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Environmental Noise Assessment

Proposed Hall
Brookvale Public School, Brookvale, NSW

REPORT No
6736-1.1R

DATE ISSUED
11 April 2019

Prepared For:
SARM Architects
Suite 4, 7 Ridge Street
North Sydney NSW 2059

Attention: Ms Kim Howell



Revision History

Report	Date	Prepared	Checked	Comment
Draft	08/04/2019	William Wang	Stephen Gauld	By email, for client review
Final	11/04/2019	William Wang	Stephen Gauld	

Document R\6736-1.1R, 16 pages plus attachments

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TABLE OF CONTENTS

1.0	CONSULTING BRIEF	4
2.0	PROJECT DESCRIPTION	5
3.0	NOISE SURVEY INSTRUMENTATION	7
4.0	NOISE EMISSION CRITERIA	8
4.1	Background Noise Level.....	8
4.2	SEPP (Educational Establishments and Child Care Facilities) 2017.....	9
4.3	NSW Noise Policy for Industry	9
4.3.1	Intrusiveness Noise Level	9
4.3.2	Amenity Noise Level.....	10
4.4	Project Specific Noise Emission Criteria.....	11
5.0	HALL NOISE EMISSION	12
5.1	School Hall.....	12
6.0	NOISE CONTROL RECOMMENDATIONS.....	14
6.1	Daytime Operation	14
6.2	Evening Operation	14
6.3	Building Construction	14
6.3.1	Walls	14
6.3.2	Ceiling and Roof System	14
6.3.3	Glazing and Glazed Doors	15
7.0	NOISE ASSESSMENT STATEMENT	16

TABLES

Table 1	Residential Receptor Locations	5
Table 2	Noise Instrumentation	7
Table 3	Ambient Noise Levels – Brookvale.....	8
Table 4	Amenity Noise Level.....	10
Table 5	Hall Activity L_{eq} Sound Power Levels	12
Table 6	Predicted L_{eq} Hall Noise Levels During the Day (Both Glass Doors Open)	13
Table 7	Predicted L_{eq} Hall Noise Levels in the Evening (South-Eastern Door Open)	13
Table 8	Schedule of Glazed Windows and Door Constructions.....	15



1.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by SARM Architects to carry out an acoustic assessment for the proposed new hall to be constructed at Brookvale Public School, Brookvale, NSW. The scope of work is as follows:

- Review the architectural drawings.
- Inspect the site in Brookvale.
- Prepare a site plan identifying the development and nearby noise sensitive locations
- Measure the background noise levels at critical locations and times
- Establish acceptable noise level criteria
- Quantify noise emission from the proposed hall
- Calculate the level of noise emission, taking into account building envelope transmission loss, screen walls, ground absorption and distance attenuation
- Provide recommendations for noise emission control (if necessary)
- Prepare an Environmental Noise Assessment Report.



2.0 PROJECT DESCRIPTION

A new hall is proposed to be constructed at Brookvale Public School.

Long term ambient noise measurements have been taken adjacent to the proposed hall site as shown in Figure 1. Ambient noise levels are presented in Section 3 of this report. This location has been chosen to represent the acoustic environment at the nearby residential neighbours.

Existing residences are located around the proposed hall site. Figure 1 and Table 1 show the assessment locations for residential premises used in this assessment. These residential locations are representative of the nearest affected premises, with the residential premises located further away will experience a lower noise impact from the school hall as a result of distance attenuation.

Table 1 Residential Receptor Locations

Location	Address
R1 – Residential	5 Gulliver Street
R2 – Residential	4 Alfred Road
R3 – Residential	6A Elizabeth Place

Acceptable noise limits are derived from the EPA's Noise Policy for Industry for intrusive noise impacts from mechanical plant and noise from the use of the hall, at each residence.

Noise levels from the use of the hall have been calculated at the nearest residential premises and are presented in Section 5.0.



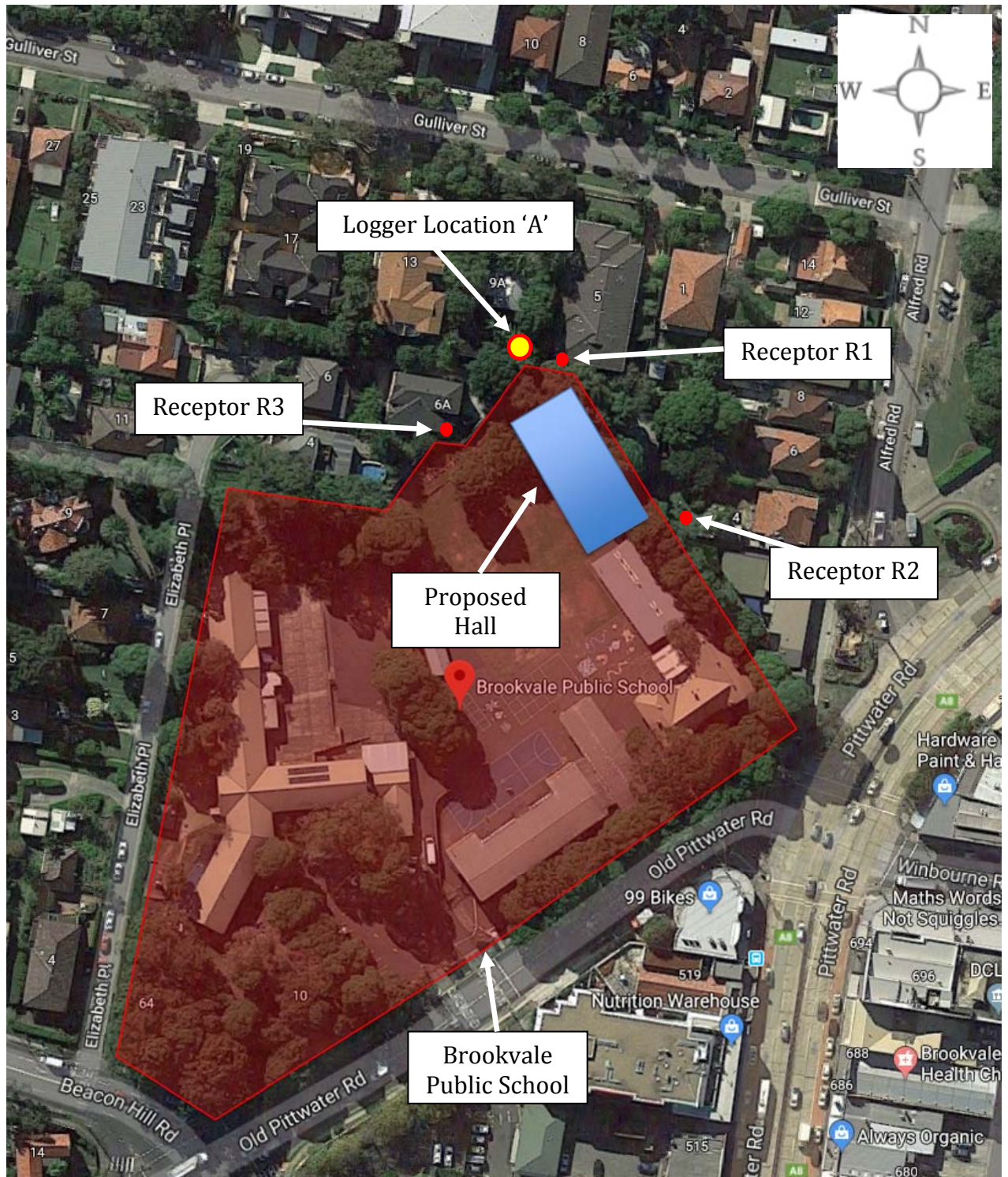


Figure 1 : Location Plan – Brookvale Public School



3.0 NOISE SURVEY INSTRUMENTATION

Noise level measurements and analysis were made with instrumentation as follows in Table 2:

Table 2 Noise Instrumentation

Description	Model No	Serial No
Infobyte Noise Logger(Type 1)	iM4	122
Condenser Microphone 0.5" diameter	MK 250	5219

An environmental noise logger is used to continuously monitor ambient noise levels and provide information on the statistical distribution of noise during an extended period of time. The Infobyte Noise Monitor iM4 is a Type 1 precision environmental noise monitor meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meter.

All instrument systems had been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less than 1 dB for unattended measurements. No adjustments for instrument drift during the measurement period were warranted.



4.0 NOISE EMISSION CRITERIA

4.1 Background Noise Level

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring period (typically 15 minutes).

The Rating Background Level (RBL) is defined by the NSW EPA as the median value of the (lower) tenth percentile of L_{90} ambient background noise levels for the day, evening or night time periods, measured over a number of days during the proposed days and times of operation.

The places of worst possible annoyance are the residences identified in Table 1. These potentially affected locations can be seen in Figure 1. The times of greatest annoyance will be during the day time and evening when the hall may be in use.

The measured noise levels are presented in the attached Appendix A and also in Table 3 below.

Table 3 Ambient Noise Levels – Brookvale

Location	Time Period	L_{90} Rating Background Level (dBA)	Existing Ambient L_{eq} Noise Level (dBA)
Location 'A' – 9 Gulliver Street, Brookvale (Rear Yard)	Day (7 am to 6 pm)	46	56
	Evening (6 pm to 10 pm)	44	54
	Night (10 pm to 7 am)	34	50

Atmospheric conditions were ideal for noise monitoring. Noise measurements were therefore considered reliable and typical for the receptor area.



4.2 SEPP (Educational Establishments and Child Care Facilities) 2017

The NSW Department of Planning and Environment (DoPE) published the State Environmental Planning Policy (SEPP) (Educational Establishments and Child Care Facilities) 2017 on 1 September 2017. 'Schedule 2 Schools – complying development' of the SEPP requires the following:

'6. Noise

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.

4.3 NSW Noise Policy for Industry

The NSW Environment Protection Authority (EPA) published the *Noise Policy for Industry* (NPI) in October 2017, superseding the NSW Industrial Noise Policy. The NPI is specifically aimed at assessing noise from industrial noise sources listed in Schedule 1 of the Protection of the Environment Operations Act 1997 (POEO, 1997).

Brookvale Public School is not a 'scheduled premises' under the Protection of the Environment Operations Act 1997 as it is not required to hold a licence under that Act for operations at the site.

The NPI provides a useful framework to assess noise emission from non-scheduled premises, whether that premises produces intrusive or non-intrusive noise.

While the NPI is not strictly applicable to this site, as the site is not scheduled, in the absence of other relevant standards the limits set out in the NPI will be used as a guide in determining whether the level of noise is considered intrusive or not.

4.3.1 Intrusiveness Noise Level

The EPA states in Section 2.3 of its NPI that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the rating background noise level by more than 5 dB when beyond a minimum threshold (NPI, 2017, Section 2.3).

The representative Rating Background Levels in Brookvale was 46 dBA during the day, 44 dBA in the evening and 34 dBA at night. Therefore the acceptable L_{eq} noise intrusiveness noise level for broadband noise at these locations is:

- $(46 + 5 =) 51 \text{ dBA } L_{eq} 15 \text{ minute}$ during the day
- $(44 + 5 =) 49 \text{ dBA } L_{eq} 15 \text{ minute}$ in the evening
- $(34 + 5 =) 39 \text{ dBA } L_{eq} 15 \text{ minute}$ at night.



4.3.2 Amenity Noise Level

Depending on the type of area in which the noise is being made, there is a certain reasonable expectancy for noise amenity. The NPI provides a schedule of recommended L_{eq} industrial noise levels that under normal circumstances should not be exceeded. If successive developments occur near a residential area, each one allowing a criterion of background noise level plus 5 dB, the ambient noise level will gradually creep higher.

The recommended L_{eq} noise levels in Table 5 below are taken from Section 2.2 of the INP.

Table 4 Amenity Noise Level

Receiver	Noise Amenity Area	Time of Day	L_{Aeq} Noise Level, dBA
			Recommended amenity noise level
Residential	Suburban	Day	55
		Evening	45
		Night	40

The project specific amenity noise level is then calculated to be the recommended amenity noise level minus 5 dB(A).

The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the project amenity noise level. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardise the time periods for the intrusiveness and amenity noise levels, the NPI assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq, period} + 3 \text{ decibels (dB)}$.

The existing L_{eq} noise level at Brookvale was 56 dBA during the day, 54 dBA in the evening and 50 dBA at night. Therefore the acceptable L_{eq} amenity noise level for in this area is:

- $(55 - 5 + 3 =) \text{ 53 dBA } L_{eq} \text{ 15 minute during the day}$
- $(45 - 5 + 3 =) \text{ 43 dBA } L_{eq} \text{ 15 minute in the evening}$
- $(40 - 5 + 3 =) \text{ 38 dBA } L_{eq} \text{ 15 minute at night.}$



4.4 Project Specific Noise Emission Criteria

When all the above factors are considered, we find that the most stringent noise criterion at the nearby residential premises will be:

- **51 dBA** L_{eq} 15 minute during the day
- **43 dBA** L_{eq} 15 minute in the evening
- **38 dBA** L_{eq} 15 minute at night

These criteria apply at the most-affected point on or within the residential property boundary. For upper floors, the noise is assessed outside the nearest window.



5.0 HALL NOISE EMISSION

The main sources of noise from the proposed hall will be from the use including indoor sports, school assemblies, award ceremonies and school concerts or performances.

Calculations are based on the building layout and construction shown on the architectural drawings by SARM Architects shown in Appendix B.

5.1 School Hall

The Hall will be used by students and teachers during school hours for activities such as indoor sport and fitness, school assemblies, drama and music rehearsal and production. The School may be used infrequently outside of these hours for school events.

We recommend that use of the hall be restricted to daytime and evening period of 7 am to 10 pm only.

A schedule of the sound power levels for loudest activities that may occur within the Hall is presented in Table 5.

Table 5 Hall Activity L_{eq} Sound Power Levels

Description	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)								
	dBA	63	125	250	500	1k	2k	4k	8k
Amplified music – concert	98	103	106	102	95	92	86	81	78
Indoor ball sports	97	71	74	79	84	94	92	87	81
Fitness class – 30 students with amplified music	87	93	87	82	81	84	79	75	72

The indoor sports and fitness class may occur during the daytime and are therefore compared against the daytime criteria. The amplified music during a concert / disco / function may occur during the evening and is therefore compared against the evening criteria.



The predicted level of noise from activities within the hall is calculated with both doors open during the day and the south-eastern door open in the evening as shown below in Table 6 and Table 7 below respectively at the worst affected residences.

The high level glass louvres may be open during the daytime, however must be closed in the evening.

Table 6 Predicted L_{eq} Hall Noise Levels During the Day (Both Glass Doors Open)

Receptor Location	Predicted Noise Level (dBA)	Noise Criteria (dBA)	Compliance (Yes/No)
R1 – 5 Gulliver Street, Brookvale			
- Fitness class	30	51	Yes
- Indoor ball sports	37	51	Yes
R2 – 4 Alfred Road, Brookvale			
- Fitness class	43	51	Yes
- Indoor ball sports	51	51	Yes
R3 – 6A Elizabeth Place, Brookvale			
- Fitness class	44	51	Yes
- Indoor ball sports	50	51	Yes

Table 7 Predicted L_{eq} Hall Noise Levels in the Evening (South-Eastern Door Open)

Receptor Location	Predicted Noise Level (dBA)	Noise Criteria (dBA)	Compliance (Yes/No)
R1 – 5 Gulliver Street, Brookvale			
- Concert / Disco / Function	40	43	Yes
R2 – 4 Alfred Road, Brookvale			
- Concert / Disco / Function	43	43	Yes
R3 – 6A Elizabeth Place, Brookvale			
- Concert / Disco / Function	40	43	Yes

The levels of noise in Table 6 and 7 are within the acceptable noise criteria in Section 4.4 and are therefore acceptable.



6.0 NOISE CONTROL RECOMMENDATIONS

In order to meet the acceptable noise level criteria, we recommend the following management controls be implemented as part of the operation of the hall.

6.1 Daytime Operation

During the daytime (7 am to 6 pm), the large glass folding doors and operable high level louvres may remain open.

6.2 Evening Operation

During the evening (6 pm to 10 pm), the large glass folding door to the south-west and operable high level louvres must be closed.

The large glass folding door to the south-east may remain open for access and overflow if required.

6.3 Building Construction

To provide adequate noise reduction through the external facades of the hall, we recommend the following construction:

6.3.1 Walls

All external walls may be of double brick or brick veneer construction.

Any other external wall construction achieving a weighted sound reduction index R_w 50 will be acceptable.

If lightweight wall cladding is proposed, we recommend the following wall construction:

- Hardies' 'Linea' or 'Stria' cement composite cladding (or alternative cladding with equivalent surface density) on the outside of timber or steel studs; and
- one layer of 13 mm thick sound rated or 16 mm fire rated plasterboard on the internal side; and
- wall cavity lined with 75 mm thick glasswool insulation (min 10 kg/m³ density).

6.3.2 Ceiling and Roof System

- All roofs may be of metal deck construction
- Ceilings under the roof in the hall are to comprise a single layer of 10 mm plasterboard construction.
- Insulation batts are to be placed between the ceiling joists. The recommended insulation specifications 160 mm thick glasswool (min 10 kg/m³ density).



6.3.3 Glazing and Glazed Doors

Table 8 below specifies minimum sound reduction index (R_w) ratings required for various windows and glazed doors.

A typical glazing specification is given in Table 8, however an alternative glazing specification may be used if the R_w is achieved or exceeded.

Table 8 Schedule of Glazed Windows and Door Constructions

Room Description	Min R_w	Typical Glazing Specification
Glass Hinged Large Bi-Fold Doors	32	6.38 mm laminated glass with acoustic seals
Glass Hinged Entry Doors	28	5 mm toughened glass with acoustic seals
High Level Glass Louvres	28	5 mm toughened glass with acoustic seals

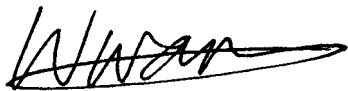
This schedule of construction is typical and for general guidance to the architect in preparing final construction drawings and specifications. Other constructions that provide the same or better Sound Transmission Loss performance may also be acceptable.



7.0 NOISE ASSESSMENT STATEMENT

Day Design Pty Ltd was engaged by SARM Architects to provide acoustical advice for the proposed new hall to be constructed at Brookvale Public School Brookvale, NSW.

Measurements and calculations show that the level of noise emitted by the proposed hall at Brookvale Public School will be able to meet the acceptable noise level requirements of the Education SEPP and EPA NSW Noise Policy for Industry as detailed in Section 4 of this report.



William Wang, BE (Mechatronics), MIEAust, MAAS

Senior Acoustical Engineer

for and on behalf of Day Design Pty Ltd

AAAC MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australasian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

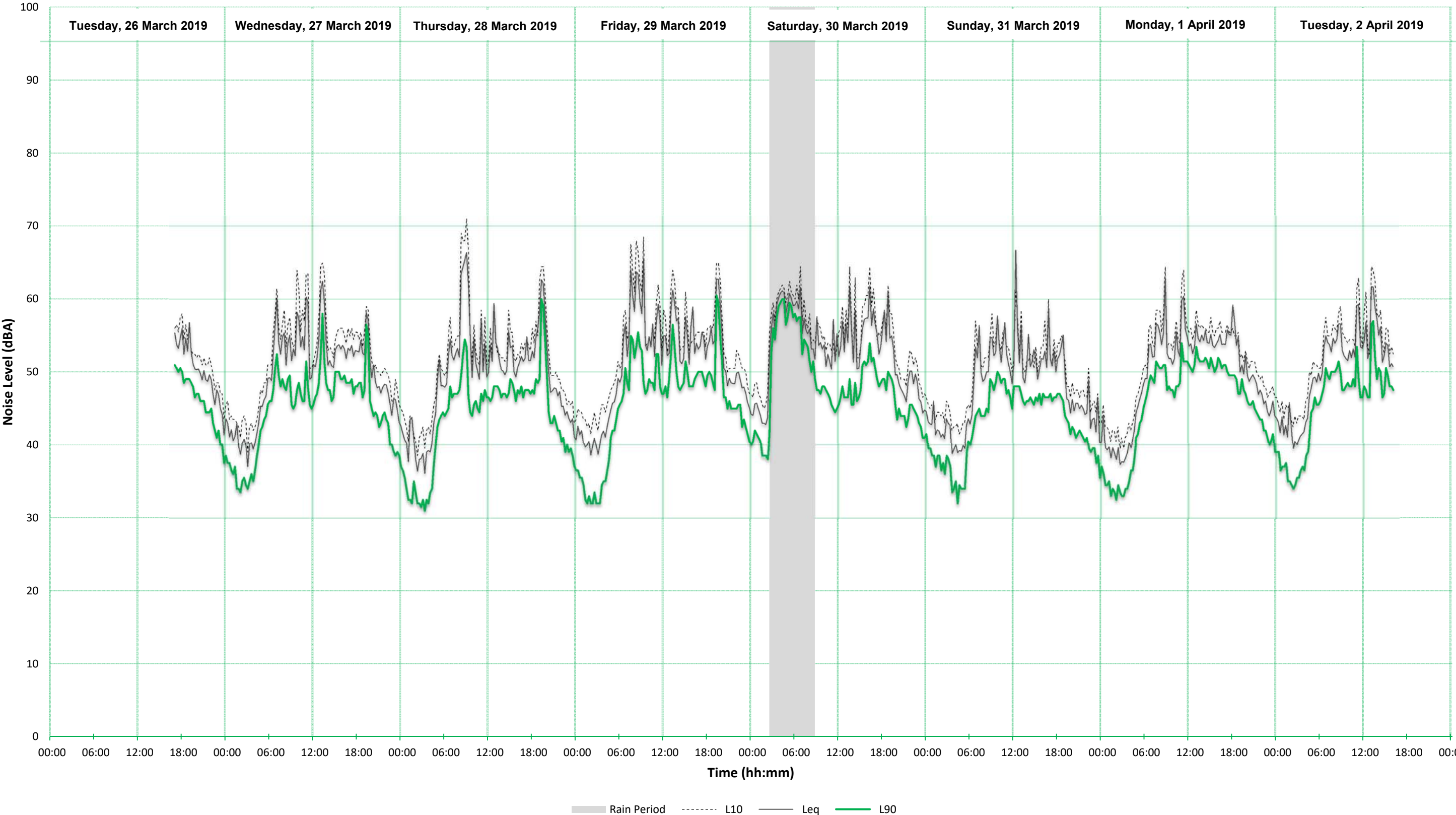
Attachments:

- Appendix A – Ambient Noise Survey
- Appendix B – Architectural Drawings
- AC108-1 to 4 – Glossary of Acoustical Terms
- AC500-10 – Modifying Factor Corrections

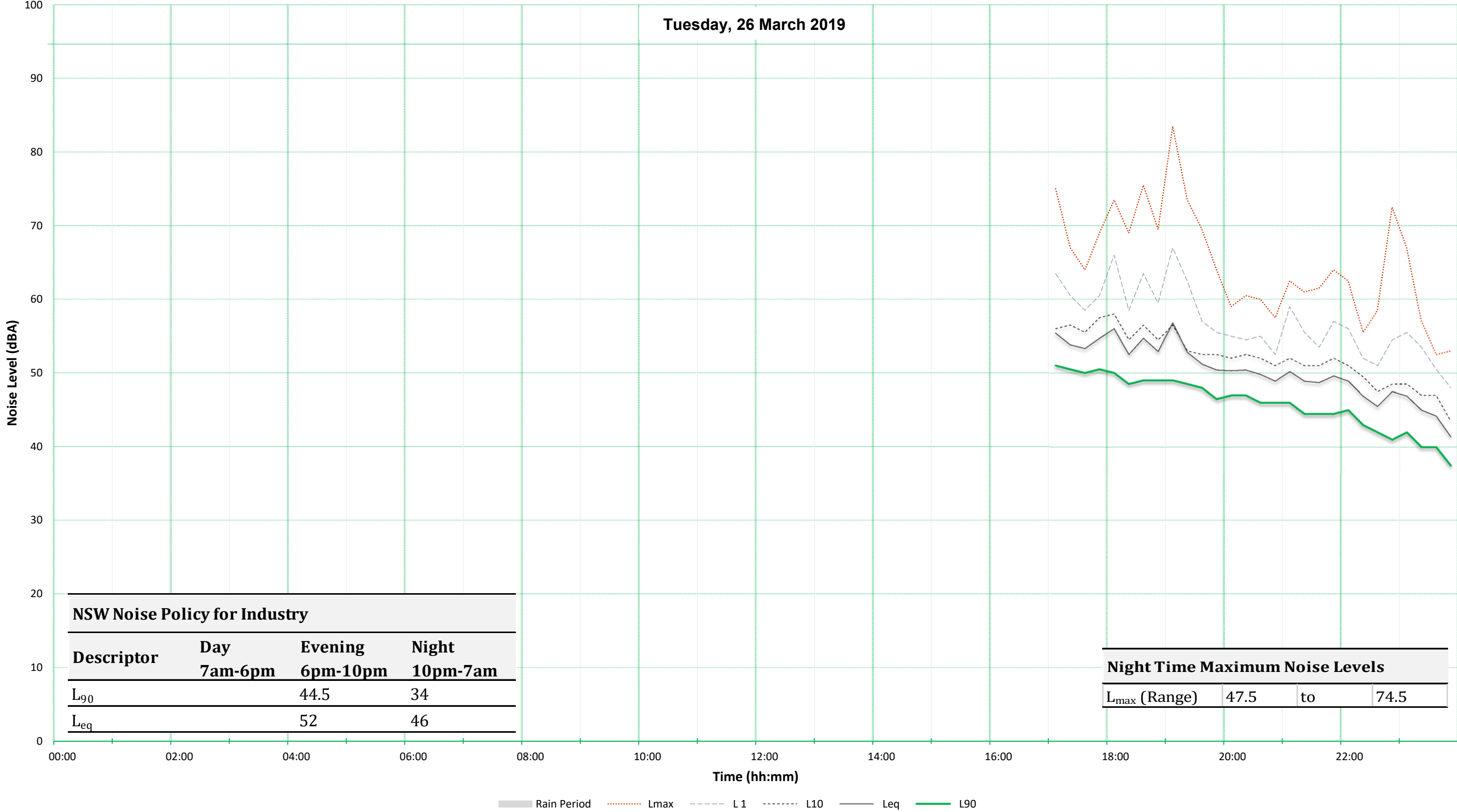


AMBIENT NOISE SURVEY

Located at Rear of 9 Gulliver Street, Brookvale, NSW



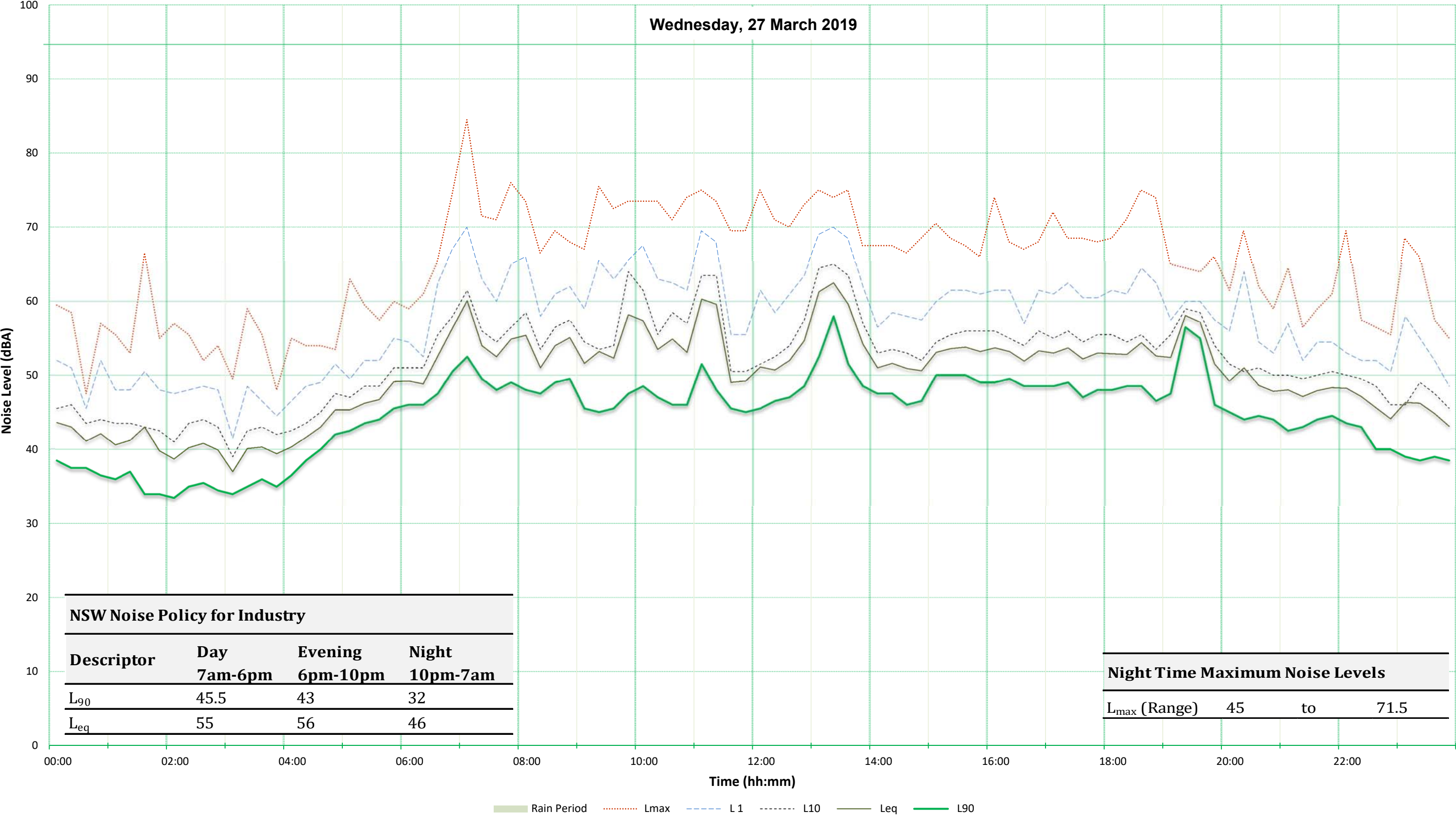
Located at Rear of 9 Gulliver Street, Brookvale, NSW



AMBIENT NOISE SURVEY

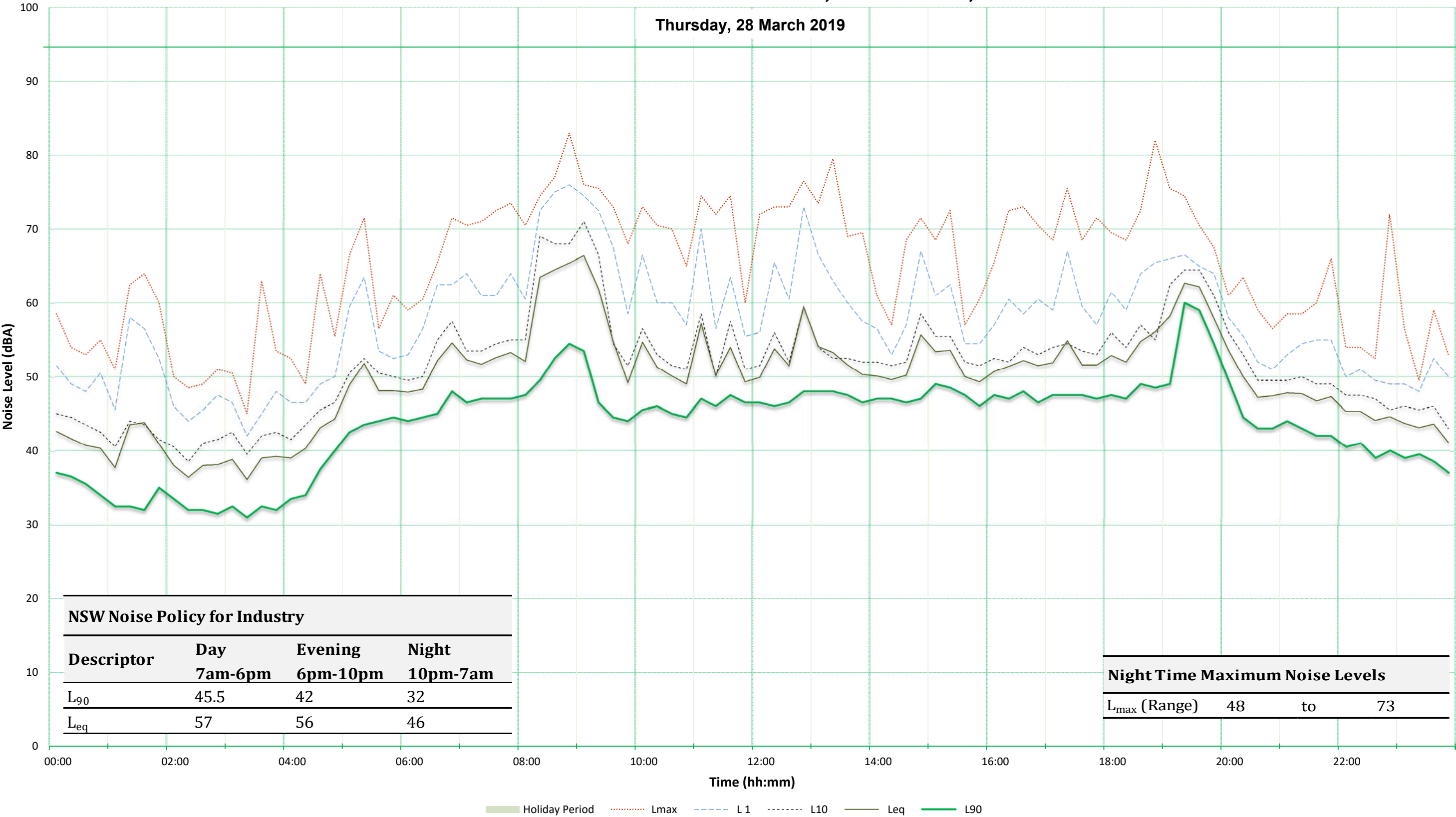
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Wednesday, 27 March 2019



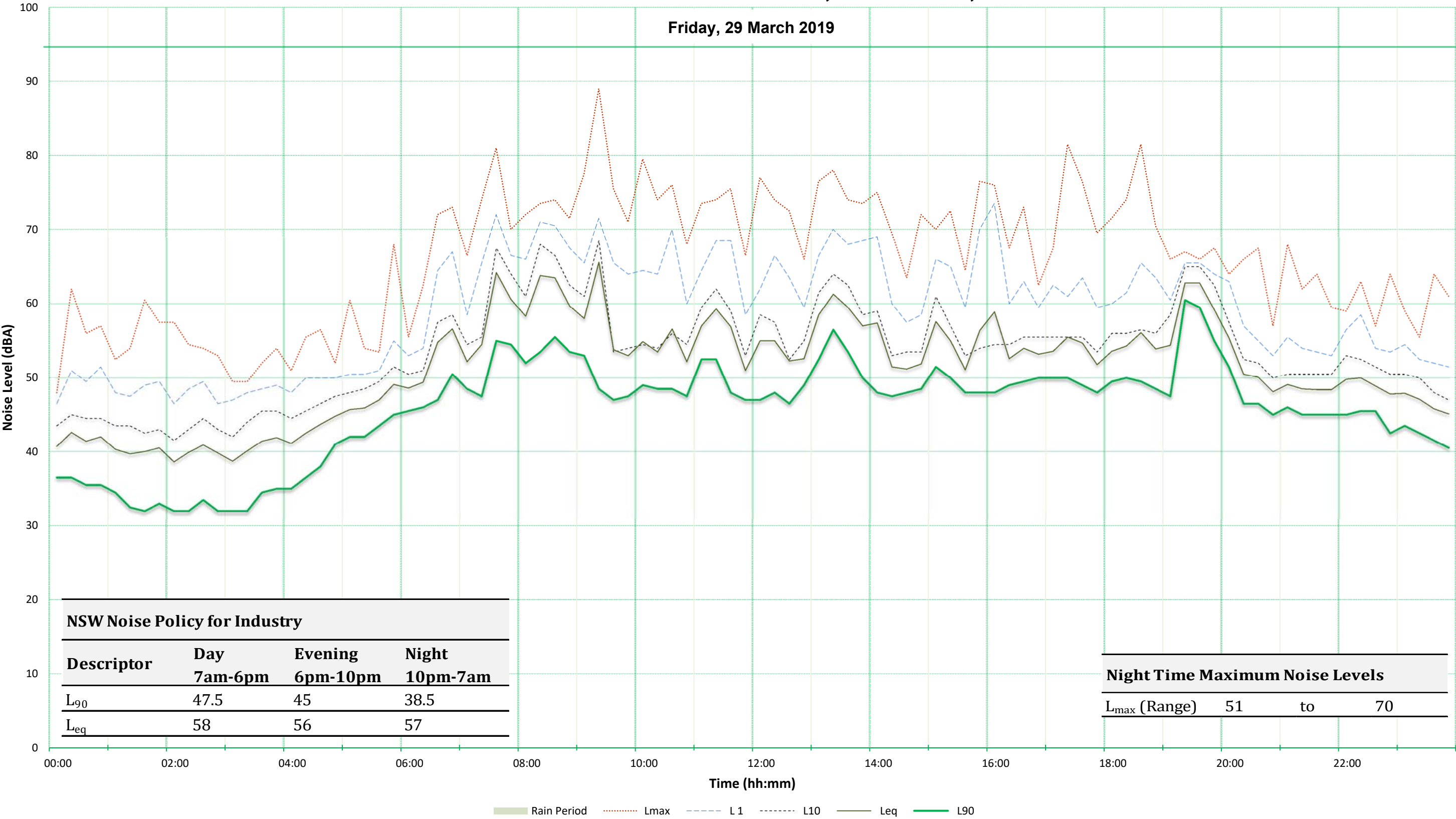
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Thursday, 28 March 2019



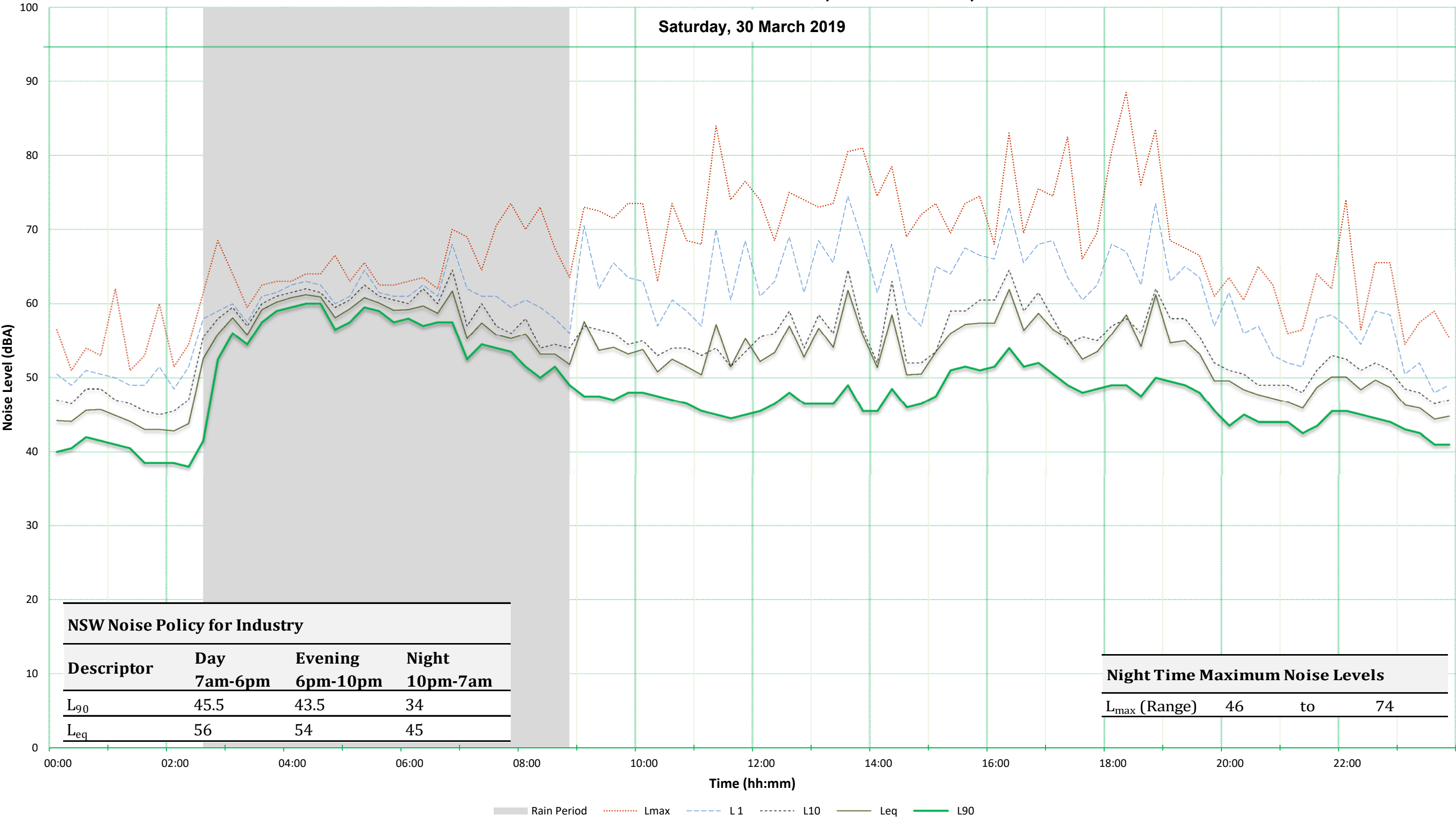
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Friday, 29 March 2019



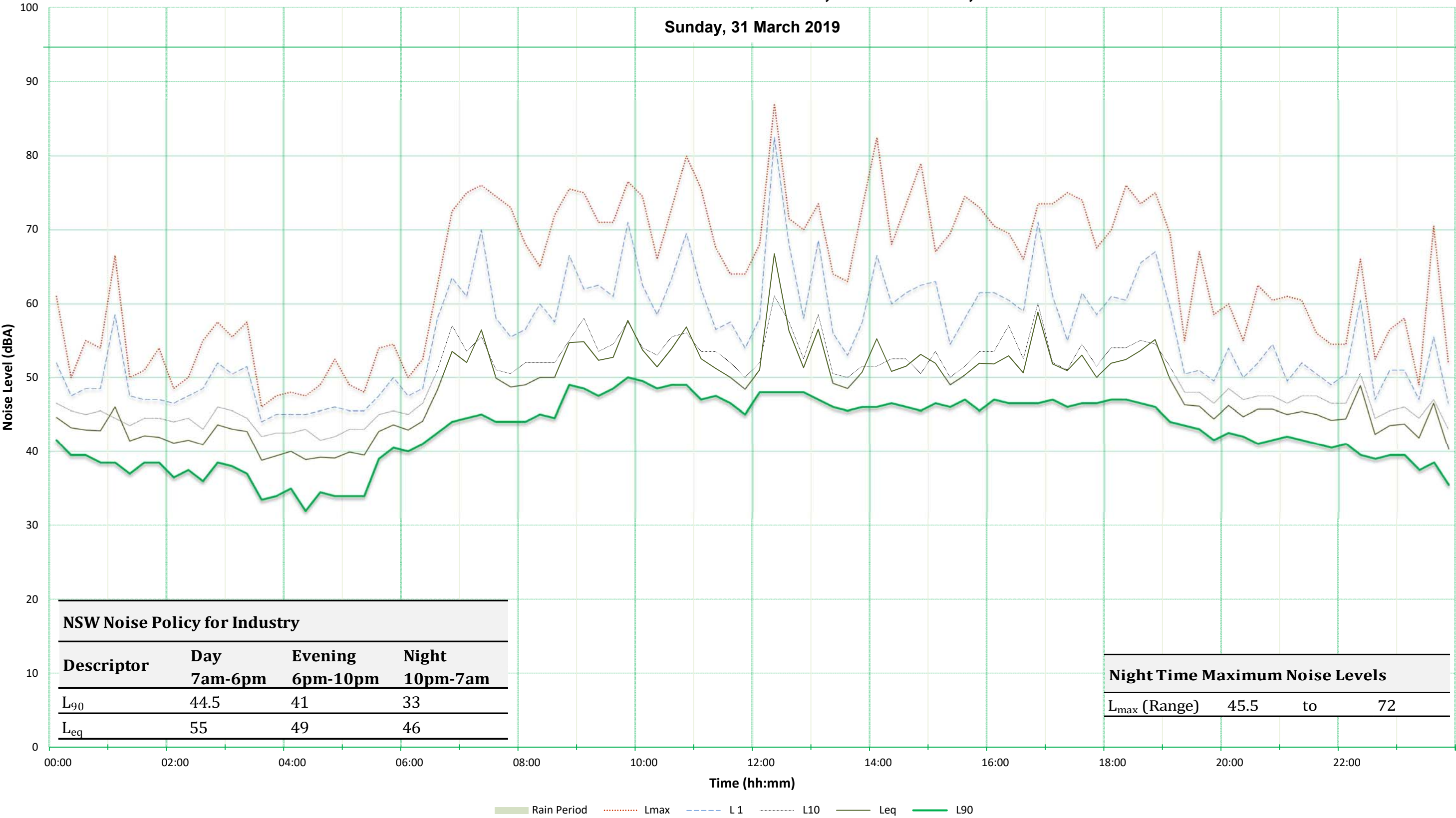
Located at Rear of 9 Gulliver Street, Brookvale, NSW

Saturday, 30 March 2019



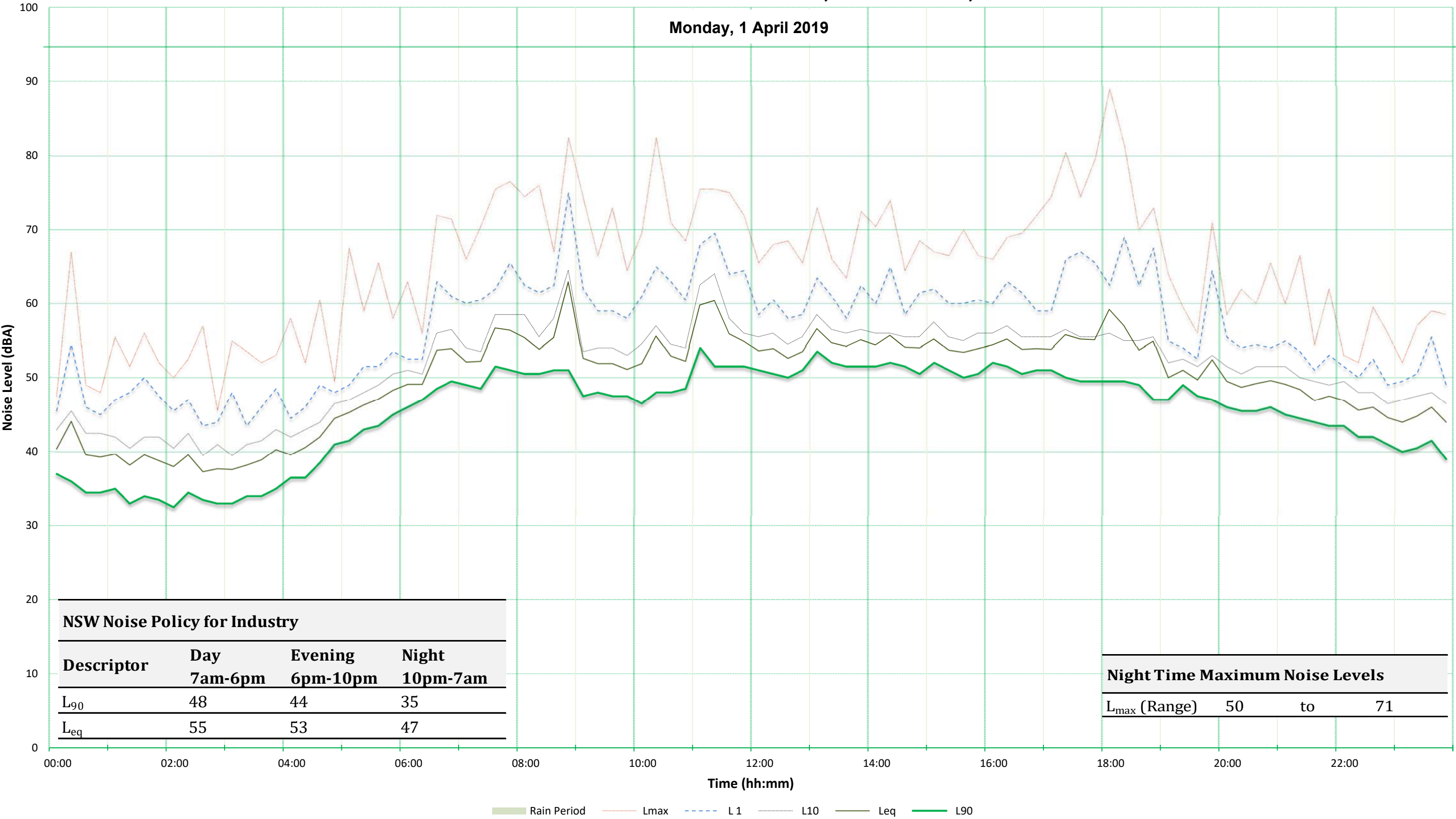
Located at Rear of 9 Gulliver Street, Brookvale, NSW

Sunday, 31 March 2019



Located at Rear of 9 Gulliver Street, Brookvale, NSW

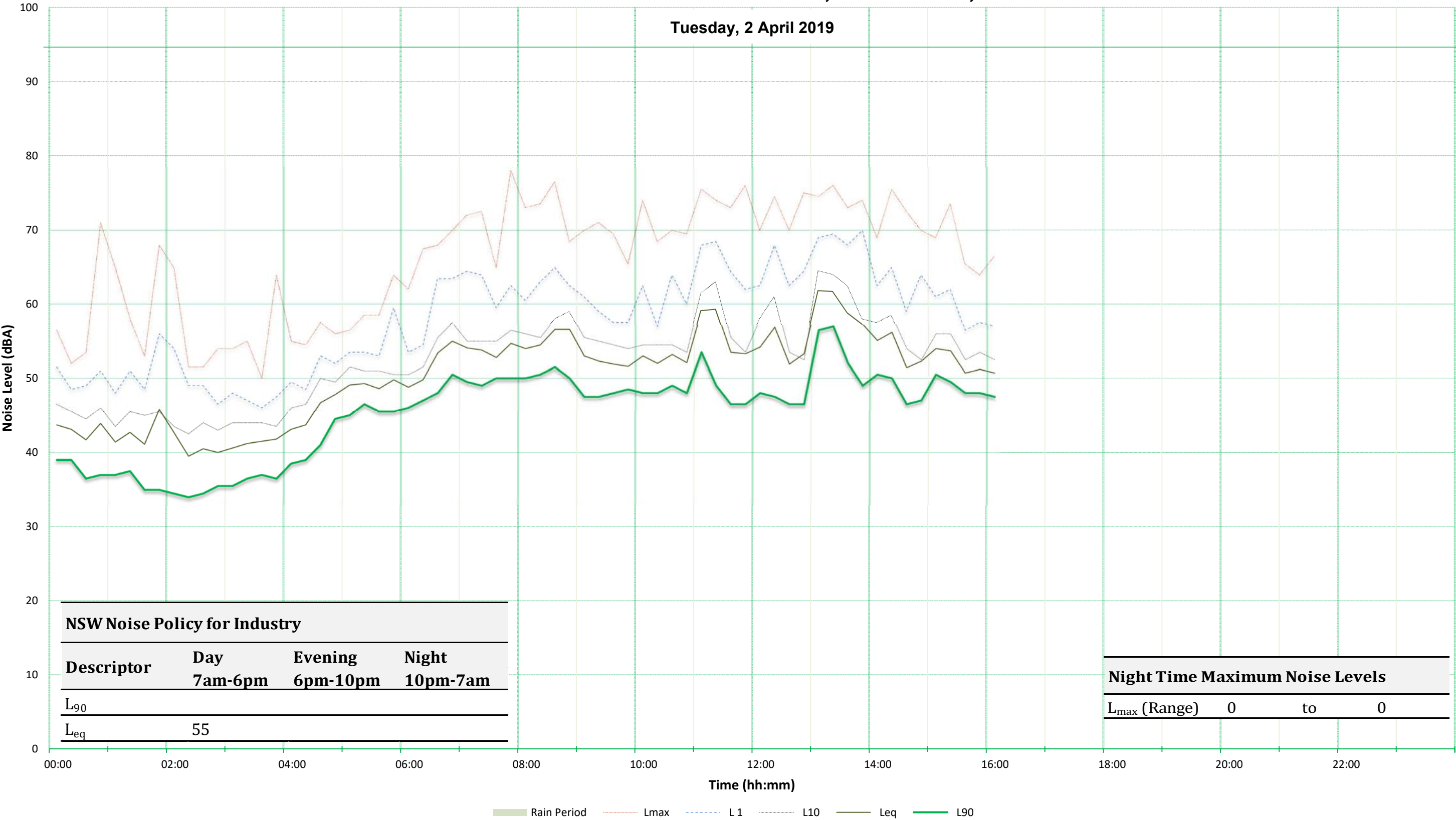
Monday, 1 April 2019



AMBIENT NOISE SURVEY

Located at Rear of 9 Gulliver Street, Brookvale, NSW

Tuesday, 2 April 2019



BROOKVALE PUBLIC SCHOOL

NEW HALL & REFURBISHMENT OF BLOCK B

OLD PITTWATER ROAD, BROOKVALE



LOCATION PLAN
NTS

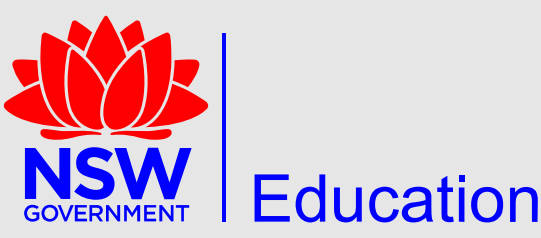


BROOKVALE PUBLIC SCHOOL SITE AREA
NTS

ARCHITECTURAL

DA01	COVER PAGE AND LOCATION PLAN
DA02	SITE ANALYSIS PLAN
DA03	SITE PLAN
DA04	DEMOLITION PLAN
DA05	FLOOR PLAN
DA06	ROOF PLAN & FINISHES SCHEDULE
DA07	ELEVATIONS
DA08	SECTIONS
DA09	CONSTRUCTION MANAGEMENT PLAN
DA10	SHADOW DIAGRAM
DA11	OPEN LANDSCAPED AREA STUDY
DA12	HALL REUSE PLAN

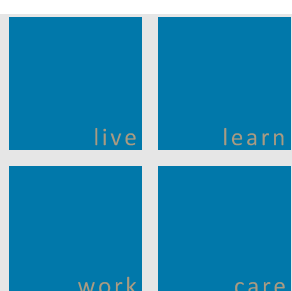
NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100



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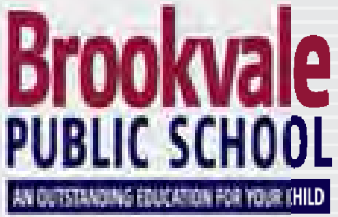
DRAWING LIST AND
LOCATION PLAN
DA01
DATE: April 2019 Job #: 18004



- LEGEND**
- EXISTING SITE CONDITIONS
 - EXISTING BUILDINGS
 - PROPOSED NEW BUILDING
 - CHANGE OF USE - SEE DA12 - HALL REUSE PLAN
 - LOT BOUNDARIES

1 SITE PLAN
1:500

NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100

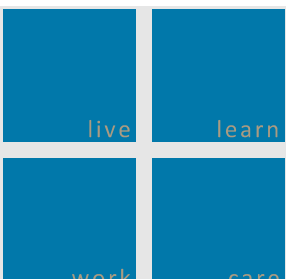


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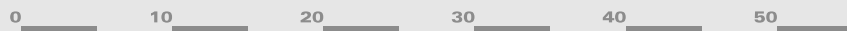


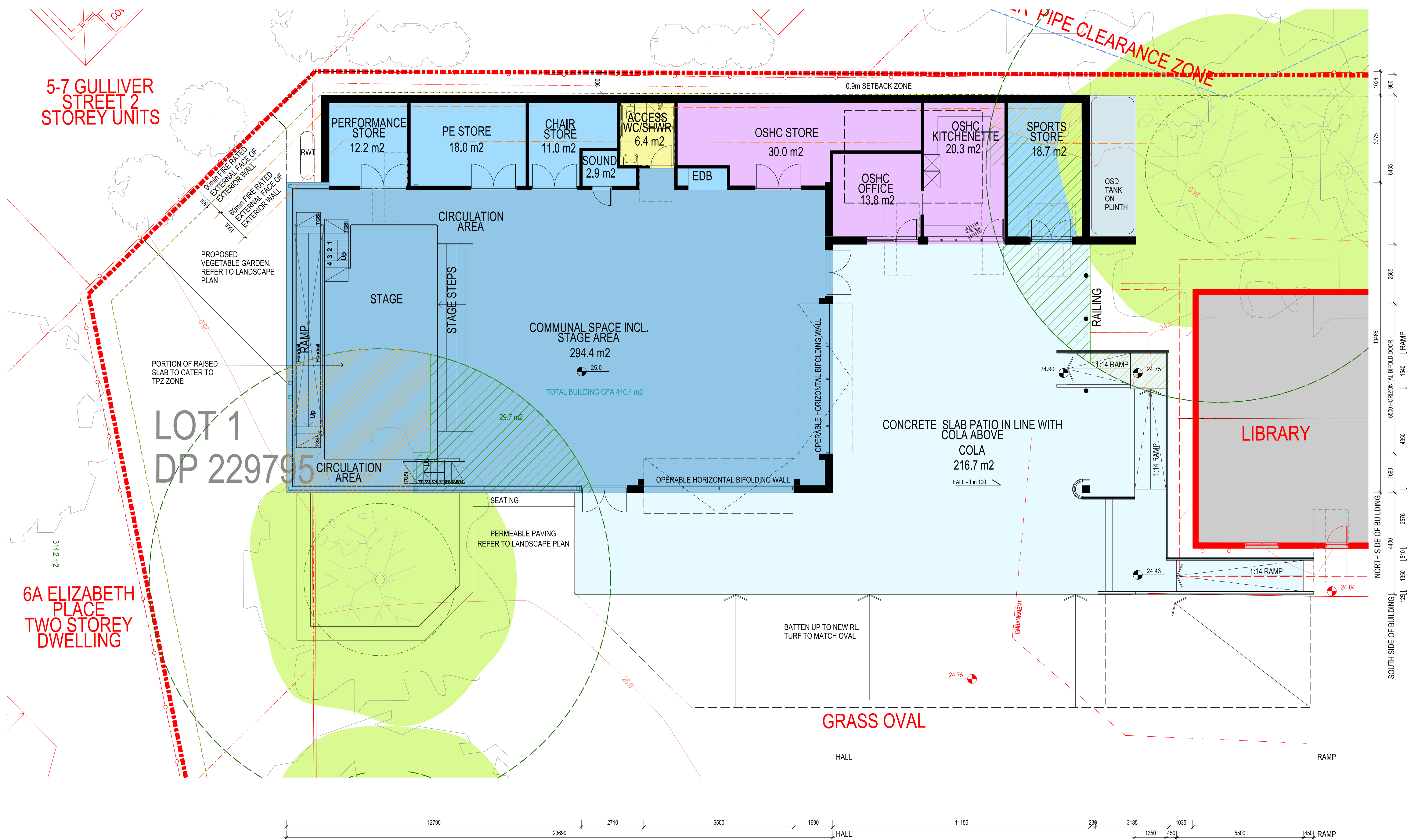
SITE PLAN

DA03

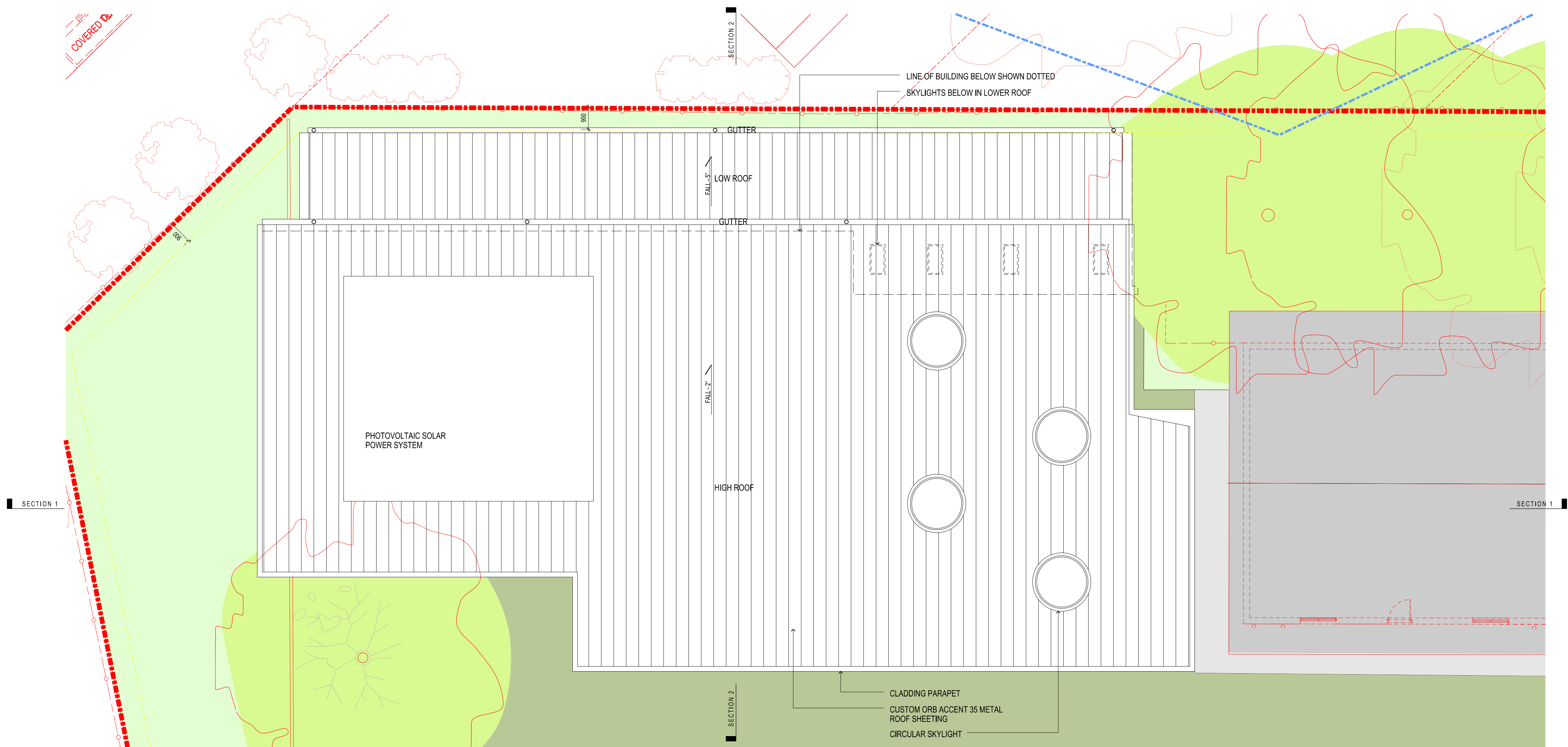
DATE: April 2019

Job #: 18004





1 GROUND FLOOR PLAN
1:100



1 ROOF PLAN
1:100

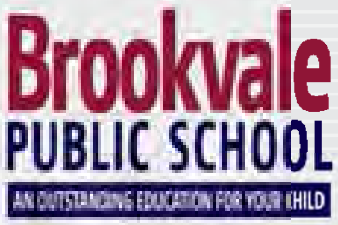
EXTERIOR SKETCH PERSPECTIVE



MATERIALS / COLOUR PALLETTE

1. WF1 COMPRESSES FIBRE CEMENT CLADDING - EQUITONE TECTIVA - TE20	2. WF2 COMPRESSES FIBRE CEMENT CLADDING - EQUITONE TECTIVA - TE10	3. WBP BRICK - WHITE/ CREAM	4. WS1 LYSAGHT PANEL RIB CLADDING - 'GULLY'	5. DULUX PAINT - TO DOORS AND EXTERIOR COLUMNS	6. DOOR/ WINDOW FRAMES	7. WF3 FEATURE COMPRESSED FIBRE CEMENT CLADDING - EQUITONE NATURA - N 359	8. FEATURE SIGNAGE ALUMINIUM
9. FOLDING GLAZED DOOR RENLITA - POWDER COATED	10. CUSTOM ORB ACCENT 35 METAL ROOF - LIGHT GREY	11. SK1 FEATURE SKYLIGHTS	12. SK2 SKYLIGHTS - VELUX	13. GLAZED LOUVRES			

NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100

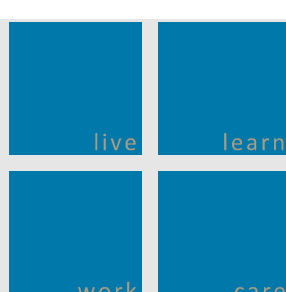


Education

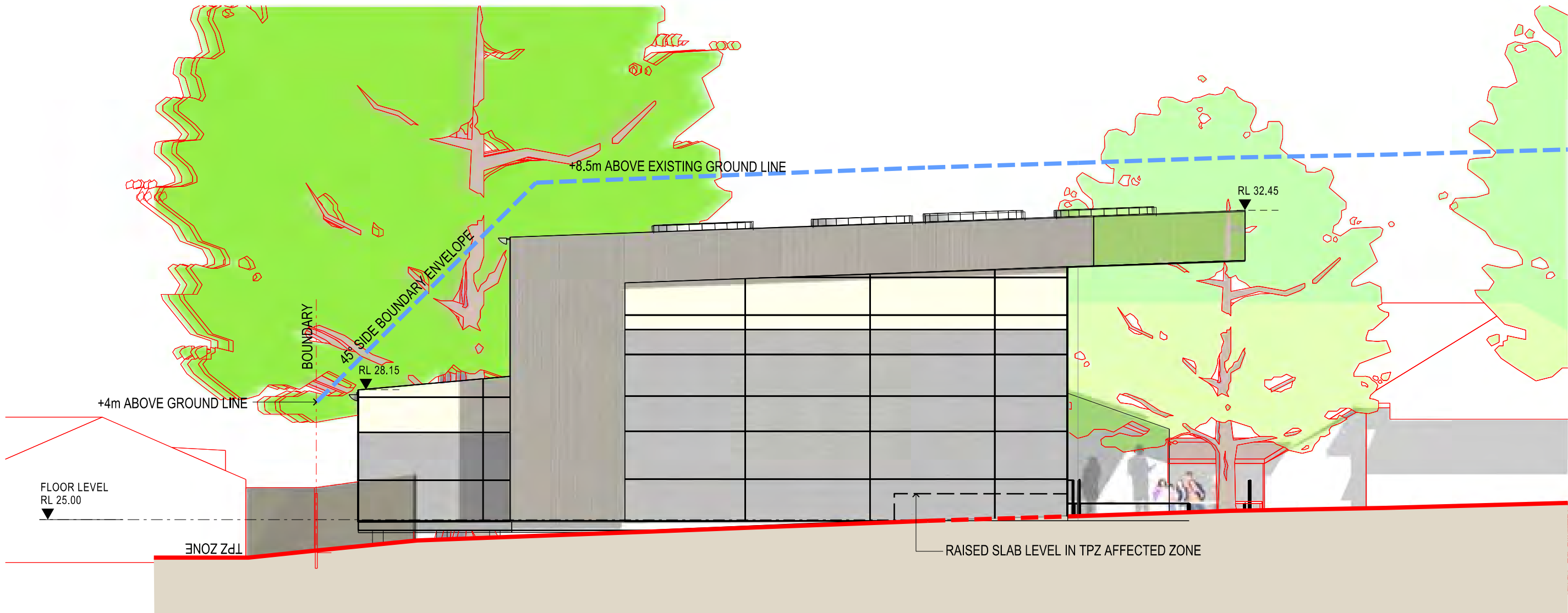
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ROOF PLAN AND FINISHES SCHEDULE
D A 0 6
DATE: April 2019 Job #: 18004



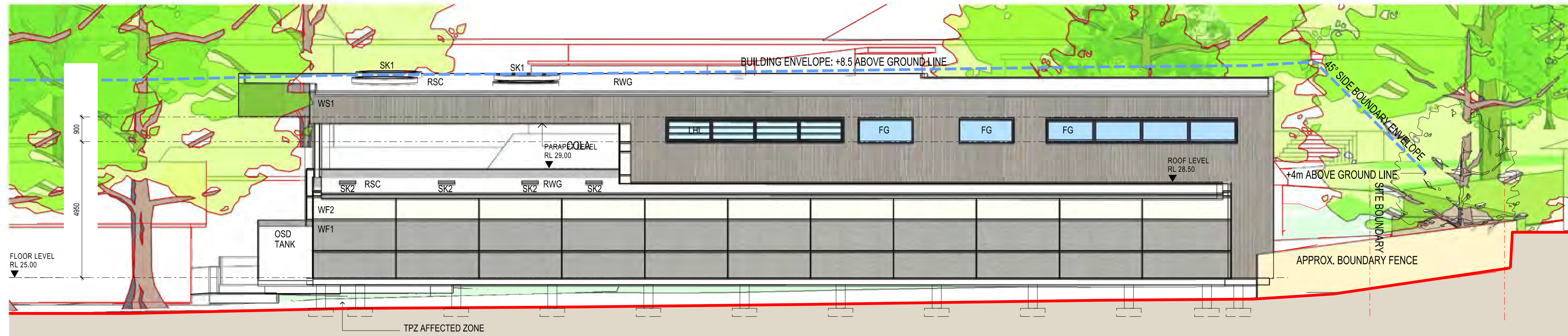
3 NORTH EAST ELEVATION
1:100



4 SOUTH EAST ELEVATION
1:100



2 NORTH WEST ELEVATION
1:100



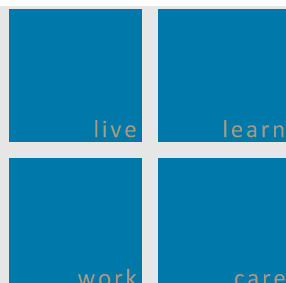
1 SOUTH EAST ELEVATION
1:100

NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100



Education

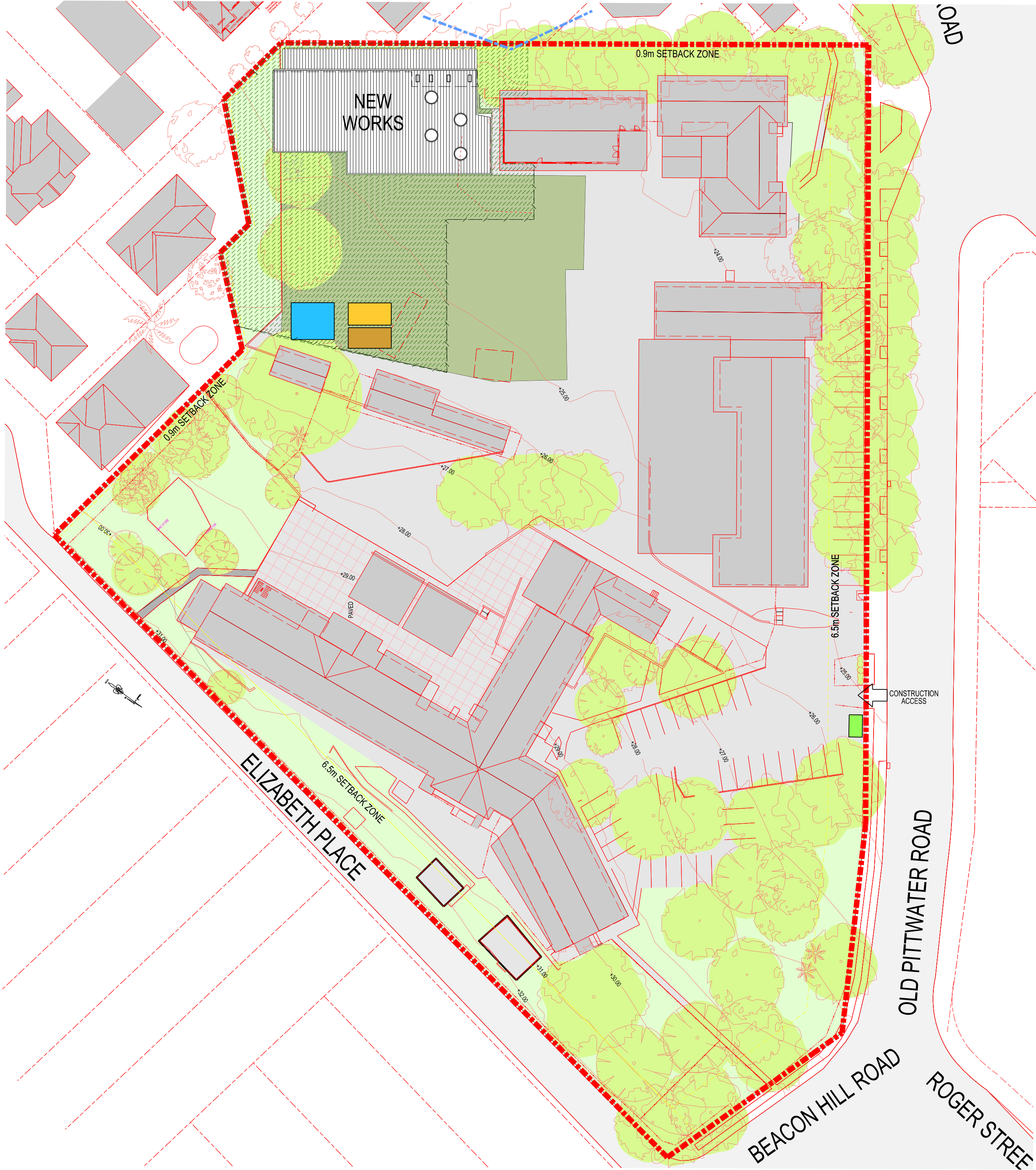
SARM | Architects



ELEVATIONS

D A 0 7

DATE: April 2019 Job #: 18004



To be read in conjunction with Site Management Plan

TREES

Existing trees in Construction zone to be retained and protected during works as per Arborist report, and Landscape Plan.

TRAFFIC MANAGEMENT

Refer to Construction Traffic Management Plan report for Construction Entrance details

1 CONSTRUCTION MANAGEMENT PLAN
1:500

LEGEND

- EXISTING WORKS
- NEW WORKS
- STORAGE PILE FOR RUBBISH - GENERAL WASTE
- STORAGE PILE FOR RUBBISH - RECYCLED
- STORAGE PILE FOR CONSTRUCTION MATERIALS
- CONSTRUCTION ZONE
- BUILDER'S FENCE
- EXISTING WASTE MANAGEMENT AREA

Section 1 - Demolition
This section must be completed in accordance with 'Chapter 1 - Demolition' of the Waste Management Guidelines

MATERIALS ON SITE	DESTINATION			
	Evidence such as weighbridge dockets and invoices for waste disposal or recycling must be retained on site for inspection			
	REUSE AND RECYCLING (MOST FAVOURABLE)		DISPOSAL (LEAST FAVOURABLE)	
Types of Waste Material	Estimated Volume (m³) or Weight (t)	ONSITE RE-USE ✓ Specify how material will be reused on site	OFFSITE RECYCLING ✓ Recycling Outlet (RO) ✓ Waste Transport Contractor (WTC)	OFFSITE DISPOSAL ✓ Specify landfill site (LS) ✓ Specify Waste Transport Contractor (WTC)
Excavated Material	N/A		WTC	RO
Garden Organics	3 mature trees			WTC
Bricks	10.6m³		*	LS
Tiles	N/A			
Concrete	25m³		*	
Timber	0.2t	Denailed and prepared for re-use		
Plasterboard	N/A			
Metals	0.5t		*	
Asbestos	N/A			
Other waste (please specify)	1.2t (ceramic tiles, plastics, PVC tubing)		*	
Estimated Total % Recovered				

* Approved landfill site by licensed contractor.

Waste management plan to be read in conjunction with DA 10/1 Construction management plan and Northern Beaches Waste Management Plan that meets with the requirements of Northern Beaches Waste Management Guidelines and Parts C8 & C9 of the Warringah DCP 2011

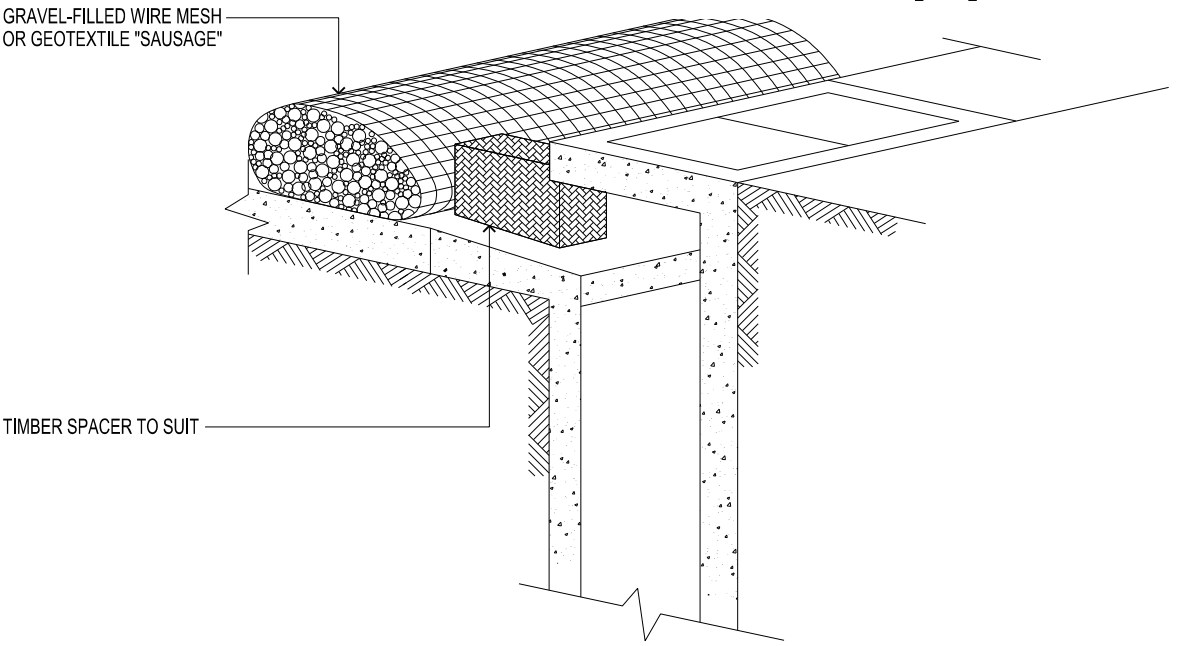
Construction Phase

All construction waste is unknown but is to be kept at a minimum. Disposal is to be to an approved landfill site by a licensed contractor. Hazardous waste will be suitably disposed in accordance with all Australian codes and standards.

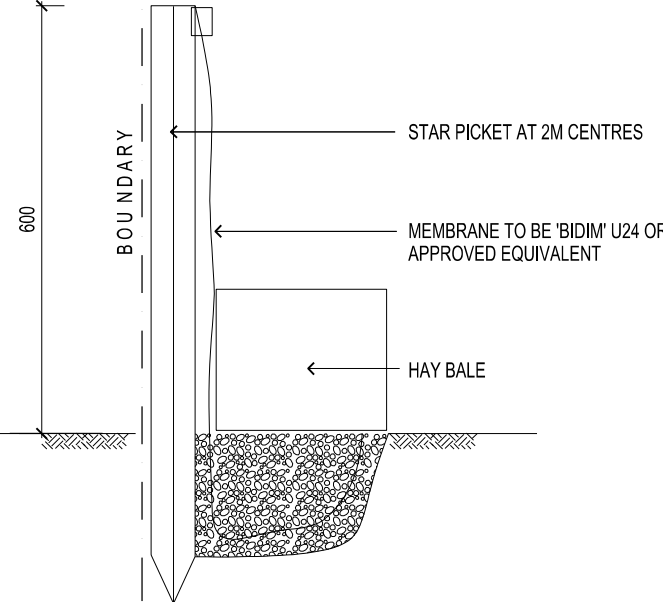
On-going (Operation) Phase

All waste will be stored and disposed in the same manner as present. The proposed development does not interfere with the present waste management procedures.

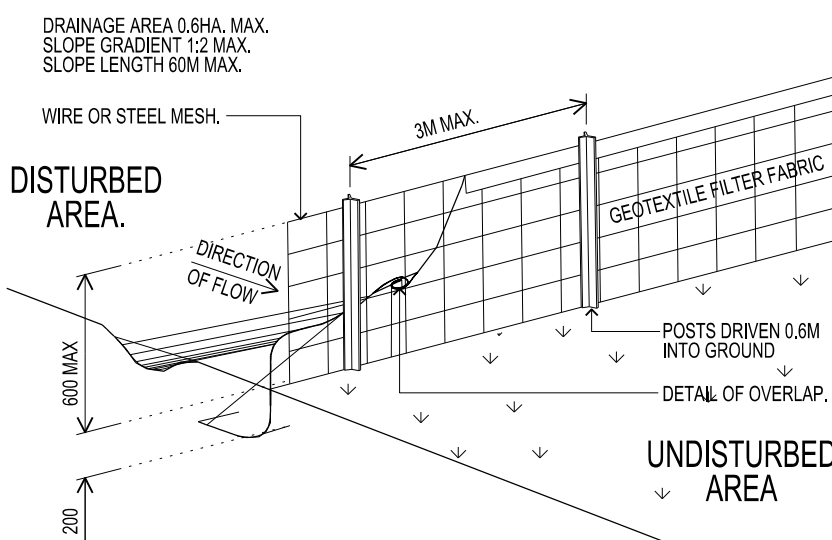
1 WASTE MANAGEMENT PLAN
-



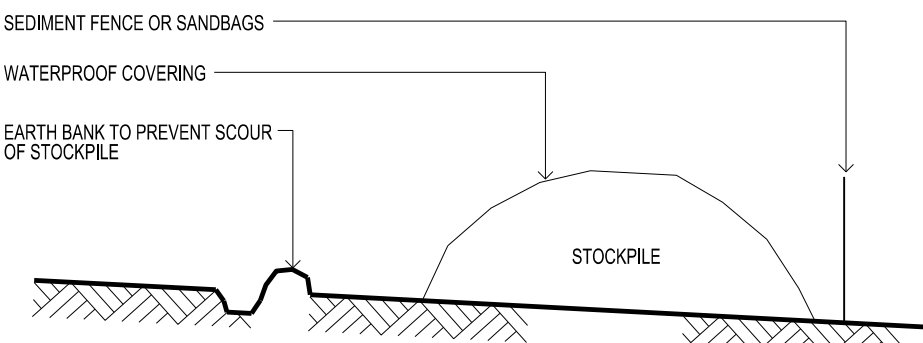
PORTABLE GRAVEL KERB INLET SEDIMENT TRAP
N.T.S.



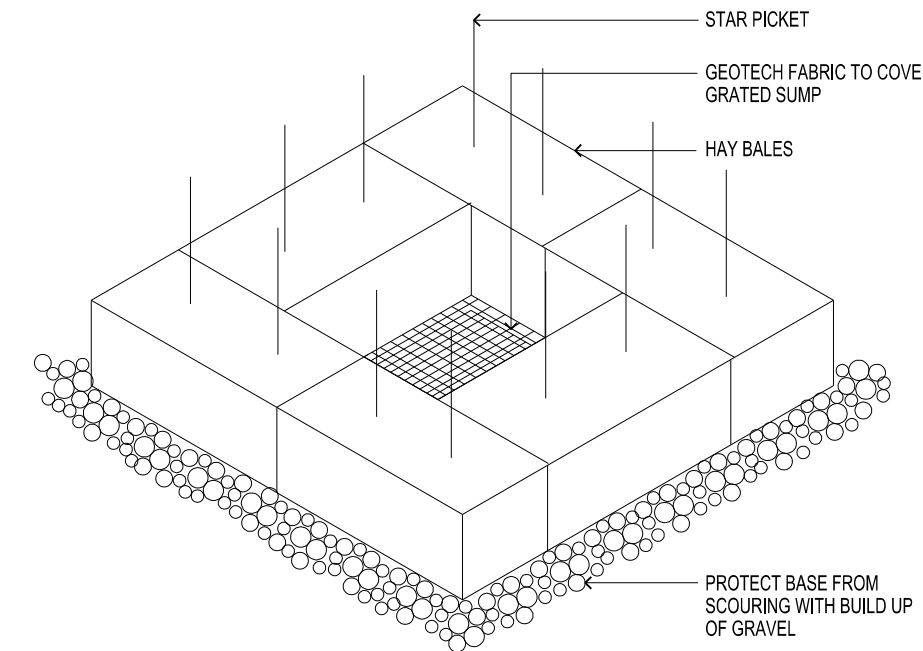
SILT FENCE DETAIL
N.T.S.



SEDIMENT FENCE
N.T.S.



MATERIALS STOCKPILE
N.T.S.



STORMWATER PIT INLET SEDIMENT TRAP
N.T.S.

1 EROSION AND SEDIMENT CONTROL MEASURES
-

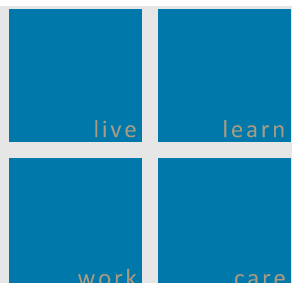
NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100



Education

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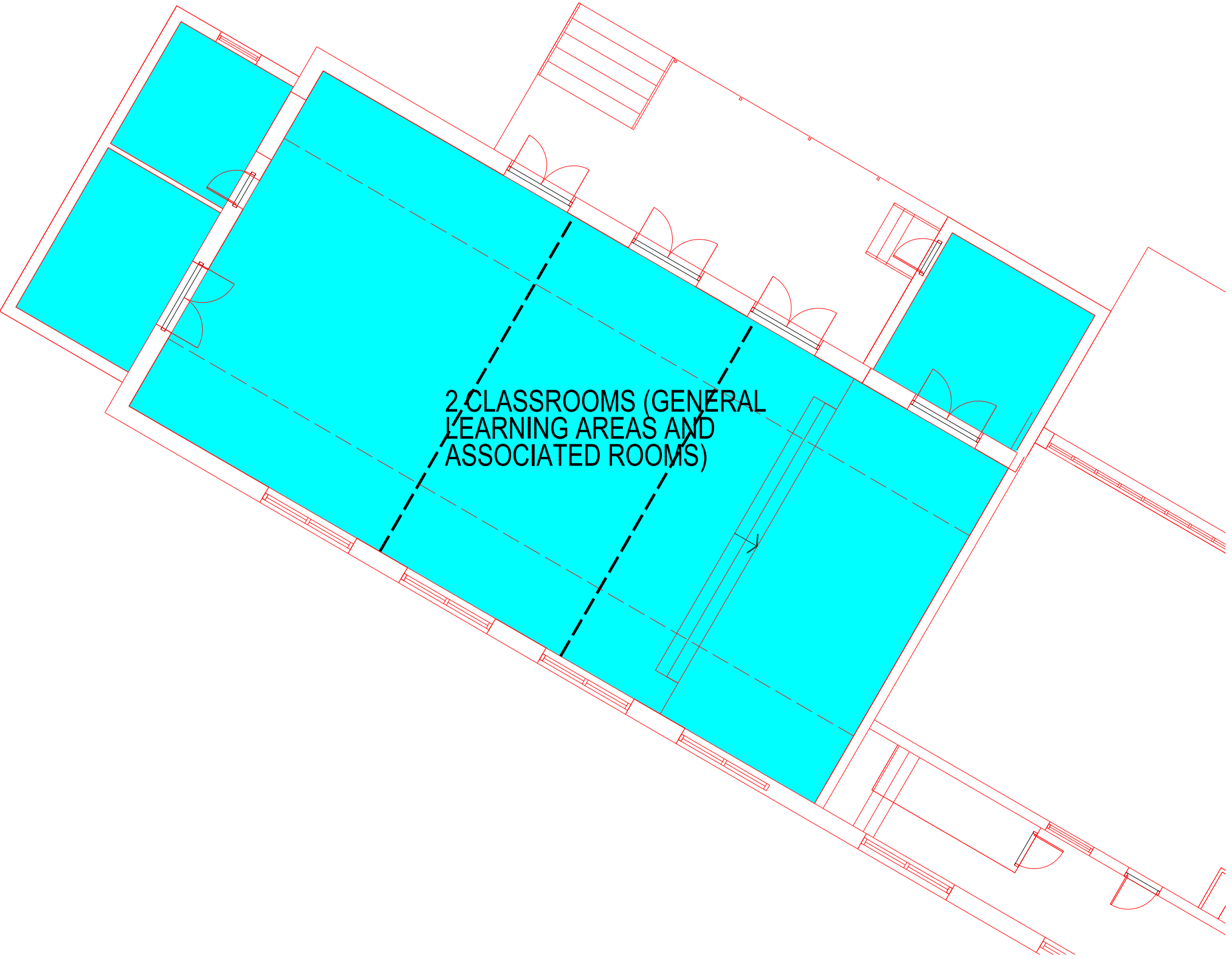
Architects



CONST. SOIL AND WATER MANAGEMENT PLAN
DA09
DATE: April 2019 Job #: 18004



1 HALL REUSE LOCATION PLAN
1:500



2 HALL REUSE FLOOR PLAN
1:100

LEGEND

LOCATION OF HALL TO BE CONVERTED TO TWO CLASSROOMS.
CHANGE OF USE

NEW CORE 21 HALL
BROOKVALE PUBLIC SCHOOL
Old Pittwater road, Brookvale, NSW, 2100

Brookvale
PUBLIC SCHOOL
AN OUTSTANDING EDUCATION FOR YOUR CHILD

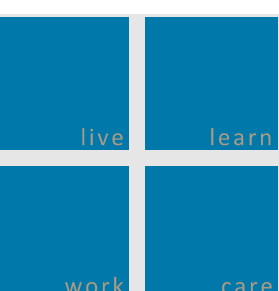


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HALL REUSE PLAN

D A 1 2

DATE: April 2019

Job #: 18004

0 1 2 3 4 5 6 7 8 9 10

ACOUSTICAL – Pertaining to the science of sound, including the generation, propagation, effects and control of both noise and vibration.

AMBIENT NOISE – The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including road traffic, factories, wind in the trees, birds, insects, animals, etc.

AUDIBLE – means that a sound can be heard. However, there are a wide range of audibility grades, varying from “barely audible” to “just audible”, “clearly audible” and “prominent”. Chapter 83 of the NSW Environment Protection Authority – Environmental Noise Control Manual (1985) states:

“noise from a particular source might be offensive if it is clearly audible, distinct from the prevailing background noise and of a volume or character that a reasonable person would be conscious of the intrusion and find it annoying or disruptive”.

It follows that the word “audible” in an environmental noise context means “clearly audible”.

BACKGROUND NOISE LEVEL – Silence does not exist in the natural or the built-environment, only varying degrees of noise. The Background Noise Level is the average minimum dBA level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by cicadas, lawnmowers, etc. It is quantified by the L_{A90} or the dBA noise level that is exceeded for 90 % of the measurement period (usually 15 minutes).

- **Assessment Background Level (ABL)** is the single figure background level representing each assessment period – day, evening and night (ie three assessment background levels are determined for each 24hr period of the monitoring period). Determination of the assessment background level is by calculating the tenth percentile (the lowest tenth percent value) of the background levels (L_{A90}) for each period (refer: NSW Industrial Noise Policy, 2000).
- **Rating Background Level (RBL)** as specified by the Environment Protection Authority is the overall single figure (L_{A90}) background noise level representing an assessment period (day, evening or night) over a monitoring period of (normally) three to seven days.

The RBL for an assessment period is the median of the daily lowest tenth percentile of L_{90} background noise levels.

If the measured background noise level is less than 30 dBA, then the Rating Background Level (RBL) is considered to be 30 dBA.

DECIBEL – The human ear has a vast sound-sensitivity range of over a thousand billion to one. The decibel is a logarithmic unit that allows this same range to be compressed into a somewhat more comprehensible range of 0 to 120 dB. The decibel is ten times the logarithm of the ratio of a sound level to a reference sound level. See also Sound Pressure Level and Sound Power Level.

Decibel noise levels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dBA, and another similar machine is placed beside it, the level will increase to 53 dBA, not 100 dBA. Ten similar machines placed side by side increase the sound level by 10 dBA, and one hundred machines increase the sound level by 20 dBA.

dBA – The human ear is less sensitive to low frequency sound than high frequency sound. We are most sensitive to high frequency sounds, such as a child’s scream. Sound level meters have an inbuilt weighting network, termed the dBA scale, that approximates the human loudness response at quiet sound levels (roughly approximates the 40 phon equal loudness contour).



However, the dBA sound level provides a poor indication of loudness for sounds that are dominated by low frequency components (below 250 Hz). If the difference between the “C” weighted and the “A” weighted sound level is 15 dB or more, then the NSW Industrial Noise Policy recommends a 5 dBA penalty be applied to the measured dBA level.

dbc – The dbc scale of a sound level meter is similar to the dBA scale defined above, except that at high sound intensity levels, the human ear frequency response is more linear. The dbc scale approximates the 100 phon equal loudness contour.

EQUIVALENT CONTINUOUS NOISE LEVEL, L_{Aeq} – Many noises, such as road traffic or construction noise, vary continually in level over a period of time. More sophisticated sound level meters have an integrating electronic device inbuilt, which average the A weighted sound pressure levels over a period of time and then display the energy average or L_{Aeq} sound level. Because the decibel scale is a logarithmic ratio the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closely to the L_{Aeq} noise level.

FREE FIELD – This is a sound field not subject to significant reflection of acoustical energy. A free field over a reflecting plane is usually outdoors with the noise source resting on hard flat ground, and not closer than 6 metres to any large flat object such as a fence or wall; or inside an anechoic chamber.

FREQUENCY – The number of oscillations or cycles of a wave motion per unit time, the SI unit being the Hertz, or one cycle per second.

IMPACT ISOLATION CLASS (IIC) – The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation.

IMPACT SOUND INSULATION ($L_{nT,w}$) – Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE – An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

INTRUSIVE NOISE LEVEL, L_{Aeq} – The level of noise from a factory, place of entertainment, etc. in NSW is assessed on the basis of the average maximum noise level, or the L_{Aeq} (15 min). This is the energy average A weighted noise level measured over any 15 minute period.

LOUDNESS – The degree to which a sound is audible to a listener is termed the loudness. The human ear perceives a 10 dBA noise level increase as a doubling of loudness and a 20 dBA noise increase as a quadrupling of the loudness.



MAXIMUM NOISE LEVEL, L_{Amax} – The rms maximum sound pressure level measured on the "A" scale of a sound level meter during a noise survey is the L_{Amax} noise level. It may be measured using either the Fast or Slow response time of the meter. This should be stated.

NOISE RATING NUMBERS – A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the dBA level minus five.

NOISE – Noise is unwanted sound. Sound is wave motion within matter, be it gaseous, liquid or solid. "Noise includes sound and vibration".

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient".

OFFENSIVE NOISE - (Reference: Dictionary of the Protection of the Environment Operations Act 1997). *"Offensive Noise means noise:*

- (a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
 - (i) *is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or*
 - (ii) *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
- (b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."*

PINK NOISE – Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T_{60} – The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60} . The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT, α – α Sound is absorbed in porous materials by the viscous conversion of sound energy to heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α . An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2000 Hz is termed the Noise Reduction Coefficient (NRC).

SOUND ATTENUATION – If an enclosure is placed around a machine, or a silencer is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 30 dBA, reduces the sound energy by one thousand times.

SOUND EXPOSURE LEVEL (SEL) – The total sound energy of a single noise event condensed into a one second duration or in other words it is an L_{eq} (1 sec).



SOUND PRESSURE LEVEL, L_p – The level of sound measured on a sound level meter and expressed in decibels, dB, dBA, dBC, etc. $L_p = 20 \times \log (P/P_0) \dots \text{dB}$

where P is the rms sound pressure in Pascal and P_0 is a reference sound pressure of 20 μPa .
 L_p varies with distance from a noise source.

SOUND POWER LEVEL, L_w – The Sound Power Level of a noise source is an absolute that does not vary with distance or with a different acoustic environment.

$$L_w = L_p + 10 \log A \dots \text{dB, re: } 1\text{pW,}$$

where A is the measurement noise-emission area in square metres in a free field.

SOUND TRANSMISSION CLASS (STC) – An internationally standardised method of rating the sound transmission loss of partition walls to indicate the decibels of noise reduction of a human voice from one side to the other. (Refer: Australian Standard AS1276 – 1979)

SOUND TRANSMISSION LOSS – The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL EXCEEDENCE SOUND LEVELS, L_{A90} , L_{A10} , L_{A1} , etc – Noise which varies in level over a specific period of time (usually 15 minutes) may be quantified in terms of various statistical descriptors:

The L_{A90} is the dBA level exceeded for 90 % of the time. In NSW the L_{A90} is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

The L_{A10} is the dBA level that is exceeded for 10 % of the time. In NSW the L_{A10} measured over a period of 10 to 15 minutes. It was until recently used to describe the average maximum noise level, but has largely been replaced by the L_{Aeq} for describing level-varying noise.

The L_{A1} is the dBA level that is exceeded for 1 % of the time. In NSW the L_{A1} may be used for describing short-term noise levels such as could cause sleep arousal during the night.

STEADY NOISE – Noise, which varies in level by 6 dBA or less, over the period of interest with the time-weighting set to “Fast”, is considered to be “steady”. (Refer AS 1055.1 1997)

WEIGHTED SOUND REDUCTION INDEX, R_w – This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 to 3,150 Hertz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999).

Internal partition wall $R_w + C$ ratings are frequency weighted to simulate insulation from human voice noise. The $R_w + C$ is always similar in value to the STC rating value. External walls, doors and windows may be $R_w + C_{tr}$ rated to simulate insulation from road traffic noise. This is normally a lower number than the STC rating value.

WHITE NOISE – White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.



NSW NOISE POLICY FOR INDUSTRY MODIFYING FACTOR CORRECTIONS

AC500-10

Table C.1 **Modifying factor corrections**
(See definitions in Section C2)

Factor	Assessment/ Measurement	When to apply	Correction ¹	Comments
Tonal noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (<i>ISO1996.2-2007 – Annex D</i>).	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: <ul style="list-style-type: none"> • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz. 	5 dB ^{2,3}	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. Note: Narrow-band analysis using the reference method in <i>ISO1996-2:2007, Annex C</i> may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted Leq,T levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and: <ul style="list-style-type: none"> • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2 dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2dB(A) positive adjustment applies for the daytime period. 	2 or 5 dB ²	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.



Table C.1 **Modifying factor corrections – continued**

Factor	Assessment/ Measurement	When to apply	Correction ¹	Comments
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for night-time only
Duration	Single-event noise duration may range from 1.5 min to 2.5 h.	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum Adjustment	Refer to individual modifying factors.	Where two or more modifying factors are indicated.	Maximum correction of 10 dB(A) ² (excluding duration correction).	

Notes:

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.
2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

