27 – Acoustic Assessment Report (Noise / Vibration)

27

Department of Education

Waitara Public School

Acoustic Report

December 2017

Executive summary

Noise and vibration impacts for the construction and operational phases of the project has been assessed. Existing noise levels were identified through background noise measurements and used to establish construction and operational noise criteria.

Construction noise and vibration

The predicted noise levels are predicted to exceed the noise management levels during standard construction hours. No residential receivers are expected to experience noise levels above the highly affected noise level of 75 dBA.

Traffic noise impact due to construction are not expected as noise levels along the construction traffic routes are not predicted to significantly increase road traffic noise levels.

Safe working distances for vibration activities have been identified for standard structures. No buildings have been identified within the safe working distances. There is the potential for minor human comfort vibration impacts at residences directly adjacent to the work.

It is typical for construction projects to exceed the construction noise and vibration management levels. Any impacts due to construction works are temporary in nature and would not represent a permanent impact on the community and surrounding environment. The predicted noise and vibration levels are generally conservative and would only be experienced for limited periods during construction. Impacts may be reduced through the introduction of feasible and reasonable mitigation measures which have been recommended. However, these mitigation measures are unlikely to reduce noise levels below the construction noise management levels or human comfort criteria.

Construction mitigation measures

To protect the amenity of local residents mitigation measures have been recommended to manage noise and vibration during construction.

For construction activities that are undertaken within the recommended standard construction hours (7am to 6pm Monday to Friday and 8am to 1pm Saturday) the work practices in Table 5-1 would be considered where feasible and reasonable where noise levels are predicted to exceed the construction noise management levels.

Table 0-1 Feasible and reasonable work practices

Construction noise and vibration mitigation measures	
Construction mitigation measures	Noise generating construction activities should be undertaken in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). The standard hours for construction work should be in accordance with the Guideline: • 7:00 am – 6:00 pm Monday to Friday • 8:00 am – 1:00 pm Saturdays • no work on Sundays or Public Holidays. Work outside normal hours should only comprise: • the delivery of materials outside normal hours requested by police or other authorities for safety reasons emergency work to avoid the loss of lives and/or property

Construction noise and vibration mitigation measures	
	Residences within 500 m of the site should be notified as to the timing and duration of the construction works and provided with a contact phone number for any complaints or concerns during the construction period.
	Site inductions Inductions for the work crew would include the specific noise issues and mitigation measures required for the site. The induction would include: • all relevant standard noise mitigation measures • relevant licence and approval conditions • permissible hours of work • location of any sensitive receivers that may exceed the construction noise management level • construction employee parking areas • designated loading/ unloading areas and procedures • site opening/closing times (including deliveries) • behavioural practices that minimise noise: avoiding dropping materials from height and avoiding metal to metal contact on material.
	The distance between plant and equipment and any sensitive receiver should be maximised where practicable.
	Vehicles, plant and equipment would be regularly maintained and kept in good operating condition. Machines found to produce excessive noise should be removed from site or stood down until repairs or modifications can be made.
	Plant should be turned off when not in use. For example, trucks should not be left idling if not operational.
Vibration	Should any buildings be identified that are located within the structural damage vibration buffer distances identified in Section 4.2.2, a property condition report should be prepared for the premises before and after undertaking the work. Compliance vibration monitoring should also be undertaken during high vibration generating activities where buildings are located within the structural damage buffer distances to confirm vibration criteria are not exceeded.

Operational noise

Based on the assumptions in the report, operation of the school is predicted to comply with the *Industrial Noise Policy* (EPA, 2000) noise criteria. The proposal should be acceptable from an acoustic perspective assuming the recommended mitigation measures are implemented.

Operational mitigation measures

The following mitigation measures are recommended:

- Events at the school hall should finish prior to 10 pm to negate any sleep disturbance impacts.

- If noisy events in the school are proposed which have the potential to generate internal noise levels in excess of 90 dBA then additional acoustic treatments to the school hall should be considered.

Road traffic noise

Noise levels are predicted to increase by up to 0.5 dBA due to traffic generation from the Project and would meet the *Road Noise Policy* (DECCW, 2011) criteria. The proposal should be acceptable from an acoustic perspective assuming the recommended mitigation measures are implemented.

Road traffic noise intrusion has been considered in the design to comply with the internal noise criteria.

Table of contents

Table index

Figure index

Appendices

Appendix B - noise level charts – M2

Glossary

Term	Definition
Adverse	Meteorological effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time.
Calm	Where noise enhancing meteorological conditions do not occur at a site for a significant period of time.
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dB(A)	Decibel expressed with the frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at low and high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90 per cent of the measurement period.
$L_{Aeq(15hr)}$	The L_{Aeq} noise level for the period 7:00 to 22:00 hours.
$L_{Aeq(9hr)}$	The L_{Aeq} noise level for the period 22:00 to 7:00 hours.
L_{Amax}	The maximum A-weighted sound pressure level occurring in a specified time period.
Noise sensitive receiver	A noise modelling term used to describe a map reference point where noise is predicted. They consist of areas or places potentially affected by noise or vibration including: • a residential dwelling • an educational institution, library, childcare centre or kindergarten • a hospital, surgery or other medical institution • an active (for example sports field, golf course) or passive (for example national park) recreational area • commercial or industrial premises • a place of worship.
Peak particle velocity	Peak particle velocity is the maximum vector sum of three orthogonal time-synchronized velocity components regardless of whether these component maxima occurred simultaneously.
Rating background level	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
Tonality	Noise containing a prominent frequency or frequencies characterised by definite pitch.
VDV	Vibration dose value - As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

1. Introduction

1.1 Overview

GHD was requested to prepare a Noise and Vibration Impact Assessment (NVIA) for the Waitara Public School redevelopment situated at 68 Edgeworth David Avenue, Wahroonga.

This NVIA assesses the operational and construction noise and vibration impacts from the project. The NVIA has been prepared to meet the Secretary's Environmental Assessment Requirements (SEARs) in Table 1-1 for preparation of an Environmental Impact Statement (EIS).

Table 1-1 Environmental Assessment Requirements

Environmental Assessment Requirements	Section addressed
Legislation, policies and guidelines	
Relevant legislation • *Protection of the Environment Operations Act 1997* • *Secretary's Environmental Assessment Requirements*	Section 3.1
Relevant Policies and Guidelines • *NSW Industrial Noise Policy* (EPA) • *Interim Construction Noise Guideline* (DECC) • *Asessing Vibration: a Technical Guideline* • *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning, 2008)	Section 3.2.1 Section 3.2.2 Section 3.3 Section 3.6
Noise and vibration impacts	
10. Noise and Vibration Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation, including consideration of any public address system, school bell and use of any school hall for concerts etc. (both during and outside school hours), and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.	Section 4.1 Section 4.2 Section 4.3

1.2 Methodology

The following methodology was used to assess the potential noise and vibration impacts associated with construction and operation of the Project in order to address the SEARS:

- identifying sensitive receivers in the area surrounding the Project
- describing the existing noise environment
- establishing noise and vibration assessment criteria at sensitive receiver locations
- assessing the potential construction and operational noise and vibration impacts from the Project
- assessing potential traffic noise impacts from operation and construction
- assess noise intrusion onto the development
- provide recommendations for reasonable and feasible noise and vibration mitigation measures.

1.3 Report structure

The report is structured as follows:

- **Chapter 1 – Introduction.** This chapter introduces the Project and describes the Project area.
- **Chapter 2 – Existing environment**. This chapter describes the existing environmental values of the study area relevant to the noise and vibration assessment
- **Chapter 3 – Compliance criteria**. This chapter outlines the relevant Commonwealth and State legislation and any guidelines and assessment criteria relevant to construction and operation.
- **Chapter 4 – Assessment of impacts.** This chapter examines the potential environmental impacts associated with the construction and operation of the Project.
- **Chapter 5 – Mitigation measures.** This chapter outlines the proposed mitigation strategies during the construction and operation to manage any identified impacts.
- **Chapter 6 – Conclusion.** This chapter provides a conclusion to the report and presents the next steps in the advancement of the Project.

1.4 Scope and limitations

This report has been prepared by GHD for Department of Education and may only be used and relied on by Department of Education for the purpose agreed between GHD and Department of Education as set out in Section 1.2 of this report. GHD otherwise disclaims responsibility to any person other than Department of Education arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD accepts no responsibility for the integrity of the software coding of any commercial software used.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report, specifically Section 4. GHD disclaims liability arising from any of the assumptions being incorrect. GHD has prepared this report on the basis of information provided by Department of Education and others who provided information to GHD, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

It is not the intention of the assessment to cover every element of the acoustical environment, but rather to conduct the assessment with consideration to the prescribed work scope. The findings of the acoustic assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that not all variations in environmental conditions can be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

2. Existing environment

2.1 Sensitive receivers and land uses

Waitara Public School is located on the corner of Edgeworth David Avenue and Myra Street in the Ku-ring-gai and Hornsby Shire local government areas. The Project site is located in and surrounding by Low Density Residential (R2) land zone usage. The site shares a common boundary with residential receivers located to the south and east, Myra Street separating the school from the residential receivers to the west and Edgeworth David Avenue separating receivers to the north.

Receivers immediately surrounding the site which may be impacted by operational noise are provided in Table 2-1 and shown in Figure 2-1. Receivers within a 100 m radius may experience noise impacts during construction of the development.

Table 2-1 Modelled sensitive receivers

Receiver ID	Receiver type	Receiver address
RES01	Residential	44 Myra Street
RES02	Residential	46 Myra Street
RES03	Residential	37 Myra Street
RES04	Residential	39 Myra Street
RES05	Residential	41 Myra Street
RES06	Residential	43 Myra Street
RES07	Residential	45 Myra Street
RES08	Residential	47 Myra Street
RES09	Residential	49 Myra Street
RES10	Residential	51 Myra Street
RES11	Residential	53 Myra Street
RES12	Residential	57 Myra Street
RES13	Residential	81 Edgeworth David Avenue
RES14	Residential	83 Edgeworth David Avenue
RES15	Residential	85 Edgeworth David Avenue
RES16	Residential	87 Edgeworth David Avenue
RES17	Residential	89 Edgeworth David Avenue
RES18	Residential	2 Ingalara Avenue
RES19	Residential	4 Ingalara Avenue
RES20	Residential	6 Ingalara Avenue

Receiver ID	Receiver type	Receiver address
RES21	Residential	8 Ingalara Avenue
RES22	Residential	10 Ingalara Avenue
RES23	Residential	34 Highlands Avenue
RES24	Residential	39 Highlands Avenue

Figure 2-1 Noise monitoring location and surrounding sensitive receivers

2.2 Existing noise environment

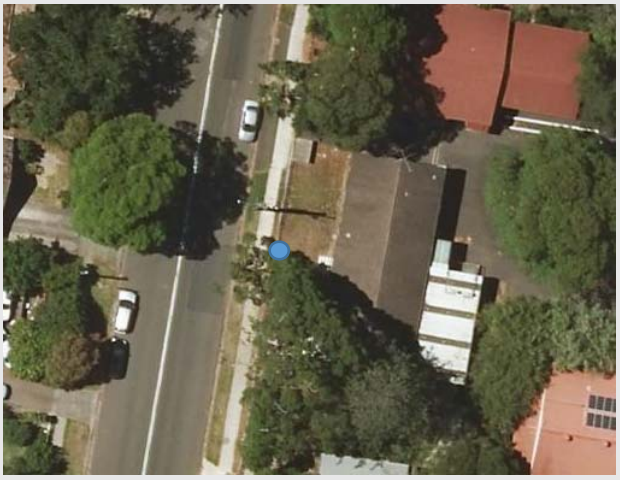
Background noise monitoring is required to establish the noise criteria for the Project. Background noise monitoring was conducted at the locations in Table 2-2 between 17 July and 24 July 2017 (M1 – adjacent to Myra Street) and 7 October and 14 October 2017 (M2 – rear of school adjacent to 34 Highlands Ave and 10 Ingalara Ave) in accordance with the *Industrial Noise Policy* (INP) (EPA, 2000) to determine the background and ambient noise levels. The INP recommends background noise monitoring at the most affected noise sensitive locations. The most affected locations would be located opposite the school along Myra Street and Edgeworth David Avenue, and adjacent to the school on Highlands Avenue and Ingalara Avenue. Background noise monitoring was undertaken at the school at a similar setback from Myra Street as the most affected locations. This background noise at these locations are considered representative of the surrounding environment.

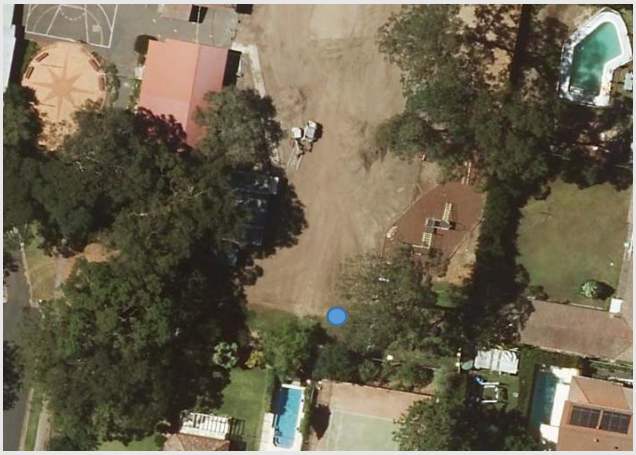
The methodology of the noise monitoring is as follows:

- noise monitoring was undertaken using one Rion NL-52 and one Svan 977 environmental noise logger. All noise loggers were programmed to accumulate the L_{A90}, L_{A10} and L_{Aeq} noise descriptors continuously over the entire monitoring period
- meteorological data was sourced from the Bureau of Meteorology's Terrey Hills AWS (station number 066059)
- a calibration check was performed on the noise monitoring equipment using a sound level calibrator with a sound pressure level of 94 dBA at 1 kHz. At completion of the measurements, the meter's calibration was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dBA
- the data collected by the loggers was downloaded and analysed. Data was excluded during periods where average wind speeds were greater than 5 m/s or when rainfall occurred

A summary of the noise monitoring locations and equipment details is provided in Table 2-2. Noise monitoring locations are shown in Figure 2-1.

Table 2-2 Noise monitoring location and equipment details

ID	Equipment details	Equipment settings	Equipment location
M1	Rion NL-52 Type 1 SN: 131632	A-weighted Fast time response 15 minute intervals	

M2	Svan 977 Type 1 SN: 45743	A-weighted Fast time response 15 minute intervals	

2.2.1 Noise monitoring results summary

Background noise monitoring data was used to determine the Rating Background Levels (RBL) for the day, evening and night-time periods. The rating background levels are summarised in Table 2-3. Daily noise level charts for the entire monitoring period are presented in Appendix A.

Table 2-3 Summary of M1 noise monitoring results, dBA

Date	Rating background level (RBL), 90th percentile $L_{A90(period)}$			Ambient noise levels $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
Monday-17-Jul-17	50	45	37	64	61	58
Tuesday-18-Jul-17	50	45	37	63	66	59
Wednesday-19-Jul-17	52	47	39	62	62	60
Thursday-20-Jul-17	52	46	40	63	63	59
Friday-21-Jul-17	51	46	39	63	63	59
Saturday-22-Jul-17	49	45	37	64	62	58
Sunday-23-Jul-17	48	43	37	65	61	58
Monday-24-Jul-17	49	-	-	62	-	-
Total	**50**	**45**	**37**	**63**	**63**	**59**

Table 2-4 Summary of M2 noise monitoring results, dBA

Date	Rating background level (RBL), 90th percentile $L_{A90(period)}$			Ambient noise levels $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
Tuesday-7-Nov-17	44	39	33	62	53	46
Wednesday-8-Nov-17	44	37	35	61	52	46
Thursday-9-Nov-17	44	43	36	62	52	47
Friday-10-Nov-17	43	43	33	62	52	45
Saturday-11-Nov-17	40	39	32	56	50	46
Sunday-12-Nov-17	40	39	32	56	46	48
Monday-13-Nov-17	41	37	34	62	48	44
Tuesday-14-Nov-17	42	-	-	60	-	-
Total	**42**	**39**	**33**	**61**	**51**	**46**

3. Compliance criteria

3.1 State legislation

3.1.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* is the key piece of environment protection legislation to control noise emission on the environment.

3.1.2 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements includes the following noise requirements:

- an assessment of the construction noise vibration impacts with consideration to the *Interim Construction Noise Guideline* (DECCW, 2009) and *Assessing Vibration: A Technical Guideline* 2006
- an assessment of the operational noise impacts from the school with consideration to the *NSW Industrial Noise Policy* (EPA, 2000)
- *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning 2008)

3.2 Construction noise and vibration criteria

3.2.1 Construction noise

The *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as Monday to Friday: 7am to 6pm, Saturday: 8am to 1pm and no work on Sundays or public holidays. These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.

Construction noise management levels at sensitive residential receivers are provided in Table 3-1. The construction noise management levels during recommended standard hours represent a noise level that, if exceeded, would require management measures including:

- reasonable and feasible work practices
- contact with the residences to inform them of the nature or works to be carried out, the expected noise levels and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The noise affected construction noise management levels during

recommended standard hours is not intended as a noise limit but rather a level where noise management is required and as such should not be included as a noise limit in the environmental protection license.

Table 3-1 Residential construction noise management levels, dBA

Time of day	Noise management level, $L_{Aeq(15\ min)}$	Application notes
Recommended standard hours	Noise affected: RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. • 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 dBA	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: • times identified by the community when they are less sensitive to noise (such as before and after school, or mid-morning or mid-afternoon for works near residences) • 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 dBA	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 measures have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Noise management levels for other sensitive land uses are provided in Table 3-2 and only apply when the properties are in use.

Table 3-2 Noise management levels for other sensitive land uses

Land use	Noise management level, $L_{Aeq(15\ min)}$
Commercial premises	70 dBA (external)

A summary of the construction noise management levels are provided in Table 3-3.

Table 3-3 Proposal construction noise management levels, dBA

Receiver type	Construction noise management levels, $L_{Aeq(15\ min)}$				
	Standard construction hours		Outside standard construction hours		
	Noise affected	Highly noise affected	Day	Evening	Night
Residential receivers – Myra St and Edgeworth David Ave	60	75	55	50	42
Residential receivers – Highlands Ave and Ingalara Ave	52	75	47	44	38
Commercial	70	-	-	-	-

Sleep disturbance criteria during construction

The ICNG also refers to the *Environmental Criteria for Road Traffic Noise* (EPA, 1999) for guidance on sleep disturbance from maximum noise level events. This guideline has since been superseded by the *Road Noise Policy* (RNP) (DECCW, 2011). Both guidelines provide a discussion on research into the effects of maximum noise events on sleep disturbance. The *Industrial Noise Policy application notes* also provide guidance on sleep disturbance impacts. The results of this research is aimed at limiting the level of sleep disturbance due to environmental noise and concludes that the L_{Amax} or $L_{A1(1min)}$ level of any noise should not exceed the ambient $L_{A90(15min)}$ noise level by more than 15 dB(A) which is consistent with the *Industrial Noise Policy* (EPA 2000) screening test. The RNP provides further guidance, which indicates that:

- maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions
- one or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

Sleep disturbance is not anticipated from construction as construction work is expected to occur during recommended standard construction hours.

3.2.2 Construction vibration

Human comfort

Vibration is assessed based on the criteria in *Assessing Vibration: a technical guideline* (DEC 2006). *British Standard (BS) 6472 – 2008, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by the guideline as the preferred standard for assessing the 'human comfort criteria'. Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in Table 3-4 for sensitive receivers.

Whilst the assessment of response to vibration in *BS 6472-1:1992* is based on vibration dose value and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of a peak particle velocity, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in *BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration,* as shown below in Table 3-5.

Table 3-4 Human comfort intermittent vibration dose values (BS 6472-1992)

Receiver type	Period	Intermittent vibration dose value ($m/s^{1.75}$)	
		Preferred value	Maximum value
Residential	Day	0.2	0.4
	Night	0.13	0.26

Note 1: Day is between 7am and 10pm and night is between 10 pm and 7 am

Table 3-5 Guidance on effects of vibration levels for human comfort (BS 5228.2 – 2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

Structural damage

BS 7385 is used to assess the effects of transient vibration on structures. The criteria provided in BS 7385 are presented in Table 3-6. The criteria provided in BS 7385 should be applied to all structures as BS 7385 states *'a building of historical value should not (unless it is structurally unsound) to be assumed to be more sensitive'*. Structures of significance should be assessed on a case-by-case basis if a dilapidation report indicates that they are structurally unsound.

Table 3-6 Transient vibration guide values – minimal risk of cosmetic damage (BS 7385-2)

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above

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.

Summary of vibration criteria

A summary of vibration screening criteria is provided in Table 3-7. The criteria are provided as a guide for determining potential human comfort or structural damage impacted buffer distances to determine if further detailed investigation is required. The levels provided in Table 3-7 are recommended screening criteria for the impact assessment. During construction of the Project compliance monitoring should be assed against all criteria in Section 3.2.2.

Table 3-7 Recommended screening vibration criteria

Receiver type	Criteria type	Peak particle velocity screening criteria	
		Day	Night
Residential	Human comfort	1 mm/s	0.3 mm/s
	Structural damage	15 mm/s[1]	

Note 1: Higher magnitude of vibration is acceptable at higher frequencies

3.3 State legislation

3.3.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* is the key piece of environment protection legislation to control noise emission on the environment.

3.3.2 State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017 [NSW] Schedule 2 Schools—complying development

The SEPP (EECCF) 2017 provides the following information relating to noise emission from the use and operation of mechanical plant:

> *A new building or (if the development is an alteration or addition to an existing building for the purpose of changing its use) an existing building that is to be used for the purpose of a school or school-based child care must be designed so as not to emit noise exceeding an LAeq of 5 dB(A) above background noise when measured at any lot boundary.*

3.4 Department of Education DG11

3.4.1 Internal Noise Levels

Mechanical plant

Control of steady state internal noise levels is most important in rooms and spaces used for spoken word teaching. DG11 provides recommended internal noise levels to control steady-state noise such as mechanical equipment. The relevant recommended internal levels are presented below in Table 3-8**Error! Reference source not found.**.

Road traffic noise

Road Noise for general learning areas, music, drama, movement studios and halls shall be assessed consistent with the requirements of State Environmental Planning Policy

(Infrastructure) 2007 – regulation 102. An assessment should be undertaken where directed for any site impacted by traffic noise. Generally it is recommended for all sites impacted by noise from roads with greater than 20,000 vehicles AADT and required for all sites impacted by noise from roads with greater than 40,000 vehicles AADT. The guideline internal noise levels presented in Acoustic Performance Guidelines (section 11.06) is to be used in the assessment.

Table 3-8 Acoustic Performance Guidelines (table 11.06 from DG11)

Room	Internal noise level (dB L_{Aeq})	Reverberation time, s $RT_{60(Av\ 500\ Hz\ and\ 1000\ Hz)}$
Libraries – general areas	40	< 0.6
Teaching spaces – primary schools	35	< 0.5

3.4.2 Emission criteria

'Generally noise emission to the environment from mechanical services noise sources (such as air conditioners) are the subject of a development consent conditions. In NSW the development consent conditions will refer to the Industrial Noise Policy (INP) or Local Council requirement.

Where no condition regarding noise sources exists for a school development, noise emission from such sources should be designed, in-principle, to satisfy the requirements of the Industrial Noise Policy.

Noise associated with school activity (such as music or sport within a hall) are not a stationary noise source and is not subject to the INP requirements.'

3.5 Operational noise criteria

The SEARs refer to the INP which can be used for guidance on the assessment of operational noise impacts. The INP include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the cumulative noise level at a receiver.

The INP noise criteria are planning levels and are not mandatory limits required by legislation however the noise criteria will assist the determining authority to assess operational noise impacts and establish noise limits in the conditions of consent. Where noise criteria are predicted to be exceeded, feasible and reasonable noise mitigation strategies are assessed.

3.5.1 Intrusive criteria

The intrusive noise criteria controls the relative audibility of operational noise compared to the background level at residential receivers. The intrusive criteria are determined by a 5 dB(A) addition to the rating background level. The INP requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'* which results in an intrusive noise criterion of 35 dB(A). The INP application notes recommend that the intrusive noise criteria for the evening period should not exceed the daytime period and the night-time period should not exceed the evening period.

3.5.2 Amenity criteria

The amenity criteria limits the total level of extraneous noise and controls cumulative noise impacts from other industries and developments on all receiver types. The amenity criteria are determined based on the overall acoustic characteristics of the receiver area, the receiver type and the existing level of industrial noise.

Residential receiver areas are characterised into ‘urban’, ‘suburban’, ‘rural’ or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic.

The amenity criteria aim to limit continual increases in noise levels from industrial noise sources and developments and apply to all industrial noise sources at the receiver location. To prevent cumulative noise level increases above the amenity criteria, the INP provides adjustments to the amenity criteria to set a target level for the Project. The applicable adjustment is scaled as per INP Table 2.2 and is based on the existing level of industrial noise at the receiver location.

3.5.3 Modifying factor adjustments

The INP requires that modifying factor adjustments are added to the measured or predicted noise levels if the noise sources contain tonal, low frequency, intermittent or impulsive characteristics, which have the potential to increase annoyance. The modifying factor adjustments are summarised in Table 3-9.

Table 3-9 Modifying factor adjustments

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is above 400 Hz • 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive • 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.	5 dBA[2]
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C and A weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more.	5 dBA[2]
Impulsive noise	A-weighted fast response and impulse response	If the difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB.	Apply the difference in measured noise levels as the correction up to a maximum of 5 dBA
Intermittent noise	Subjectively assessed	When the night-time noise level drops to that of the background noise level with a noticeable change in noise level of at least 5 dBA.	5 dBA
Duration[3]	If the duration of the noise event in any 24 hour period is as follows: • 1.0 to 2.5 hours then increase the noise criteria by 2 dBA day and 0 dBA night • 15 minutes to 1 hour then increase the noise criteria by 5 dBA day and 0 dBA night • 6 minutes to 15 minutes then increase the noise criteria by 7 dBA day and 2 dBA night • 1.5 minutes to 6 minutes then increase the noise criteria by 15 dBA day and 5 dBA night • less than 1.5 minutes then increase the noise criteria by 20 dBA day and 10 dBA night.		

Note 1: Where two or more modifying factors are present the maximum correction is limited to 10 dBA.

Note 2: Where a source emits a tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low frequency range.

Note 3: Duration correction is a negative correction which increases the noise criteria

3.5.4 Sleep disturbance

The INP application notes regarding sleep disturbance recommend that where the $L_{A1(1min)}$ or L_{Amax} exceeds the $L_{A90(15min)}$ by more than 15 dB(A) outside the bedroom window, a more detailed analysis is required.

Sleep disturbance is not anticipated from the school operations as it is not expected to generate significant noise after 10 pm or before 7 am.

3.5.5 Operational noise criteria

The operational noise criteria for sensitive receivers identified in the vicinity of the school are summarised in in Table 3-10.

Table 3-10 Operational noise criteria

Receiver	Time period	Amenity criteria	Intrusive criteria	Sleep disturbance screening test, (external) L_{Amax}	Project specific noise criteria (external), dBA
Residential receivers – Myra St and Edgeworth David Ave	Day	55	55	-	**55** $L_{Aeq(15\ min)}$
	Evening	45	50	-	**45** $L_{Aeq(evening)}$ **50** $L_{Aeq(15\ min)}$
	Night	40	42	52	**40** $L_{Aeq(night)}$ **42** $L_{Aeq(15\ min)}$ **52** L_{Amax}
Residential receivers – Highlands Ave and Ingalara Ave	Day	55	47	-	**47** $L_{Aeq(15\ min)}$
	Evening	45	44	-	**44** $L_{Aeq(15\ min)}$
	Night	40	38	48	**38** $L_{Aeq(15\ min)}$ **48** L_{Amax}
Commercial premises	When in use	65	-	-	**65** L_{Aeq}

Note 1: With consideration to the INP *noise amenity area* classification, the residential receivers surrounding the Project site have been classified as 'suburban'.

Note 2: The INP defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

3.6 Road traffic noise

3.6.1 Development near busy roads

The SEARs refers to the *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning, 2008) which states:

"Strategic site selection from the perspective of road and rail corridors for schools and childcare centres is particularly important as young people are generally more sensitive to the effects of noise and adverse air quality than adults.

Where new schools and childcare centres are being considered, the design should ensure that there is sufficient separation from 'busy' roads and rail corridors to avoid adverse noise and air quality impacts."

The guideline recommends an internal noise level for educational institutions of $L_{Aeq(1hr)}$ 40 dBA. This is consistent with the *Road Noise Policy* (DECCW, 2011) which also specifies the maximum levels shown in AS 2107 for spaces other than classrooms.

Internal noise levels for teaching spaces have been designed in accordance with the Department of Educations *DG11 Acoustics* which provides a more stringent internal noise level criteria of 35 dBA L_{Aeq}.

3.6.2 Traffic generation

The *Road Noise Policy* (DECCW 2011) provides traffic noise criteria for sensitive receivers in the vicinity of existing roads (Table 3-11). The criteria are applied to traffic on public roads to identify potential road traffic impacts and the requirement for reasonable and feasible mitigation measures.

The *Road Noise Policy* (DECCW 2011) application notes state that *"for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*

If road traffic noise increases during operation and construction work is within 2 dBA of current levels then the objectives of the *Road Noise Policy* (DECCW 2011) are met and no specific mitigation measures are required.

Table 3-11 Road traffic noise criteria, dB(A)

Type of development	Day 7 am to 10 pm	Night 10 pm to 7 am
Existing residence affected by additional traffic on arterial roads generated by land use developments	60 $L_{Aeq(15\ hour)}$	55 $L_{Aeq(9\ hour)}$
Existing residence affected by additional traffic on local roads generated by land use developments	55 $L_{Aeq(1\ hour)}$	50 $L_{Aeq(1\ hour)}$

4. Assessment of impacts

4.1 Construction noise

4.1.1 Construction activities and sources

The noise emissions from construction have been assessed at the surrounding potentially affected receivers during the standard construction hours. A quantitative assessment has been undertaken with consideration to the ICNG.

Construction activities would generally be carried out during the recommended standard construction working hours. Early morning oversized deliveries may be required on occasion for some of the construction works and may occur outside the recommended construction hours. No work would be intended on Sundays or public holidays.

Construction traffic movements would primarily be associated with the transportation of construction machinery and equipment to the proposal site and the transportation of material

Plant and equipment needed for the proposal would be determined during the construction planning phase. The anticipated plant and equipment used for the proposal is shown in Table 4-1 with the corresponding noise emission sound power levels. Noise level data has been obtained from *AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites*. Other equipment may be used however it is anticipated that they would produce similar noise emissions.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.
- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore noise predictions are considered conservative.

Table 4-1 Construction plant and equipment sound power levels, dBA

Plant and equipment	Sound power level
Excavator	108
Air compressor	103
Bulldozer	113
Concrete pump	112
Crane	108
Front end loader	114
Grader	112
Vibrating roller	110
Scraper	114
Backhoe	111
Dump truck	111
Truck	110
Concrete agitator truck	107
Water tanker	112
Light vehicle	109
Hand tools	105

4.1.2 Predicted construction noise impacts

Construction noise impacts were estimated using the distance attenuation relationship described below:

$$SPL = SWL - 20\log_{10}(d) + 10\log_{10}(Q) - 11$$

Where *d = distance (m) between source and receiver*

Q = Directivity index (2 for hemispherical propagation)

SPL = sound pressure level at the distance d from the source

SWL = sound power level of the source

The equipment noise levels were distance attenuated from the site and the noise levels are shown in Table 4-2. Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional minor losses such as atmospheric absorption, directivity, ground absorption and shielding ignored in the calculations.

Construction works during standard construction hours are predicted to exceed the noise affected CNML at surrounding residential receivers. It is recommended that the noise mitigation measures detailed in Section 5.1 be implemented where feasible and reasonable. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all reasonable and feasible noise mitigation measures would reduce

noise levels to below the noise affected CNML under all circumstances. A Construction Noise and Vibration Management Plan should be developed by the contractor to implement the construction noise and vibration mitigation measures and reduce the impacts to the surrounding residences.

Table 4-2 Construction plant and equipment noise levels at distance

Plant and equipment	Noise level at distance							
	25 m	50 m	100 m	150 m	200 m	300 m	400 m	500 m
Excavator	**69**	**63**	57	53	51	47	45	43
Air compressor	**64**	58	52	48	46	42	40	38
Bulldozer	**74**	**68**	**62**	58	56	52	50	48
Concrete pump	**73**	**67**	**61**	57	55	51	49	47
Crane	**69**	**63**	57	53	51	47	45	43
Front end loader	**75**	**69**	**63**	59	57	53	51	49
Grader	**73**	**67**	**61**	57	55	51	49	47
Vibrating roller	**71**	**65**	59	55	53	49	47	45
Scraper	**75**	**69**	**63**	59	57	53	51	49
Backhoe	**72**	**66**	**60**	56	54	50	48	46
Dump truck	**72**	**66**	**60**	56	54	50	48	46
Truck	**71**	**65**	59	55	53	49	47	45
Concrete agitator truck	**68**	**62**	56	52	50	46	44	42
Water tanker	**73**	**67**	**61**	57	55	51	49	47
Light vehicle	**70**	**64**	58	54	52	48	46	44
Hand tools	**66**	**60**	54	50	48	44	42	40

Note: **Bold text** indicates exceedences to the 60 dB(A) CNML during standard construction hours for receivers on Myra St and Edgeworth David Avenue. Red text indicates exceedences to the 52 dB(A) CNML during standard construction hours for receivers on Highlands Ave and Ingalara Avenue.

4.1.3 Assessment of construction noise impacts

Where the predicted $L_{Aeq(15\ minute)}$ noise level is greater than the noise affected level all feasible and reasonable work practices should be applied, however, it is unlikely that mitigation measures would reduce the predicted noise levels below the management levels. The magnitudes of construction noise levels are dependent on the duration of construction, the type of equipment, location of activities, the surrounding environment's background noise levels and the weather conditions during construction. The predicted noise levels are generally conservative as the construction noise model predicts the worse-case 15 minute scenario and these levels may not represent the actual noise emission experienced by the community throughout the entire construction period.

The residential noise management level of 60 dBA during standard construction hours is predicted to be exceeded at residences located within 100 m of the construction works at some stage during construction.

The highly noise affected level of 75 dBA is not predicted to be exceeded at any residential receiver as no residential receiver would be located within 25 m of the works.

Mitigation measures to manage noise impacts have been recommended and are provided in Section 5.1.

4.1.4 Sleep disturbance

All construction activity is expected to occur during recommended standard hours therefore sleep disturbance impacts are not expected.

4.1.5 Construction traffic impacts

The application notes[1] for the *Road Noise Policy* state that *"for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."* This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the *Road Noise Policy* are achieved.

A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase).

Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

The increase in vehicle movements would be limited to the period of construction. Noise level increases due to construction traffic would not be significant when compared with the existing vehicle numbers in the study area.

4.2 Construction vibration impacts

Assessment of vibration has been conducted to determine potential impacts with consideration to structural damage and human comfort criteria. Expected vibration generating activities include compaction during bulk earthworks and the use of excavators.

[1]http://www.environment.nsw.gov.au/noise/roadnoiseappnotes.htm 12 December 2012

4.2.1 Vibration source levels

Typical vibration levels for vibration generating equipment are detailed in Table 4-3.

Table 4-3 Vibration generating equipment

Equipment	Peak particle velocity source level (mm/s)	Data reference
Compactor	5 to 7 at 10 m	*Environmental Noise Management Manual* (RTA, 2001)
Dozer	2.5 to 4 at 10 m	
Backhoe	1 at 10 m	
Excavator	2.5 at 8 m	Tynan, A.E. *Ground Vibration Damaging Effects to Buildings,* Australian Road Research Board 1973
Grader	2.5 at 8 m	

Energy from equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- the efficiency of the energy transfer mechanism of the equipment (i.e impulsive; reciprocating, rolling or rotating equipment)
- the frequency content
- the impact medium stiffness
- the type of wave (surface or body)
- the ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. Typical rate of vibration attenuation can be calculated from the following regression analysis formula:

$V = kD^{-n}$, *where*

- V = Peak Particle Velocity
- D = Distance
- k = site constant (if k is unknown, the site constant can be calculated from the other known parameters)
- n = site attenuation exponent

The value of the site attenuation exponent, n, depends on the soil and ground type, *Construction noise and vibration impact on sensitive premises, Proceedings of Acoustics* (Roberts, 2009) suggests the following values for *n*:

- 1.4 for weak or soft soils such as loose soils, mud, loose beach sand, dune sand and ploughed ground
- 1.3 for competent soils such as most sands, sandy clays, gravel, silts and weathered rock
- 1.1 for hard soils such as dense compacted sand, dry consolidated clay and some exposed rocks
- 1.0 for hard competent rock such as bedrock and freshly exposed hard rock.

A site attenuation exponent value of 1.3 has been assumed for this assessment.

4.2.2 Assessment of vibration impacts

Vibration levels at various distances from plant and equipment are provided in Table 4-4. Buffer distances to comply with the recommended vibration screening criteria (refer to Table 3-7) are presented in Table 4-5.

Human comfort impacts are dependent on the type of equipment operating and distance to construction works. For continuous vibration, the recommended screening criteria for human comfort are 1.0 mm/s during the day period.

Construction activities on the site have the potential to exceed the human comfort criteria at receivers directly adjacent to the site and within the safe work buffer distances. Mitigation measures have been recommended in Section 5.1 to manage human comfort vibration impacts.

No structural damage vibration impacts are expected as construction activities are not expected to occur within the structural damage buffer distances.

Table 4-4 Typical vibration levels at distances

Equipment	Peak particle velocity (mm/s) at distance				
	10 m	20 m	30 m	40 m	50 m
7 tonne compactor	6.0	2.4	1.4	1.0	0.7
Dozer	3.3	1.3	0.8	0.5	0.4
Backhoe	1.0	0.4	0.2	0.2	0.1
Excavator	1.6	0.7	0.4	0.2	0.1
Grader	2.0	1.0	0.7	0.5	0.4

Table 4-5 Vibration buffer distances to comply with recommended peak particle velocity screening criteria

Equipment	Human comfort buffer distance, m Screening criteria 1 mm/s	Structural damage buffer distance, m Screnning criteria 15 mm/s
Compactor	40	5
Dozer	25	4
Backhoe	10	2
Excavator	15	3
Grader	15	3

4.3 Operational noise

Operational noise has been assessed for the following scenarios:

- mechanical plant
- use of the PA system and period alarm
- noise from the school hall during special events (evening period).

Department of Education *DG11 Acoustics Section 11.04 Noise Emission (To The Environment)* states *"Noise associated with school activity (such as music or sport within a hall) are not a*

stationary noise source and is not subject to the Industrial Noise Policy (EPA 2000) requirements".

The INP has been used to assess noise from the school hall during special events as it is a requirement of the SEARs. However noise from the school hall and playgrounds associated with general school activities including music, sport or playground noise has not been assessed, as it is not a specific requirement of the SEARs.

4.3.1 Assessment parameters

Noise modelling was undertaken using CadnaA Version 2017. CadnaA is a computer program for the calculation, assessment and prognosis of noise exposure. Environmental noise propagation in CadnaA was calculated using algorithm in *ISO 9613-2 'Acoustics – Attenuation of sound during propagation outdoors'*. The following tasks were undertaken as part of the operational noise impact assessment:

- Noise criteria was determined based on the sensitive receiver type and time of day
- Appropriate site specific conditions for the noise model were developed
- The sound power levels of each activity was established
- The impacts on sensitive receivers surrounding the site were assessed

The following noise modelling assumptions were made to establish site specific conditions:

- surrounding land was modelled assuming a mixture of hard and soft ground with a ground absorption coefficient of 0.5
- terrain topography with a 1 metre resolution of the study area was used to generate the site used to predict noise levels.
- receivers were modelled at a height of 1.5 m above ground level
- modelled scenarios take into account the shielding effect from surrounding buildings and structures on and adjacent to the site
- atmospheric air absorption was based on an average temperature of 10ºC and an average humidity of 70%.

4.3.2 Noise generating equipment

Noise source on-site are provided in Table 4-6 for each activity. Mechanical services and plant selection have not been determined at this stage. The following assumptions have been made about the building's mechanical services. Note that the HVAC system is not included in the current design but has been included in the noise emission assessment to account for the possibility that the system may be included in the future.

- Three air conditioner condenser units have been modelled located on the rooftop of the proposed development operating simultaneously
- Six small exhaust ducts located servicing the building bathrooms.

Table 4-6 Noise source levels, dBA

Scenario	Noise level, dB(A)	Notes and assumptions
Mechanical plant	80 dB(A) SWL	SWL based on *AAAC Child Care Centre Acoustic Assessment*

Scenario	Noise level, dB(A)	Notes and assumptions
PA system and period alarm	85 dB(A) SWL	Impulsive adjustment applied Event time 1 minute per 15 minute period Locations estimated based on guidance contained within *Department of Education DG64 - Communications*
School hall concert special event	90 dB(A) internal SPL	Internal sound pressure level based on typical school band concert Standard solid core door and no acoustic seal

4.3.3 Predicted operational noise levels

The predicted noise level for each scenario is provided for each receiver in Table 4-7. The noise levels are predicted to comply with the noise criteria for all assessed scenarios.

Table 4-7 Predicted operational noise levels, dBA

Receiver	Mechanical plant	PA system and period alarm	School hall concert (Evening criteria)
R01	32	33	22
R02	29	34	25
R03	30	37	24
R04	31	40	25
R05	32	42	28
R06	32	43	30
R07	32	46	34
R08	32	46	36
R09	32	46	38
R10	30	33	39
R11	30	27	40
R12	30	24	39
R13	37	25	42
R14	37	26	43
R15	36	30	42
R16	37	44	41

Receiver	Mechanical plant	PA system and period alarm	School hall concert (Evening criteria)
R17	37	41	39
R18	29	35	28
R19	28	31	14
R20	25	25	8
R21	26	26	7
R22	26	28	7
R23	30	36	8
R24	33	40	7

4.3.4 Sleep disturbance

All school activity are expected to occur during the day or evening period therefore sleep disturbance impacts are not expected.

It is recommended that events at the school hall should finish prior to 10 pm to avoid associated sleep disturbance noise impacts.

4.4 Road traffic noise

4.4.1 Noise intrusion

Predicted maximum road traffic noise levels $L_{Aeq(1\ hour)}$ and the calculated $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ for the proposed development are presented in Table 4-8. Predictions are based on the traffic modelling and the predicted one-way traffic generation of 104 and 79 vehicles during the AM and PM peak hours (Traffic Impact Assessment, GHD 2017). Predictions are based on worst case peak hour traffic volumes, and at all other times predicted road traffic noise levels are expected to be lower.

Compliance with the Department of Education DG11 noise criteria is based on the acoustic mitigation measures provided in Section 5.3.

Table 4-8 Predicted and calculated road traffic noise levels, dB(A)

Location	$L_{Aeq(1\ hour)}$	$L_{Aeq(15\ hour)}$[1]	$L_{Aeq(9\ hour)}$[2]
North-east façade	66.4	63.8	60.9
North-west façade	66.8	64.2	61.3
South-west façade	59.6	57.0	54.1
South-east façade	54.2	51.6	48.7

Note:

[1] Based on information provided within Austroads *Modelling, Measuring and Mitigating Road Traffic Noise,* a correction factor of -2.6 has been applied to the $L_{Aeq(1hr)}$ to obtain the $L_{Aeq(15hr)}$

[2] Based on information provided within Austroads *Modelling, Measuring and Mitigating Road Traffic Noise,* a correction factor of -5.5 has been applied to the $L_{Aeq(1hr)}$ to obtain the $L_{Aeq(9hr)}$

4.4.2 Noise generation

The traffic report (Traffic Impact Assessment, GHD 2017) predicts the following traffic generation during the peak hour would be due to school drop-offs.

- 104 inbound and 104 outbound vehicle trips in AM peak periods (8:30 am – 9:30 am)
- 79 inbound and 79 outbound vehicle trips in PM peak periods (3:00 pm – 4:00 pm).

Traffic generation is predicted to increase noise levels by up to 0.5 dBA. The noise level increase is less than 2 dBA and the objectives of the RNP are met. Therefore no noise impacts from operational traffic movements are expected and no specific mitigation measures are required.

5. Mitigation measures

5.1 Construction mitigation measures

To protect the amenity of local residents mitigation measures have been recommended to manage noise and vibration during construction.

For construction activities that are undertaken within the recommended standard construction hours (7am to 6pm Monday to Friday and 8am to 1pm Saturday) the work practices in Table 5-1 would be considered where feasible and reasonable where noise levels are predicted to exceed the construction noise management levels.

Table 5-1 Feasible and reasonable work practices

Construction noise and vibration mitigation measure	
Construction mitigation measures	Noise generating construction activities should be undertaken in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). The standard hours for construction work should be in accordance with the Guideline: • 7:00 am – 6:00 pm Monday to Friday • 8:00 am – 1:00 pm Saturdays • no work on Sundays or Public Holidays. Work outside normal hours should only comprise: • the delivery of materials outside normal hours requested by police or other authorities for safety reasons • emergency work to avoid the loss of lives and/or property
	Residences within 500 m of the site should be notified as to the timing and duration of the construction works and provided with a contact phone number for any complaints or concerns during the construction period.
	Site inductions Inductions for the work crew would include the specific noise issues and mitigation measures required for the site. The induction would include: • all relevant standard noise mitigation measures • relevant licence and approval conditions • permissible hours of work • location of any sensitive receivers that may exceed the construction noise management level • construction employee parking areas • designated loading/ unloading areas and procedures • site opening/closing times (including deliveries) • behavioural practices that minimise noise: • avoiding dropping materials from height and avoiding metal to metal contact on material.
	The distance between plant and equipment and any sensitive receiver should be maximised where practicable.
	Vehicles, plant and equipment would be regularly maintained and kept in good operating condition. Machines found to produce excessive noise should be removed from site or stood down until repairs or modifications can be made.

Construction noise and vibration mitigation measure	
	Plant should be turned off when not in use. For example, trucks should not be left idling if not operational.
Vibration	Should any buildings be identified that are located within the structural damage vibration buffer distances identified in Section 4.2.2, a property condition report should be prepared for the premises before and after undertaking the work. Compliance vibration monitoring should also be undertaken during high vibration generating activities where buildings are located within the structural damage buffer distances to confirm vibration criteria are not exceeded.

5.2 Operational mitigation measures

Operational noise levels are anticipated to comply with the noise criteria assuming the following mitigation measures are considered:

- Events at the school hall should finish prior to 10 pm to negate any sleep disturbance impacts.
- If noisy events in the school are proposed which have the potential to generate internal noise levels in excess of 90 dBA then additional acoustic treatments to the school hall should be considered.

5.3 Noise intrusion recommended acoustic treatments

The following recommended acoustic treatments should be incorporated into the building design to achieve the indoor design levels outlined in Section 3. Alternative treatments can be used if the minimum Rw rating is achieved.

5.3.1 Glazing treatments for windows and glazed doors

The minimum recommended acoustic glazing treatments for the proposed development are specified in Table 5-2.

Note that all windows throughout are proposed to be fixed glazing. Should any glazing be operable, acoustic seals should be installed.

The building should be designed so that there is sufficient ventilation to comply with the requirements of the Building Code of Australia when windows are closed. This may require forced ventilation.

The minimum R_w rating has also been provided and alternative glazing treatments can be selected if they achieve the corresponding R_w rating.

Table 5-2 Recommended glazing treatments

Area	Door / window description	Minimum Glazing Treatment	Minimum R_w rating
North facing façade	North windows	10.38 mm laminated glass	35
South facing façade	South windows	6 mm glass	28

5.3.2 External walls

The following external wall construction is proposed throughout the building:

- Equitone compressed fibre cement external cladding
- 90 mm timber stud wall system
- Insulation (R2.2)

The minimum recommended internal wall linings for the proposed development are specified in Table 5-3.

Table 5-3 Recommended internal wall linings

Area	Wall description	Recommended lining
Northern rooms	All walls	2 x 13 mm standard plasterboard
Southern rooms	All walls	1 x 13 mm standard plasterboard

5.3.3 Roof / Ceiling

The following roof / ceiling construction is proposed throughout the building:

- Corrugated steel external lining
- Suspended ceiling system
- Insulation (R2.2) with 200 mm airgap

The minimum recommended internal ceiling linings for the proposed development are specified in Table 5-4.

Table 5-4 Recommended internal ceiling linings

Area	Recommended lining
Northern rooms	2 x 13 mm standard plasterboard
Southern rooms	1 x 13 mm standard plasterboard

5.4 Mechanical ventilation

Mechanical ventilation is proposed to be installed as the external façade is to contain fixed glazing. The following mechanical plant will be installed throughout the school:

Homebase / Learning Space

- One (1) ceiling mounted fan coil unit (FCU) – Sound pressure level of 39 – 43 dBA
- One (1) energy recovery ventilator (ERV) – Sound pressure level of 39.5 – 41.5 dBA

Maker Space / Common Areas

- Two (2) ceiling mounted fan coil unit (FCU) – Sound pressure level of 45.5 – 48.5 dBA
- Two (2) energy recovery ventilator (ERV) – Sound pressure level of 41.5 – 43.5 dBA

Amphitheatre

- Two (2) ceiling mounted fan coil unit (FCU) – Sound pressure level of 39 – 43 dBA
- Two (2) energy recovery ventilator (ERV) – Sound pressure level of 39.5 – 41.5 dBA

At this stage, specific units and mechanical design has not been finalised. Preliminary design is based on the noise levels presented above. Units will be located within the ceiling void and must be designed to achieve the internal noise levels presented in Table 3-8 above. Based on the above noise specifications units, the mechanical plant can be designed to achieve compliance with the internal level requirements.

A detailed assessment of internal noise levels from the mechanical plant should be undertaken at a later stage, either schematic or detailed design stage.

6. Conclusion

Noise and vibration impacts for the construction and operational phases of the project has been assessed. Existing noise levels were identified through background noise measurements and used to establish construction and operational noise management levels.

6.1 Construction noise and vibration

The predicted noise levels are predicted to exceed the noise management levels during standard construction hours. No residential receivers are expected to experience noise levels above the highly affected noise level of 75 dBA.

Traffic noise impact due to construction are not expected as noise levels along the construction traffic routes are not predicted to significantly increase road traffic noise levels.

Safe working distances for vibration activities have been identified for standard structures. No buildings have been identified within the safe working distances. There is the potential for minor human comfort vibration impacts at residences directly adjacent to the work.

It is typical for construction projects to exceed the construction noise and vibration management levels. Any impacts due to construction works are temporary in nature and would not represent a permanent impact on the community and surrounding environment. The predicted noise and vibration levels are generally conservative and would only be experienced for limited periods during construction. Impacts may be reduced through the introduction of feasible and reasonable mitigation measures which have been recommended. However, these mitigation measures are unlikely to reduce noise levels below the construction noise management levels or human comfort criteria.

6.2 Operational noise

Operational noise emission from mechanical plant, PA systems, period alarms and school concerts were assessed. Based on the assumptions in the report, operation of the school is predicted to comply with the *Industrial Noise Policy* (EPA, 2000) noise criteria.

6.3 Road traffic noise

Road traffic noise levels were predicted during the worst peak hour period and are expected to comply with the *Road Noise Policy* (DECCW, 2011) criteria.

6.4 Road traffic noise intrusion

To achieve the required indoor design sound levels presented in Section 3, the noise mitigation measures recommended in Section 5 should be incorporated into the design including glazing treatments, external wall treatments and roof/ceiling system treatments.

The proposal would be acceptable from an acoustic perspective assuming the recommended mitigation measures are implemented.

7. References

Bureau of Meteorology (2017), Terrey Hills AWS (ID 066059) data between 17 July and 24 July 2017

DECCW (2011), *Road Noise Policy*

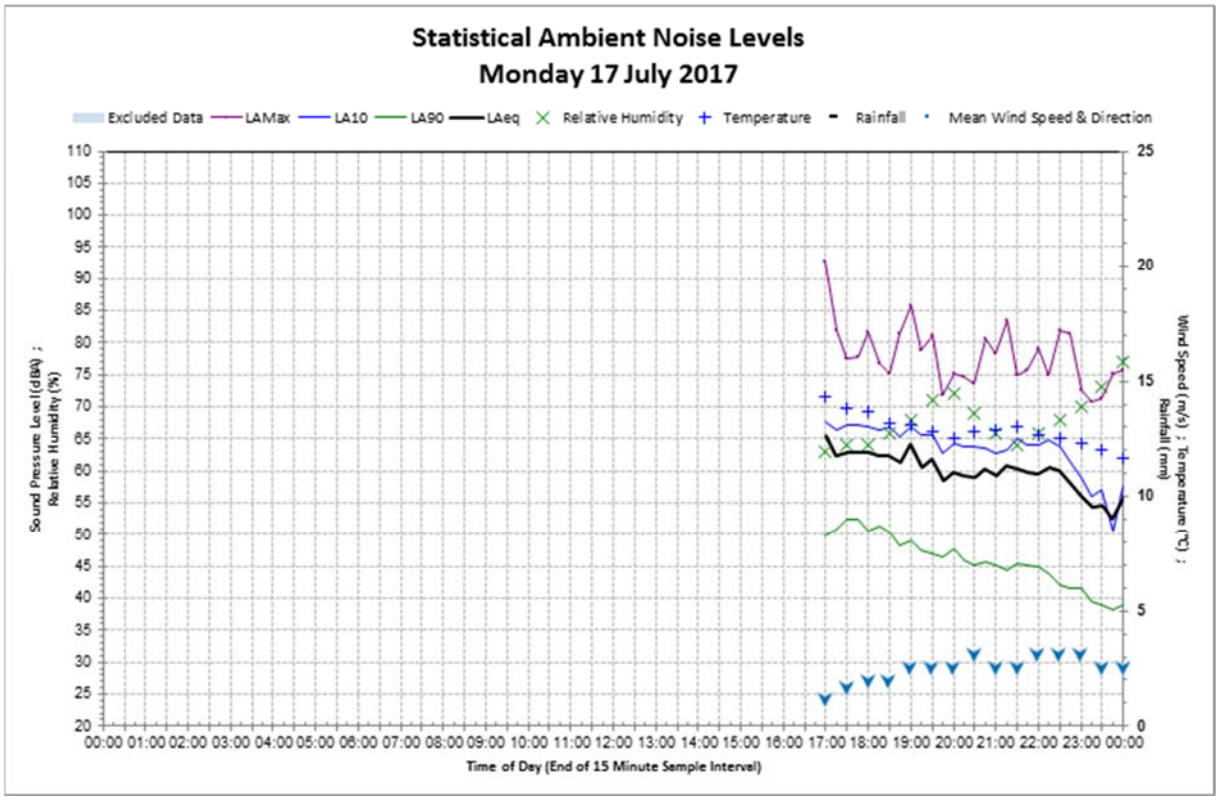
EPA (2000), *NSW Industrial Noise Policy*

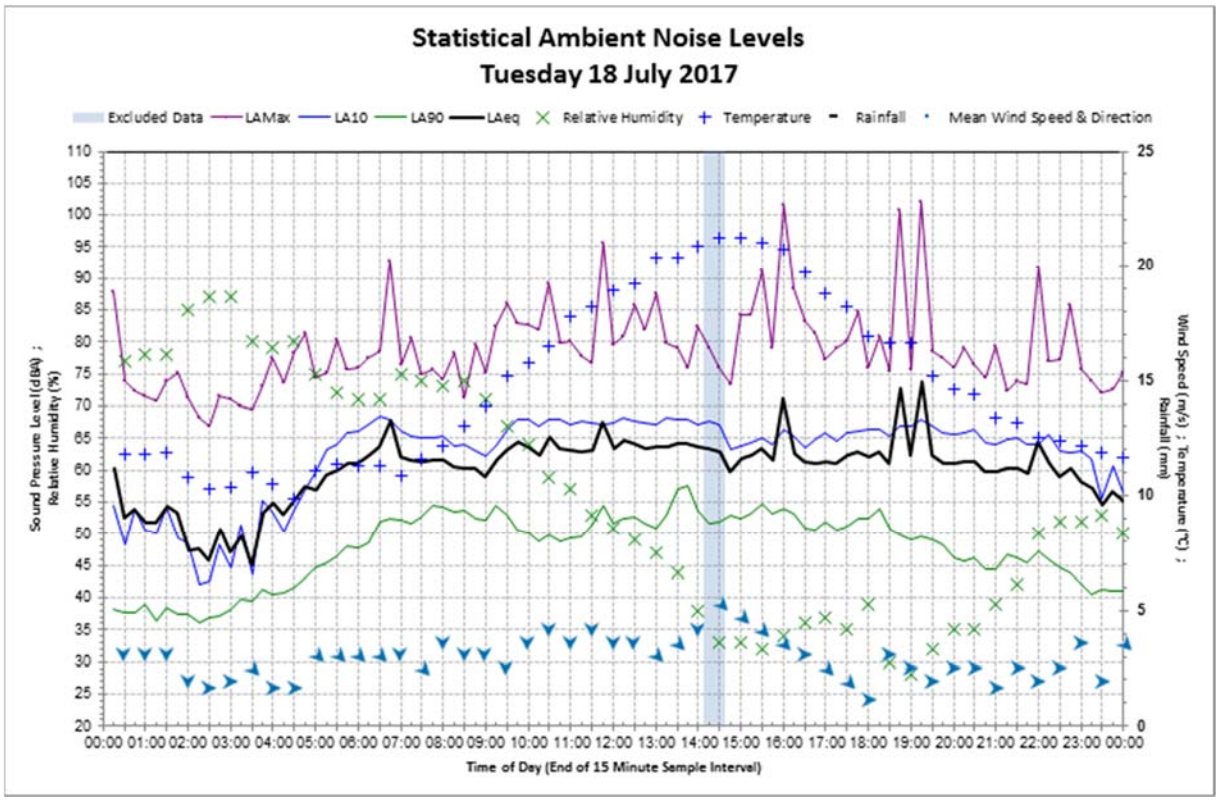
GHD (2017), *Waitara Public School Expansion Traffic Impact Assessment*

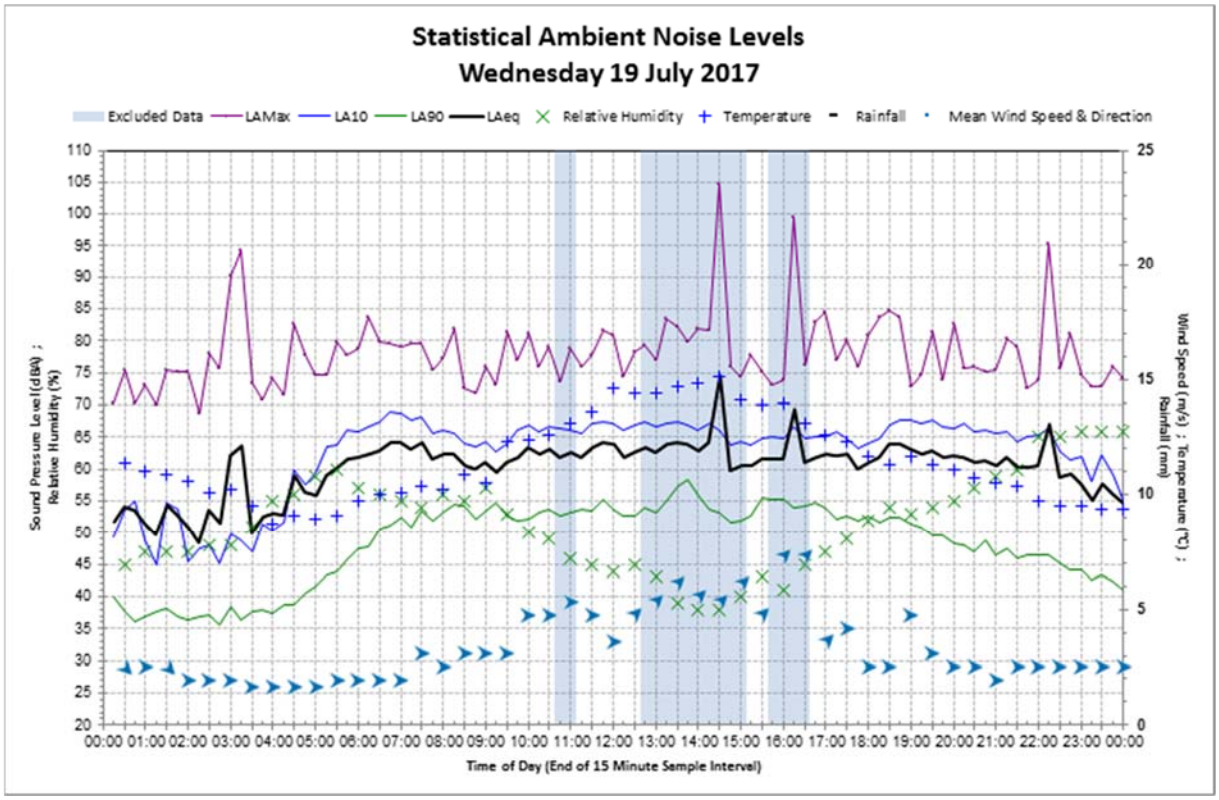
NSW Department of Education (2017), *DG64 Communications*

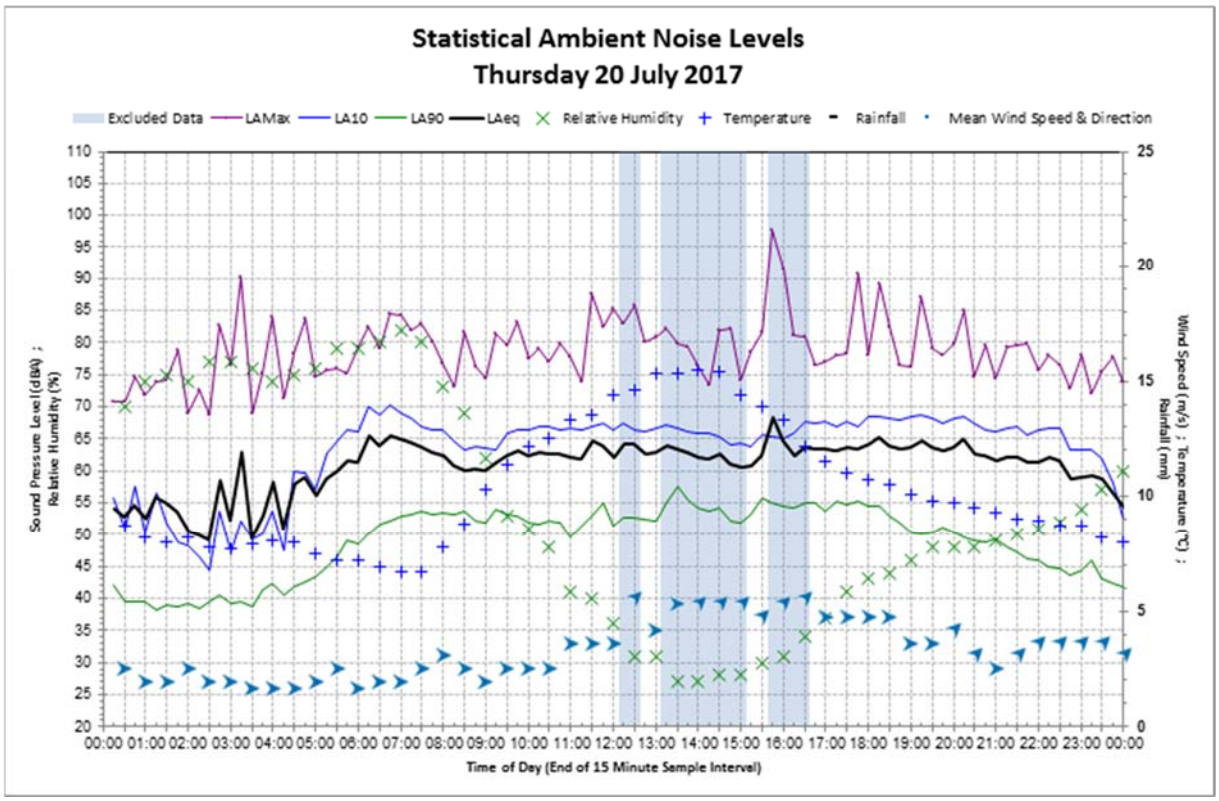
Appendices

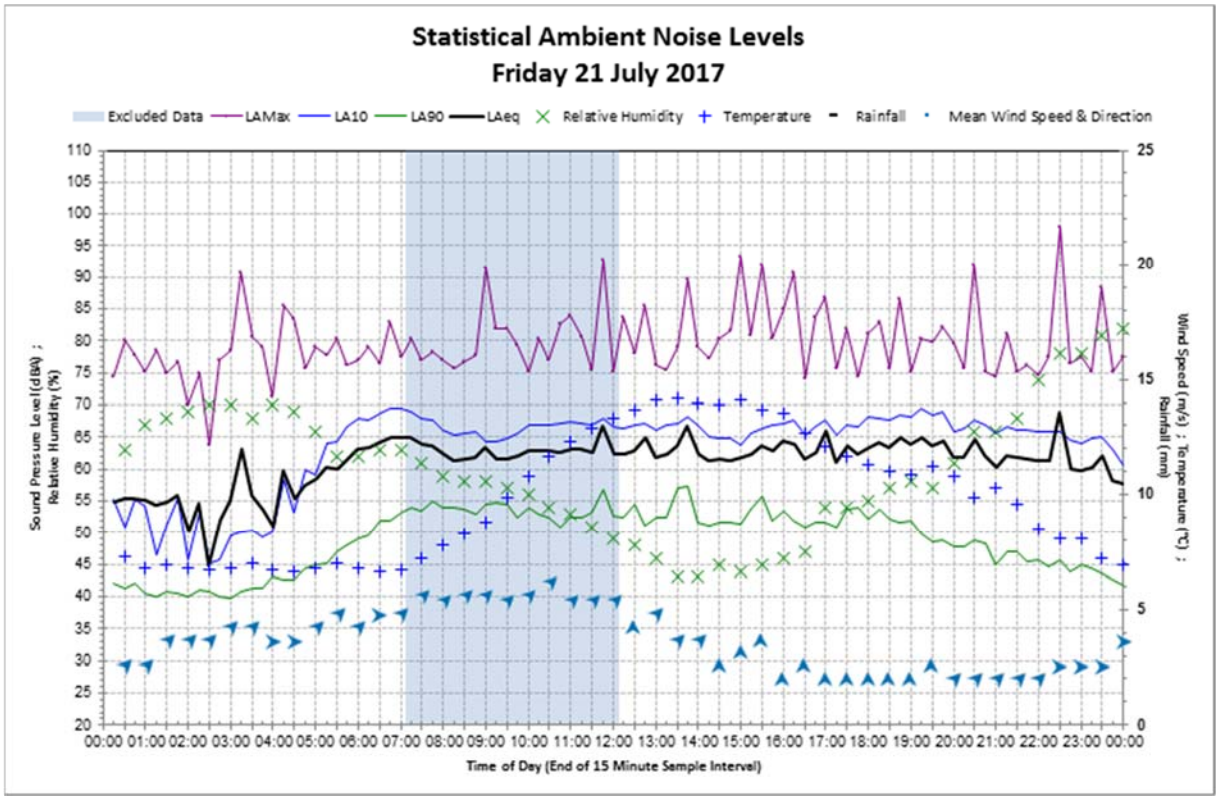
Appendix A - noise level charts – M1

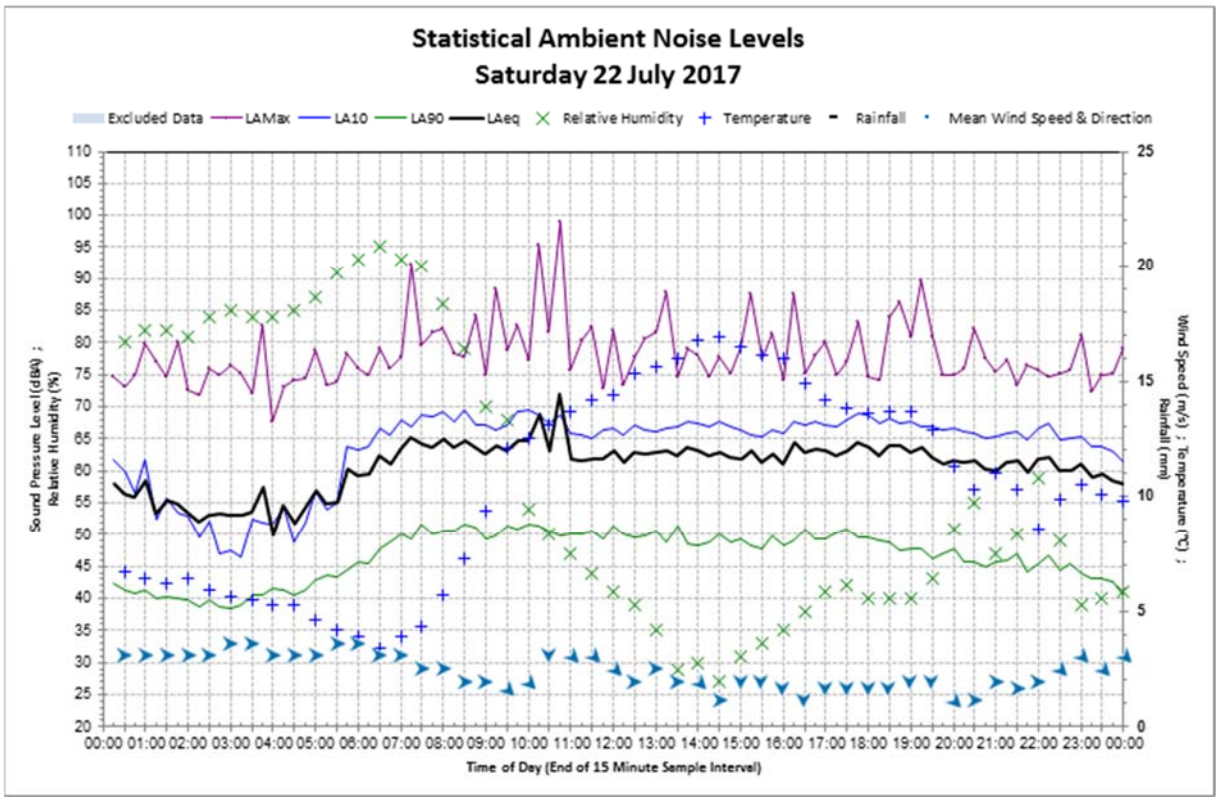


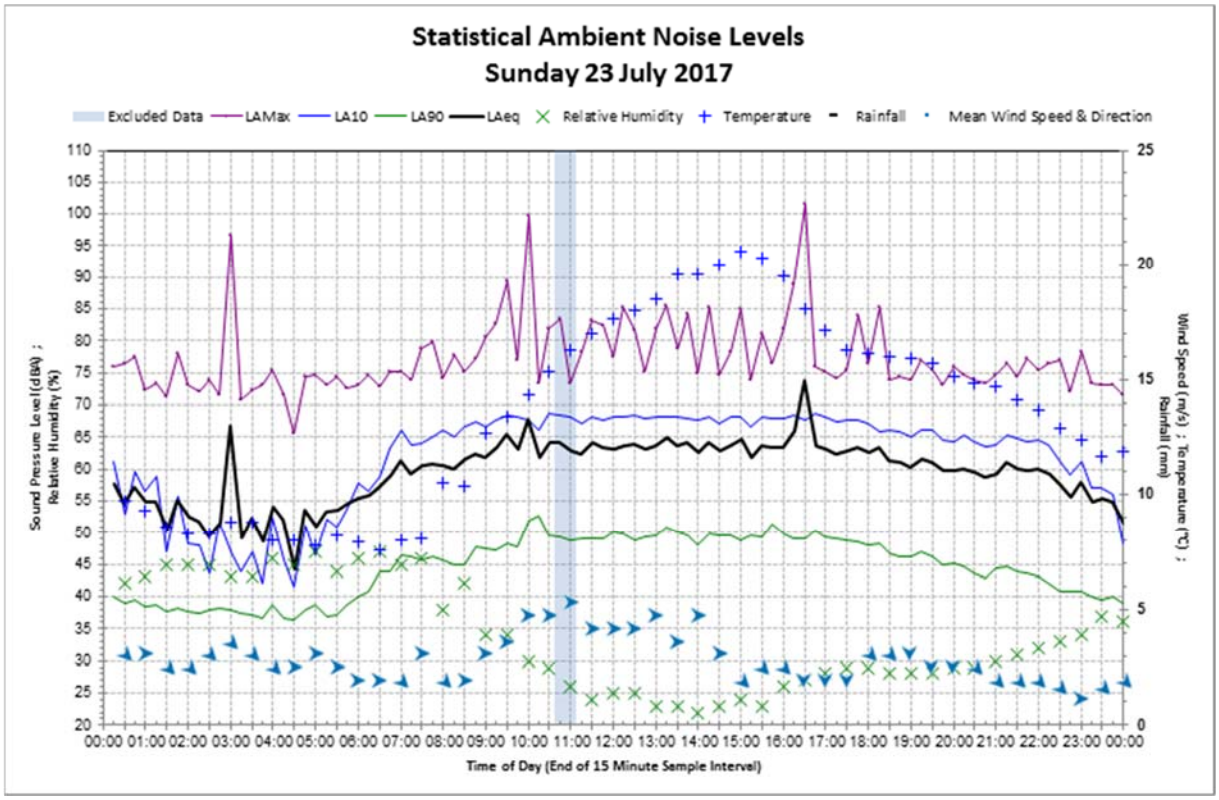


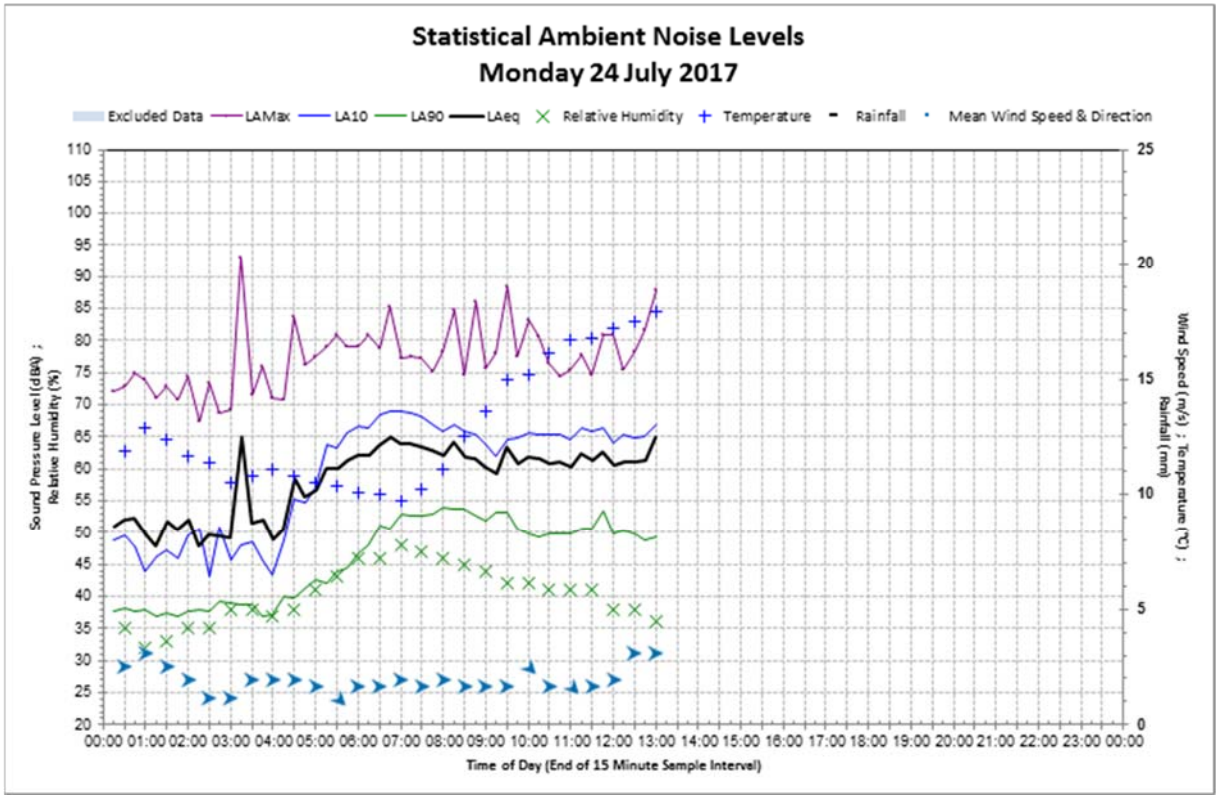

Statistical Ambient Noise Levels
Wednesday 19 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Thursday 20 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

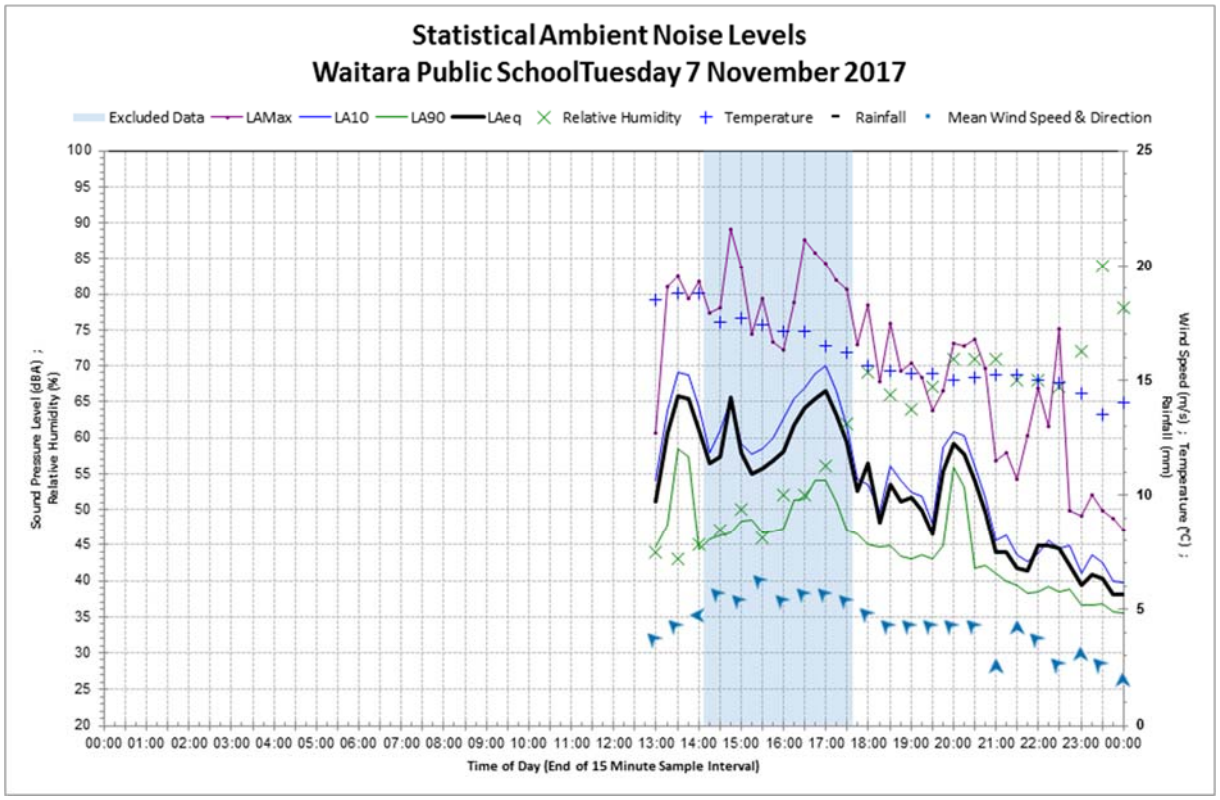

Statistical Ambient Noise Levels
Friday 21 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

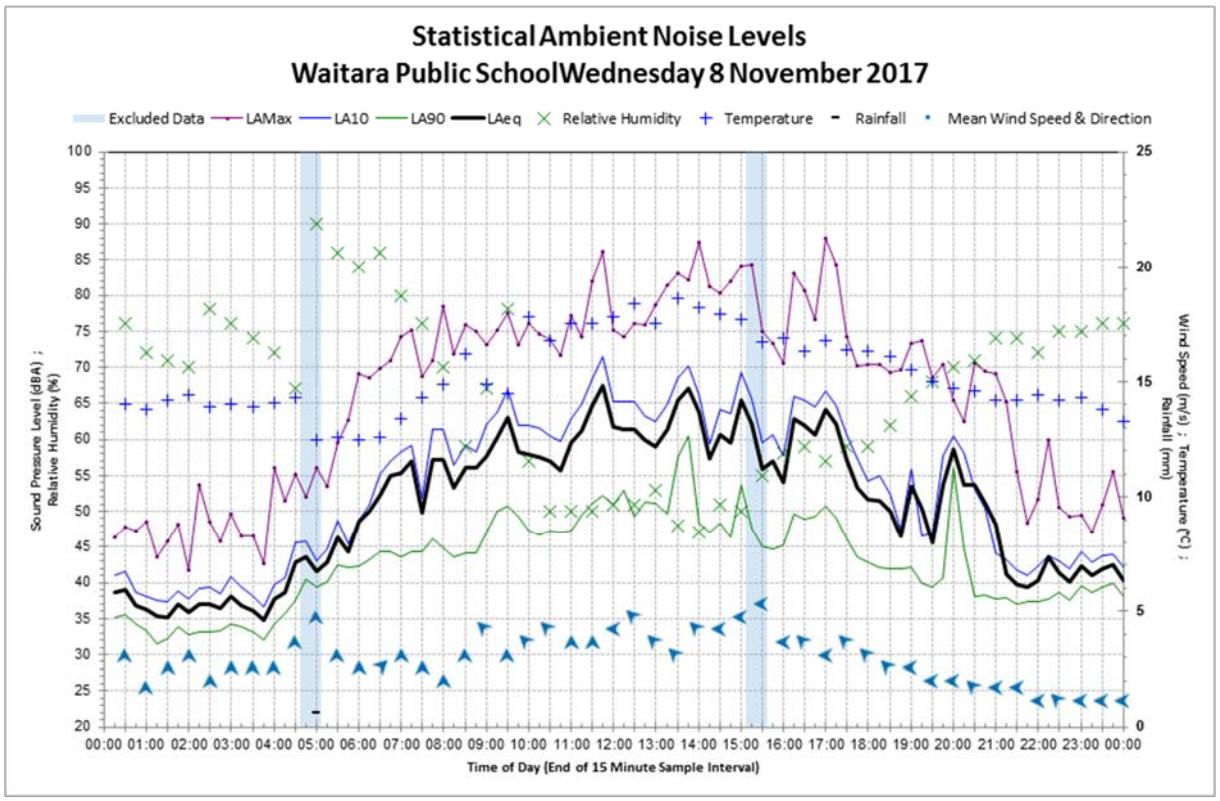

Statistical Ambient Noise Levels
Saturday 22 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

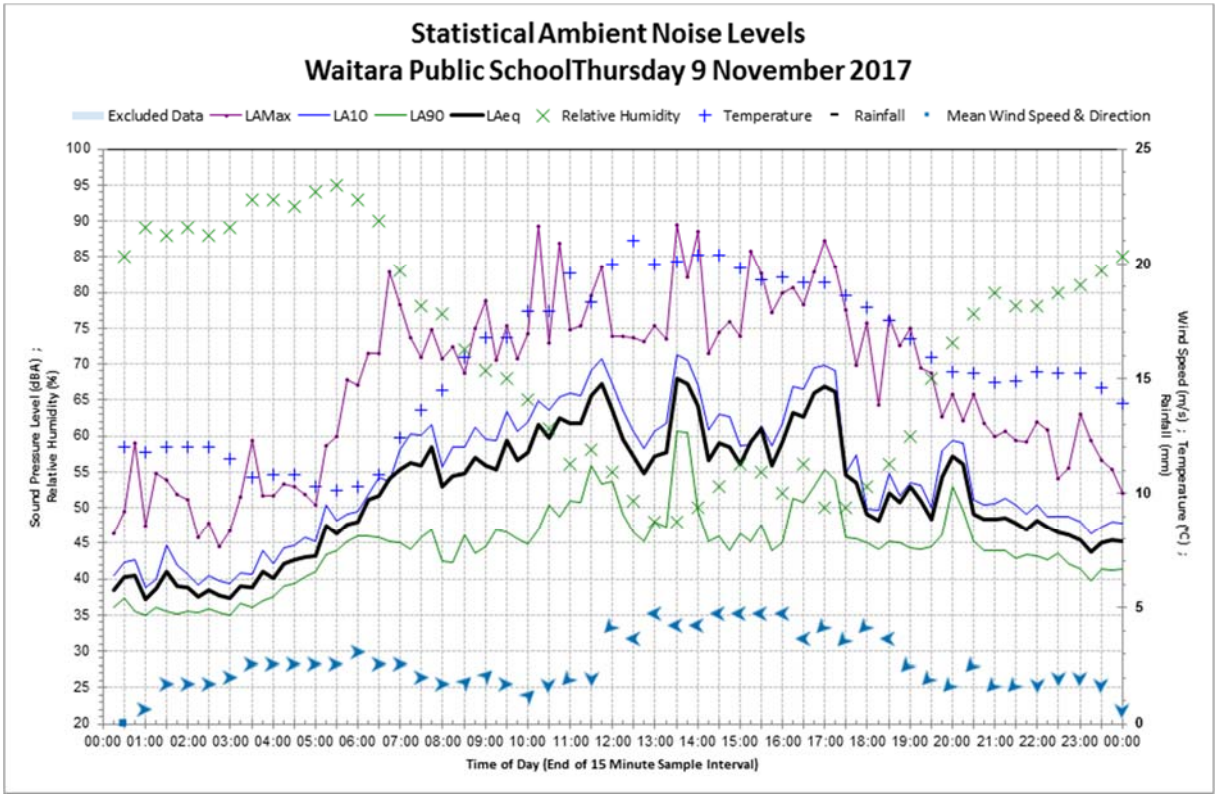

Statistical Ambient Noise Levels
Sunday 23 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

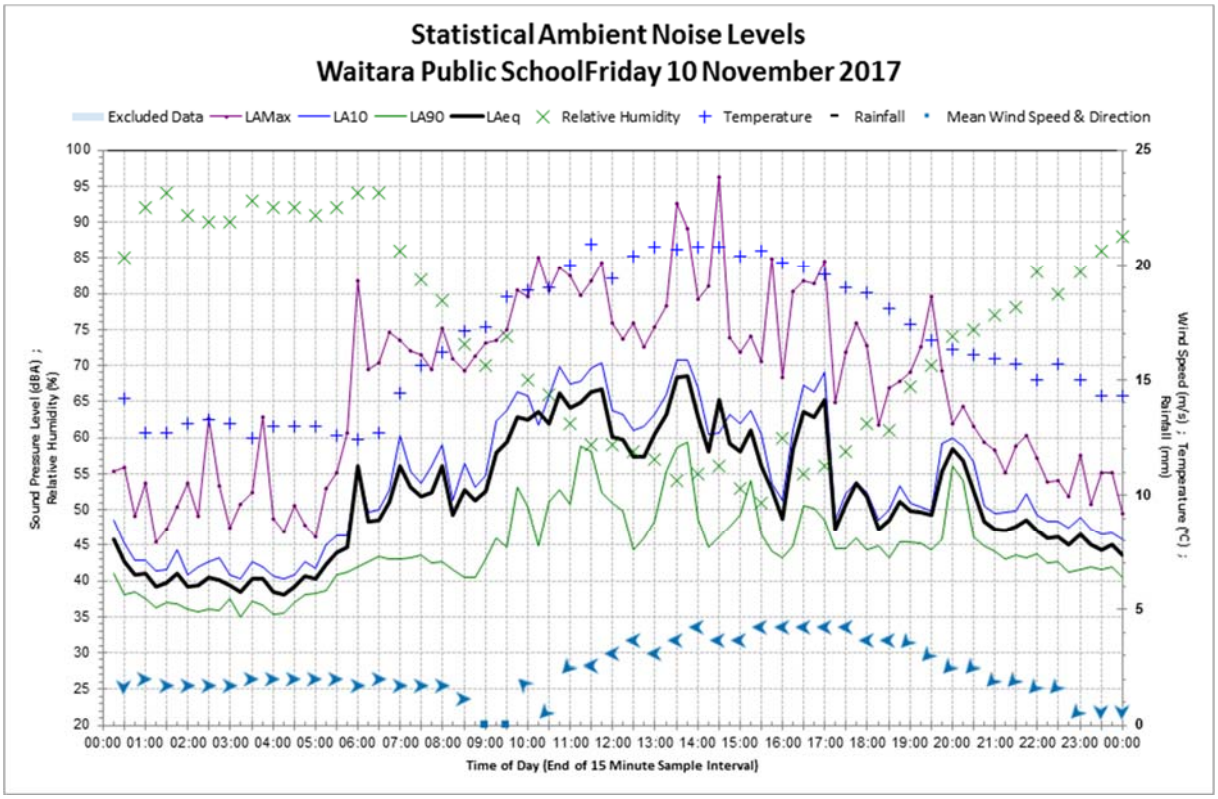

Statistical Ambient Noise Levels
Monday 24 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

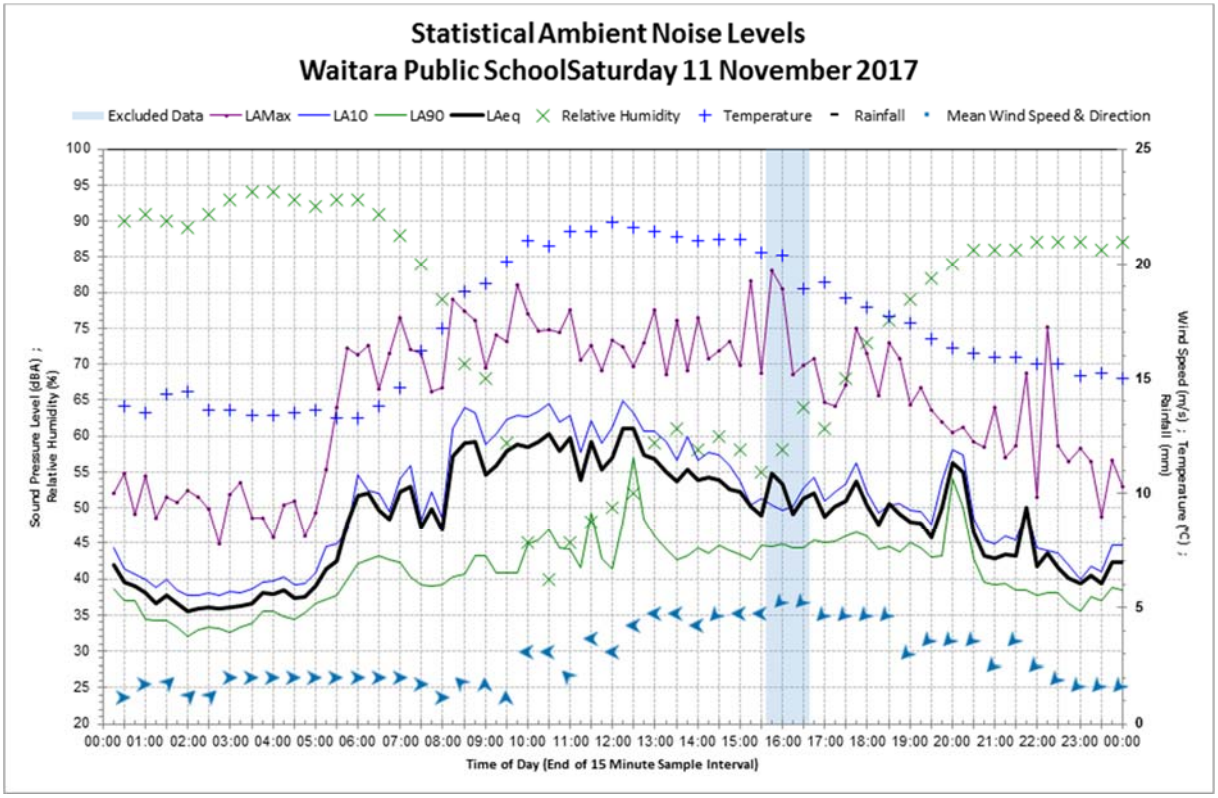
Appendix B - noise level charts – M2

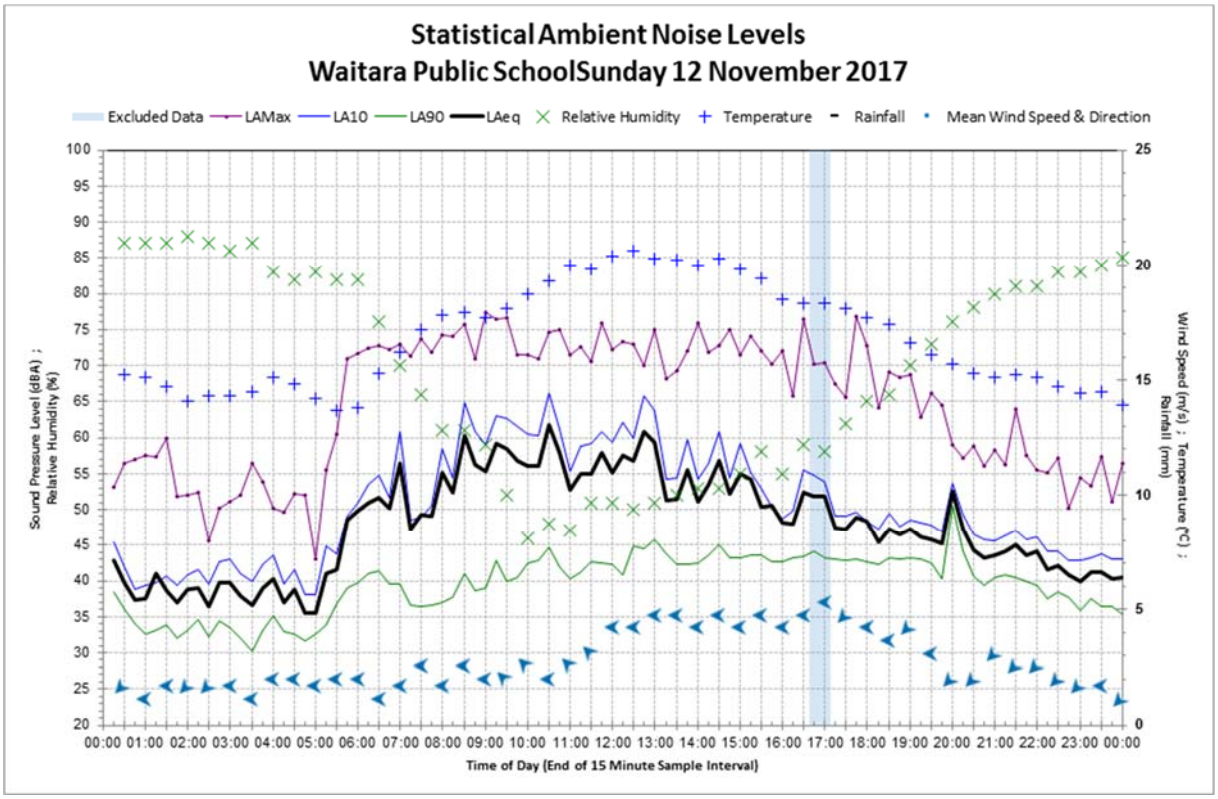


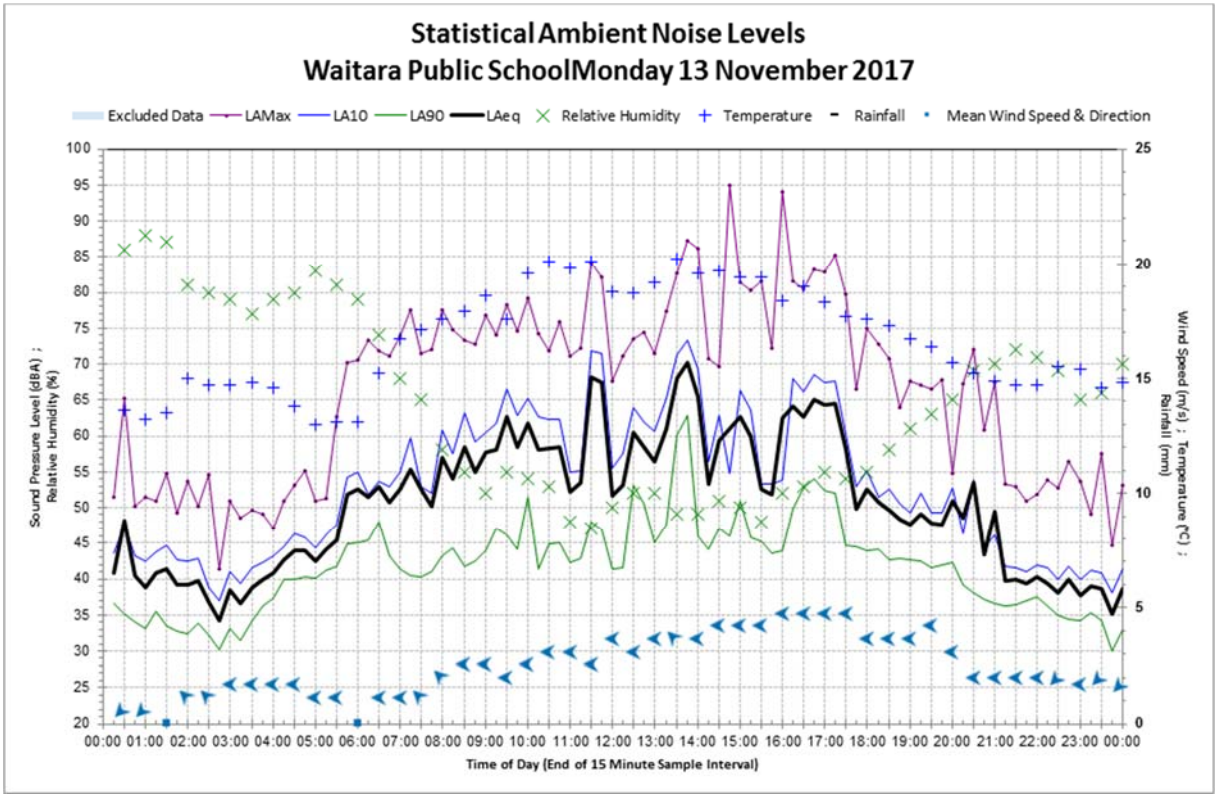


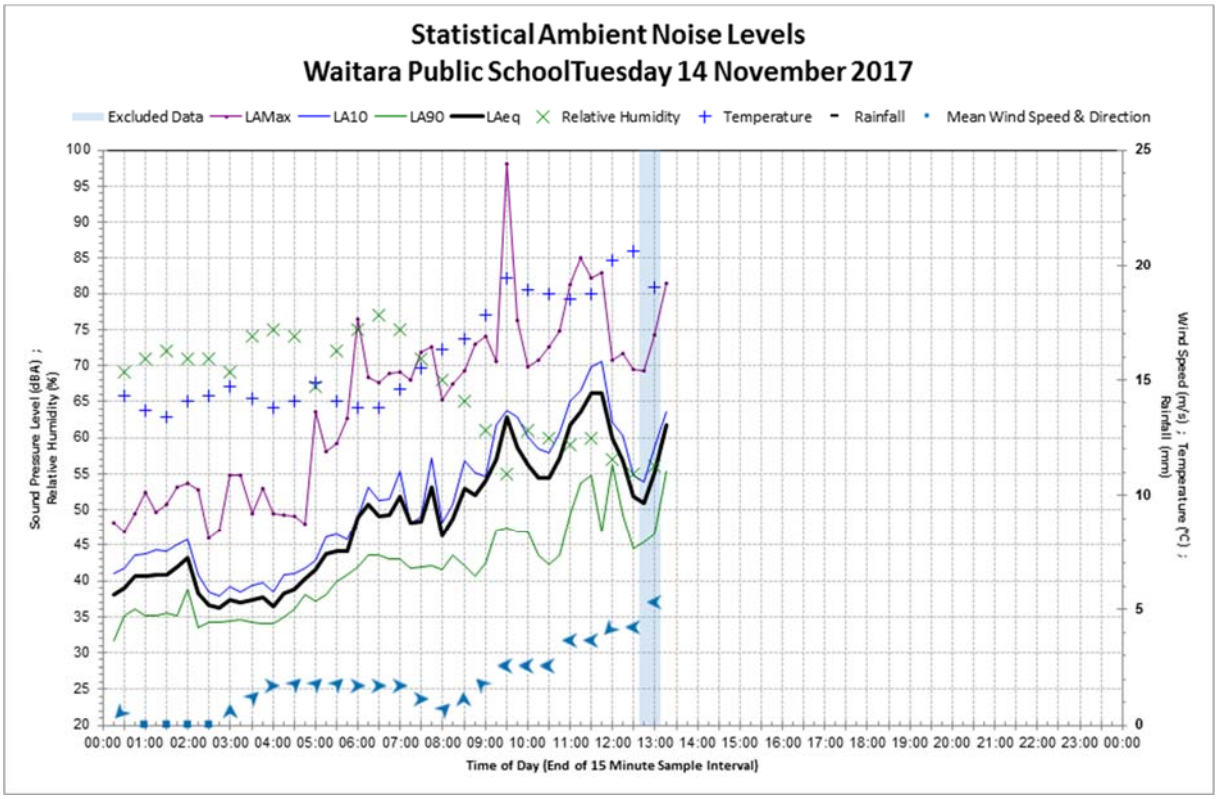

Statistical Ambient Noise Levels
Waitara Public SchoolThursday 9 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Waitara Public SchoolFriday 10 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Waitara Public SchoolSaturday 11 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Waitara Public SchoolSunday 12 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Waitara Public SchoolMonday 13 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Waitara Public SchoolTuesday 14 November 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

GHD

Level 3
22 Giffnock Avenue
T: 61 2 9239 7100 F: 61 2 9239 7199 E: sydmail@ghd.com

GHDDocId/\\ghdnet\ghd\AU\Sydney\Projects\21\26108\7. Waitara PS\01 Architecture\03 Scheme Design\SSD DA\Appendix I Acoustic Report\20171219\212610853 - Waitara PS - NVIA Report_Rev2.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	V Lau	E Milton		M Warren		15/08/17
1	V Lau / C Gordon	E Milton				17/11/17
2	V Lau / C Gordon	E Milton				20/12/17

www.ghd.com