has been used in this case as a benchmark to determine whether use of the hall is likely to cause disturbance to nearby sensitive receivers. It is noted that, with the control measures indicated in Table 23, the NPfI criteria will be met at all sensitive receivers.

In consideration of the above, it is unlikely that the use of outdoor areas will cause significant disturbance to nearby noise sensitive receivers.

Operational noise contours for hall use, with the above noise emission controls, are presented in Appendix C.

5.4 School bell and public address operation noise emission

Speakers types, locations and orientation for the school bell and/or public address systems have not been determined at this stage of the design. The speaker design must be assessed during the detailed design stage and appropriate acoustic measures incorporated to meet the relevant criteria presented in 3.0. The following should be considered in the design of the speaker system to reduce noise emission to nearby receivers:

- Speaker location and direction
- Use of directional speakers
- The use of more speakers, set at lower volume levels, closer to the listeners will reduce noise emission outside of school grounds

5.5 Cumulative emission from school grounds

The cumulative noise level from noise emission sources assessed above will be higher than the noise emission from any of the individual sources. However, it is unlikely that most noise sources will not be in operation simultaneously, for example use of the school hall will occur at different time of the day than outdoor play.

It is noted that the operation of building services would occur during the same periods as one of the outdoor area usage or hall usage scenarios, however, due to the relative locations and orientations of the relative activities and plant, it is not likely that the combined noise emission will result in excedences of the NPfI criteria additional to those already noted in the Sections above.

5.6 Road and rail traffic noise intrusion assessment

Both road and rail traffic would result in noise intrusion into the NLPS development including the child care centre and playground. The façade of the NLPS buildings should be designed to attenuate traffic noise intrusion to meet the criteria presented in Section 3.3.

Attended measurements of traffic noise were conducted at the three locations on 24 September 2020 to determine external road traffic noise levels and on 20 April 2020 to determine rail traffic noise levels. The results of these road and rail traffic measurements are presented in Table 24 and Table 25 respectively.

Table 24 Road traffic noise levels at NLPS façade, $L_{Zeq,15hr}$ levels, dB

Location	Octave Band Centre Frequency, Hz									Overall, L_{Aeq} level, dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
Location 1: Forbes Street	64	63	58	53	51	51	45	41	31	55
Location 2: Lachlan Street	64	66	69	57	52	53	50	44	39	59
Location 3: Burnside Drive	72	76	66	58	55	55	53	48	40	61

Table 25 Rail noise levels at NLPS facade - Burnside Drive

Description	Octave Band Centre Frequency, Hz									Overall, L_{Aeq} level, dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
Rail Traffic Noise Levels, $L_{eq, 1hr}$	59	62	60	58	55	56	56	54	53	58

The following minimum acoustic performances for the façade are recommended to meet the traffic noise intrusion requirements:

- Glazed elements
  - Maximum 50% façade area
  - Minimum R_w 35 acoustic performance
  - Indicative construction: 12.76 mm laminated glass
  - Windows must be closed to meet traffic noise intrusion requirements
- Opaque elements
  - Minimum R_w 45 acoustic performance and
  - Indicative construction:
    - 60 mm thick panelised brick, 28 mm furring channel with 25 mm bulk insulation in cavity and 13 mm plasterboard; OR
    - 9 mm fibre cement sheet, 64 mm steel stud with 50 mm bulk insulation in cavity and 13 mm fire rated plasterboard

If these façade elements are included in the design, then the resultant noise levels would be 40 dB(A) or less within the proposed primary school and 39 dB(A) within the proposed child care centre.

5.7 Air traffic noise intrusion assessment

Air traffic, from air ambulances utilising the Liverpool Hospital Helipads, would result in noise intrusion to into the NLPS development. The façade and roof of the NLPS buildings should be designed to attenuate traffic noise intrusion to meet the criteria presented in Section 3.4.

The approach and departure paths for the Liverpool hospital are:

- Directly to the west of the helipads; and
- To the west-north-west of the helipads.

The proposed NLPS buildings are located approximately 300 metres from the nearest approach/departure path.

Based on this distance and the sound power levels of the Bell 412 and Leonardo AW139 Air Ambulance helicopters, the external aircraft design noise level adopted for this assessment is presented in Table 26.

Table 26 Air ambulance L_{Zmax} noise level, dB

Location	Octave band centre frequency, Hz							Overall L_{Amax} sound level, dB(A)
	63	125	250	500	1k	2k	4k	
NLPS Buildings	85	80	74	78	76	73	67	81

The façade constructions presented in Section 5.6 to control road and rail traffic noise intrusion are sufficient to attenuate air traffic noise intrusion to the relevant criteria. In addition to the façade construction, the NLPS roof construction must also meet a minimum R_w 45 acoustic performance to achieve the relevant aircraft noise intrusion criteria.

5.8 Traffic generation noise assessment

GTA Consultants have prepared a Transport and Accessibility Assessment for the proposed NLPS development. The traffic flows presented by GTA Consultants have been studied and it has been concluded that if the proposed development were to go ahead, traffic noise on surrounding roads would increase as detailed in Table 27.

Table 27 Summary of traffic flow increase in the peak periods (vehicles/hr)

Location	2023				2033			
	Existing	Existing + NLPS	% Increase	Increase in Noise Levels, dB(A)	Future Base[1]	Future with NLPS	% Increase	Increase in Noise Levels, dB(A)
AM Peak 7:45 am to 8:45 am								
Burnside Drive								
- East of Lachlan Street	531	1,419	167	**4**	974	1,553	59	**2**
- South of new roundabout	531	812	53	**2**	974	581	0	**0**
Lachlan Street								
- West of Hart Street	470	1,228	161	**4**	835	1,346	61	**2**
- West of Drummond Street	599	1,363	128	**4**	971	1,480	52	**2**

Location	2023				2033			
	Existing	Existing + NLPS	% Increase	Increase in Noise Levels, dB(A)	Future Base[1]	Future with NLPS	% Increase	Increase in Noise Levels, dB(A)
- West of Forbes Street	536	1,502	180	**4**	1,110	1,619	46	**2**
- West of Goulburn Street	602	1,463	143	**4**	1,155	1,555	35	**1**
Hart Street								
- North of Lachlan Street	349	745	114	**3**	693	757	9	**0**
Drummond Street								
- North of Lachlan Street	202	240	19	**1**	240	240	0	**0**
Forbes Street								
- North of Lachlan Street	397	156	0	**0**	156	156	0	**0**
- North of Campbell Street	454	200	0	**0**	200	200	0	**0**
- South of Campbell Street	278	200	0	**0**	200	200	0	**0**
Goulburn Street								
- North of Lachlan Street	127	75	0	**0**	75	75	0	**0**
- North of Campbell Street	330	386	17	**1**	301	411	37	**1**
- South of Campbell Street	531	376	0	**0**	291	401	38	**1**
Campbell Street								
- West of Forbes Street	610	0	0	**0**	0	0	0	**0**
- West of Goulburn Street	469	164	0	**0**	164	164	0	**0**
PM Peak 2:45 pm to 3:45 pm								
Burnside Drive								
- East of Lachlan Street	298	910	205	**5**	474	1,041	120	**3**
- South of new roundabout	298	312	5	**0**	312	312	0	**0**
Lachlan Street								
- West of Hart Street	352	946	169	**4**	558	1,003	80	**3**
- West of Drummond Street	461	1,027	123	**3**	639	1,143	79	**3**
- West of Forbes Street	452	1,112	146	**4**	723	1,231	70	**2**
- West of Goulburn Street	301	1,078	258	**6**	774	1,168	51	**2**
Hart Street								
- North of Lachlan Street	226	418	85	**3**	386	433	12	**1**
Drummond Street								
- North of Lachlan Street	137	215	57	**2**	215	215	0	**0**
Forbes Street								
- North of Lachlan Street	152	126	0	**0**	127	127	0	**0**

Location	2023				2033			
	Existing	Existing + NLPS	% Increase	Increase in Noise Levels, dB(A)	Future Base[1]	Future with NLPS	% Increase	Increase in Noise Levels, dB(A)
- North of Campbell Street	303	137	0	**0**	106	106	0	**0**
- South of Campbell Street	200	106	0	**0**	106	106	0	**0**
Goulburn Street								
- North of Lachlan Street	183	115	0	**0**	115	115	0	**0**
- North of Campbell Street	310	373	20	**1**	287	397	38	**1**
- South of Campbell Street	474	384	0	**0**	299	408	37	**1**
Campbell Street								
- West of Forbes Street	439	-	-	**-**	-	-	-	**-**
- West of Goulburn Street	313	113	0	**0**	113	113	0	**0**

Notes:

1. *This base traffic flow includes additional traffic likely to be generated as a result of a significant redevelopment of Liverpool Hospital*

GTA Consultants have advised of the following daily traffic movements outside the peak periods noted in Table 27:

- 2023 Daily movements outside of peak hours
  - Staff: 41 vehicle movements
  - Students: 152 vehicle movements
  - TOTAL: 193 vehicle movements
- 2033 Daily movements outside of peak hours
  - Staff: 38 vehicle movements
  - Students: 196 vehicle movements
  - TOTAL: 234 vehicle movements

Traffic noise levels are predicted to increase significantly on some roads in proximity to the proposed NLPS development. Increases of more than 2 dB are predicted for Burnside Drive, Lachlan Street and Hart Street. It is noted that there are no residential properties on Burnside Drive. It is also noted that the traffic flows and increases in noise levels presented in Table 27 are for the AM and PM peak periods for vehicle movements associated with the school. Outside these hours traffic generation, and hence traffic noise generation would be negligible, therefore over the 15 hour period there the increase in road traffic noise levels would be less than 2 dB. Compliance with the RNP screening criterion would be achieved.

5.9 Operational vibration

Items installed as part of NLPS are not expected to produce any significant vibration, therefore no further assessment has been undertaken.

6.0 Construction Noise and Vibration Assessment

6.1 Construction noise

This construction noise and vibration assessment is based on typical construction scenarios for this type of development.

6.1.1 Construction hours

Construction activities at the NLPS site are proposed to be limited to the recommended standard hours as defined by the ICNG as follows:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- Sunday and Public Holidays: No works

6.1.2 Construction phases and sources

The equipment and associated sound powers for the proposed NLPS development works are shown in Table 28. The assessment has been based on a worst-case scenario of all equipment operating concurrently. There would be no significant noise generating demolition works as the NLPS development site is currently playing fields and free of any structures that may require demolition.

Table 28 Construction phases and equipment

Phase	Equipment/activity	Percentage time on	'A' Weighted SWL dB(A)
Site Preparation and Excavation	Smooth Drum Roller	100	105
	Plate Compactor	100	108
	Front End Loader	100	108
	Posi-Track Loader	100	104
	5 Tonne Excavator	100	94
	10 Tonne Excavator	100	94
	Rigid Truck	100	98
	Articulated Truck	100	98
	Overall	**-**	**113**
NLPS Construction	Posi Track Loader	100	104
	50 Tonne Mobile Crane	100	104
	Concrete Boom and Pump	100	106
	Concrete Agitator Delivery Truck	100	105
	Asphalt Paving Machine	100	106
	Rigid Truck	100	98
	Articulated Truck	100	98
	300 Tonne All-Terrains Crane	100	106
	Overall	-	**113**

Construction is scheduled to be undertaken during recommended standard hours only. As such the impacts of construction activities on sleep disturbance do not need to be assessed. Sound power levels were obtained from published datasets in Australian Standard AS 2436:2010 *Guide to noise*

and vibration control on construction, demolition and maintenance sites, British Standard BS5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise* and AECOM's database.

6.1.3 Modelling and conditions

Modelling of the proposed construction scenario has been performed using SoundPLAN 8.1. Standard weather conditions were applied. The following parameters were used in the modelling:

- Standard meteorological conditions – Pasquill-Gillford stability category D with source to receiver wind speed up to 0.5 m/s at 10 metres above ground level.

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 localised fixed building structures would also vary as the construction equipment moves around the site.

6.1.4 Results

Construction noise contours are presented in Appendix D. The construction NMLs are predicted to be exceeded at number receivers as presented in Table 29.

Table 29 Construction noise NML exceedances

Location		NML, dB(A)	Maximum predicted construction noise level, dB(A)	Maximum predicted exceedance, dB
Site Preparation and Excavation				
Residential properties	Lachlan Street	57	79	22
	Drummond Street	57	66	9
	Hart Street	57	71	14
	Priddle Street	57	58	1
Liverpool Boys High School		65	66	1
NLPS Construction				
Residential properties	Lachlan Street	57	79	22
	Drummond Street	57	66	9
	Hart Street	57	71	14
	Priddle Street	57	58	1
Liverpool Boys High School		65	66	1

It should be noted that some residences on Lachlan Street are classified as highly noise affected receivers. Respite periods may need to be considered for works conducted along Lachlan Street to reduce the impact on these residences.

6.2 Construction vibration

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

- Plate compactor

The minimum working distances of these items of equipment to nearby receivers are shown in Table 30 which is based on recommendations of the TfNSW *Construction Noise and Vibration Strategy* (CNVS) and AECOM's previous project experience. If these minimum 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 proposed development, works are unlikely to occur within the minimum working distances.

Table 30 Recommended minimum working distances for vibration intensive plant

Plant	Rating/description	Minimum working distance	
		Cosmetic damage	Human response
Plate Compactor	Handheld	1 m nominal	Avoid contact with structure

6.3 Construction traffic

The construction work would be undertaken in stages and would require a number of trucks, to deliver materials including concrete to the site. During early stages of construction workers may be able to park on site, during later stages they would park away from the site and either walk or use public transport to get to the site.

GTA Consultants have advised that the peak number of truck movements per day would occur during delivery of the modular buildings. The peak number of trucks visiting the site per day would be 20 trucks resulting in 40 vehicle movements.

Given the volumes of existing traffic, construction traffic would have a negligible impact, increasing road traffic noise levels by significantly less <1 dB(A). This complies with RNP requirements.

7.0 Construction Noise and Vibration Mitigation

Given that NMLs are likely to be exceeded, reasonable and feasible noise mitigation measures and work practices would need to be considered. Where receivers are predicted to be 'noise affected' the ICNG states that all feasible and reasonable works practices should be applied to meet the NMLs. It is recommended that a construction noise and vibration management plan (CNVMP) be prepared.

Details of noise and vibration mitigation measures and management practices which should be considered for each CNVMP are detailed below.

The CNVMP should include 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 what work practices (generic and specific) would be applied to minimise noise and vibration
- A complaint handling process
- Noise and vibration monitoring procedures
- Overview of community consultation required for identified high impact works.

Noise and vibration mitigation measures which should be considered in the CNVMP are detailed in Table 31.

Table 31 Recommended noise mitigation measures

Action required	Safeguard details
Management measures	
Implement community consultation measures	Notification (letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list and community and stakeholder meetings.
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.
Monitoring	A noise monitoring program should be considered.
Attended vibration measurements	Attended vibration measurements are recommended at the commencement of vibration generating activities to determine site specific minimum working distances. Vibration intensive work should not proceed within the minimum working distances unless a permanent vibration monitoring system is installed approximately a metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity objective.
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. Consideration should be given to avoiding examination periods.
Equipment selection and maintenance	Use quieter and less vibration emitting construction methods where feasible and reasonable. Equipment would be regularly inspected and maintained to ensure it is in good working order.
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.

Action required	Safeguard details
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) should be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work, subject to work health and safety requirements.
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.

7.1 Complaints handling procedure

A complaint handling procedure should be developed and documented within each CNVMP. The following section outlines items to be considered for inclusion in the procedure.

If complaints are received, an Environmental Incident Report Form should be completed to record details of the occurrence and actions taken. Where applicable, completed forms should detail the following:

- the date and time of the complaint
- the method by which the complaint was made
- any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect

- the nature of the complaint
- description of noise source that is the subject of complaint, duration of event
- location of complainant during time of incident, and general area in which the noise source was located
- identification of project related noise activities and locations that could have or are known to have contributed to the incident
- if known, identification of non-project related noise emission activities and location at time of incident
- meteorological conditions at the time of the incident
- the action taken in relation to the complaint
- any follow-up contact with the complainant
- if no action was taken, the reason why no action was taken.

All records are to be kept in a legible form, or in a form that can readily be reduced to a legible form and kept for at least 4 years after the complaint or event to which they relate took place.

The Site Environmental Officer should make available a report on complaints received to the relevant Government Agencies upon request. A response should be provided to the complainant within 24 hours. Corrective actions may involve supplementary monitoring to identify any non-compliances, and/or may involve modification of construction techniques to avoid any recurrence or minimise impacts.

A noise monitoring program should be implemented as a result of construction noise and vibration complaints.

8.0 Conclusion

This report presents the results of a noise and vibration impact assessment of the proposed New Liverpool Primary School.

Operational noise emission from the development has been assessed with consideration to the project noise trigger levels established in accordance with the NSW NPfI and measured noise levels at the development site. The impact of noise emission from new developments can be widespread when noise issues are not correctly considered, however, this assessment indicates that standard amelioration strategies would sufficiently treat noise emission to meet the project noise trigger levels and, as such, would minimise possible acoustic impacts on neighbouring areas.

Noise and vibration intrusion to the development from road, rail and air ambulance traffic has been assessed and complies with the criteria established in accordance with AS 2021:2015, AVATG and *Development Near Rail Corridors and Busy Roads – Interim Guideline.*

Traffic generation as a result of the proposed development is predicted to exceed criteria during the peak am and pm drop off and pick up times. However, at other times, traffic generation is minimal and predicted traffic noise increases would comply with the applicable criteria outlined in the NSW Road Noise Policy.

Construction noise has been assessed in accordance with the EPA's Interim Construction Noise Guideline. The worst case construction scenario has been considered. Construction works would be undertaken during standard hours. The level of exceedances of the construction noise management levels are provided in Section 6.1.4. It should be noted that the exceedances presented are the highest on each residential street during the construction phase and would generally be significantly lower for significant periods of time.

Based upon this assessment documented above, all environmental noise and vibration impacts can be appropriate managed in accordance with the relevant guidelines and standards.

Appendix A

Glossary of Acoustic Terminology

Appendix A Glossary of Acoustic Terminology

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

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.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% 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.

*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 Noise Policy for Industry and Road Noise Policy.

Appendix B

Graphical Noise Monitoring Results

Noise Logger Report

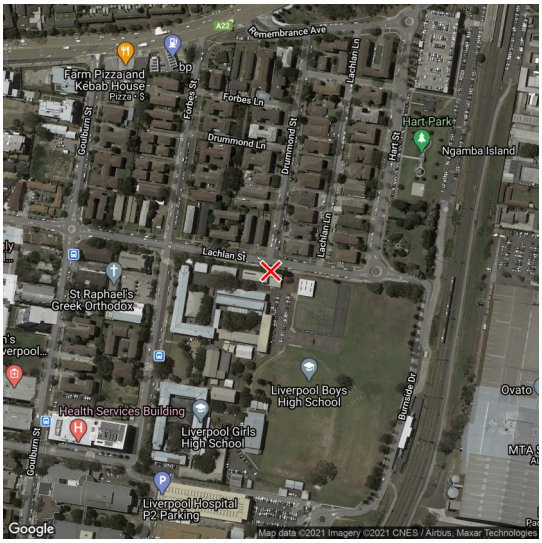
Lachlan Street, Warwick Farm

Item	Information
Logger Type	NL-52
Serial number	876010
Address	Lachlan Street, Warwick Farm
Location	Lachlan Street, Warwick Farm
Facade / Free Field	Free Field
Environment	Sunny, mild breeze at times

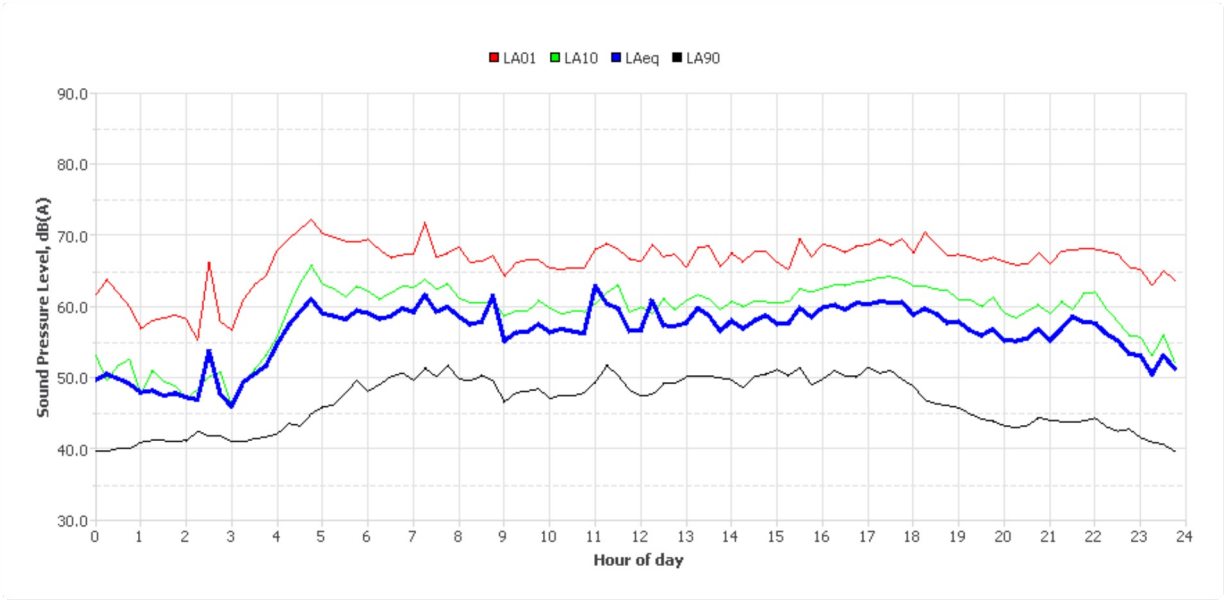
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Sep 9 2020	64	59	54	-	44	-	62	54
Thu Sep 10 2020	60	59	56	-	46	41	60	56
Fri Sep 11 2020	60	59	57	47	45	42	60	57
Sat Sep 12 2020	57	56	56	44	45	42	57	56
Sun Sep 13 2020	57	56	55	44	42	40	57	55
Mon Sep 14 2020	59	57	56	47	45	42	59	56
Tue Sep 15 2020	60	58	56	48	44	41	60	56
Wed Sep 16 2020	59	56	57	47	44	42	58	57
Thu Sep 17 2020	59	57	57	-	-	42	59	57
Fri Sep 18 2020	60	58	58	48	43	40	59	58
Sat Sep 19 2020	57	56	54	-	45	38	57	54
Sun Sep 20 2020	59	58	55	46	43	40	59	55
Mon Sep 21 2020	59	58	56	48	44	41	59	56
Tue Sep 22 2020	57	56	56	-	43	39	56	56
Wed Sep 23 2020	59	58	56	47	42	39	59	56
Thu Sep 24 2020	61	-	56	-	-	-	61	56
Summary	**60**	**58**	**56**	**47**	**44**	**41**	**59**	**56**

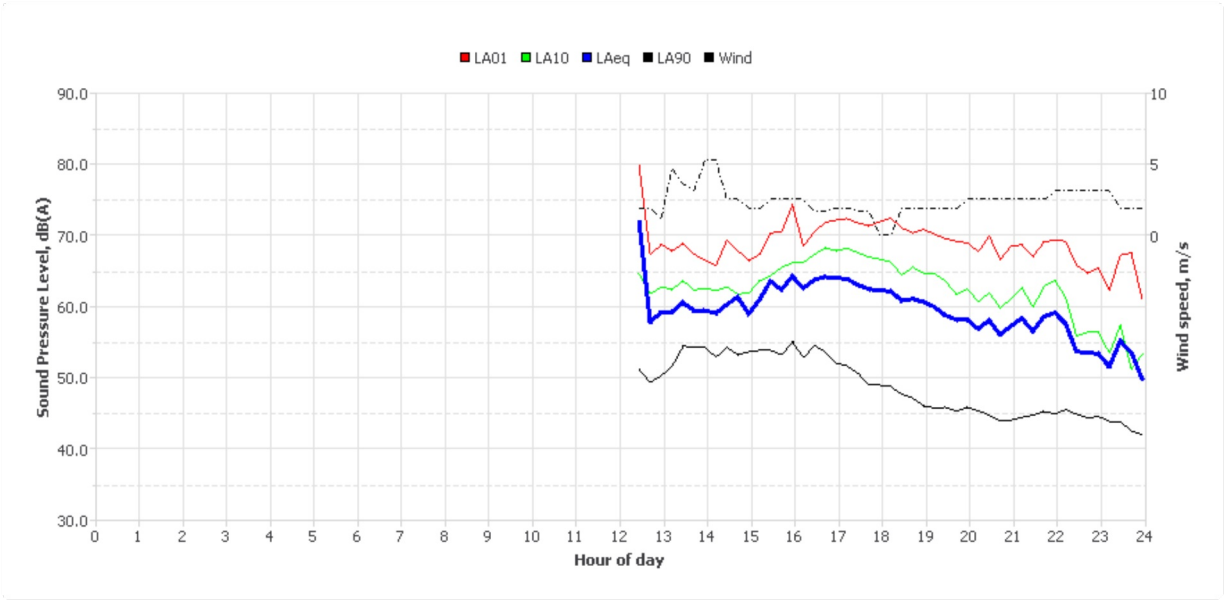
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

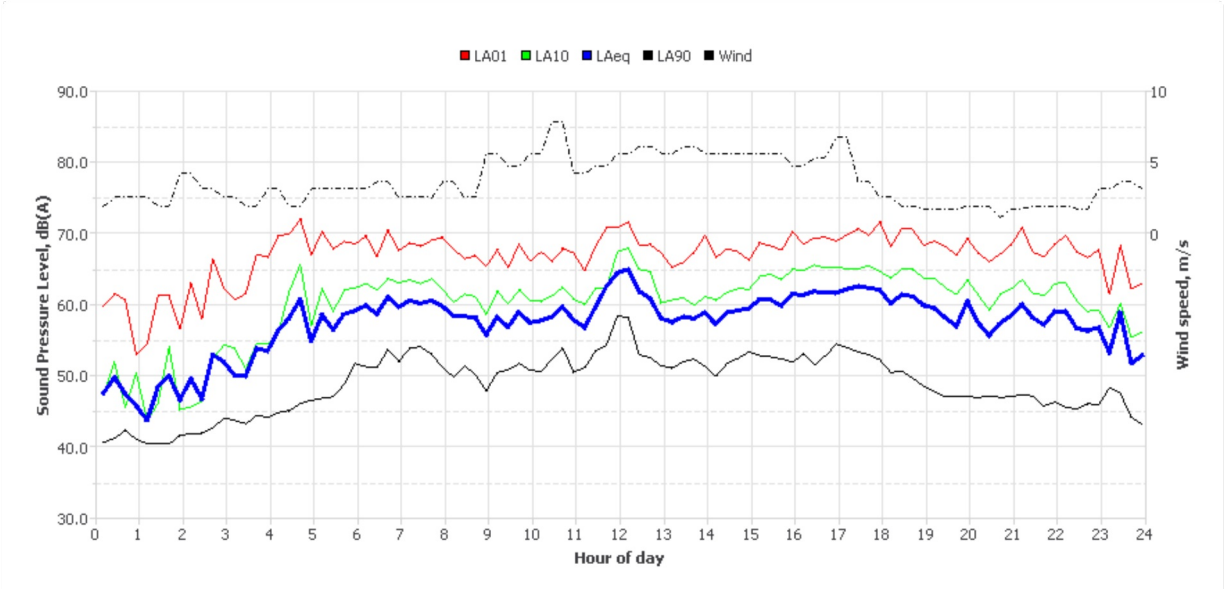
Typical Day



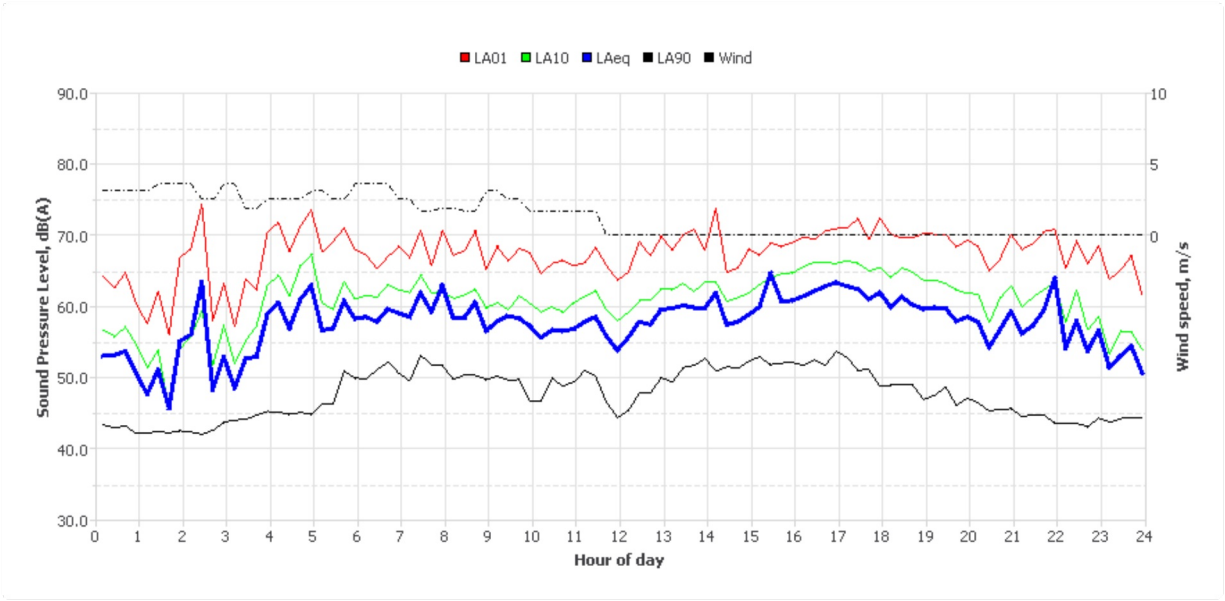
Wednesday, 09 Sep 2020



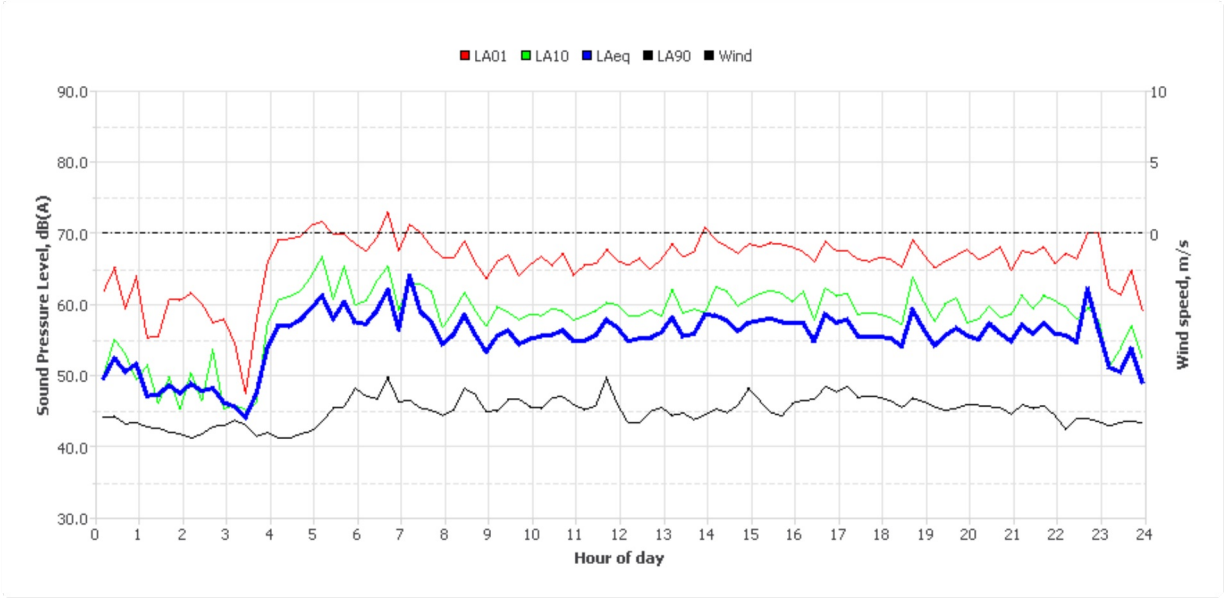
Thursday, 10 Sep 2020



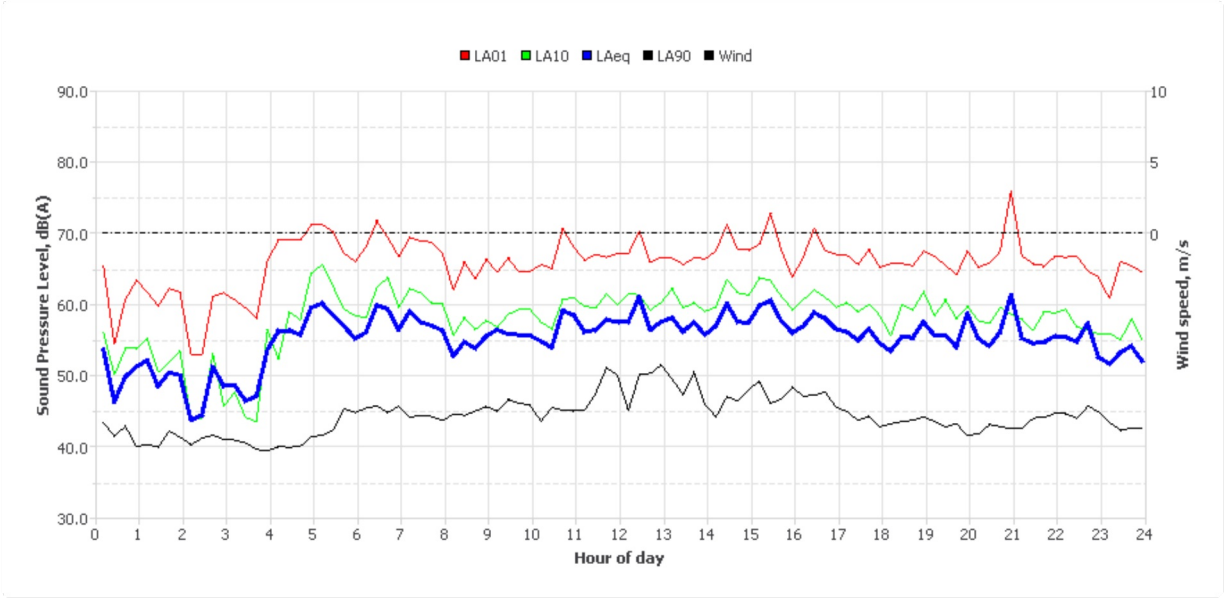
Friday, 11 Sep 2020



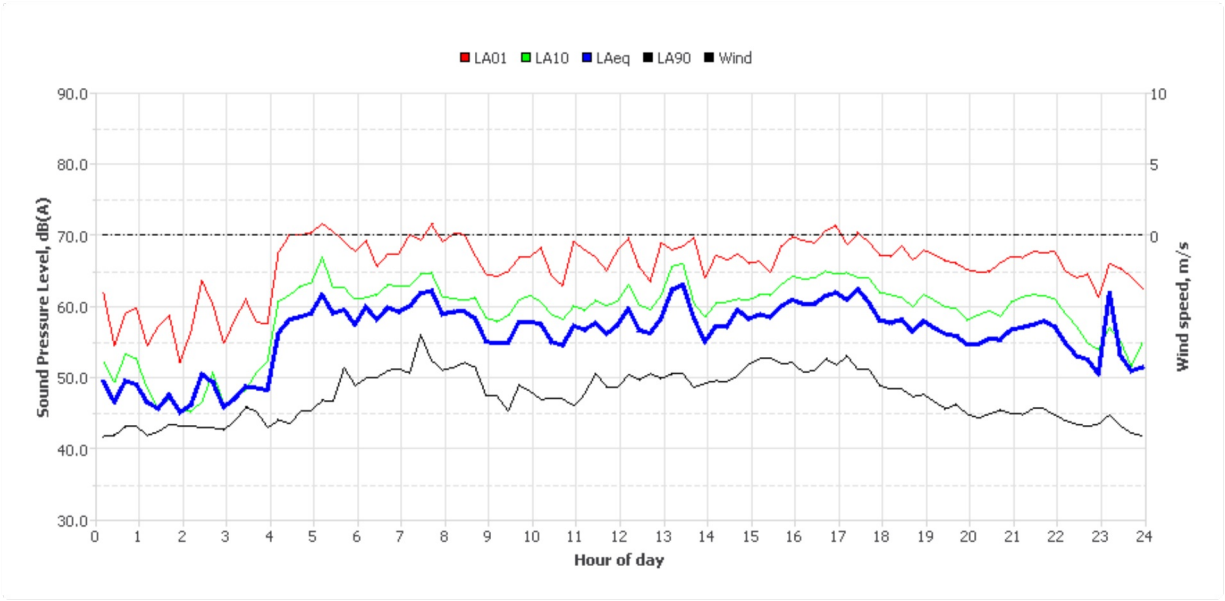
Saturday, 12 Sep 2020



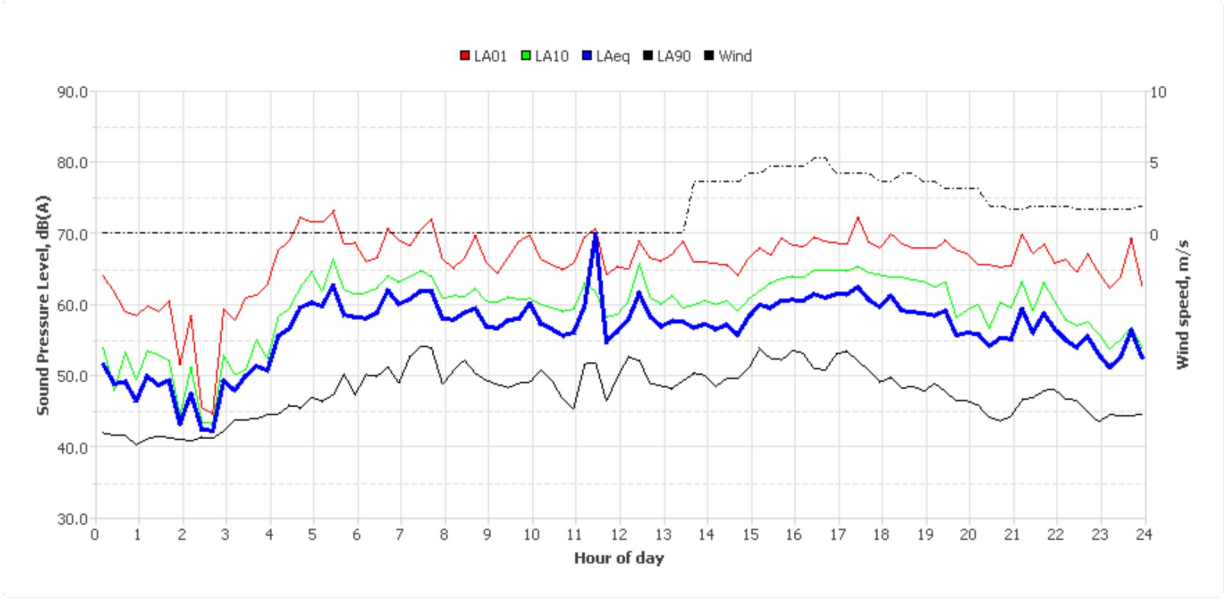
Sunday, 13 Sep 2020



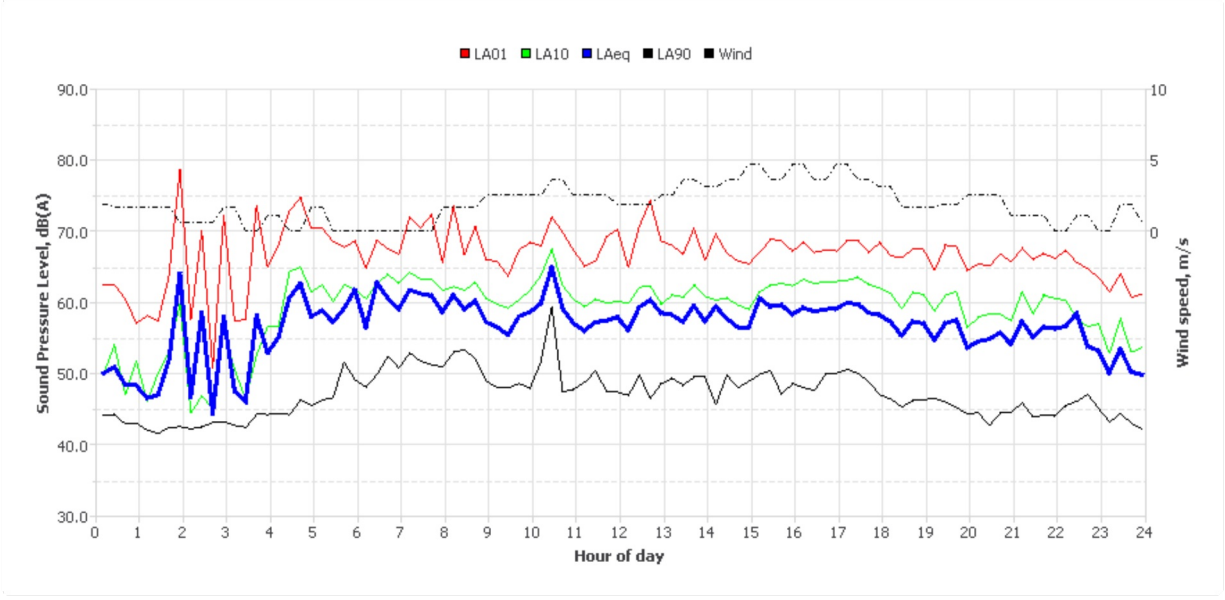
Monday, 14 Sep 2020



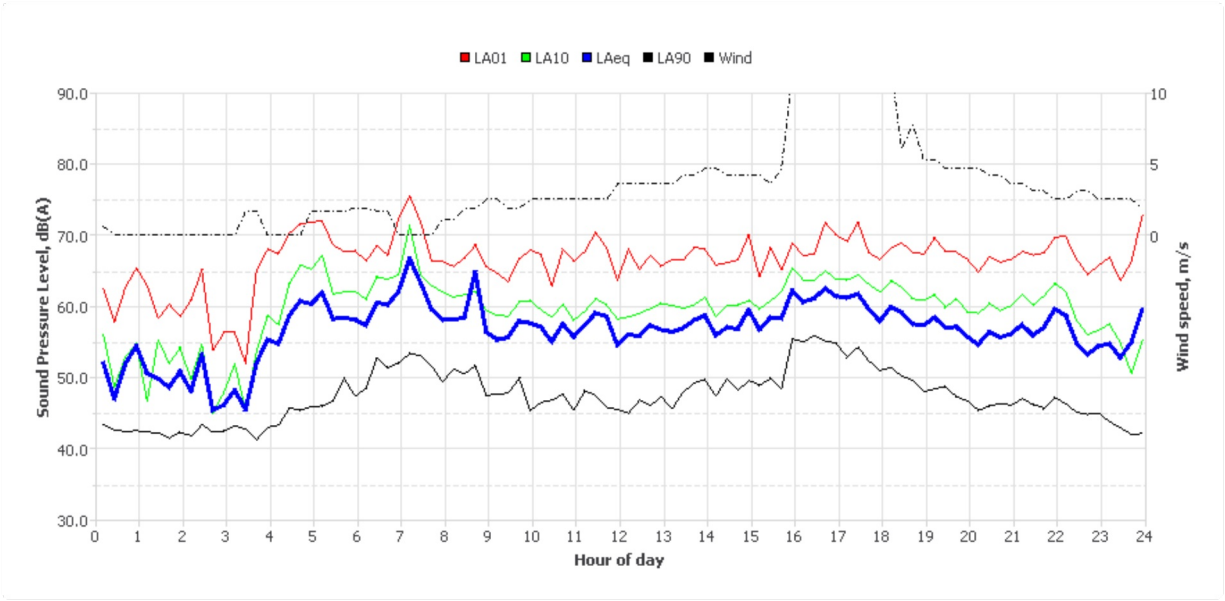
Tuesday, 15 Sep 2020



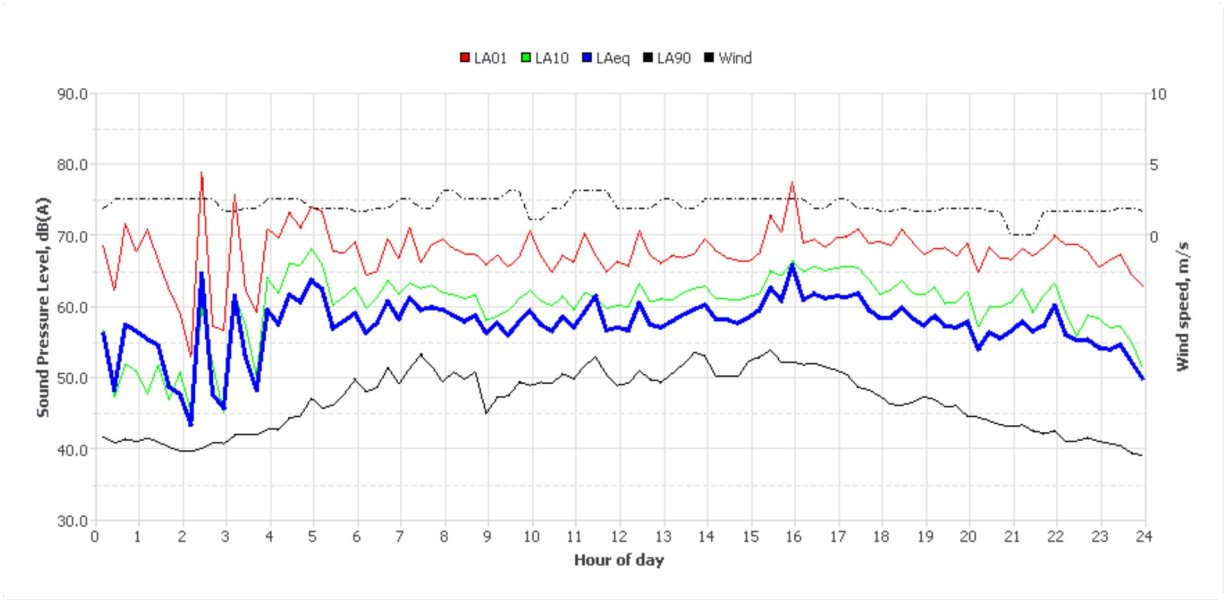
Wednesday, 16 Sep 2020



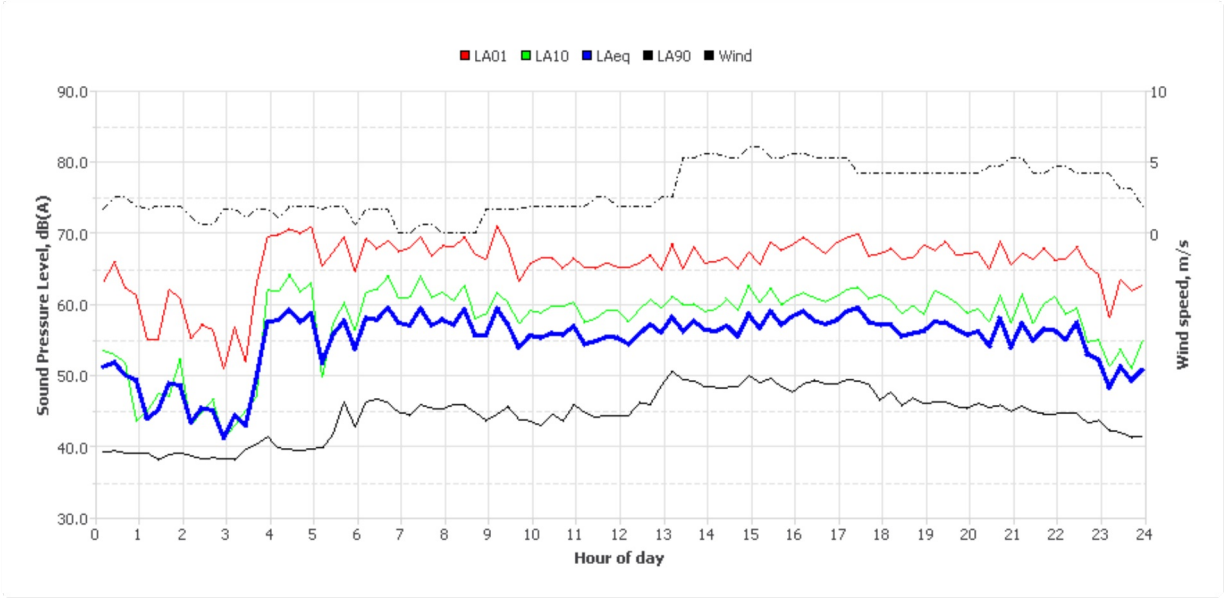
Thursday, 17 Sep 2020



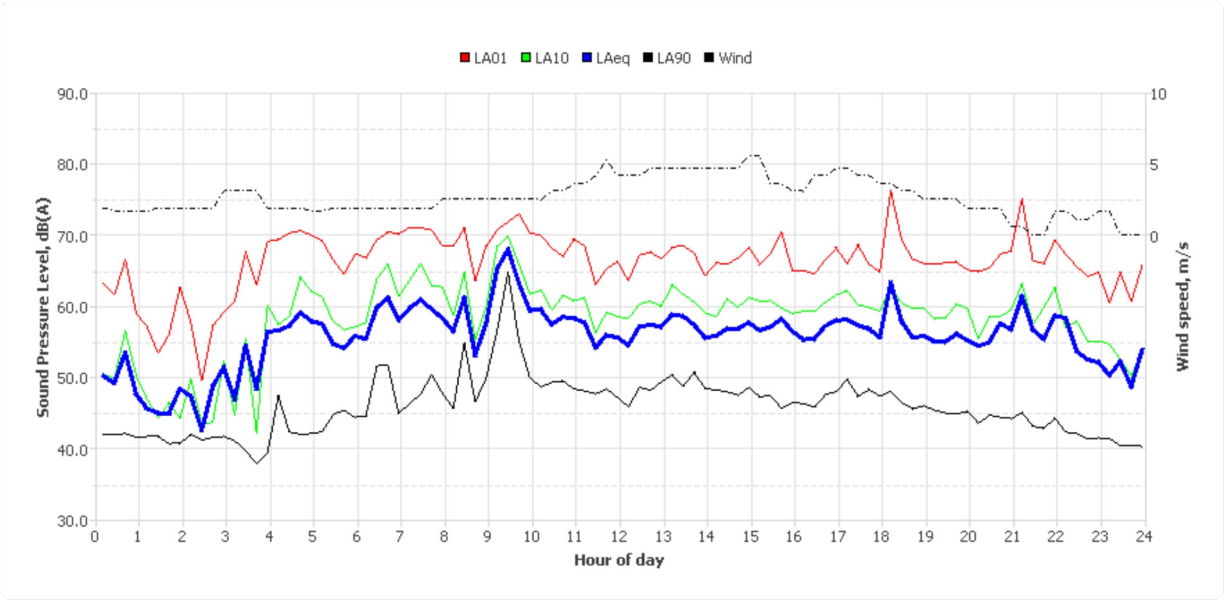
Friday, 18 Sep 2020



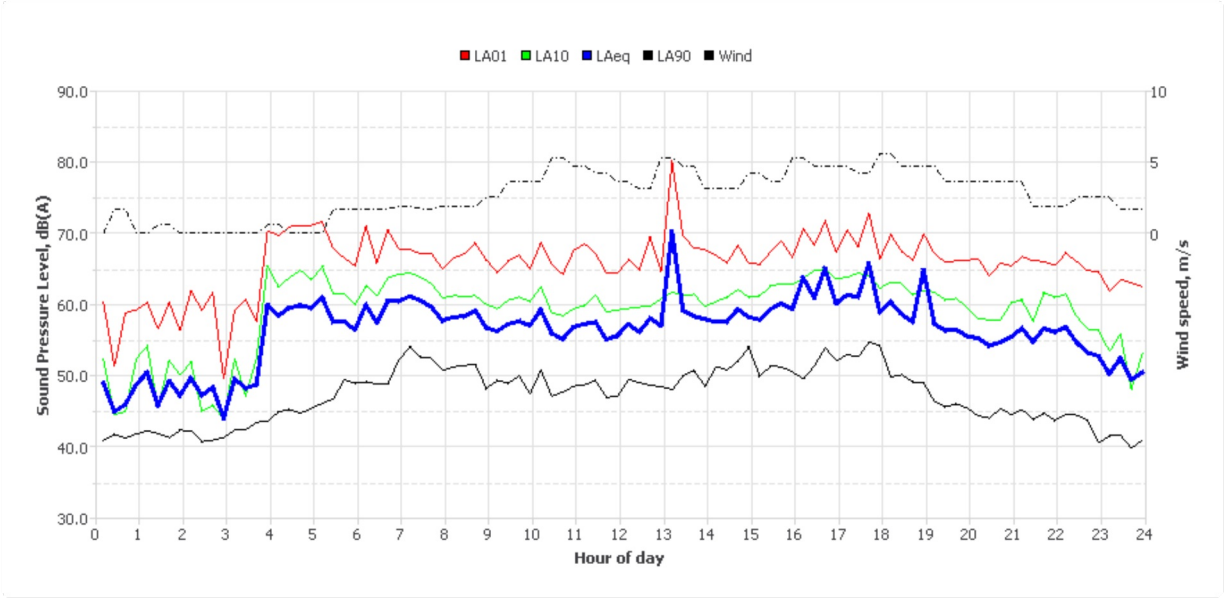
Saturday, 19 Sep 2020



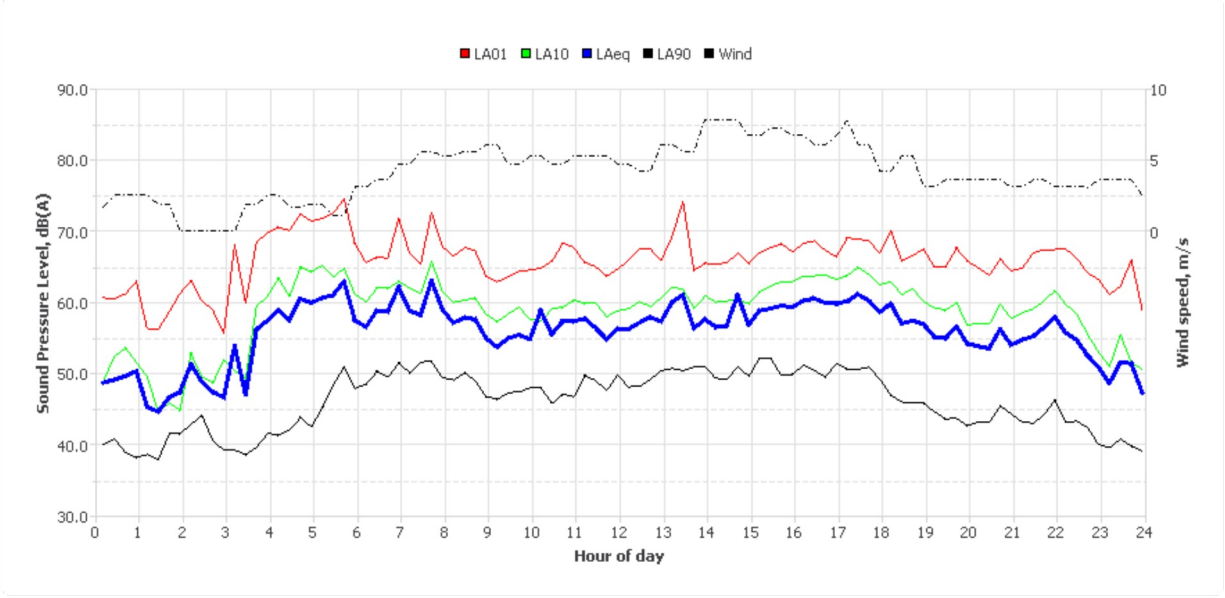
Sunday, 20 Sep 2020



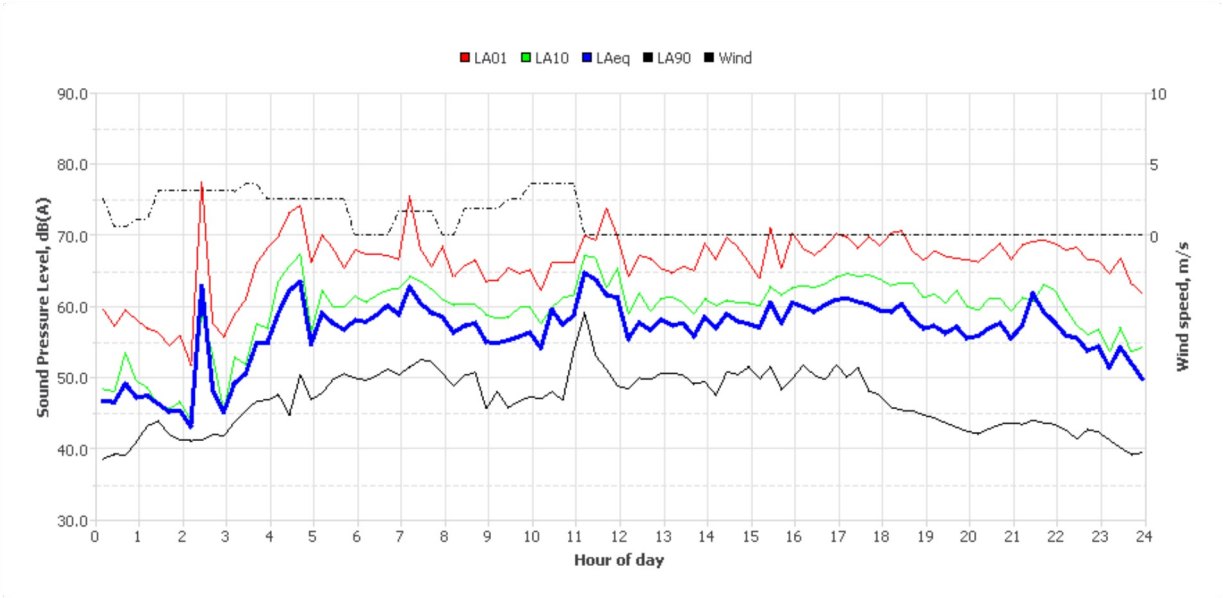
Monday, 21 Sep 2020



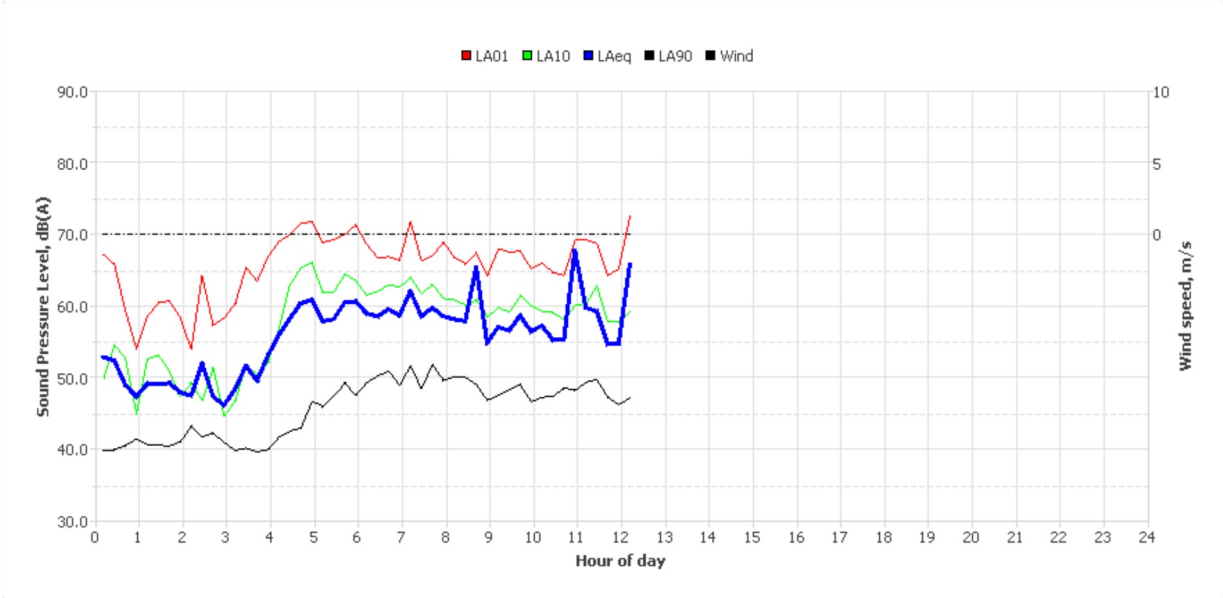
Tuesday, 22 Sep 2020



Wednesday, 23 Sep 2020



Thursday, 24 Sep 2020



Noise Logger Report

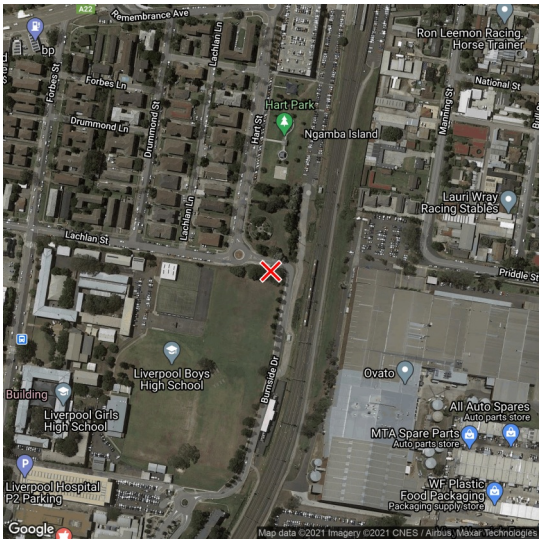
Burnside Drive, Warwick Farm

Item	Information
Logger Type	ARL 315
Serial number	15-299-444
Address	Burnside Drive, Warwick Farm
Location	Burnside Drive, Warwick Farm
Facade / Free Field	Free Field
Environment	Sunny, windy, noise dominated by trains

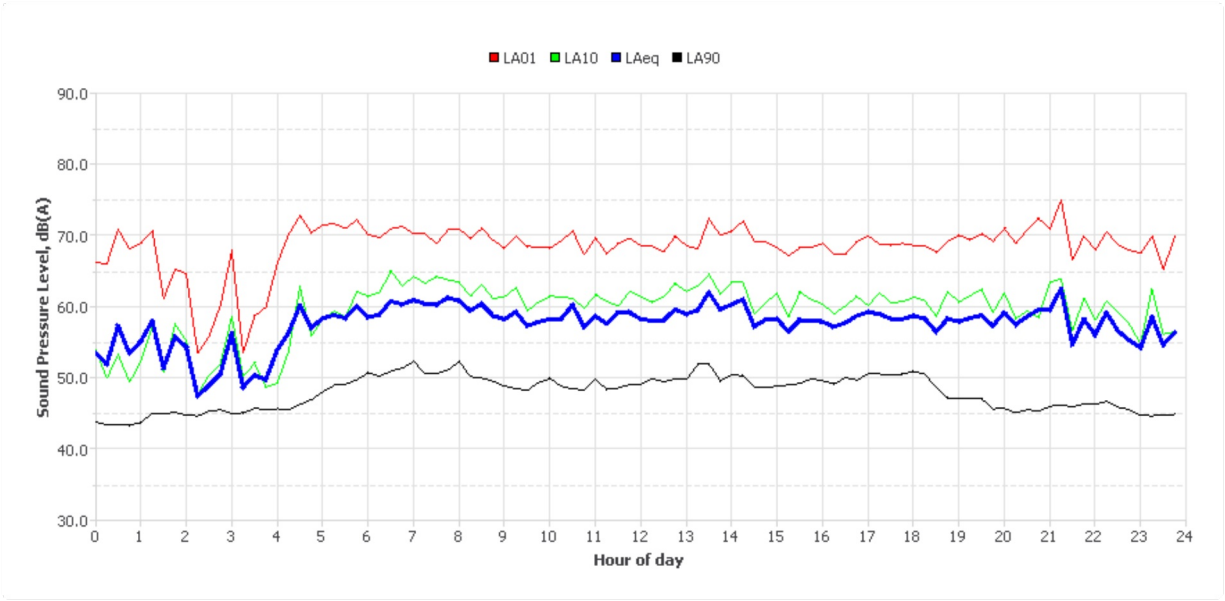
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Sep 9 2020	67	60	58	-	46	-	65	58
Thu Sep 10 2020	62	60	58	-	48	44	62	58
Fri Sep 11 2020	60	60	58	47	47	46	60	58
Sat Sep 12 2020	58	59	57	43	47	45	58	57
Sun Sep 13 2020	58	60	57	45	44	44	58	57
Mon Sep 14 2020	61	60	58	48	46	46	61	58
Tue Sep 15 2020	64	60	58	47	46	44	63	58
Wed Sep 16 2020	60	59	58	46	46	45	60	58
Thu Sep 17 2020	64	63	61	46	-	48	63	61
Fri Sep 18 2020	65	59	60	48	45	43	64	60
Sat Sep 19 2020	59	58	55	-	46	41	58	55
Sun Sep 20 2020	61	58	56	47	46	43	60	56
Mon Sep 21 2020	59	58	58	48	46	44	59	58
Tue Sep 22 2020	58	59	57	-	46	43	59	57
Wed Sep 23 2020	59	59	59	47	45	43	59	59
Thu Sep 24 2020	59	-	57	-	-	-	59	57
Summary	**62**	**60**	**58**	**47**	**46**	**44**	**61**	**58**

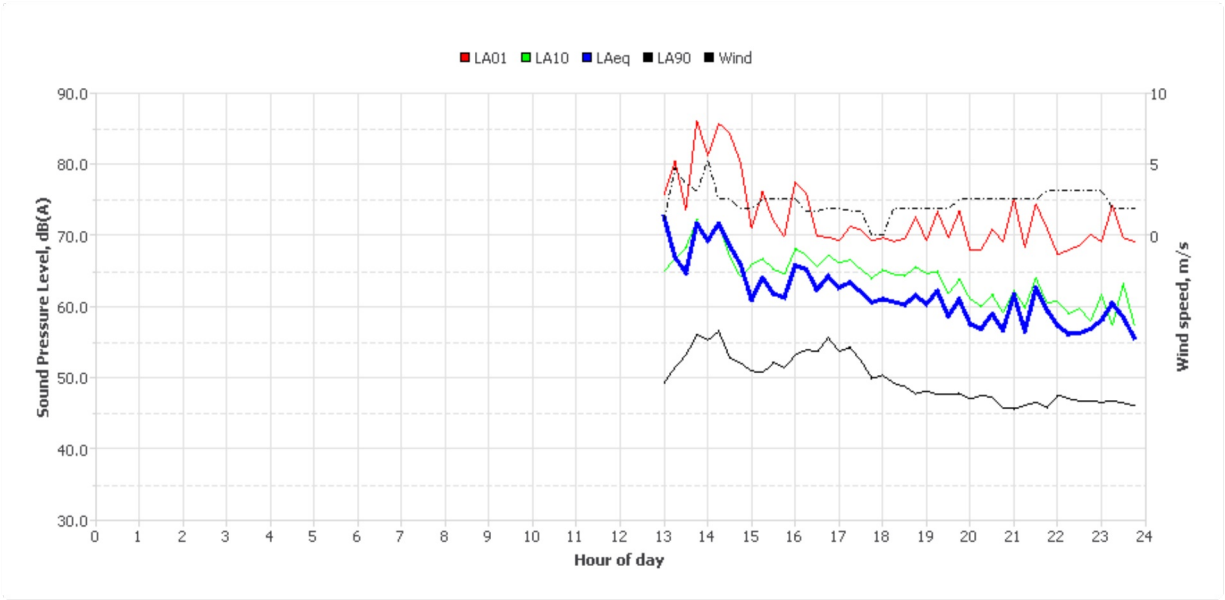
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

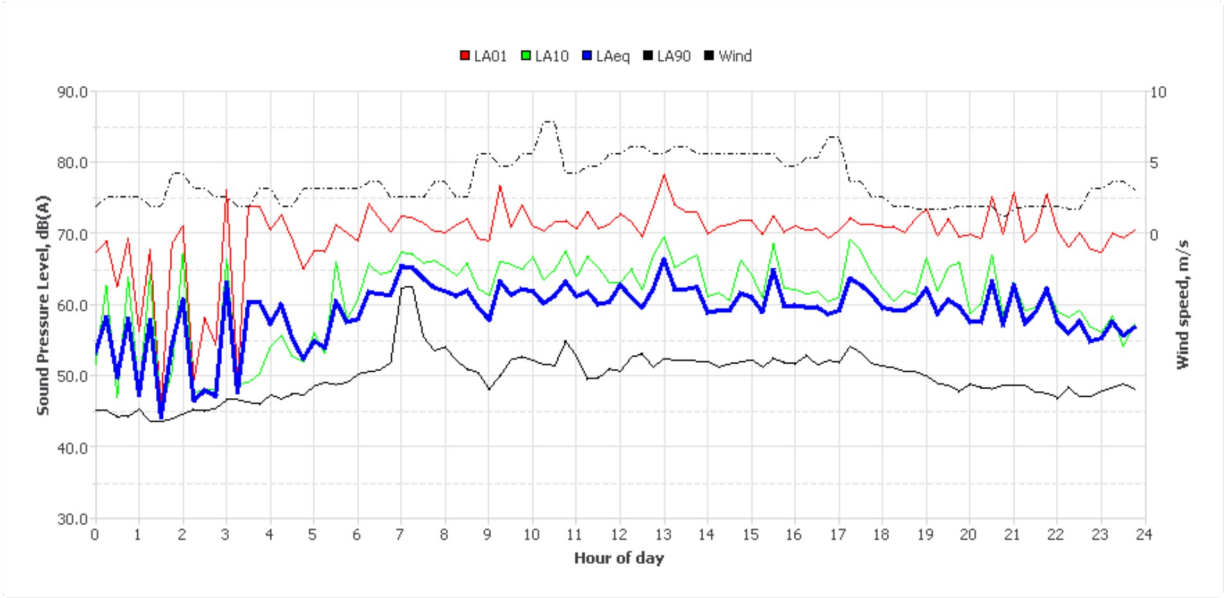
Typical Day



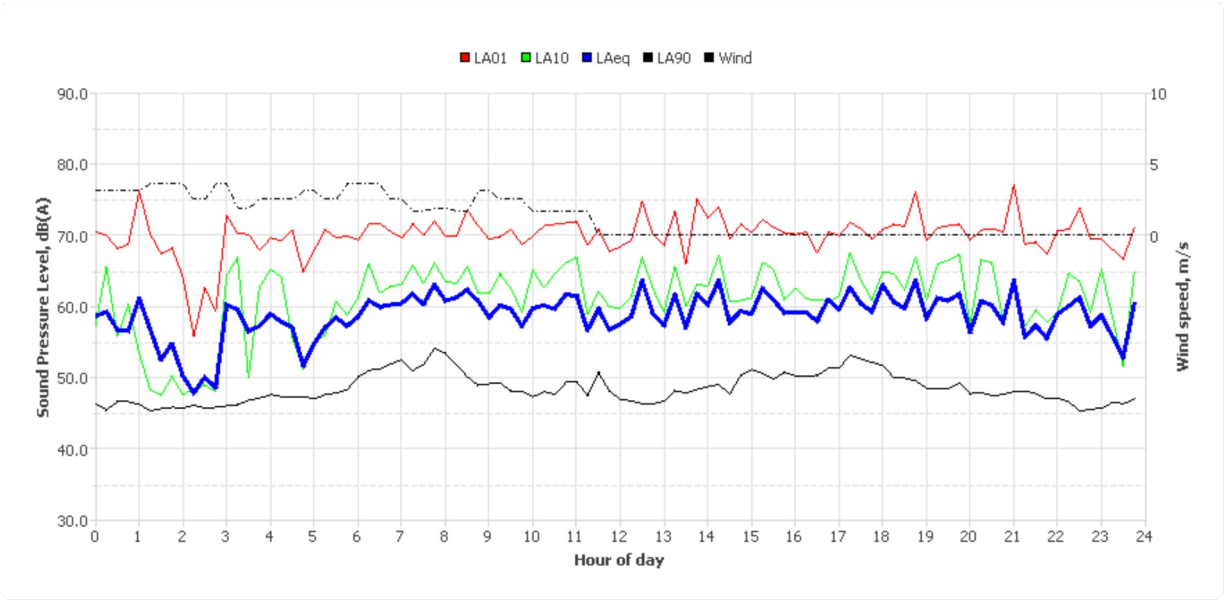
Wednesday, 09 Sep 2020



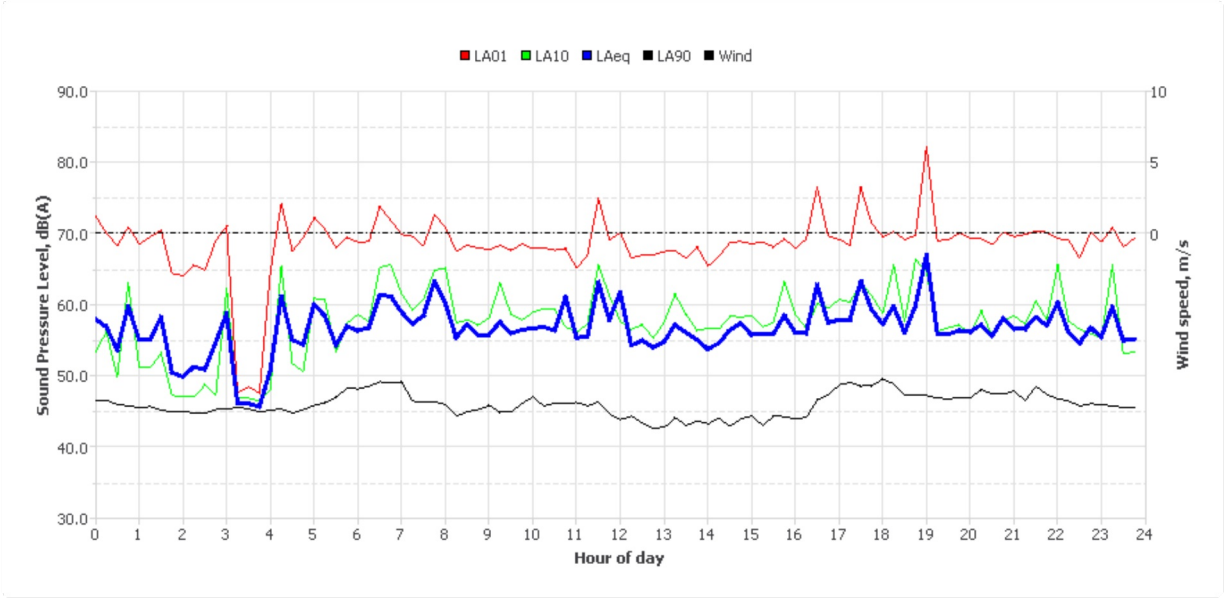
Thursday, 10 Sep 2020



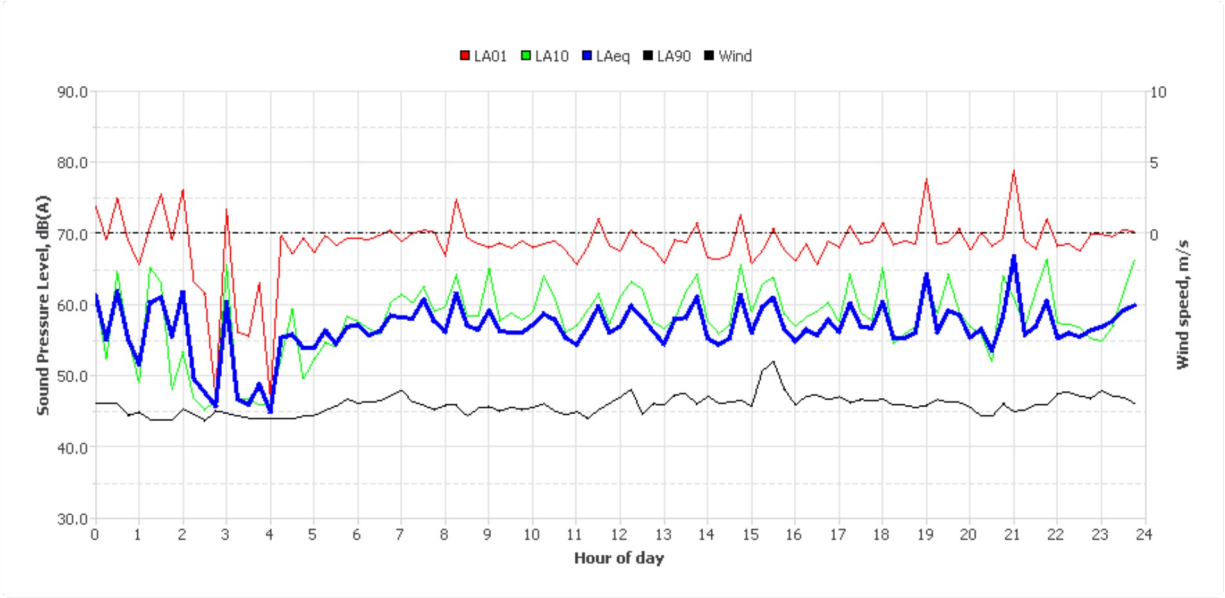
Friday, 11 Sep 2020



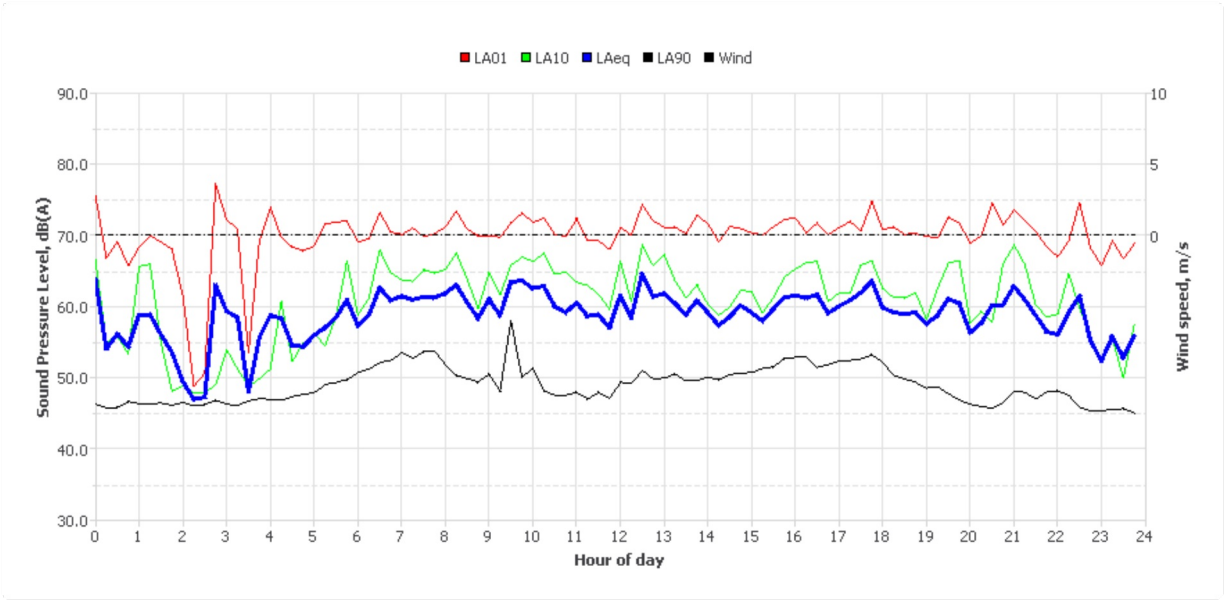
Saturday, 12 Sep 2020



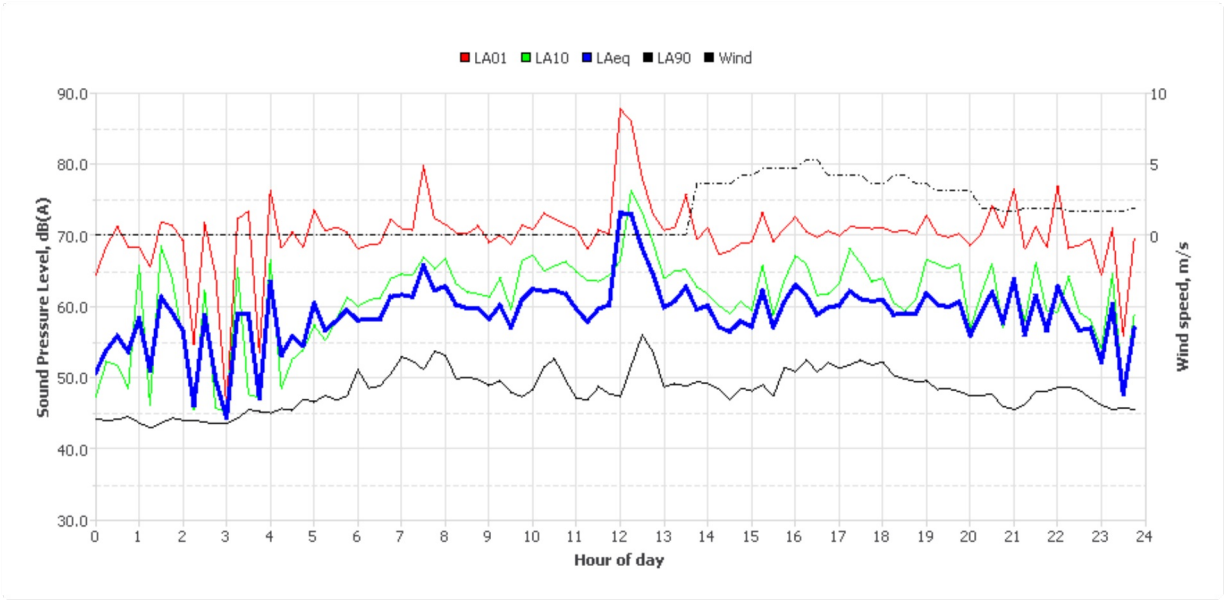
Sunday, 13 Sep 2020



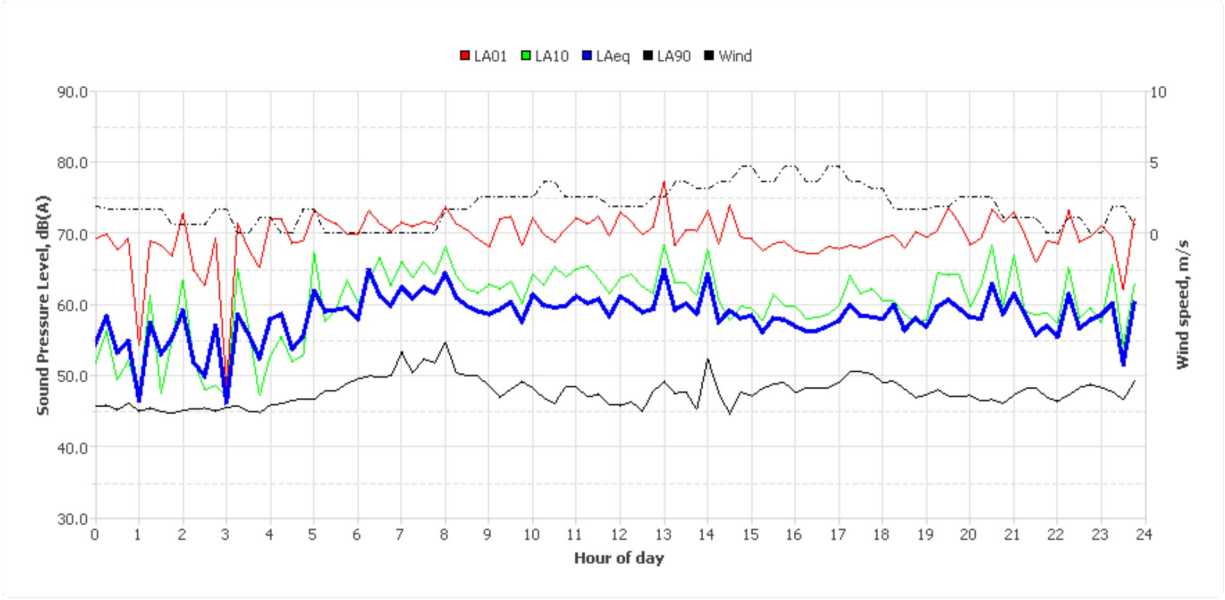
Monday, 14 Sep 2020



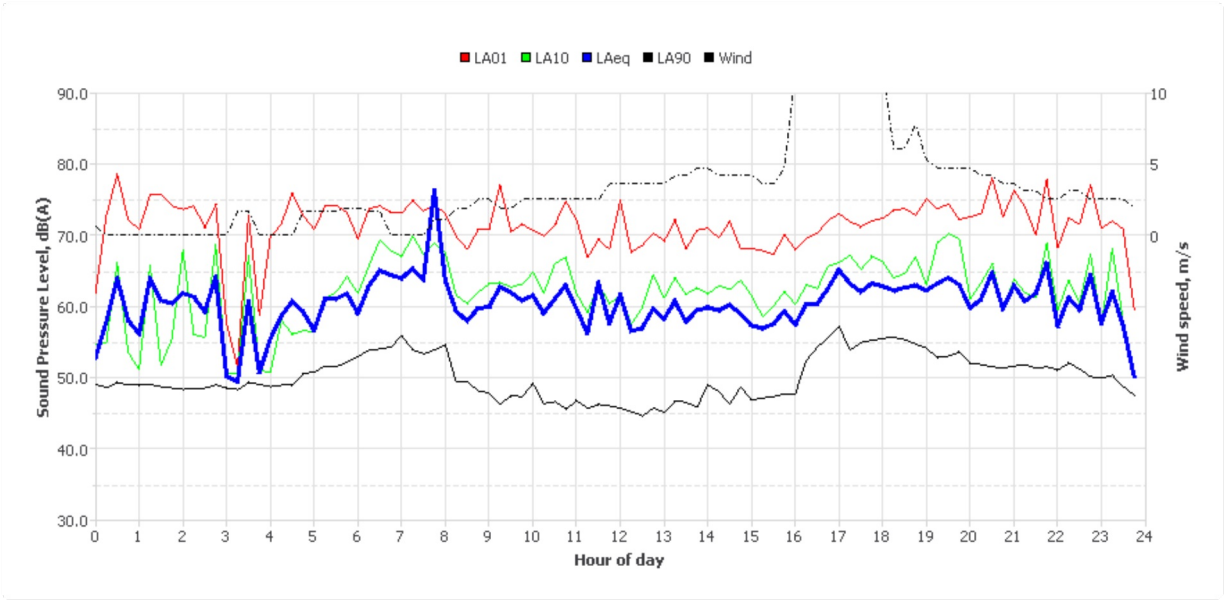
Tuesday, 15 Sep 2020



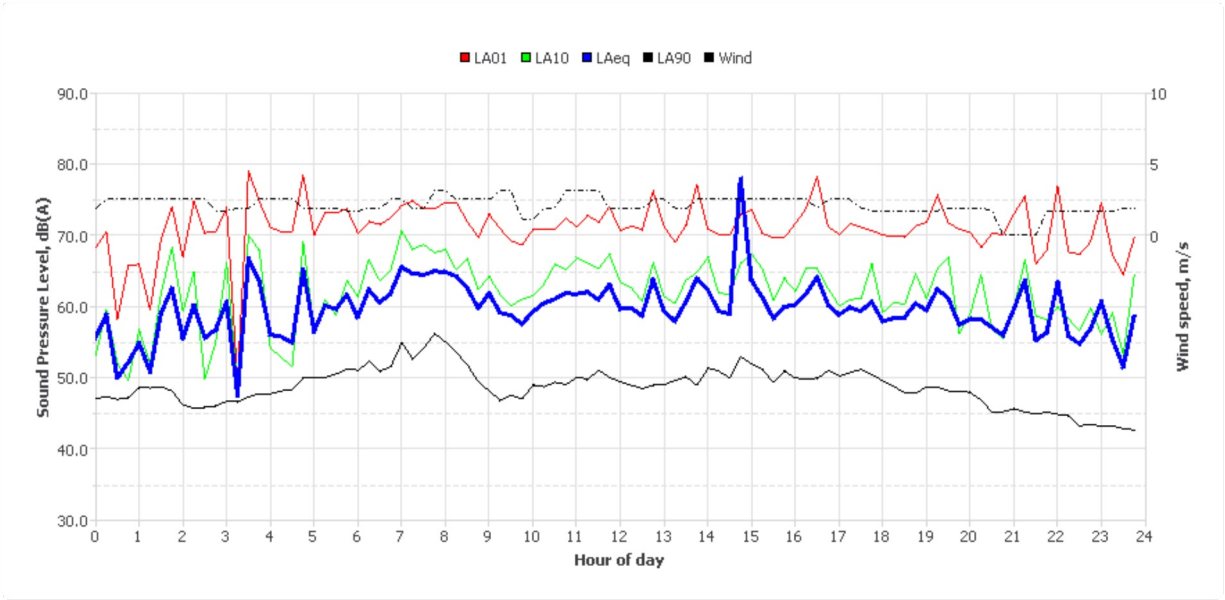
Wednesday, 16 Sep 2020



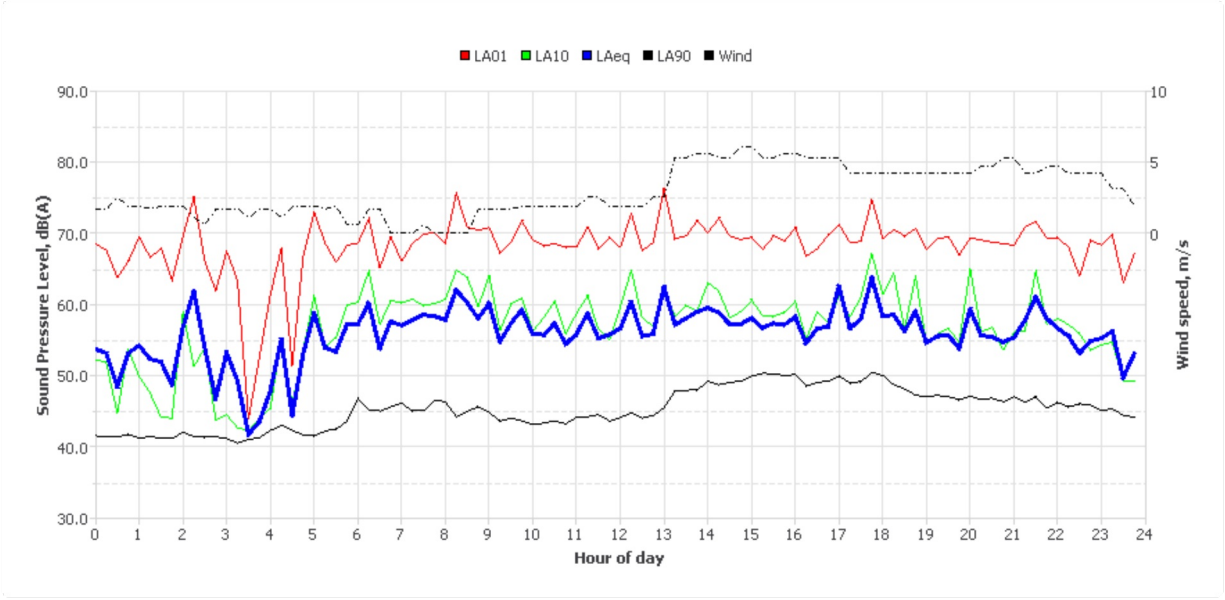
Thursday, 17 Sep 2020



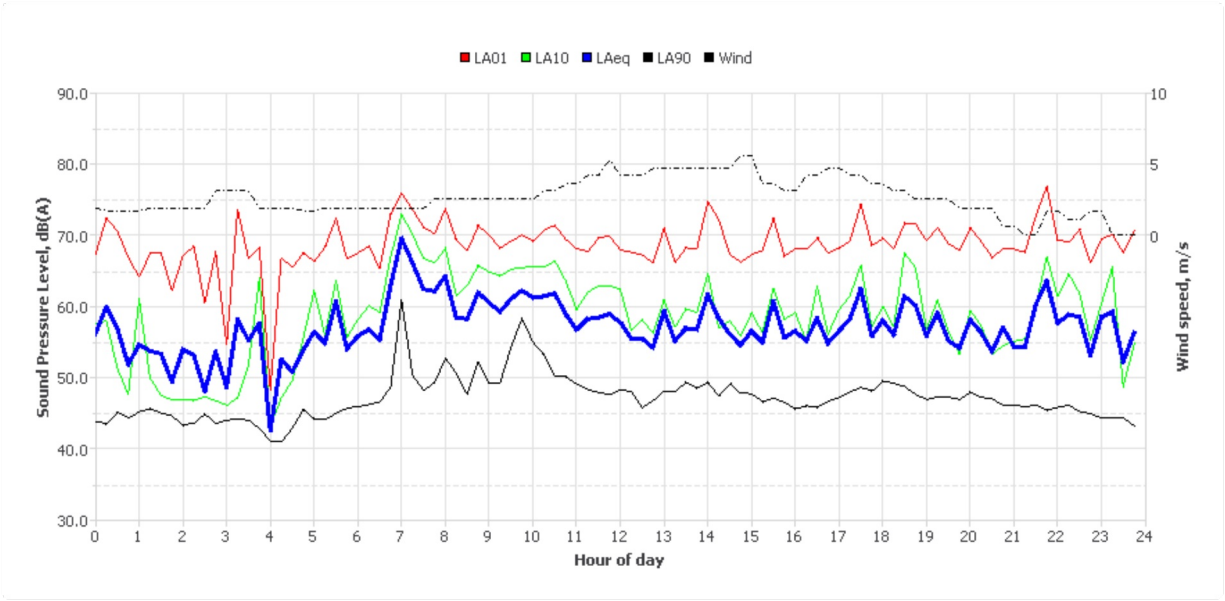
Friday, 18 Sep 2020



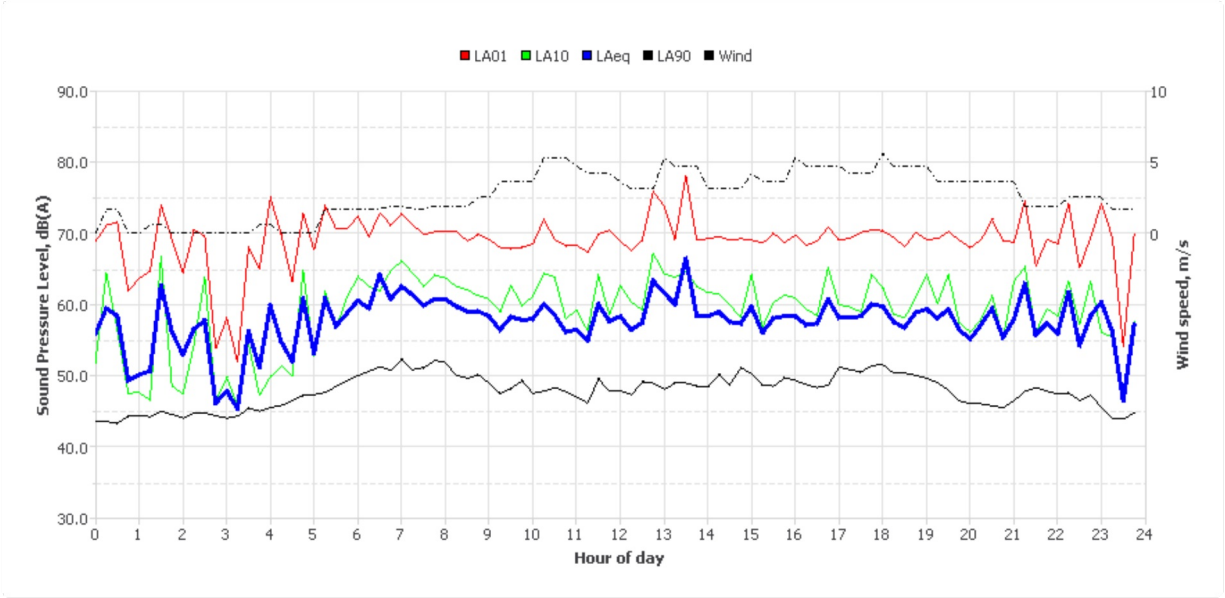
Saturday, 19 Sep 2020



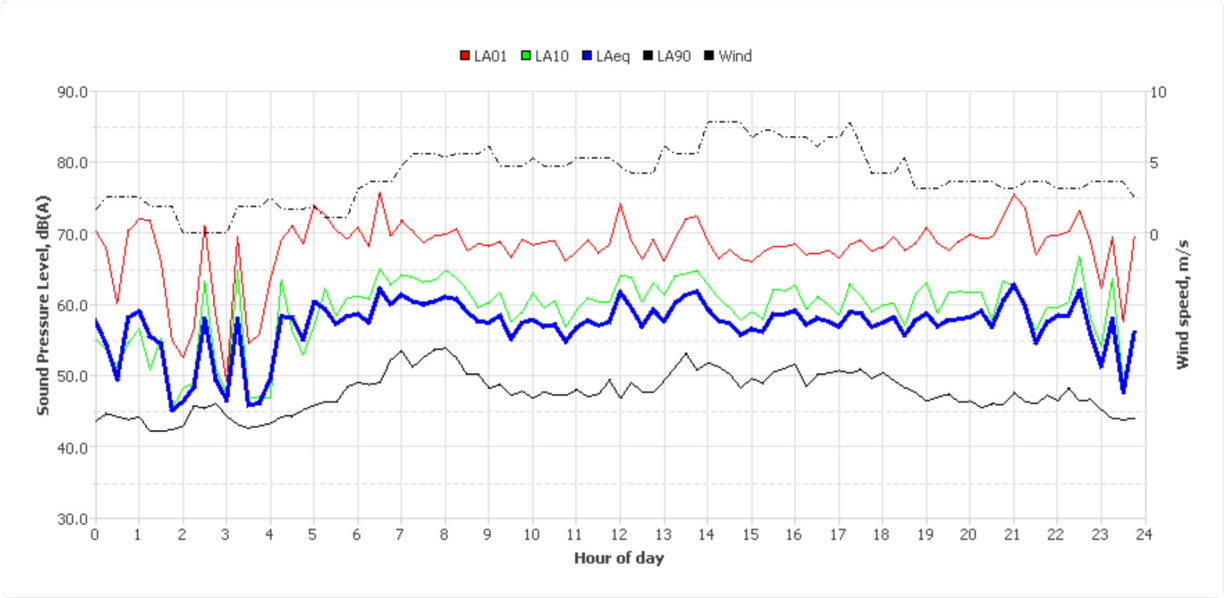
Sunday, 20 Sep 2020



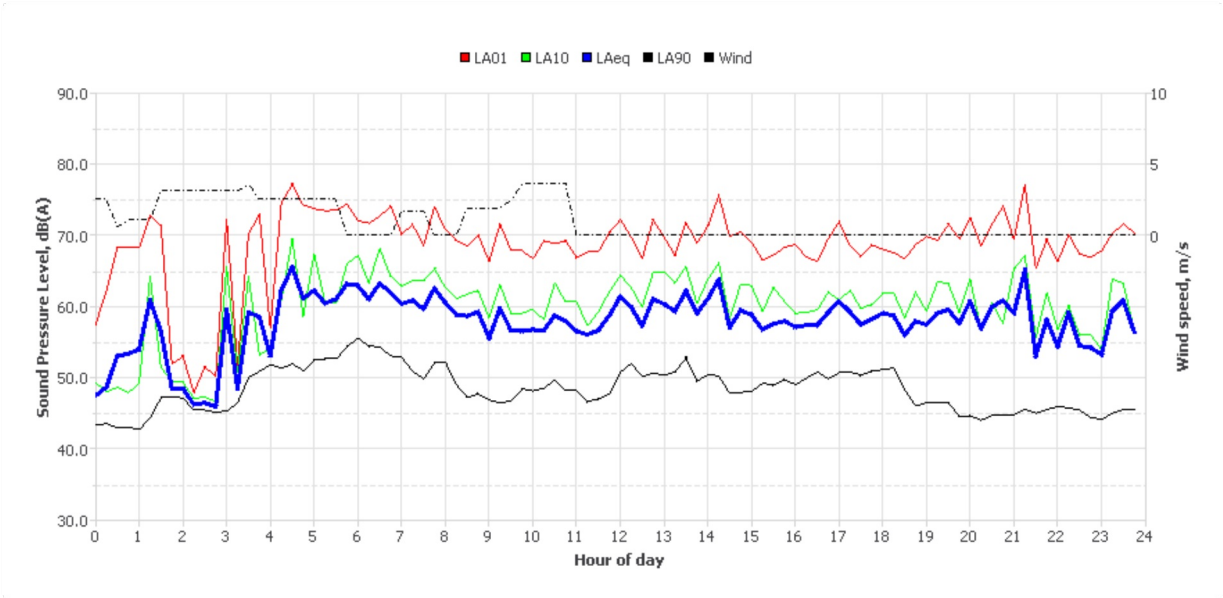
Monday, 21 Sep 2020



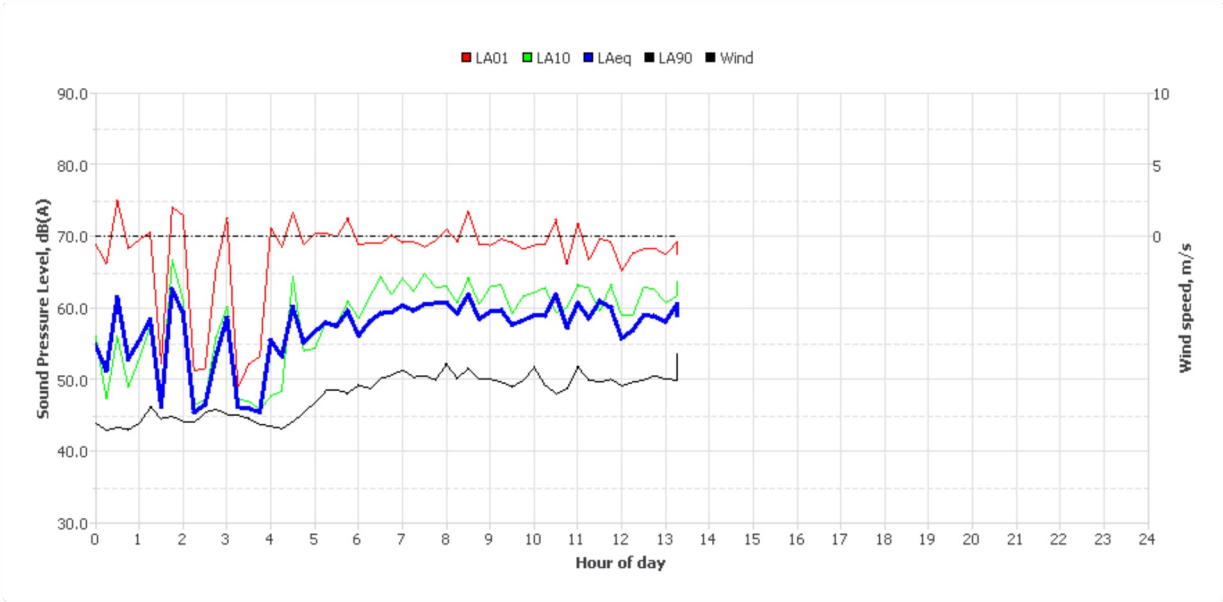
Tuesday, 22 Sep 2020



Wednesday, 23 Sep 2020



Thursday, 24 Sep 2020



Noise Logger Report

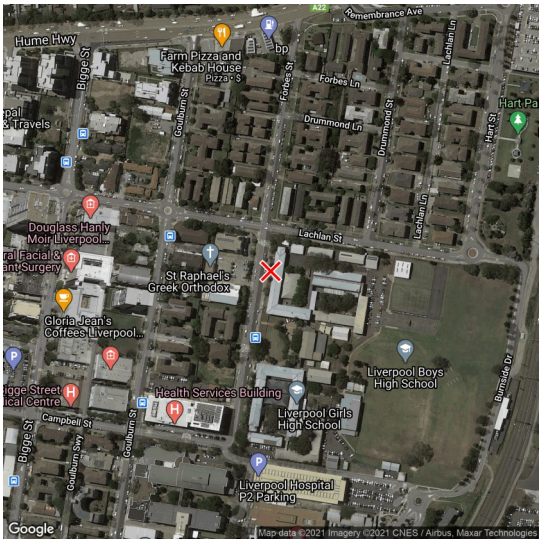
18 Forbes Street, Liverpool

Item	Information
Logger Type	NL-52
Serial number	898334
Address	18 Forbes Street, Liverpool
Location	Forbes Street Boundary of Liverpool Boys high school
Facade / Free Field	Free Field
Environment	Sunny, mild breeze at times, Birds chirping

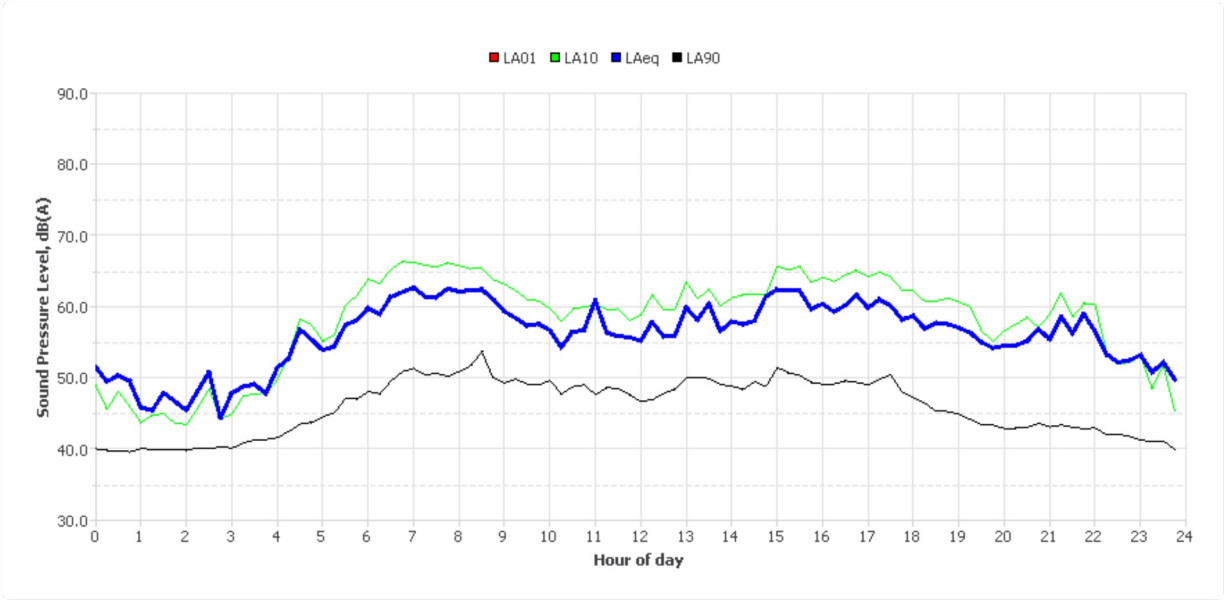
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Sep 9 2020	64	58	55	-	44	-	62	55
Thu Sep 10 2020	62	59	55	-	44	41	61	55
Fri Sep 11 2020	60	58	55	48	44	42	60	55
Sat Sep 12 2020	55	56	53	45	44	40	56	53
Sun Sep 13 2020	56	55	53	43	42	40	55	53
Mon Sep 14 2020	60	57	55	47	43	41	59	55
Tue Sep 15 2020	60	59	56	47	43	39	60	56
Wed Sep 16 2020	60	56	55	47	44	40	59	55
Thu Sep 17 2020	60	56	56	46	-	41	59	56
Fri Sep 18 2020	61	56	56	47	41	40	60	56
Sat Sep 19 2020	56	56	53	-	44	39	56	53
Sun Sep 20 2020	58	57	54	45	44	40	58	54
Mon Sep 21 2020	61	57	55	48	43	41	61	55
Tue Sep 22 2020	58	56	56	-	42	40	57	56
Wed Sep 23 2020	60	57	56	47	42	40	60	56
Thu Sep 24 2020	61	-	55	-	-	-	61	55
Summary	**60**	**57**	**55**	**47**	**43**	**40**	**59**	**55**

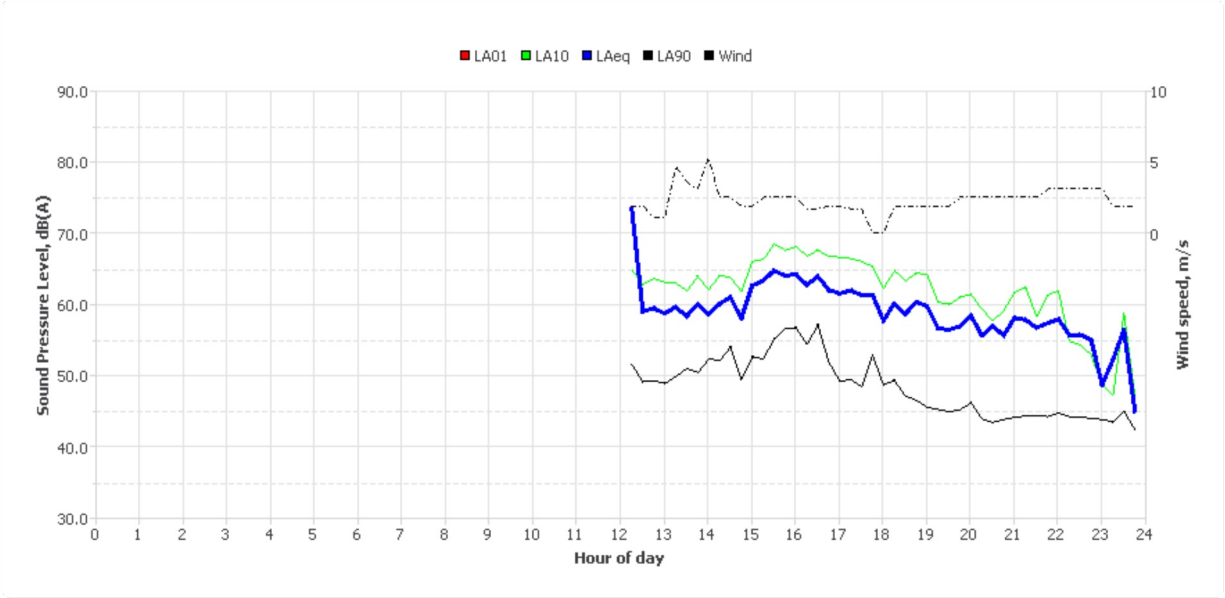
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

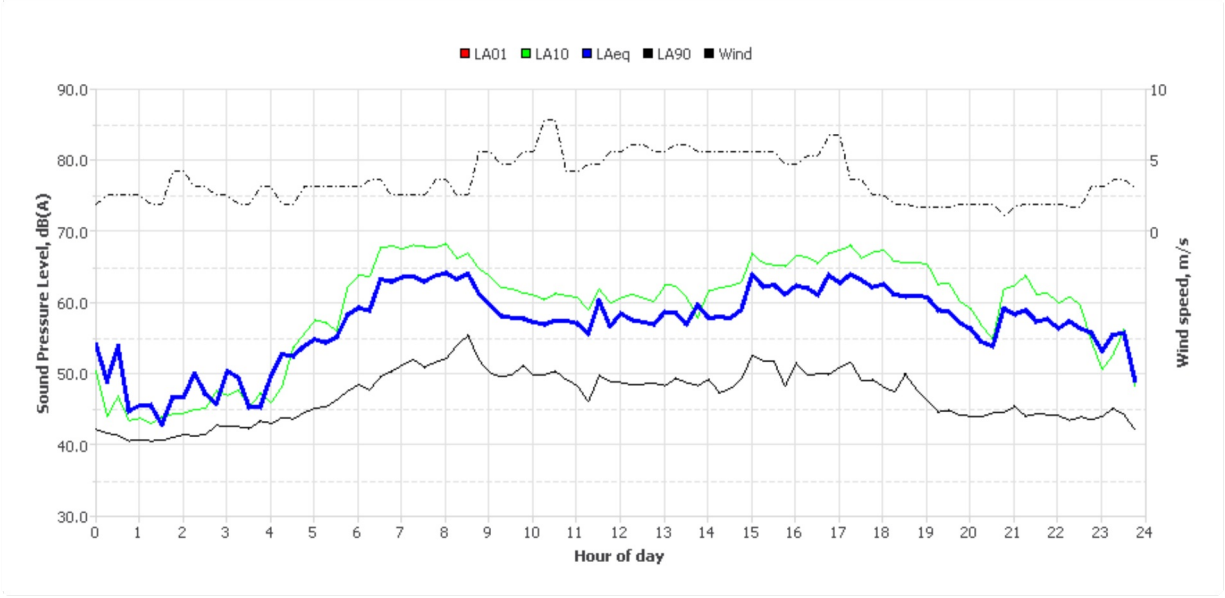
Typical Day



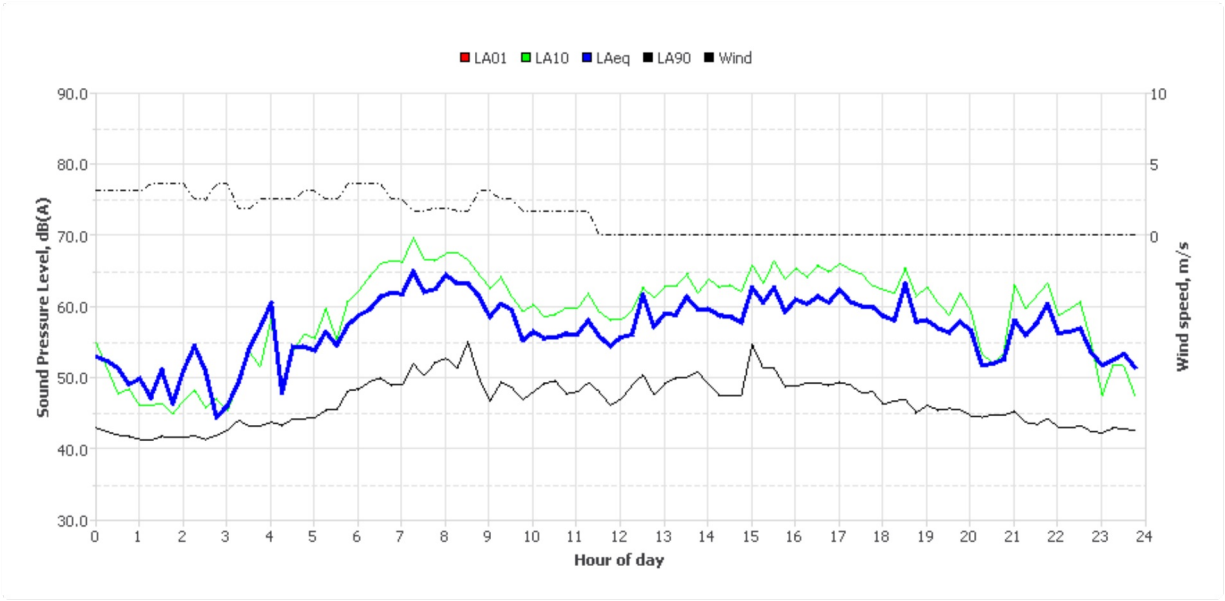
Wednesday, 09 Sep 2020



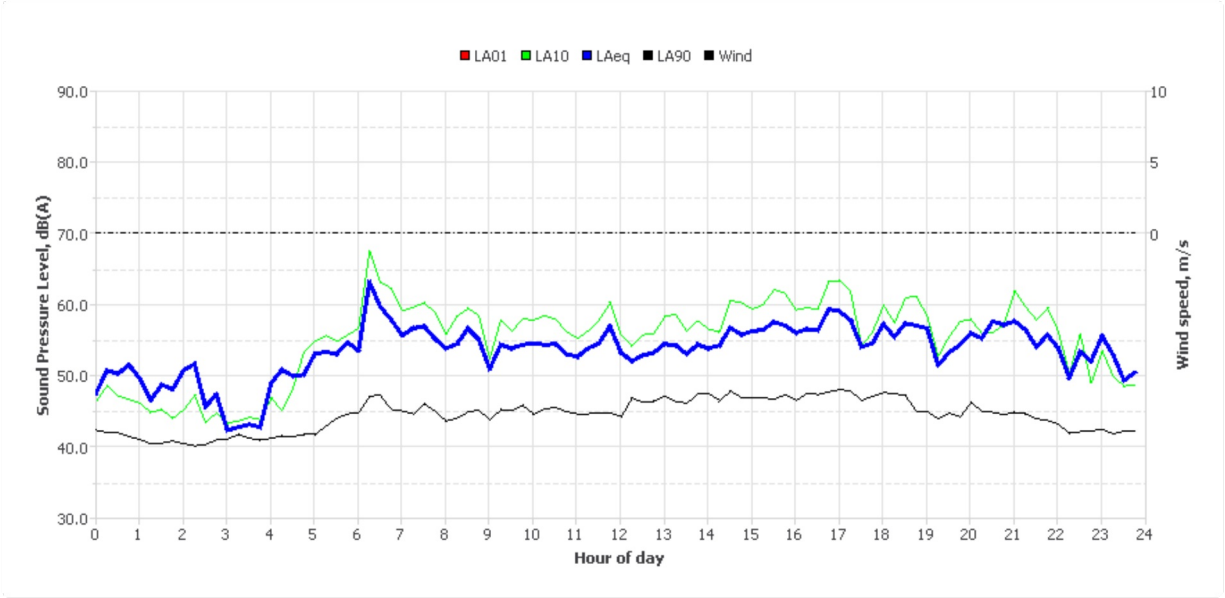
Thursday, 10 Sep 2020



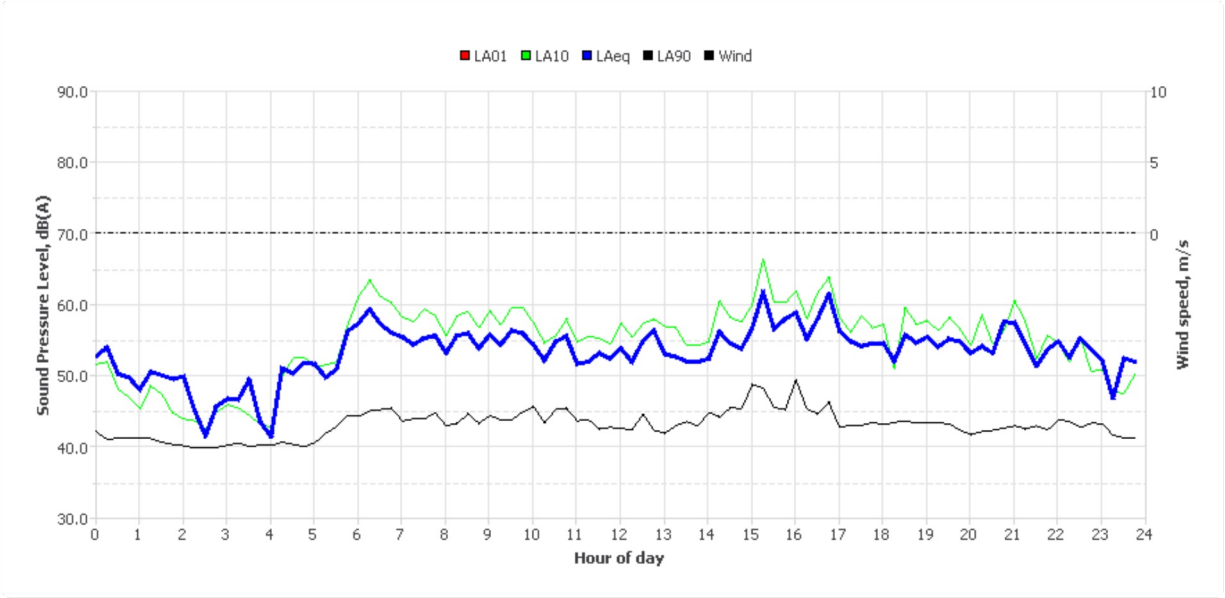
Friday, 11 Sep 2020



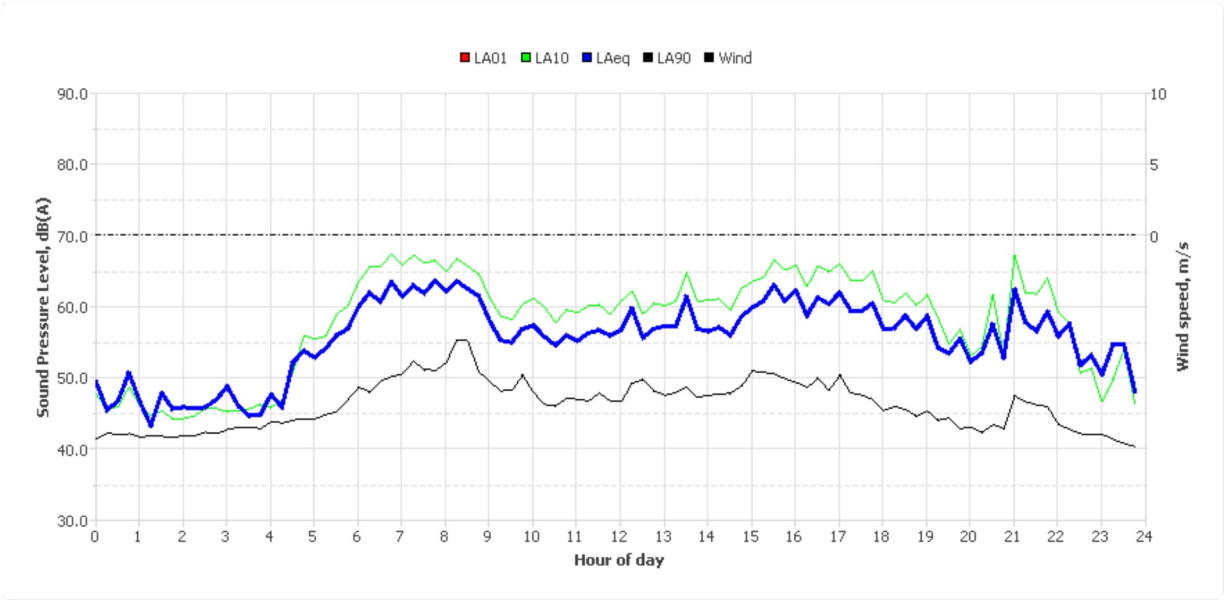
Saturday, 12 Sep 2020



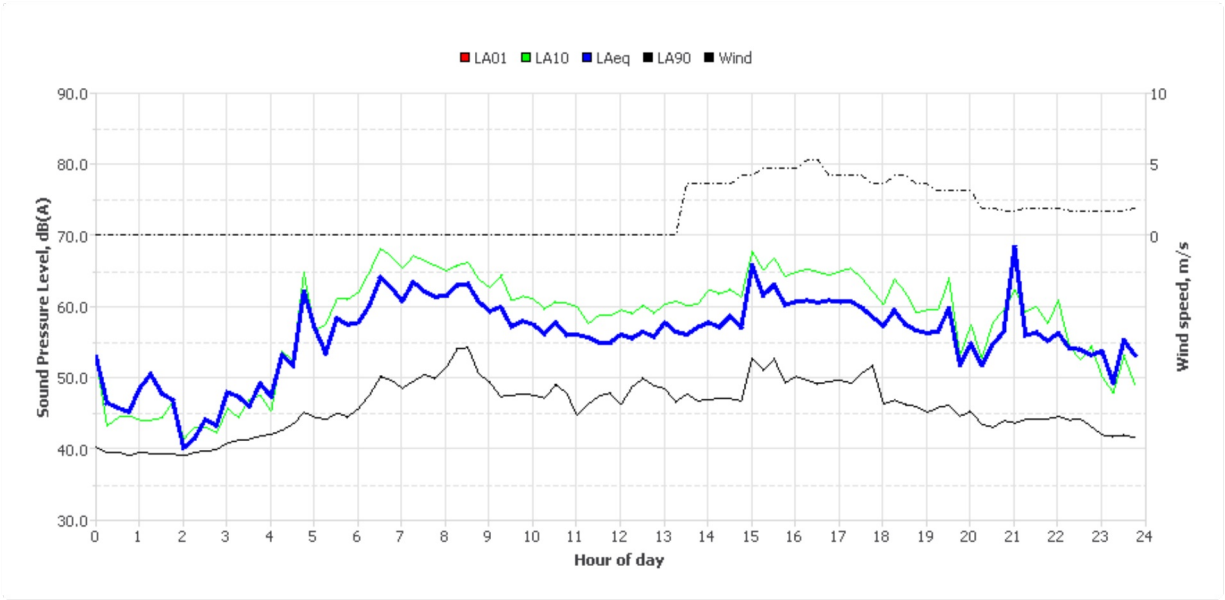
Sunday, 13 Sep 2020



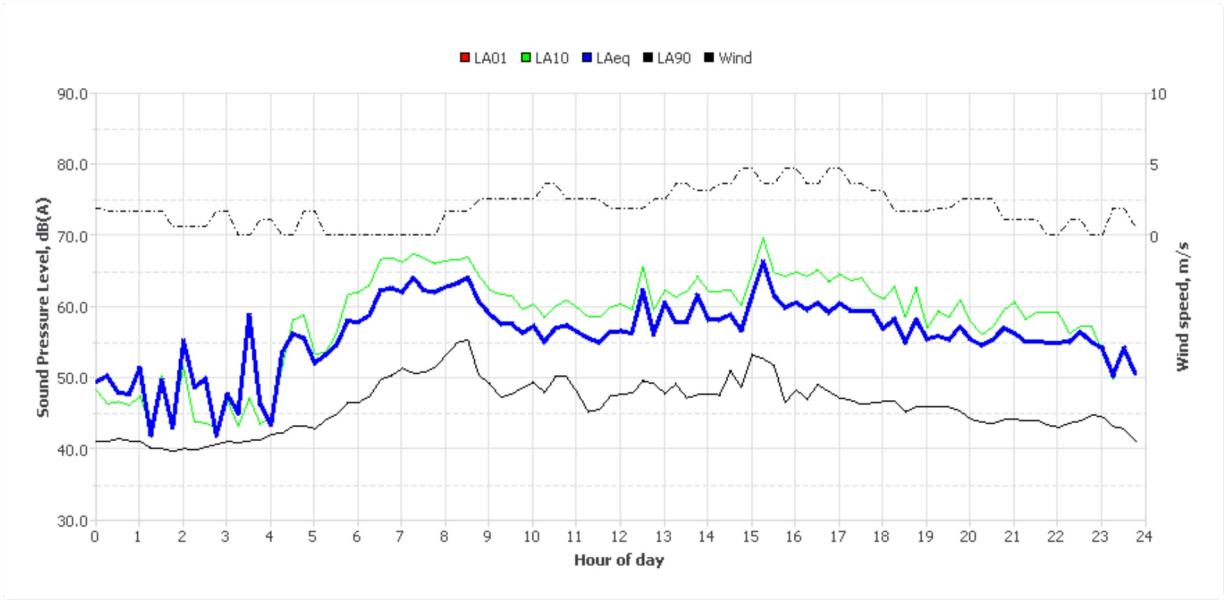
Monday, 14 Sep 2020



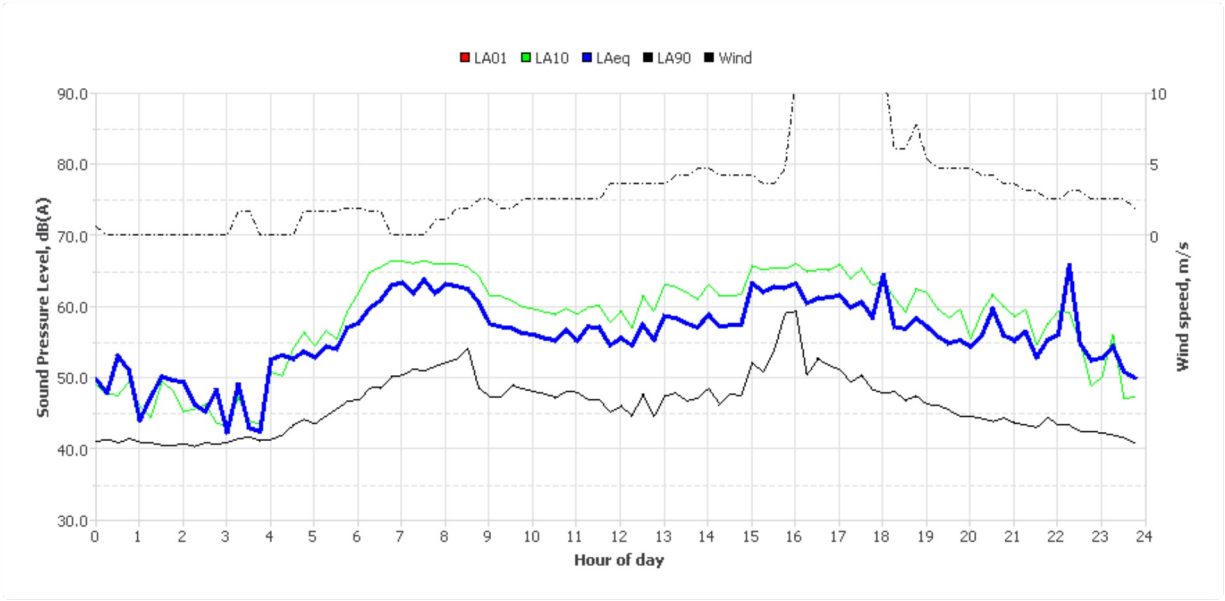
Tuesday, 15 Sep 2020



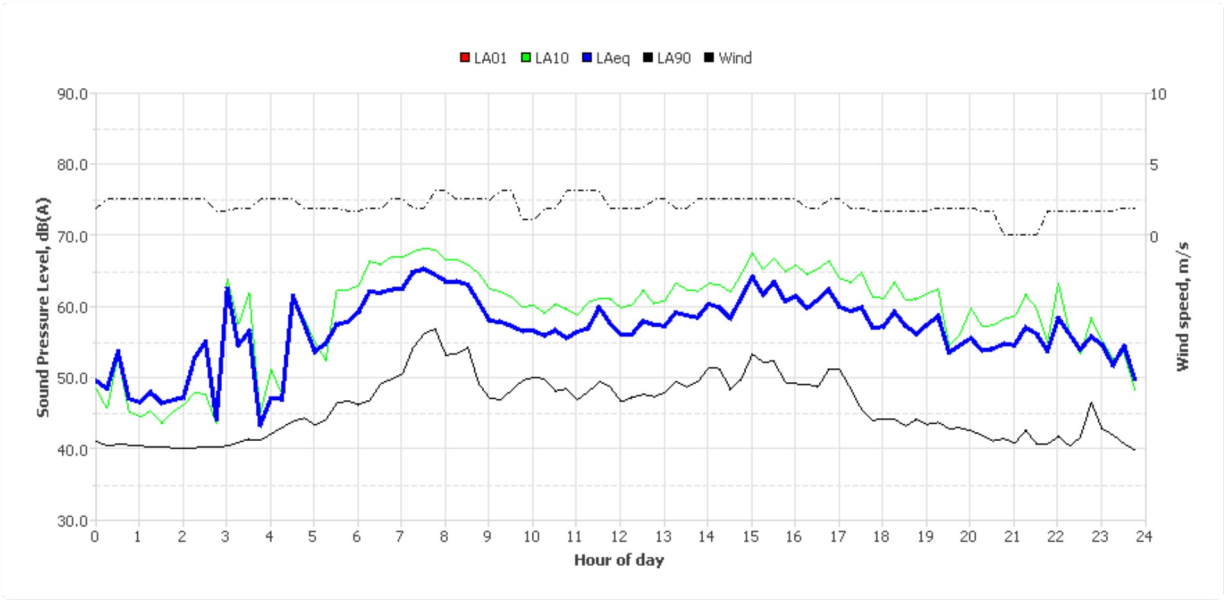
Wednesday, 16 Sep 2020



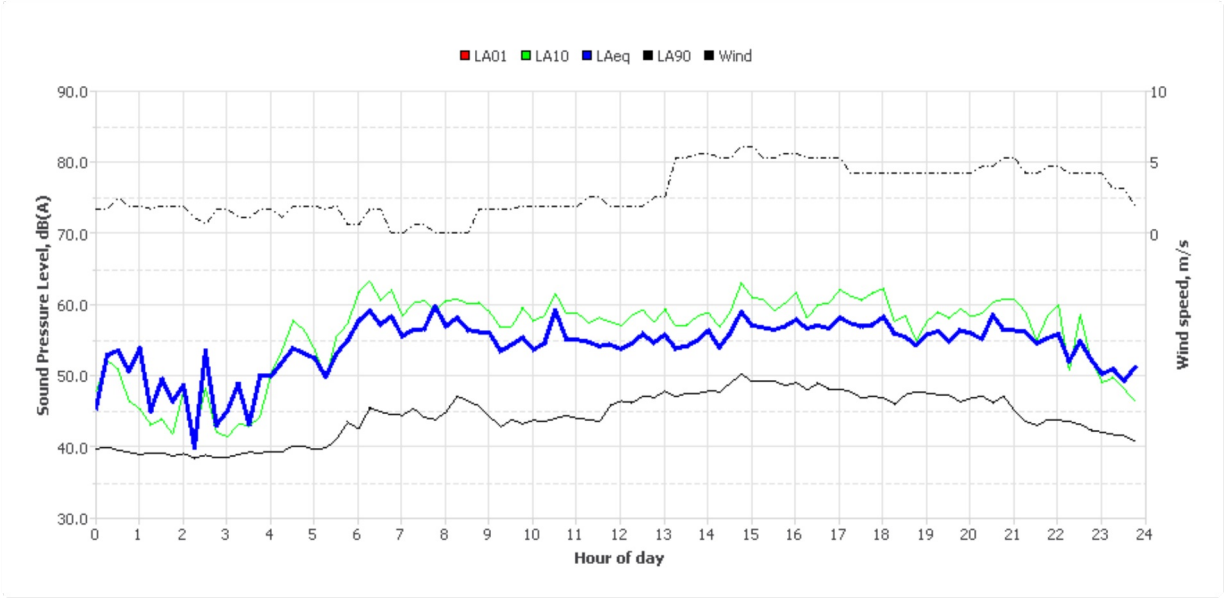
Thursday, 17 Sep 2020



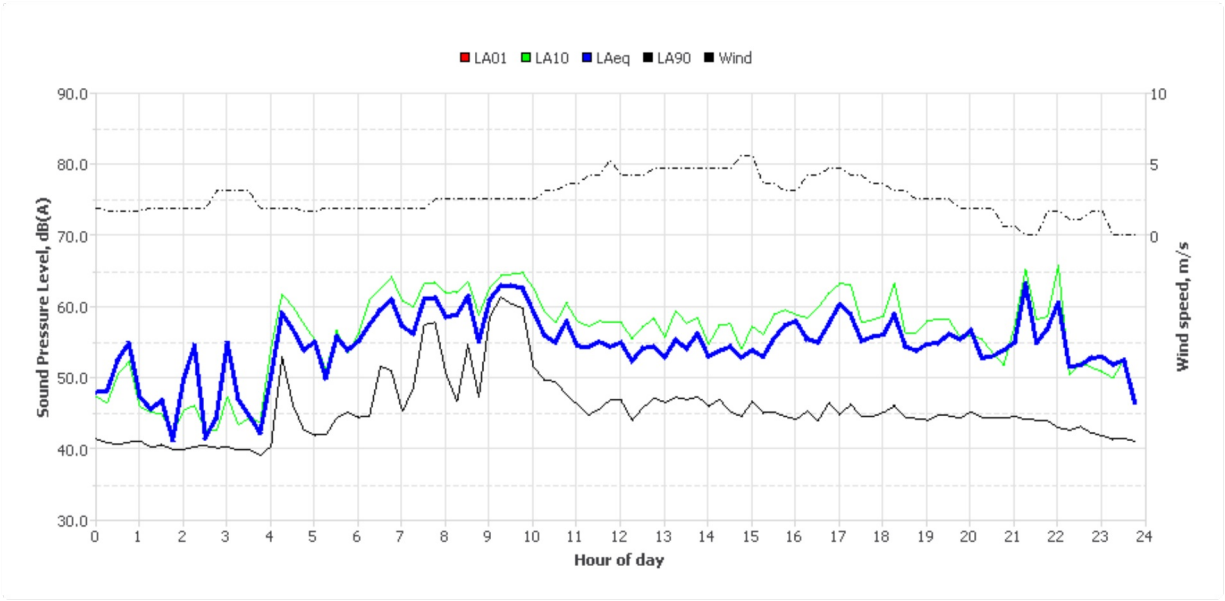
Friday, 18 Sep 2020



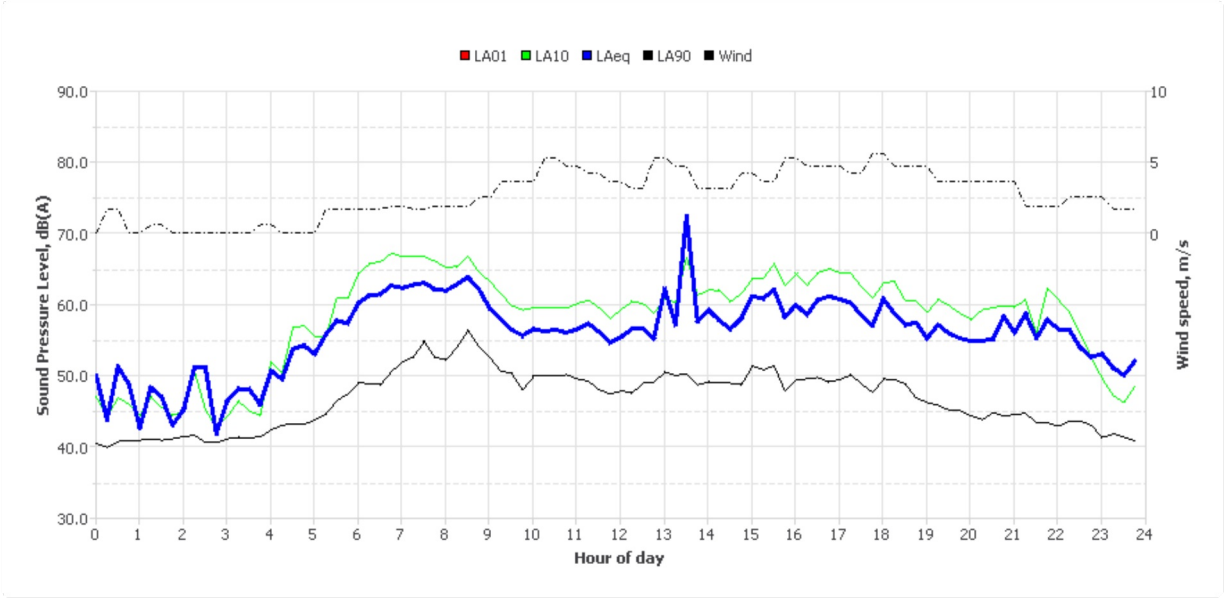
Saturday, 19 Sep 2020



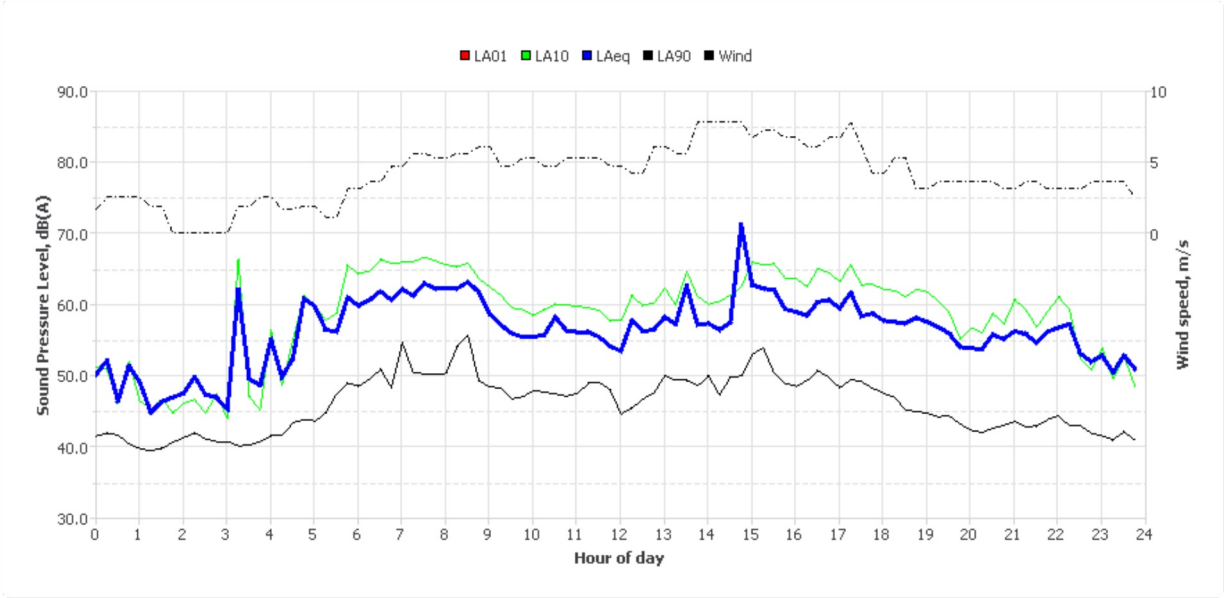
Sunday, 20 Sep 2020



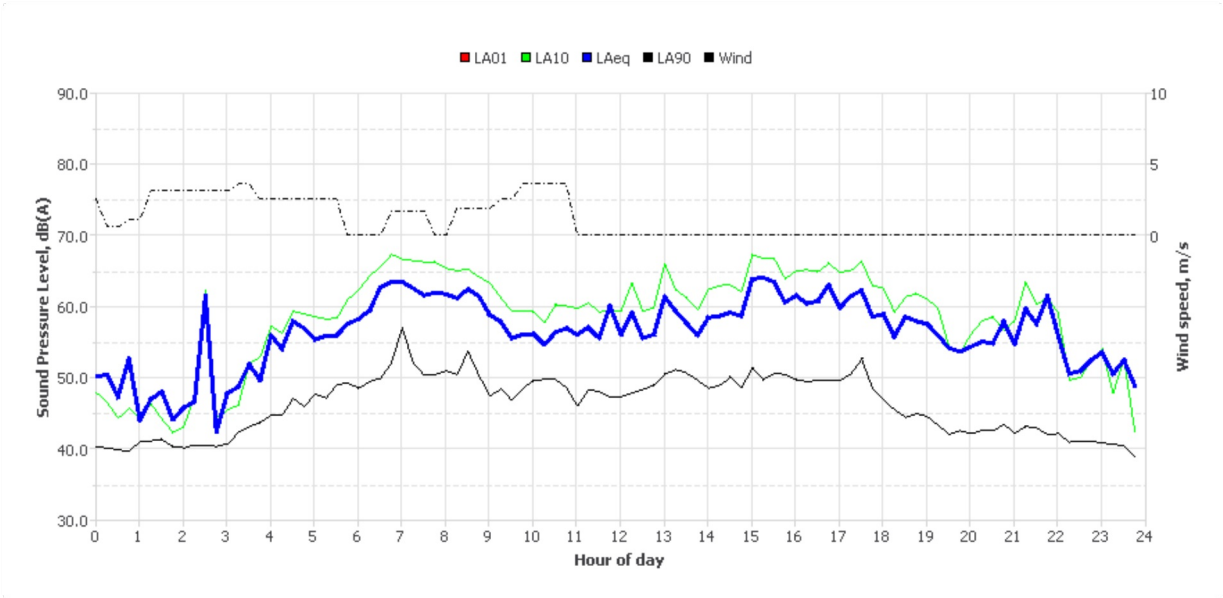
Monday, 21 Sep 2020



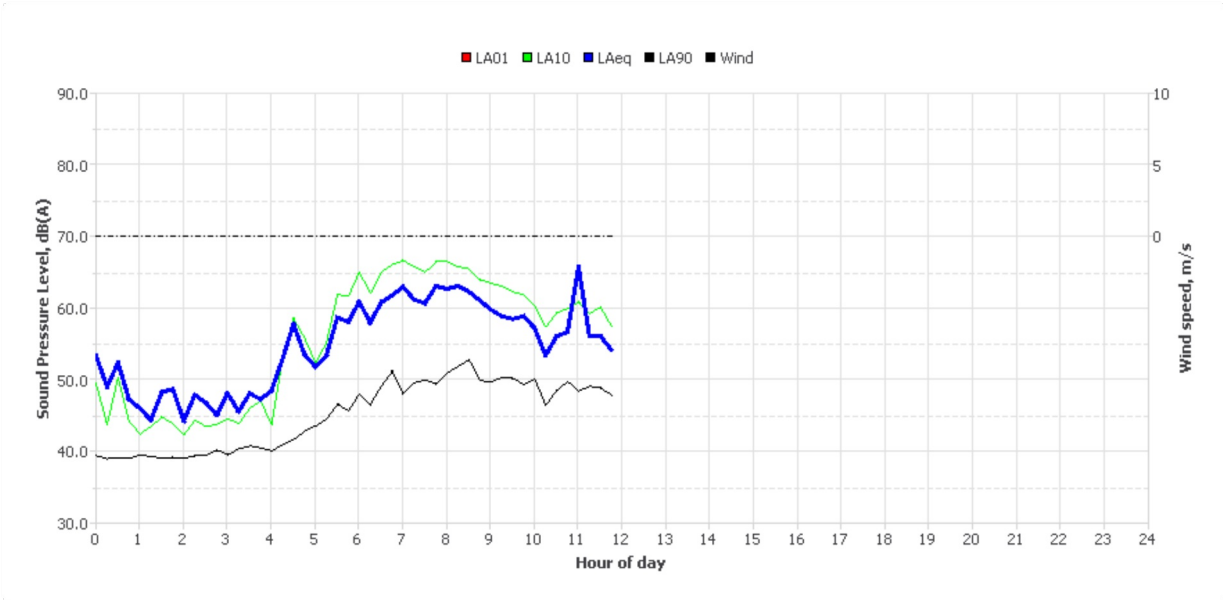
Tuesday, 22 Sep 2020



Wednesday, 23 Sep 2020

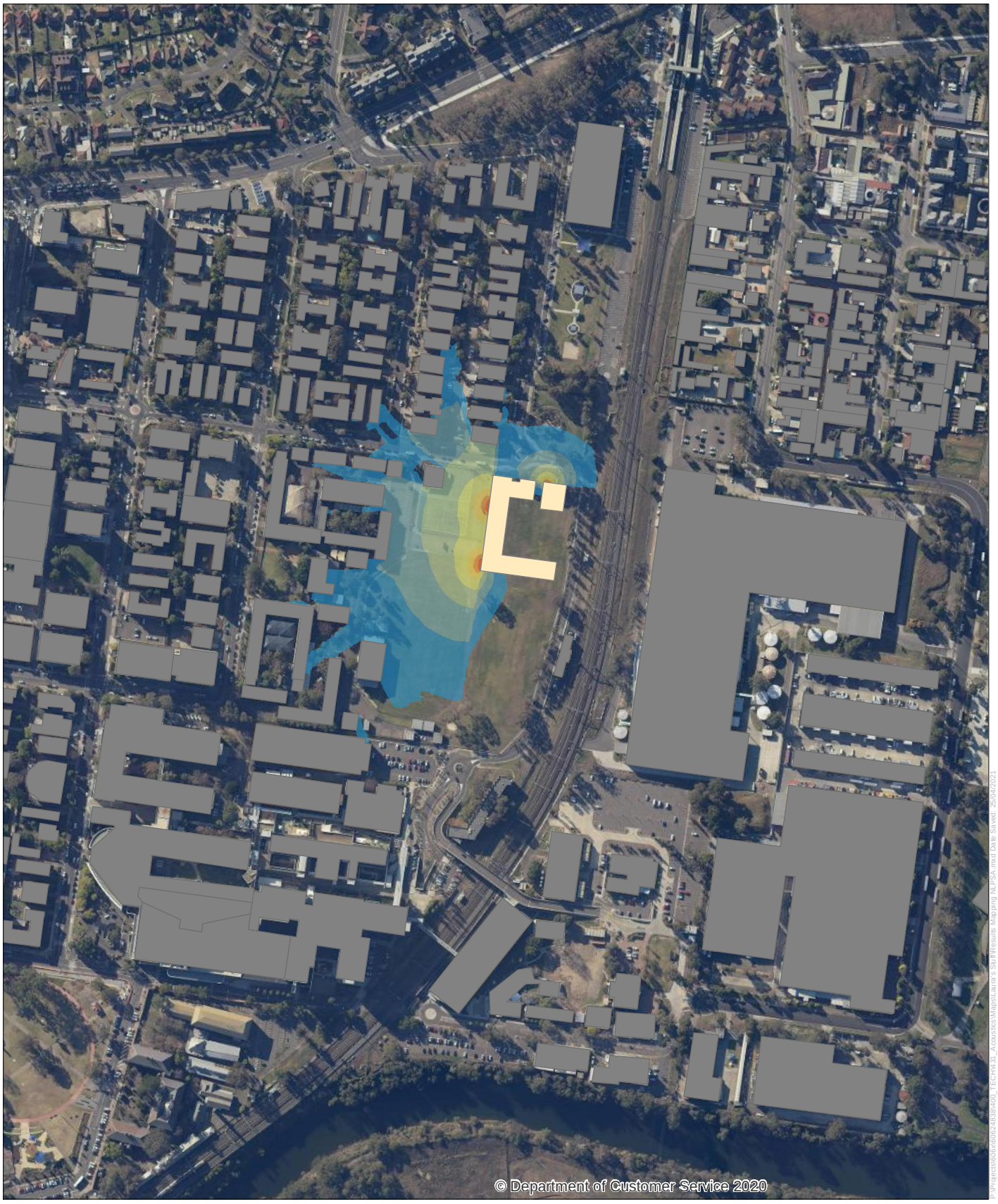


Thursday, 24 Sep 2020



Appendix C

Operational Noise Contours



New Liverpool Primary School
Building Services Noise Emission (Day)

N

0 0.08 0.16 km

AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:

P:\Projects\60606248\8400_TECH\431_Acoustics\Maps\Laura's Stuff\Results Mapping NLPSA.mxd Date Saved: 25/04/2021

New Liverpool Primary School
Building Services Noise Emission (Evening)

N

0 0.08 0.16 km

AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:

New Liverpool Primary School
Building Services Noise Emission (Night)

N

0 0.08 0.16 km

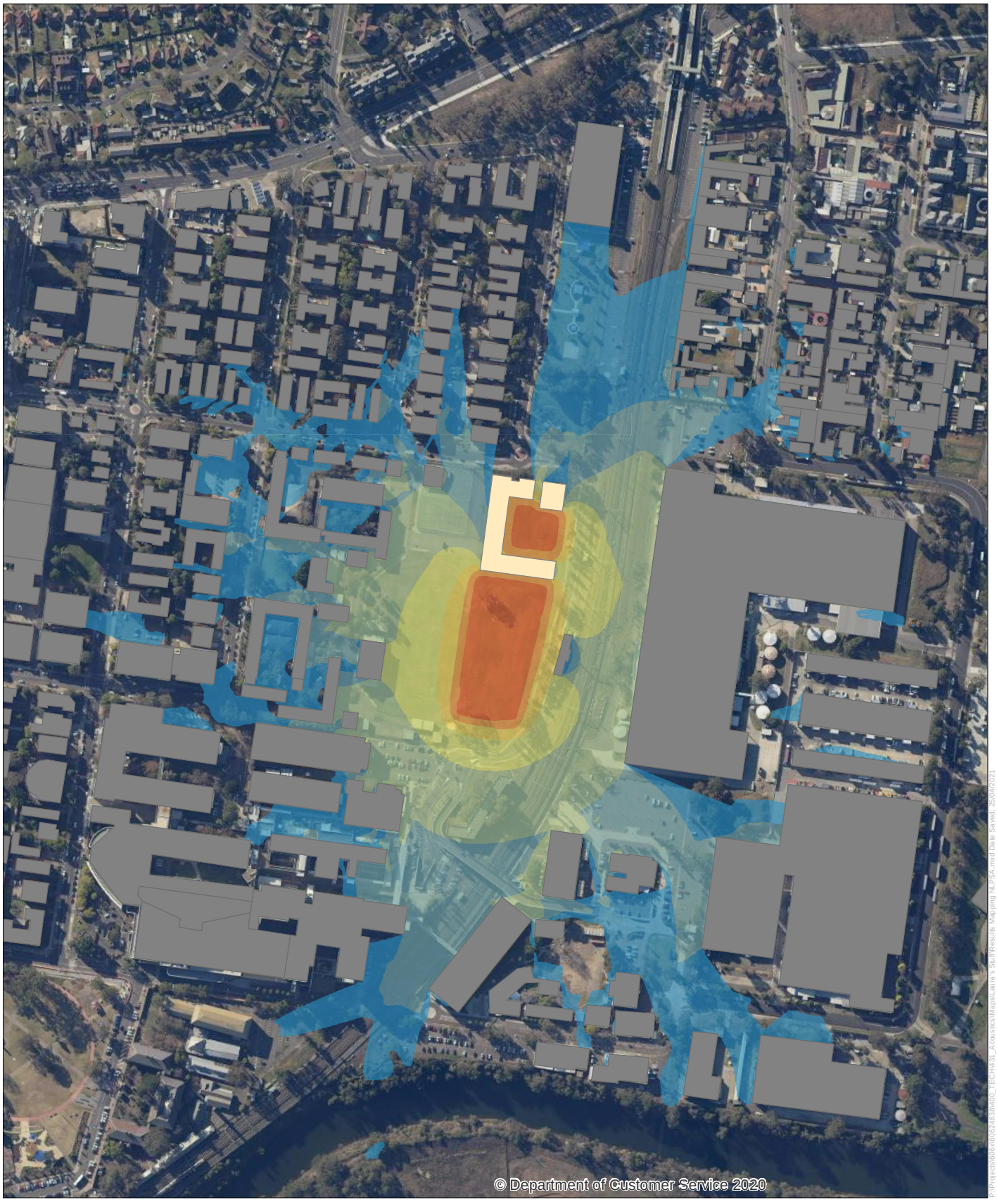
AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:



New Liverpool Primary School
Outdoor Play Noise Emission

N

0 0.08 0.16 km

AECOM

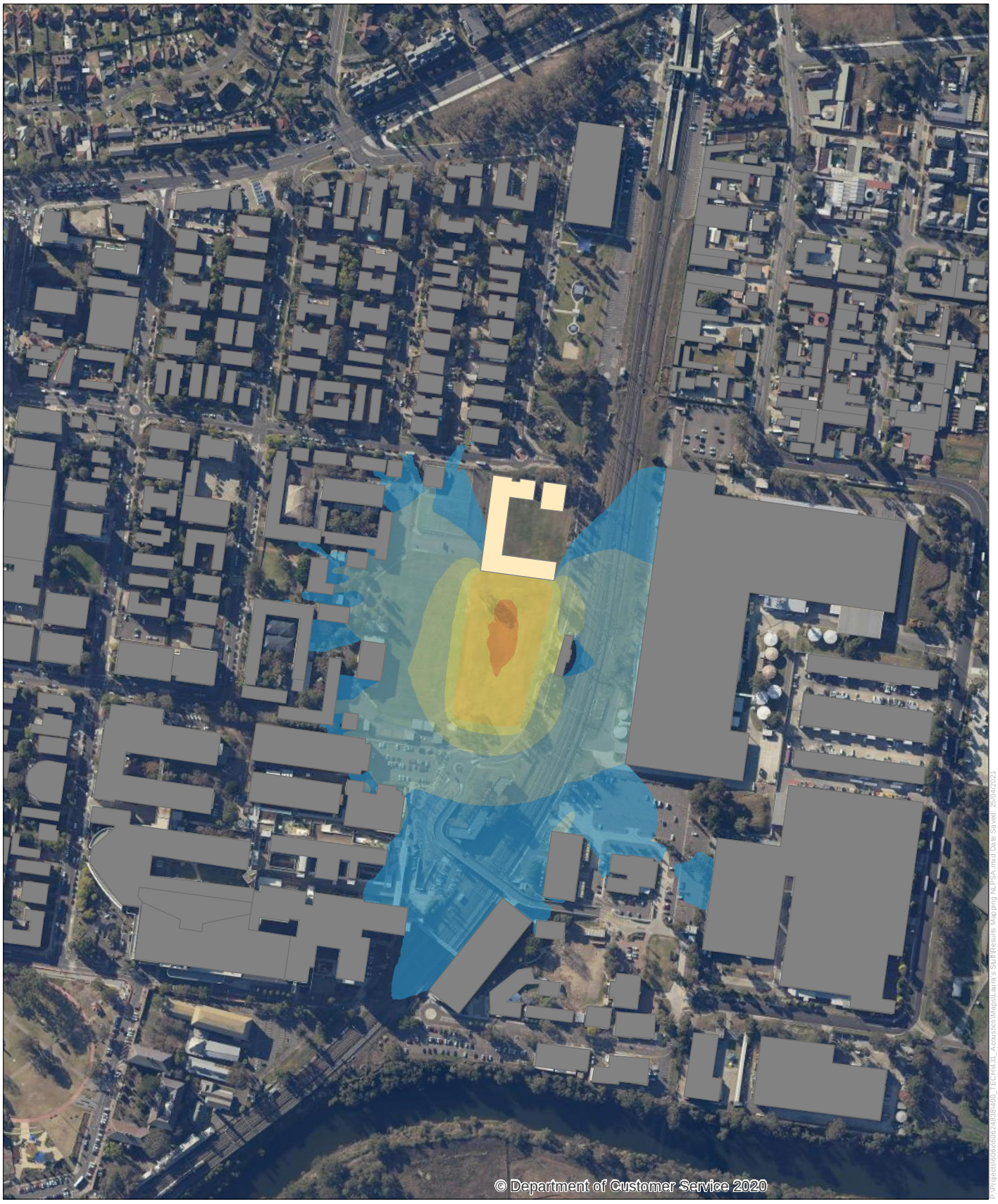
NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:

P:\Projects\60606262\388400_TECH\431_Acoustics\Maps\Laura's Stuff\Results Mapping NLPSA.mxd Date Saved: 25/04/2021



New Liverpool Primary School
PE and After School Sports Noise Emission

N

0 0.08 0.16 km

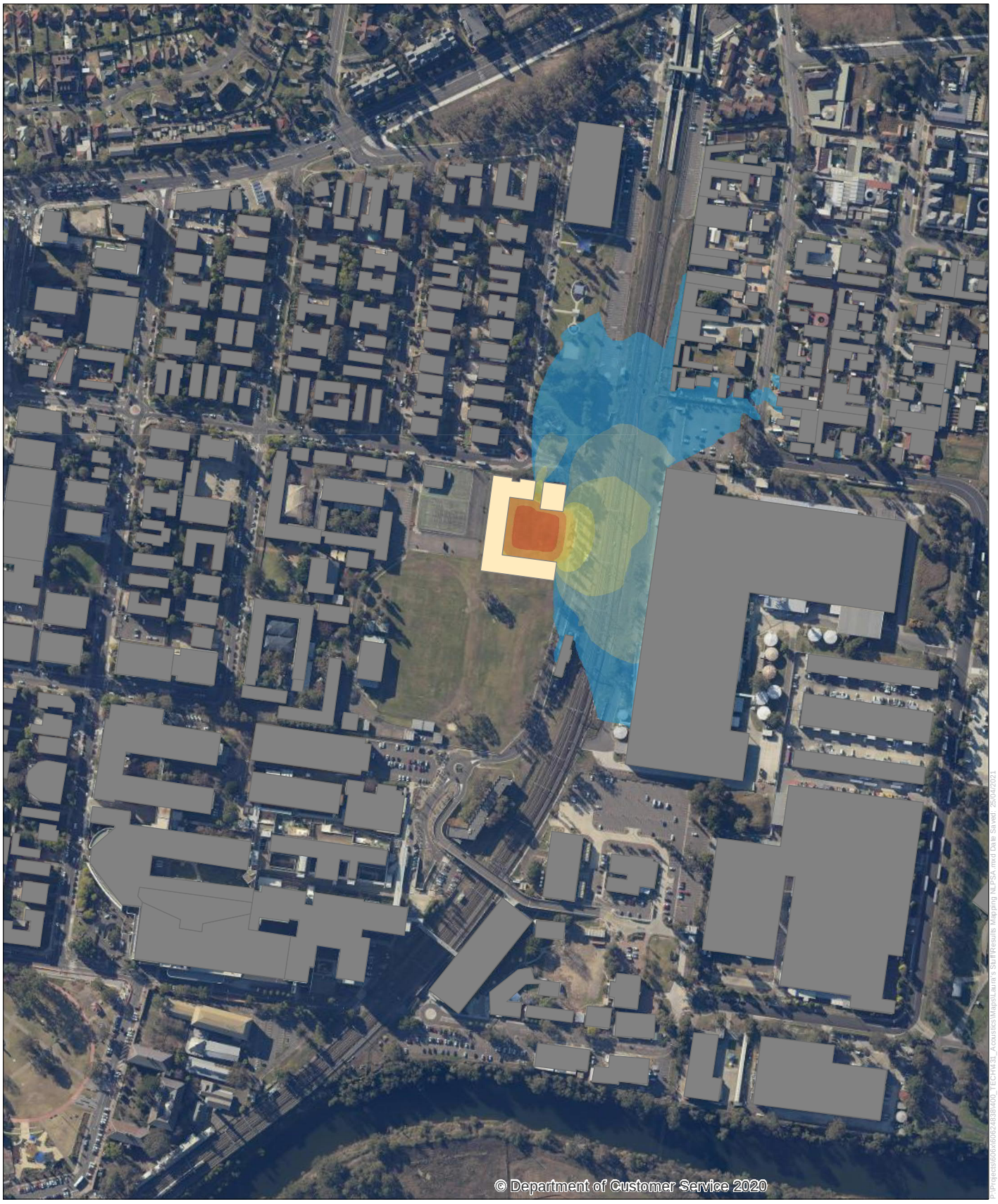
AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:



New Liverpool Primary School
OSHC Noise Emission

N

0 0.08 0.16 km

AECOM

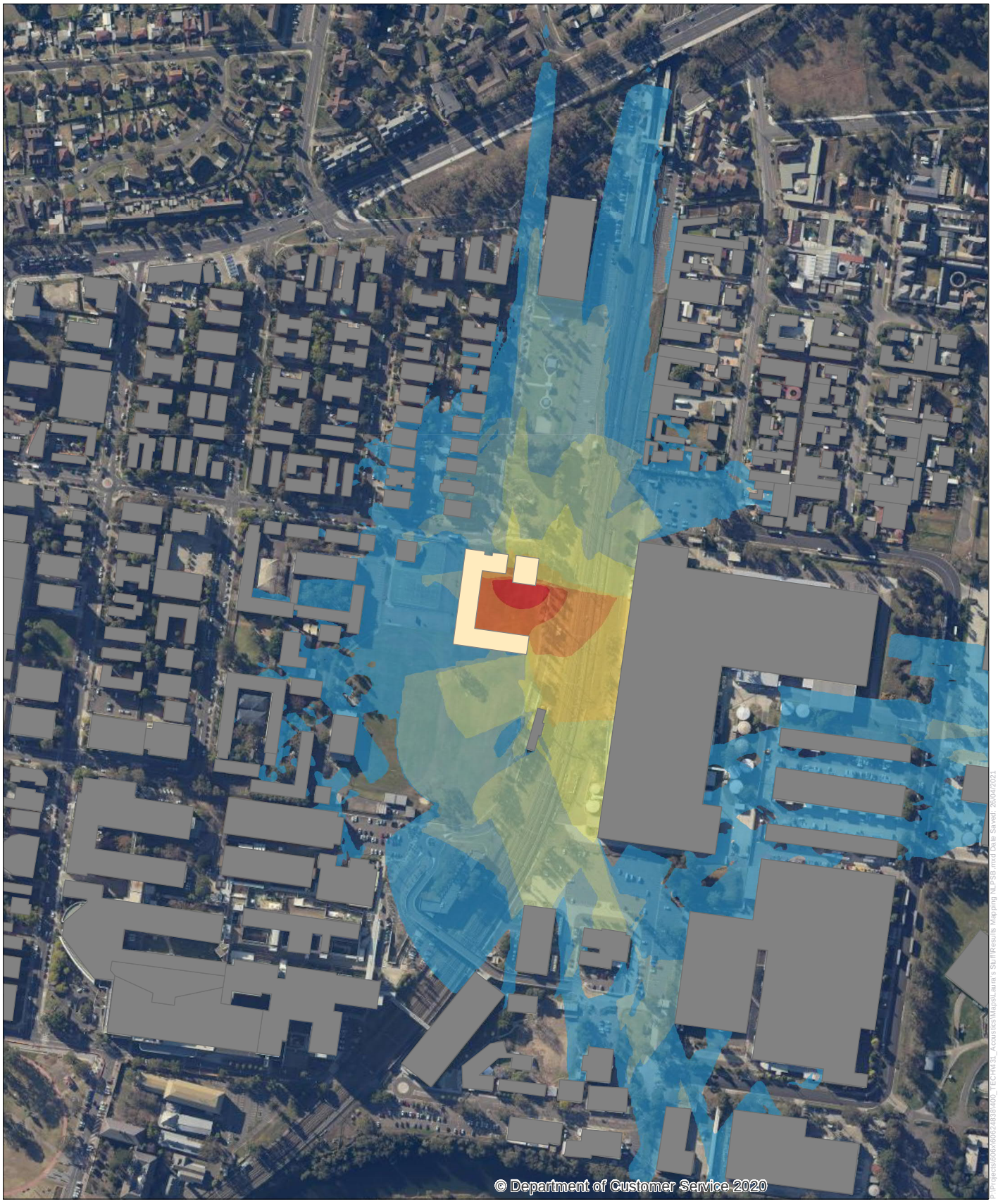
NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:

P:\Projects\60606248\384\00_TECH\41_Acoustics\Maps\Laura's Stuff\Results Mapping NLPSA.mxd Date Saved: 25/04/2021



New Liverpool Primary School
Hall Noise Emission
Category 1 - Day

N

0 0.08 0.16 km

AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:

New Liverpool Primary School
Hall Noise Emission
Category 1 - Evening

N

0 0.08 0.16 km

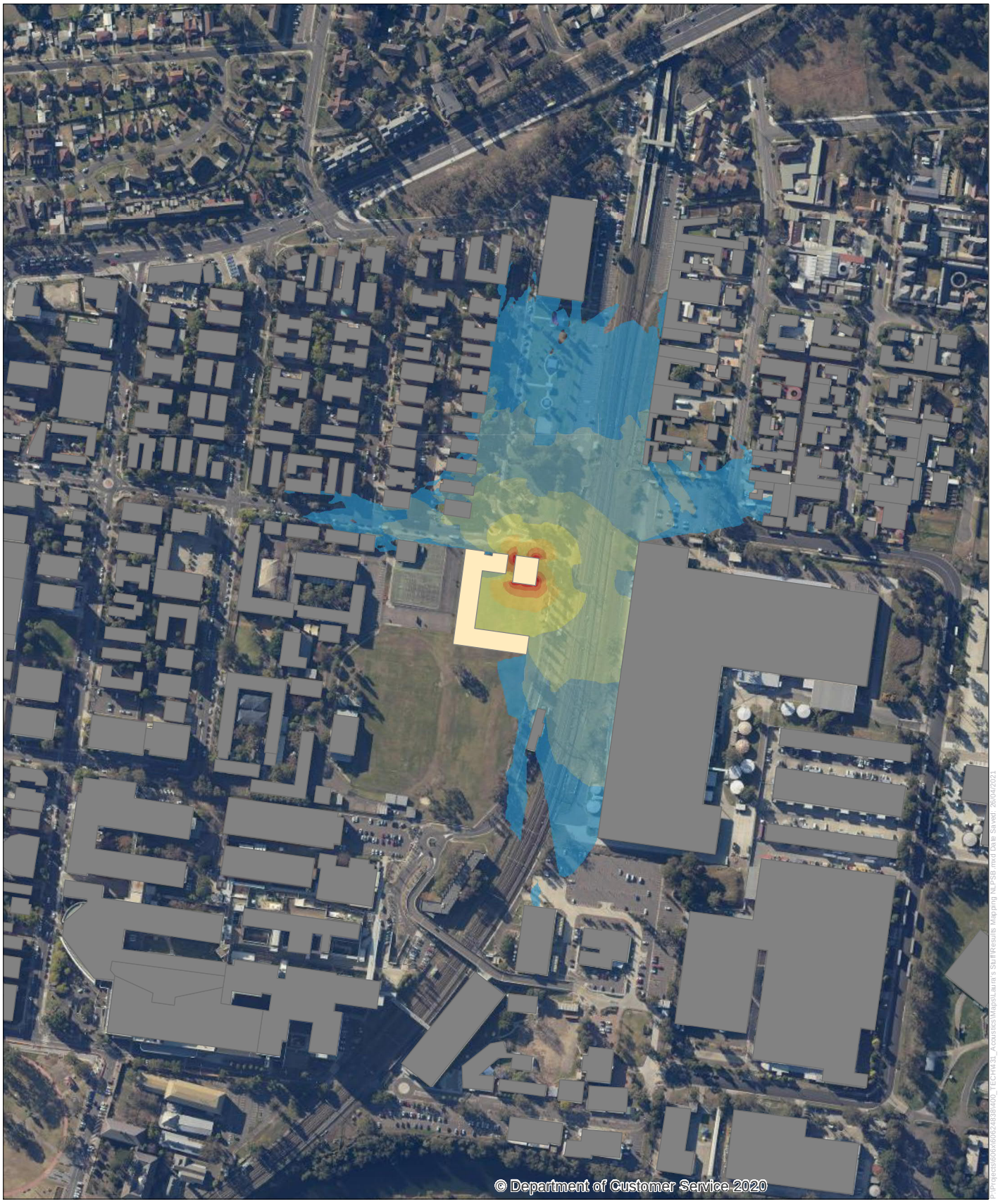
AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:



New Liverpool Primary School
Hall Noise Emission
Category 2 - Daytime

N

0 0.08 0.16 km

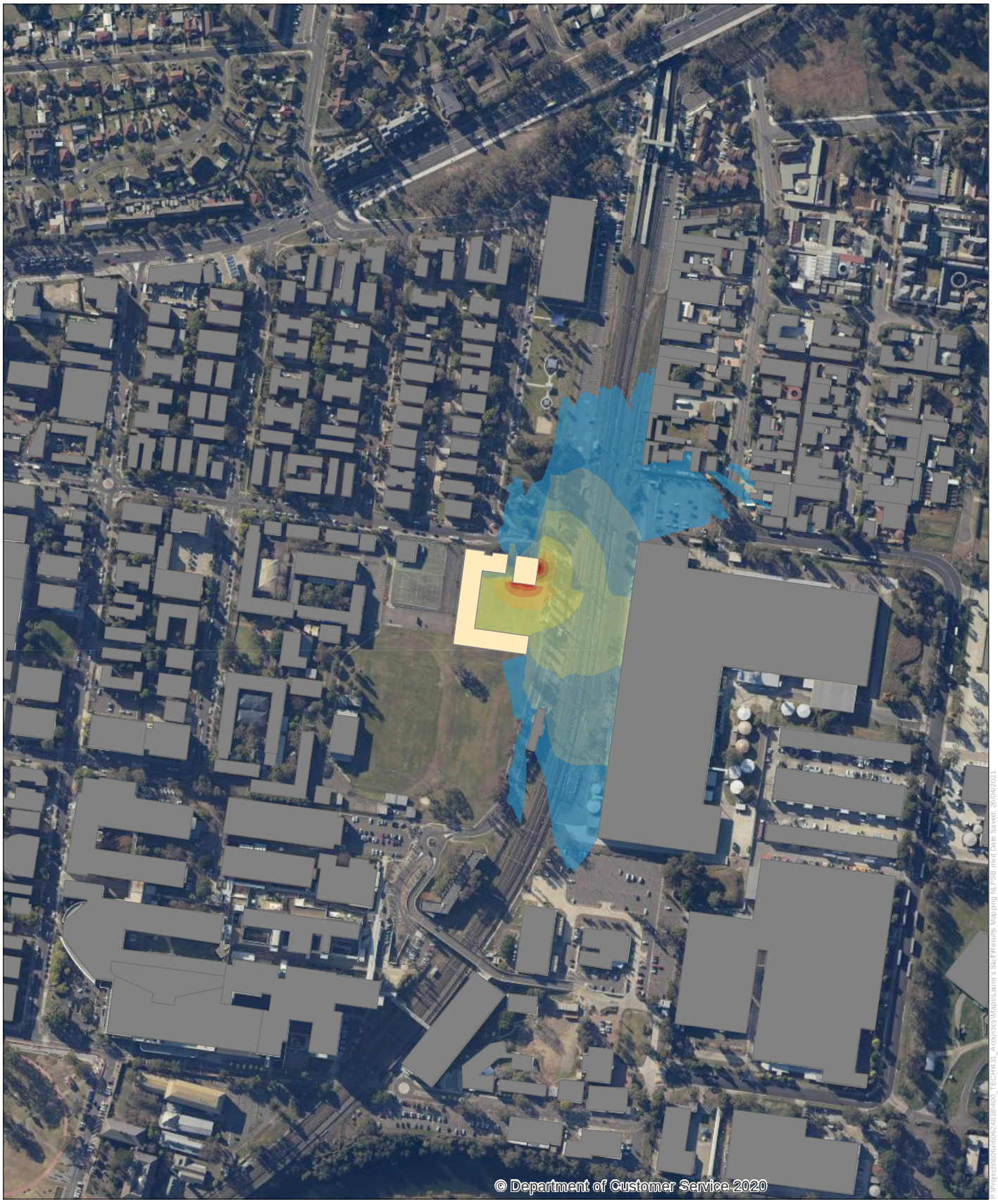
AECOM

NLPS Buildings

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

40 45 50 55 60 65 70 75

Source:



New Liverpool Primary School
Hall Noise Emission
Category 2 - Evening

N

0 0.08 0.16 km

AECOM

NLPS Buildings

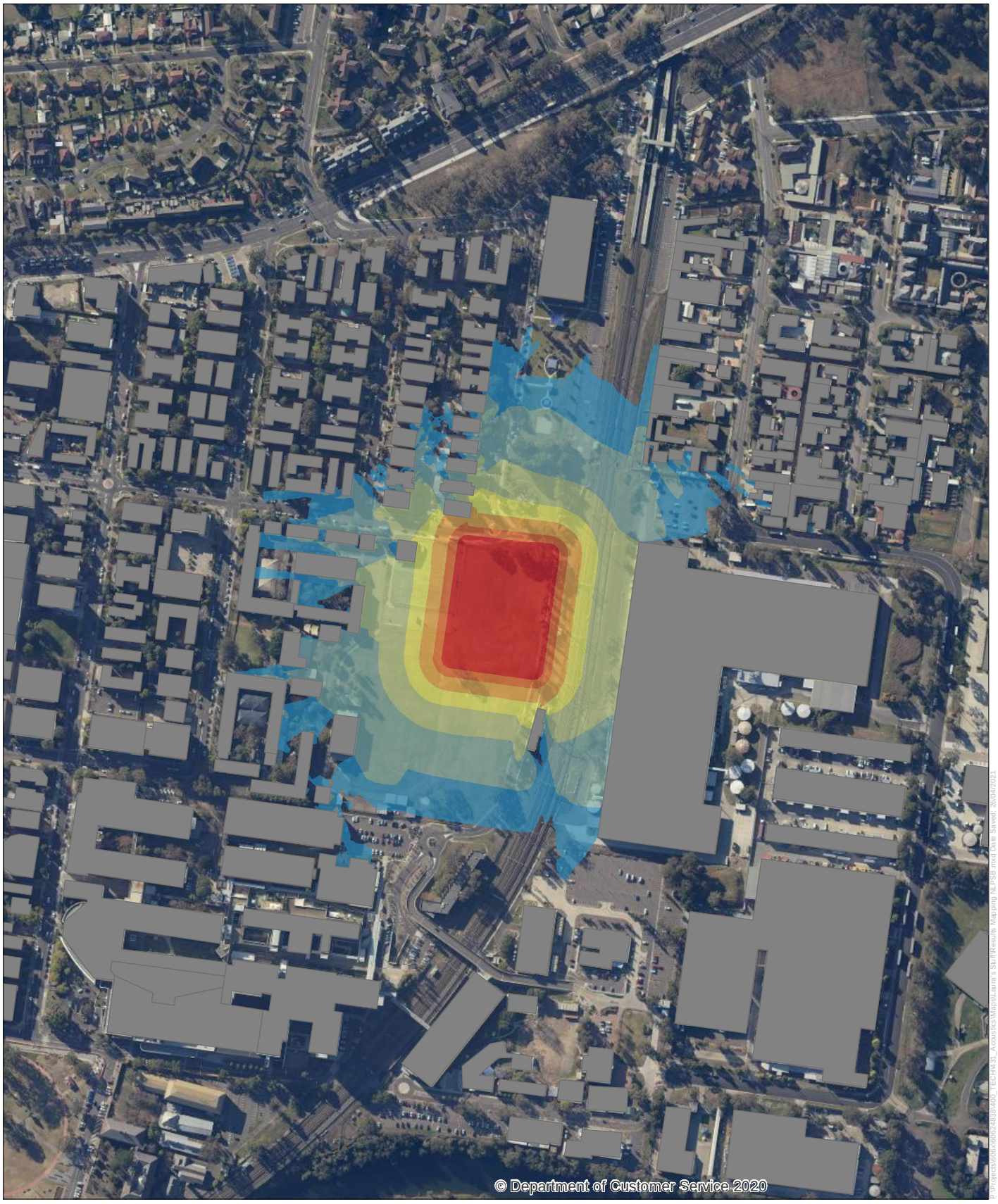
Sound Pressure Level, L_{Aeq}dB(A)

40 45 50 55 60 65 70 75

Source:

Appendix D

Construction Noise Contours



P:\Projects\60606248384\60_TECH\41_Acoustics\Maps\Laura's Stuff\Results Mapping NLPS8.mxd Date Saved: 26/04/2021

New Liverpool Primary School
Construction Noise Emission
Site Preparation and Excavation

N

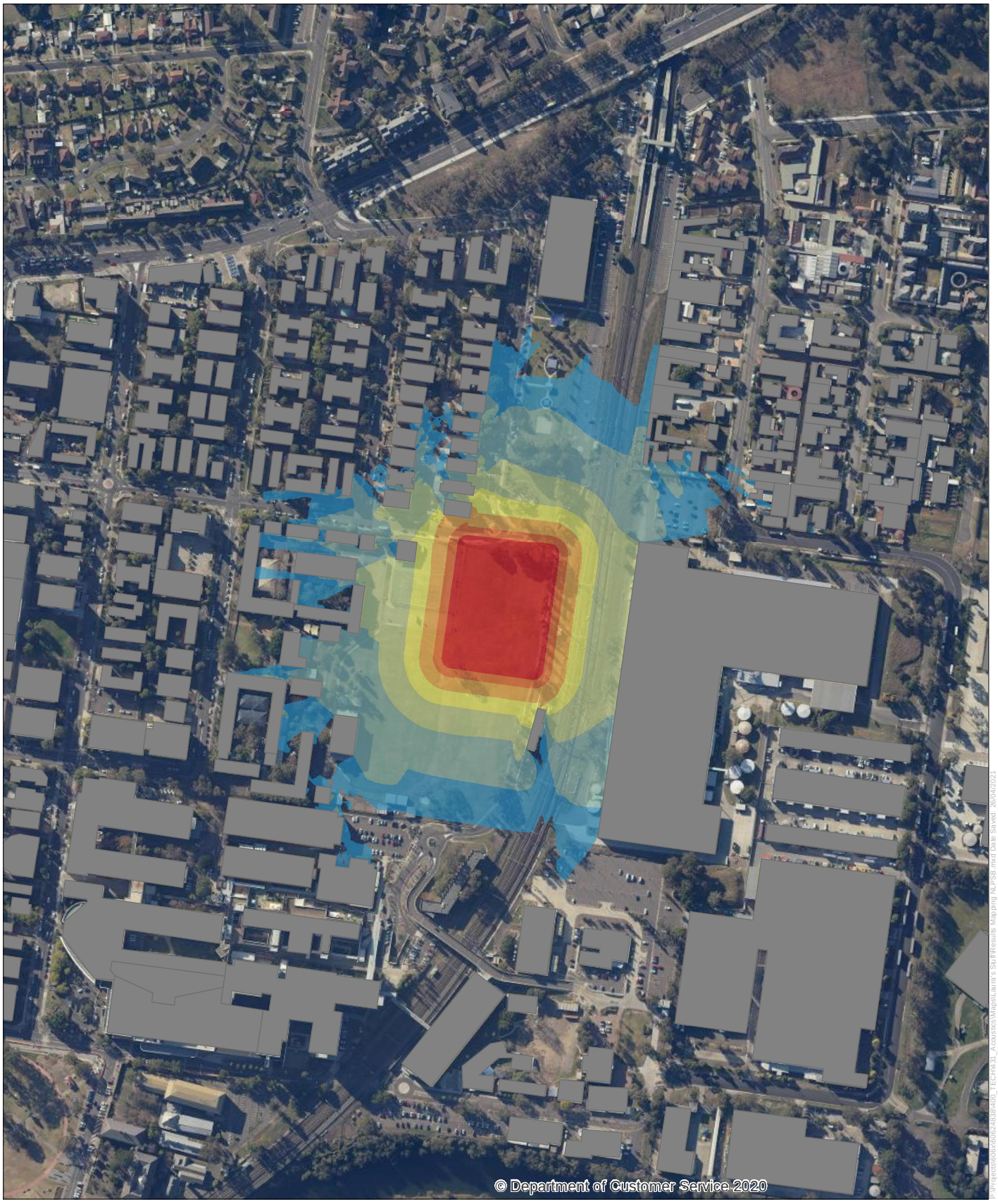
0 0.08 0.16 km

AECOM

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

57 60 65 70 75 80 85

Source:



New Liverpool Primary School
Construction Noise Emission
NLPS Construction

N

0 0.08 0.16 km

AECOM

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

57 60 65 70 75 80 85

Source:

P:\Projects\60606248\400_TECH\4.3_Acoustics\Maps\Laura's Stuff\Results Mapping NLPS8.mxd Date Saved: 26/04/2021