NSW GOVERNMENT

Transport Access Program

Stanmore Station Upgrade

Noise and Vibration Impact Assessment

Artist s impression of the proposed Stanmore Station Upgrade, subject to detailed design

January 2022

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Transport for NSW

Stanmore Station Upgrade

Environmental Noise and Vibration Assessment

wsp

JANUARY 2022

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Stanmore Station Upgrade
Environmental Noise and Vibration Assessment

Transport for NSW

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
FINAL	14/01/2022	Final report for exhibition

	NAME	DATE	SIGNATURE
Prepared by:	Neil Macabenta	14/01/2022	
Reviewed by:	Rebecca Warren	14/01/2022	
Approved by:	Rebecca Warren	14/01/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Glossary

Term	Meaning
Concept design	The concept design is the preliminary design presented in this REF, which would be refined by the Contractor (should the Proposal proceed) to a design suitable for construction (subject to Transport for NSW acceptance).
Detailed design	Detailed design broadly refers to the process that the Contractor undertakes (should the Proposal proceed) to refine the concept design to a design suitable for construction (subject to Transport for NSW acceptance).
Disability Standards for Accessible Public Transport	The Commonwealth *Disability Standards for Accessible Public Transport 2002* ('Transport Standards') (as amended) are a set of legally enforceable standards, authorised under the Commonwealth *Disability Discrimination Act 1992* (DDA) for the purpose of removing discrimination 'as far as possible' against people with disabilities. The Transport Standards cover premises, infrastructure and conveyances, and apply to public transport operators and premises providers.
Feasible	A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.
Interchange	Transport interchange refers to the area/s where passengers transit between vehicles or between transport modes. It includes the pedestrian pathways and cycle facilities in and around an interchange.
Noise sensitive receiver	In addition to residential dwellings, noise sensitive receivers include, but are not limited to, hotels, entertainment venues, pre-schools and day care facilities, educational institutions (e.g. schools, TAFE colleges), health care facilities (e.g. nursing homes, hospitals), recording studios and places of worship/religious facilities (e.g. churches).
NSW Trains	From 1 July 2013, NSW Trains became the new rail provider of services for regional rail customers.
Opal card	The integrated ticketing smartcard being introduced by Transport for NSW.
Out of hours work	Defined as work *outside* standard construction hours (i.e. outside of 7am to 6pm Monday to Friday, 8am to 1pm Saturday and no work on Sundays/public holidays).
Proponent	A person or body proposing to carry out an activity under Division 5.1 of the EP&A Act - in this instance, Transport for NSW.
Rail shutdown	Rail shutdown is the term used by railway building/maintenance contractors to indicate that they have taken possession of the track (usually a block of track) for a specified period, so that no trains operate for a specified time. This is necessary to ensure the safety of workers and rail users.

Term	Meaning
Reasonable	Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.
Sensitive receivers	Land uses which are sensitive to potential noise, air and visual impacts, such as residential dwellings, schools and hospitals.
Sydney Trains	From 1 July 2013, Sydney Trains replaced CityRail as the provider of metropolitan train services for Sydney.
TAHE	The Transport Asset Holding Company is a statutory State Owned Corporation that holds rail property assets, rolling stock and rail infrastructure in the Sydney metropolitan area and limited country locations in the State of NSW
Tactiles	Tactile tiles or Tactile Ground Surface Indicators (TGSIs) are textured ground surface indicators to assist pedestrians who are blind or visually impaired. They are found on many footpaths, stairs and train station platforms.
The Proposal	The construction and operation of the Stanmore Station Upgrade.

Abbreviations

Term	Meaning
CCTV	Closed Circuit TV
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise and Vibration Management Plan
DP&E	NSW Department of Planning and Environment
DPIE	NSW Department of Planning, Industry and Environment
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000* (NSW)
Heritage Act	*Heritage Act 1977* (NSW)
ICNG	*Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2000).
LGA	Local Government Area
NSW	New South Wales
OOHW	Out of hours work
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
RBL	Rating Background Level
REF	Review of Environmental Factors (this document)
Roads and Maritime	NSW Roads and Maritime Services (formerly Roads and Traffic Authority)
SHR	State Heritage Register
TCP	Traffic Control Plan
TGSI	Tactile Ground Surface Indicators (‘tactiles’)
TMP	Traffic Management Plan

Executive Summary

WSP Australia Pty Ltd (WSP) has been engaged by Transport for NSW (TfNSW) to undertake a noise and vibration impact assessment for the proposed Stanmore Station upgrade ('the Proposal'). This upgrade forms part of the Transport Access Program (TAP), and consistent with previous assessments, it has been conducted with reference to the *Construction Noise and Vibration Strategy DMS-ST-157* (CNVS) (TfNSW, 2019) and the NSW *Noise Policy for Industry* (NPfI) (EPA, 2017).

The Proposal is intended to improve accessibility and amenities for customers and includes new lifts, reconfiguration of bathrooms and upgrades of existing stairs, platforms, a new DDA parking space and kiss and ride bay. The potential for construction noise and vibration impacts to occur was assessed in line with the CNVS (TfNSW, 2019) and the NPfI (EPA, 2017) was used to assess operational noise.

Sensitive receivers for both noise and vibration were identified in the area surrounding the Proposal and were segregated into two Noise Catchment Areas (NCAs) – separated to the north and south of the exiting rail line – based on the similar noise environments within these areas. Based on the existing environment, potential sensitive receivers for both noise and vibration have been categorised as either residential, commercial or educational.

A site survey was carried out to establish the existing background noise levels in the areas surrounding Stanmore Station using two unattended noise monitors. The background noise levels were used to derive the project specific noise criteria for all receivers.

A total of six worst-case construction activities were assessed, with all works being undertaken during standard construction working hours, and some scenarios requiring works to also be undertaken during up to six 48-hour rail shutdowns. The total duration of work is expected to be up to 18 months.

The assessment of construction noise impacts indicates that noise levels are predicted to exceed relevant Noise Management Levels (NMLs) at the nearest sensitive receivers in both NCAs during all activities, with Scenarios SC02 (lift works), SC03 (parking modification works), SC04 (station building works) and SC05 (platform modification works) presenting the greatest impact to sensitive receivers. It is noted that a number of the scenarios incorporate plant with annoying acoustic characteristics, which have resulted in the application of a noise penalty. This includes plant such as concrete saws and chainsaws, which are expected to be used infrequently and over very short periods over the construction period. It is highly unlikely that these items of equipment would be fully utilised during works or would be used throughout out of hours periods or night time periods. When these items of equipment are not used, noise levels would be notably lower at all identified receivers.

Within NCA01, the worst case construction noise levels are predicted to exceed the NML by up to 42 dBA to 49 dBA. The closest residences to the construction works are predicted to be highly noise affected when works occur at the closest distance to the sensitive receivers. Generally the receivers would be highly noise affected for very short periods (up to or less than a day) as it is not anticipated that the works would be located at the closest distance to the receivers throughout the proposed works. As the works move further away from the receivers, they would no longer be highly noise affected. Within NCA02, worst case construction noise levels are predicted to exceed the NML by up to 21 dBA to 38 dBA during each scenario. The closest residences to the construction works are predicted to be highly noise affected when works occur at the closest distance to the sensitive receivers. Generally the receivers would be highly noise affected for very short periods (up to or less than a day) as it is not anticipated that the works would be located at the closest distance to the receivers throughout the proposed works. As the works move further away from the receivers, they would no longer be highly noise affected. Construction noise levels are predicted to exceed relevant NMLs for the commercial (C1 to C3) and educational receivers (E1 and E2) located near the Proposal.

Out of hours works (OOHW) are proposed during three construction scenarios, including during rail shutdowns. Up to six rail shutdowns are expected to occur over the duration of the Proposal (i.e. up to around 18 months). Other works may also be required to occur outside of standard hours which are not part of rail shutdowns, however it is expected that the majority of OOHW would be limited to these six periods, and night works are expected to be limited. The assessment

of OOHW construction noise impacts at residential receivers indicates that noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all out of hours activities.

During OOHW period 1, noise levels are predicted to result in exceedances of the OOHW criteria by up to 54 dBA at receivers in NCA01 and 49 dBA in NCA02. During OOHW period 2, noise levels are predicted to result in exceedances of the OOHW criteria by up to 58 dBA at receivers in NCA01 and 51 dBA in NCA02.

Any night time works are likely to generate sleep disturbance impacts at residential receivers adjacent to the construction footprints (however these are expected to be minimal). Noise management and mitigation measures would be required to manage OOHW.

Proposal-related construction traffic noise impacts are expected to comply with the road noise criteria during the daytime period, however impacts would be noticeable on local roads during night time periods. It is recommended that heavy vehicle movements to and from the site be restricted to standard (daytime) hours, where feasible. Mitigation and management measures are presented in this report.

The construction footprint is located approximately 10 metres from receivers in NCA01 and 20 metres from receivers in NCA02. There may be instances where the vibratory roller is used within the human response minimum working distance for the nearest residential dwellings within NCA01 and NCA02. Additionally, the station is listed as a State Heritage item and therefore works would occur within the proposed heritage minimum working distances. Where vibration intensive works occur within the proposed minimum working distances management and mitigation measures are required as discussed in this report.

Specifications for operational equipment has not yet been finalised for the Proposal, however mechanical plant (such as that associated with the proposed lift shafts) is not expected to substantially impact the existing environment, and standard noise controls are expected to reduce noise emissions to acceptable levels as outlined in the NPfI. Operational noise emissions would be designed to meet the NPfI noise triggers derived in this report.

Site specific noise mitigation and management measures have been outlined to reduce the potential noise impacts from construction noise and vibration associated with the Proposal. These measures have been developed with reference to the CNVS. Further noise mitigation and management measures would be required in the event of OOHW being proposed.

1 Introduction

Transport for NSW (TfNSW) proposes to provide accessibility upgrades at Stanmore Station ('the Proposal'). WSP has been engaged to undertake a noise and vibration assessment to support the Review of Environment Factors (REF) for the Proposal.

This document assesses noise and vibration impacts associated with the Proposal. Consistent with previous assessments of similar TAP projects, the assessment has been conducted with reference to the *Construction Noise and Vibration Strategy DMS-ST-157* (including the Construction Noise and Vibration Strategy Addendum) (CNVS) (TfNSW, 2019) and the NSW *Noise Policy for Industry* (NPfI) (EPA, 2017).

1.1 Proposal Description

Stanmore Station has been identified for an accessibility upgrade to ensure that it would meet key requirements of the Commonwealth *Disability Discrimination Act 1992* (DDA) and associated requirements of the *Disability Standards for Accessible Public Transport* 2002 (DSAPT).

The Proposal is located in the suburb of Stanmore in the Inner West Council local government area (LGA) located approximately four kilometres south-west from Central Station.

The Proposal is generally within a low-density residential neighbourhood, with commercial activity in the immediate surrounds of the station. The Proposal study area is immediately bounded by local roads, including Gordon Crescent and Douglas Street to the north and Trafalgar Street to the south. The Sydney Private Hospital is located around three kilometres to the west.

Stanmore Station consists of an island platform (Platform 1/2) that is accessed via an underpass that connects Douglas Street and Trafalgar Street. An additional platform is located along Trafalgar Street (Platform 3) with pedestrian access from Trafalgar Street.

Platforms 1/2 provide access from Stanmore to the city while Platforms 3 generally provides access from Stanmore to Strathfield and Parramatta. On Platform 1/2 is the main station building which contains bathrooms and a waiting room. On Platform 3, is a small station building containing a waiting room and two benches. The Proposal is presented in Figure 1.1.

The Proposal involves an accessibility upgrade of Stanmore Station as part of the TAP which would improve accessibility and amenity for customers. The Proposal would include the following key elements:

- two new lifts to provide access between the existing station underpass and the platforms
- reconfiguration of the existing bathrooms on Platform 1/2 to accommodate:
  - a new family accessible toilet
  - male and female ambulant toilets
  - a cleaners room
- provision of new canopy on Platform 1/2 to connect to the existing platform building awning and provide continuous canopy coverage between the new lift, boarding assistance zone and family accessible toilet
- provision of a new canopy on Platform 3 around the new lift to cover the lift opening and boarding assistance zone
- upgrade of the existing stairs to include new handrails, tactile ground surface indicators (tactiles) and nosings
- reinstate glazed panels to the eastern screens of the existing staircase on Platform 1/2 which faces the new lift opening

- regrading and resurfacing of the existing platform and underpass surfaces as required to provide accessible paths of travel from the new lifts to the station amenities, including the family accessible toilet and waiting rooms
- provision of a new ramp into the waiting room on Platform 2
- provision of a new ramp and stairs, and regrading of the Trafalgar Street entry to Platform 3
- removal of three trees to accommodate the new lift on Platform 3 and the DDA parking space and kiss and ride bay
- station interchange upgrades including:
  - a new DDA car parking space and a new kiss and ride bay on Douglas Street
  - upgrade of the existing footpaths and underpass of the Douglas Street entry forecourt to provide an accessible path of travel from a new DDA car parking space and a new kiss and ride bay.
  - four new bicycle hoops at the Douglas Street entrance to replace existing bicycle racks, minor work including modification of underpass walls and ceilings, upgrade of station landscaping, adjustments to station lighting, relocation of electronic ticketing (Opal readers), relocation or replacement of existing customer facilities (vending machine, waste and recycling bins and seating), public domain improvements, improvement to station communications systems (including CCTV cameras), hearing loops, wayfinding signage and installation of yellow lines and tactiles on all platforms.

Subject to approval, construction is expected to commence in mid-2022 and take up to around 18 months to complete.

Open space within the existing rail corridor in the north-eastern corner of the Proposal boundary is proposed to be used as a site compound with site sheds. The open space south of the site compound will be used as a spoil stockpile and material laydown area. The site compound will be accessed via Railway Avenue, whereas the laydown area will be accessed via an existing rail corridor access gate located along Trafalgar Street. The locations of the site compound and laydown areas are shown in Figure 1.1.

It is proposed that construction worker vehicles would utilise public parking spaces on the surrounding street network, wherever possible.

The majority of work is anticipated to be undertaken during standard hours. Certain works may need to occur outside recommended standard hours and would include night works and works during routine rail shutdowns, which are scheduled closures that would occur regardless of the Proposal when part of the rail network is temporarily closed for maintenance and trains are not operating.

Out of hours works would be required in some cases to minimise disruptions to customers, pedestrians, motorists and nearby sensitive receivers; and to ensure the safety of railway workers and operational assets. It is estimated that around six rail shutdowns would be utilised to facilitate the following activities:

- detailed site survey, services investigations and/or geotechnical investigations within and around the rail corridor
- excavation and installation of lift shafts
- service relocations.

All other work associated with the Proposal would be completed during the standard construction working hours of:

- Monday to Friday, 7.00 am to 6.00 pm
- Saturday, 8.00 am to 1.00 pm
- no work on Sundays or public holidays.

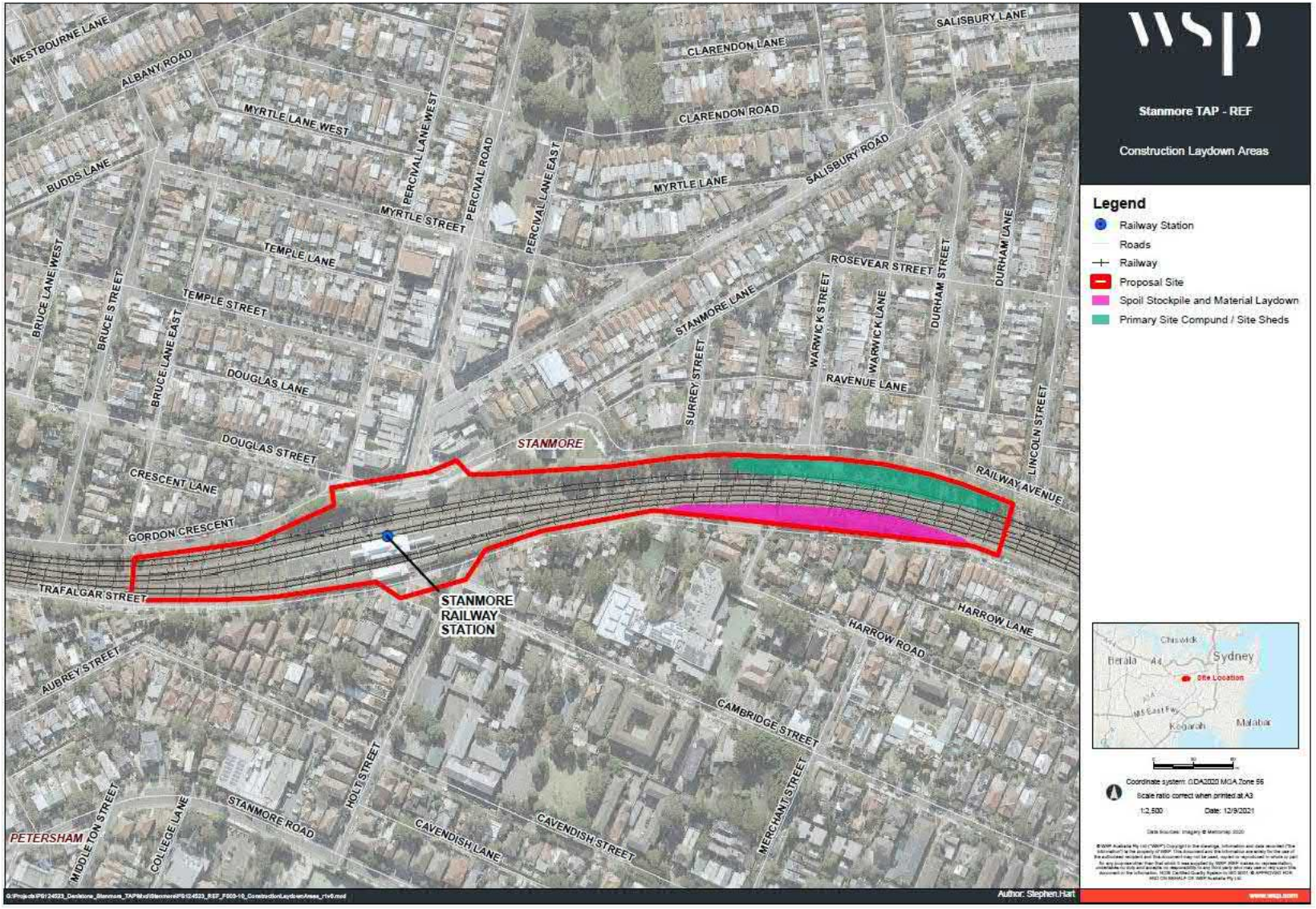


Figure 1.1 Construction compounds and laydown areas

1.2 Scope of Assessment

The purpose of this assessment is to outline the potential noise and vibration impacts associated with the accessibility upgrades at Stanmore Station.

The objectives of this study are to:

- Establish noise and vibration criteria at the nearest potentially affected sensitive receivers.
- Determine acoustically significant plant required for the construction works and site operations and to predict noise levels at the nearest sensitive receivers.
- From results of the noise predictions, assess construction and operational noise levels against relevant criteria.
- Assess potential vibration impact from construction activities.
- Recommend impact mitigation and management, where necessary.

1.3 Sensitive Receivers

The Proposal has the potential to adversely impact nearby properties that are considered sensitive to noise and vibration. The Proposal is located at Stanmore Station, adjacent to residential receivers, commercial receivers and educational receivers (Stanmore Public School and Newington Stanmore Preparatory School).

Identified sensitive receiver types surrounding the Proposal were identified via review of aerial imagery and site inspection as follows:

- Residential receivers north and south of the station.
- Non-residential receivers, including commercial premises, a library, and educational receivers.
- Potential vibration sensitive receiver, including heritage building / structure:
  - Stanmore Station (within Proposal boundary)
  - 153 Trafalgar Street, 'Victorian style dwelling' (17 metres south of the Proposal study area)
  - Stanmore Public School (50 metres south of the Proposal study area)
  - 56 Douglas Street, 'Victorian style dwelling' (95 metres north of the Proposal study area)
  - Salisbury Hotel (90 metres north of the Proposal study area)
  - 118 Percival Road, 'former bakery' (80 metres north of the Proposal study area)

Receivers have been categorised geographically into Noise Catchment Areas (NCAs) based on similar noise environments within these areas, to assist with assessment, consultation and notification. Receivers are assessed in terms of their land use types as these are assigned differing noise and vibration criteria.

The NCAs are described and minimum distances to nearby sensitive receivers outlined in Table 1.1. Figure 1.2 outlines the location of the Proposal, NCAs, noise monitoring locations and nearest representative noise sensitive receivers.

Table 1.1 Noise catchment areas and classification of representative receivers

NCA	RECEIVER ID	ADDRESS	RECEIVER TYPE	MINIMUM DISTANCE TO PROPOSAL [1]
1	C1	110 Cambridge Street, Stanmore	Commercial	7m south of site
2	C2	140 Percival Road, Stanmore	Commercial	9m north of site

NCA	RECEIVER ID	ADDRESS	RECEIVER TYPE	MINIMUM DISTANCE TO PROPOSAL [1]
2	C3	Douglas Street, Stanmore	Library	25m north of site
1	E1	100 Cambridge Street, Stanmore (Stanmore Public School)	Educational	55m south of site
1	E2	115 Cambridge Street, Stanmore (Newington Stanmore Preparatory School)	Educational	37m south of site
1	R1	203 Trafalgar Street, Stanmore	Residential	10m south of site
1	R2	175 Trafalgar Street, Stanmore	Residential	11m south of site
1	R3	167 Trafalgar Street, Stanmore	Residential	12m south of site
1	R4	91 Harrow Road, Stanmore	Residential	11m south of site
1	R5	117 Trafalgar Street, Stanmore	Residential	12m south of site
2	R6	57 Durham Street, Stanmore	Residential	22m north of site
2	R7	70 Railway Avenue, Stanmore	Residential	27m north of site
2	R8	106 Railway Avenue, Stanmore	Residential	29m north of site
2	R9	14 Douglas Street, Stanmore	Residential	35m north of site
2	R10	1 Douglas Street, Stanmore	Residential	23m north of site
2	R11	57 Bruce Street, Stanmore	Residential	20m north-west of site

(1) Minimum distance of the sensitive receiver buildings to the limits of the construction footprint.

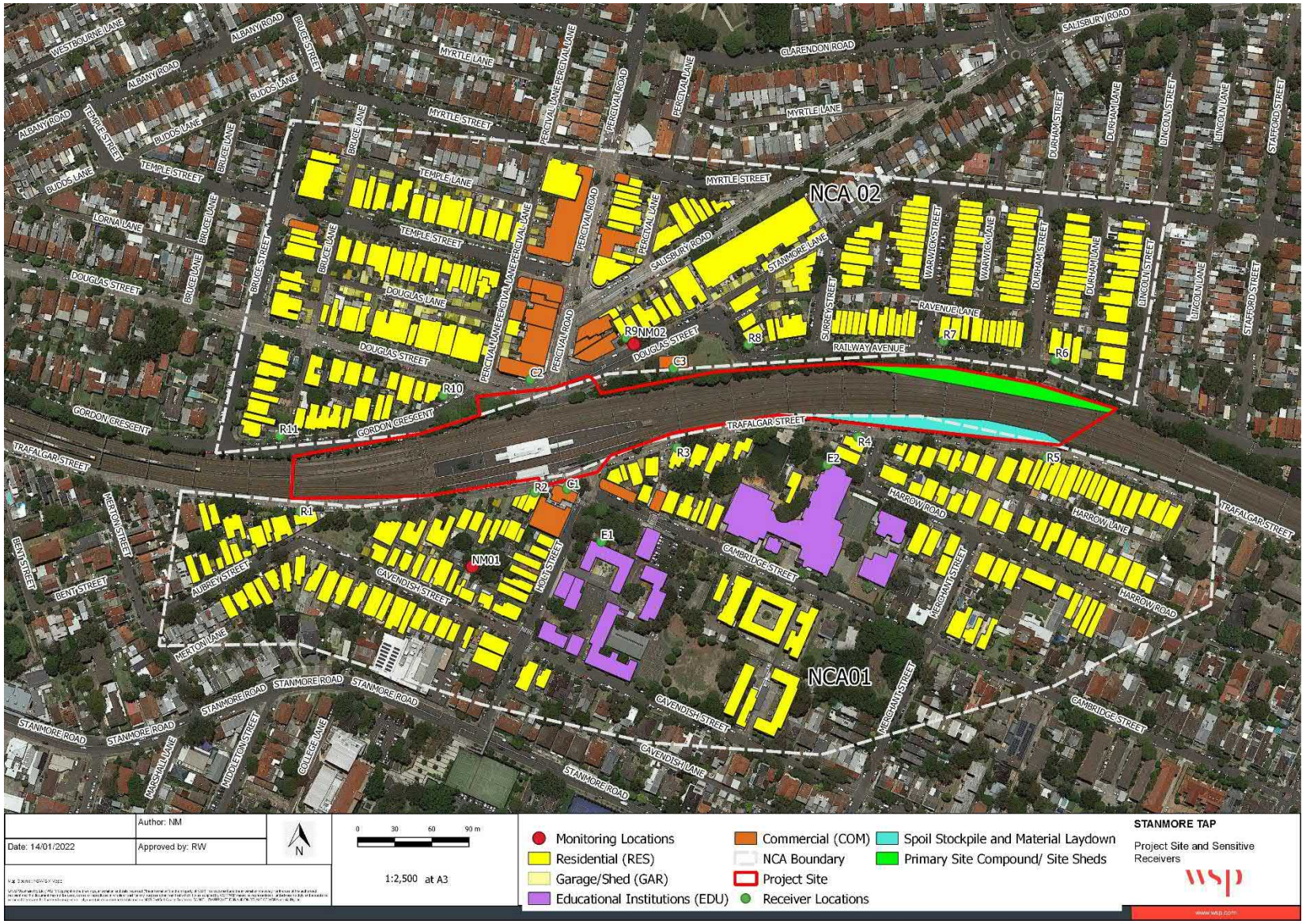


Figure 1.2 Site overview and NCA locations (Source: Metro maps)

1.4 Relevant Guidelines

This report has been written with reference to the following documents:

- TfNSW *Construction Noise and Vibration Strategy DMS-ST-157 2019 (including the Construction Noise and Vibration Strategy Addendum – Replacing Tables 8 & 9, November 2019)* (CNVS).
- NSW EPA *Noise Policy for Industry 2017* (NPfI).
- NSW DECC *Interim Construction Noise Guideline 2009* (ICNG).
- NSW EPA *Road Noise Policy 2011* (RNP).
- NSW DEC *Assessing Vibration: a technical guideline 2006* (AVTG).

Furthermore, the following Standards are referenced in this report:

- Australian Standard *AS 1055:2018 - Acoustics – Description and Measurement of Environmental Noise*.
- Australian Standard *AS NZS 2107:2016 - Recommended design sound levels and reverberation times for building interiors*
- British Standard *BS 7385-2: Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration.*
- Australian Standard *AS 2436:2010 - Guide to noise and vibration control on construction, demolition and maintenance sites.*
- Department for Environment Food and Rural Affairs (United Kingdom), *Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries.*
- British Standard *BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings.*
- German Standard *DIN 4150: Part 3 – 2016 Structural Vibration in Buildings: Effects on Structures.*

2 Existing Environment

Background and ambient noise levels surrounding the Proposal were determined through a combination of unattended and operator attended noise surveys in accordance with the *Australian Standard 1055-2018- Acoustics-Description and Measurement of Environmental Noise* (AS 1055) and the *NSW Noise Policy for Industry* (NPfI) (EPA 2017).

2.1 Noise Monitoring Locations

Background noise monitoring locations were selected to be representative of the sensitive receivers with the potential to be impacted by noise from construction works. Monitoring locations were selected considering background noise influence, extraneous noise sources and logger security. Two noise monitoring locations were used to characterise the existing noise environment at representative residential receivers on either side of the station. The noise monitoring locations were allocated to NCAs as presented in Table 2.1 and Figure 1.2.

Table 2.1 Noise monitoring locations

NOISE MONITORING LOCATION	NCA ID	SURVEY METHOD	ADDRESS	DATES
NM01	NCA01	Unattended measurement and attended measurement	139 Cavendish Street, Stanmore	17 to 26 May 2021
NM02	NCA02	Unattended measurement and attended measurement	14 Douglas Street, Stanmore	17 to 26 May 2021

2.2 Noise Monitoring Methodology

Unattended noise monitoring was conducted between 17 and 26 May 2021 at NM01 and NM02. Each noise logger was set to record the L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of ambient noise (L_{A1}, L_{A10}, L_{A90} are the noise levels for 1%, 10% and 90% of the sample time respectively).

Operator attended monitoring of ambient noise levels was undertaken at both logger locations during the daytime on 17 May 2021. These attended measurements were undertaken during periods of no rain and where the wind speed was less than five metres per second. Attended measurements were completed to qualify noise influences and identify their contribution of the various noise sources to the existing noise environment.

2.3 Instrumentation and Quality Control

The monitoring equipment was fitted with windshields and were field calibrated before and after monitoring.
No significant drifts in calibration (± 0.5 dB) were noted. The weather conditions at the time of monitoring were recorded at Canterbury Racecourse AWS (Bureau of Meteorology station number 66194), which is located around four kilometres south-west of the Proposal.

Monitoring data was excluded for periods of weather where wind speeds were greater than five metres per second or during rainfall that may have adversely affected the collected data.

All monitoring equipment has a current certified calibration certificate (National Association of Testing Authorities, NATA) at the time of use. Details of the equipment used to conduct the noise survey are presented in Table 2.2.

Table 2.2 Noise monitoring equipment

LOCATION	SURVEY METHOD	MANUFACTURER AND MODEL NO.	SERIAL NO.
NM01	Attended measurement & unattended measurement	Ngara	878043
NM02	Attended measurement & unattended measurement	Ngara	87809A
NM01 and NM02	Attended measurement & unattended measurement	NC 73 (calibrator)	112118319

2.4 Unattended Noise Survey

A summary of the results of the unattended noise monitoring is summarised in Table 2.3. The Rating Background Level (RBL) is the overall single figure background level representing each day, evening and night time period. The results of the survey are presented graphically in Appendix A.

Table 2.3 Summary of unattended noise monitoring results

LOCATION	RATING BACKGROUND LEVEL (RBL) dBA[1]			AMBIENT NOISE LEVELS L_{eq} dBA[2]		
	DAY[3]	EVE[3]	NIGHT[3]	DAY[3]	EVE[3]	NIGHT[3]
NM01	38	38	34	62	59	50
NM02	46	40	34	63	60	57

(1) Rating Background Level (RBL), the 10th percentile min L_{A90} noise level recorded over all day, evening and night time monitoring periods.

(2) Ambient noise levels: the overall noise level over each assessment period (daytime/evening/night-time) as defined in the NPfI and ICNG.

(3) Time periods defined as – Day: 7.00 am to 6.00 pm Monday to Saturday, 8am to 6pm Sunday; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am Monday to Saturday, 10.00 pm to 8.00 am Sunday.

At location NM01, south of the station in a residential backyard, an RBL of 38 dBA was recorded during the day period, 38 dBA during the evening period and 34 dBA during the night time period. The noise environment was affected by suburban and natural noise influences, with birds and natural sounds identified in lulls in noise sources from distant car pass-bys, train pass-bys and aircraft flyovers. It is noted that during the noise monitoring period, the number of aircraft flyovers were significantly lower than usual due to the COVID-19 pandemic. Therefore, it is expected that once air travel returns to its typical operation (prior to COVID-19) the ambient noise levels within the area would be higher than the measured ambient noise levels in Table 2.3.

At location NM02, located north of the station, an RBL of 46 dBA were recorded during the daytime period, reducing to 40 dBA during the evening period and 34 dBA during the night time period. The noise environment was dominated by traffic noise influences, with constant noise sources associated with car pass-bys, train pass-bys and aircraft flyovers.

2.5 Operator Attended Noise Survey

The results of the attended noise surveys and observations are detailed in Table 2.4. During the surveys, the weather was noted as being fine with light wind and suitable for noise monitoring.

At both NM01 and NM02, the background levels were characterised by urban noise sources. Ambient noise levels were controlled by car pass-bys, trains, aircrafts and birds.

Table 2.4 Summary of attended noise measurement results

LOCATION	TIME	dBA $L_{eq(15min)}$	dBA $L_{90(15min)}$	OBSERVATIONS
NM01	5:30pm – 5:45pm	64	40	**Ambient:** Aircraft flyover 74 to 82 dBA, train pass-bys typically between 47 to 52 dBA, birds and distant traffic audible at 47-50 dBA **Background:** Suburban hum
NM02	5:00pm – 5:15pm	67	52	**Ambient:** Aircraft flyover up to 80 dBA, car pass-bys up to 65 dBA, birds chirping up to 51 dBA, train pass-bys 70 dBA. **Background:** Urban hum

The results of the attended noise survey are consistent with the results of the unattended monitoring campaign (see Appendix A).

3 Assessment Criteria

3.1 Construction Noise

The CNVS establishes assessment methods for construction noise impacts at sensitive receivers from TfNSW Infrastructure and Services Division proposals. The strategy includes reference to objectives in the ICNG.

As the Proposal duration would be greater than six weeks, a detailed assessment method has been adopted per the CNVS.

3.1.1 Construction Noise Assessment Periods

Table 3.1 outlines the CNVS assessment periods applicable to the Proposal.

Table 3.1 CNVS assessment periods

NAME	RBL PERIOD	TIME PERIODS
Standard Hours (SH)	Day	Monday to Friday - 7.00 am to 6.00 pm Saturday - 8.00 am to 1.00 pm Sunday/Public Holiday - Nil
Out of Hours Works (OOHW) Period 1	Day	Saturday - 7.00 am to 8.00 am and 1.00 pm to 6.00 pm Sunday and public holidays - 8.00 am to 6.00 pm
	Evening	Monday to Saturday - 6.00 pm to 10.00 pm
Out of Hours Works (OOHW) Period 2	Day	Sunday and public holidays - 7.00 am to 8.00 am
	Evening	Sunday and public holidays - 6.00 pm to 10.00 pm
	Night	All days 10.00 pm to 7.00 am

3.1.2 Construction Noise Management Levels

The CNVS provides the methodology by which noise and vibration from construction projects can be assessed and mitigation measures identified and applied. The strategy specifies that construction NMLs are to be defined using the method specified in the ICNG. This requires the development of Noise Management Levels (NML) based on existing RBLs and a comparison of predicted construction noise levels with the NML for identified work periods.

Recommended standard hours represent the times of the day when receivers are likely to be less sensitive to noise impacts. Where work is proposed outside of standard hours, justification is required and more stringent NMLs apply. For non-residential receiver types, the NMLs only apply when the receiver is being used.

Table 3.2 sets out the application of the management levels for noise at residential receivers.

Table 3.2 Application of the ICNG NMLs for residential receivers

TIME OF DAY	NML, dBA $L_{eq,\ 15\ minute}$	HOW TO APPLY
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 for works near schools, 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 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should consult with the community.

Table 3.3 presents the NMLs for each assessment period residential receivers in each NCA. The NMLs have been calculated from the measured and adopted RBLs in each NCA as shown in Table 2.3.

Table 3.3 NMLs at residential receivers

NCA	NOISE MONITORING LOCATION	RBL dBA			NML dBA $L_{eq(15min)}$ [1]			
		DAY	EVENING	NIGHT	SH	OOHW 1	OOHW 2	HNA[2]
NCA01	NM01	38	38	34	48	43	39	75
NCA02	NM02	46	40	34	56	45	39	75

(1) Time periods as defined in Table 3.1.

(2) HNA - Highly Noise Affected

Table 3.4 lists the NMLs that have been adopted for non-residential sensitive receivers. The NMLs apply when the premises are in use during any assessment period. The recommended design sound level for the library has been adopted from AS2107:2016 as recommended in the ICNG.

Table 3.4 NMLs for non-residential sensitive receivers

RECEIVER TYPE	NMLS (EXTERNAL) dBA $L_{eq(15min)}$[1]
Commercial	External noise level – 70
Educational	External noise level – 55[2]
Library	External noise level – 55[2,3]

(1) Criteria apply when in use.

(2) External noise level determined by applying a 10 dB correction to the internal noise level criteria as stipulated in the ICNG

(3) Sourced from AS2107:2016 design sound level – upper limit.

3.1.3 Site Specific Construction Noise Management Levels

The specific NMLs for construction activities at surrounding receivers are presented in Table 3.5. These NMLs have been determined from the background noise levels provided in Table 3.3 for residential receivers.

NMLs have been presented for OOH work (OOHW) periods as it is expected that construction works will be undertaken outside of standard hours.

Table 3.5 Site Specific NMLs

RECEIVER TYPE	NML dBA $L_{eq(15min)}$ [1]			
	SH	OOHW 1	OOHW 2	HNA
Residential Receivers NCA01	48	43	39	75
Residential Receivers NCA02	56	45	39	75
Commercial[2]	70	70	70	N/A
Educational[2]	55	N/A	N/A	N/A
Library[2]	55	55	N/A	N/A

(1) Time periods as defined in Section 3.1.1.

(2) Criteria apply when in use. It is assumed that commercial and educational premises are unlikely to be operational outside standard hours.

3.1.4 Sleep Disturbance

Some of the proposed construction work may be required to take place during the night-time periods (10.00 pm to 7.00 am), which has the potential to lower sleep quality of the residents adjacent to the work due to maximum noise level events. Potential impacts include sleep disturbance and sleep awakening reactions. Typically, these periods would occur in conjunction with the six scheduled rail shutdown periods.

Section 4.3 of the ICNG discusses the method for quantifying and assessing sleep disturbance (sleep awakening). This guidance references the NSW *Road Noise Policy* (RNP) (EPA, 2013) that discusses criteria for the assessment of sleep disturbance.

The RNP suggests a screening level of $L_{1,1min}$ dBA, equivalent to the RBL + 15 dB. Where this level is exceeded, further analysis should be carried out. Section 5.4 of the RNP also states that:

- Maximum internal noise levels below 50 to 55 dBA would be unlikely to result in people's sleep being disturbed
- If the noise exceeds 65 to 70 dBA once or twice each night, the disturbance would be unlikely to have any notable health or wellbeing effects.

The guidance within the RNP indicates that internal noise levels of 50 to 55 dBA are unlikely to cause sleep awakening reactions. Therefore, at levels above 55 dBA, sleep disturbance would be considered likely. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside to inside correction has been adopted as indicated in the ICNG.

Based on the above, the noise level 65 dBA L_{max} (external) has been adopted as sleep disturbance screening criterion for assessment purposes. Feasible and reasonable safeguards should be considered where there are night-time predicted exceedances above this limit.

It should be noted that this assessment method (sleep disturbance criteria based on guidance for sleep awakening) may not capture the full extent of impacts during the early and late stage of sleep (difficulty falling asleep and waking up early). However, this assessment method would provide an indication of the potential sleep disturbance when works occur in the night-time period. The night-time impacts due to construction works are quantified and managed through the $L_{eq(15\ min)}$ assessment.

Based on this guidance, site specific sleep disturbance noise goals used to assess the likelihood for sleep disturbance within residences due to night time construction activity are presented in Table 3.6.

Table 3.6 Sleep disturbance NMLs at residential receivers

NCA	NOISE MONITORING LOCATION	SLEEP DISTURBANCE CRITERIA, dBA $L_{1,1min}$	
		RNP SCREENING CRITERION	RNP AWAKENING GOAL
NCA01	NM01	49	65
NCA02	NM02	49	65

3.2 Construction Traffic Noise

The RNP provides guidance on the assessment of noise impacts from road traffic noise on sensitive receivers.

The RNP criteria apply to traffic generated by construction activities. The existing roads immediately surrounding the Proposal include Gordon Crescent and Railway Avenue (local roads) and Douglas Street and Trafalgar Street (sub-arterial roads). Local roads are assessed over a one hour period (typically the peak hour) within the respective day and night periods, while sub-arterial roads are assessed over a 15 hour (7am – 10pm) and 9 hour (10pm – 7am) period.

Table 3.7 presents a summary of the applicable criteria for residences.

Table 3.7 Road traffic noise criteria for residential receivers on existing roads affected by additional traffic from land use developments

ROAD TYPE	ROAD TRAFFIC NOISE CRITERIA	
	DAY	NIGHT
Local Roads	55 dBA $L_{eq\ 1hr}$	50 dBA $L_{eq\ 1hr}$
Sub-arterial Roads	60 dBA $L_{eq\ 15hr}$	55 dBA $L_{eq\ 9hr}$

The RNP 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 dBA above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dBA of, or exceeds, the relevant day or night noise assessment criterion.*'

Therefore, if the road traffic noise levels increase by more than 2 dBA as a result of the proposed construction traffic and the criteria in Table 3.7 are exceeded, investigation of mitigation options would be required.

3.3 Construction Vibration

Vibration associated with construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two impacts have different criteria, with the effects of vibration on human comfort having a lower threshold.

Regarding human comfort, vibration arising from construction activities must comply with criteria presented in *Assessing Vibration: a technical guideline*, (DECC, February 2006) and *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* (BS 6472 1 2008).

Section J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration* (BS7385-2:1993). In addition, further guidance on ground vibration assessment is contained in the German Standard 4150-3 *Structural Vibration, Part 3: Effects of Vibration on Structures* (DIN 4150-3).

Section 7 of the CNVG recommends safe working distances for achieving human comfort (*Assessing Vibration: a technical guideline* (DECC, February 2006) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These are discussed further in Section 4.3.

Building structures classified as being of heritage significance are to be considered on a case by case basis, as a heritage listed structure may not be assumed to be more sensitive to vibration unless it is structurally unsound, which is unlikely for a regularly maintained structure. Guidance for the protection of vibration-sensitive heritage significant structures is presented in the German Guideline, *DIN 4150-3 Structural Vibration Part 3: Effects of vibration on structures* (DIN 4150-3). Structural damage within such structures may be reasonably expected to be avoided where vibration velocities within the structure do not exceed three millimetres per second (mm/s) for vibration frequencies between 1 and 10 Hz.

Structures that are potentially at risk of the threshold (three mm/s) or cosmetic damage would be identified by the contractor prior to the commencement of construction works. The Construction Noise and Vibration Management Plan (CNVMP) would include management at these locations before the commencement of construction activities and after construction is completed.

3.4 Operational Noise

The installation of new plant and equipment associated with the upgrade to Stanmore Station has the potential to generate operational noise impacts at receivers (typically mechanical equipment associated with the new lift shafts). Operational noise emissions from the Proposal to surrounding noise sensitive areas are assessed according to the NPfI.

3.4.1 Operational Noise Criteria

The NPfI provides the framework and process for deriving the noise limits for assessments under the *Protection of the Environment Operations Act 1997.*

The procedure specifies that there are two aspects of environmental noise that require assessment. The first relates to the intrusiveness of a noise source and allows for the noise under assessment to be a margin above the background, whilst the other procedure relates to the acceptability of the resulting noise, in relation to maintaining the amenity of the surrounding area. The more stringent of the amenity or intrusive criteria would define the appropriate criteria for a project. Further, consideration of sleep disturbance is required in terms of night time operations of noise sources.

3.4.2 Proposal Intrusiveness Noise Level

A noise source would be deemed to be non-intrusive if the monitored $L_{Aeq\ (period)}$ noise level of the development does not exceed the RBL by more than 5 dBA at residential receivers. The RBL is the median of the measured L_{A90} noise level during the day, evening and night periods during periods when the development is not in operation.

Based on the results of monitoring outlined in Section Table 2.3, Table 3.8 presents the Proposal intrusiveness levels.

Table 3.8 Proposal Intrusiveness Noise Level

NCA	MONITORING LOCATION	TIME PERIOD	RBL dBA	PROPOSAL INTRUSIVENESS NOISE LEVEL (RBL + 5dB) dBA $L_{eq(15min)}$
NCA01	NM01	Day	38	43
		Evening	38	43
		Night	34	39
NCA02	NM02	Day	46	51
		Evening	40	45
		Night	34	39

(1) Intrusiveness criteria apply to residential receivers only.

3.4.3 Proposal Amenity Noise Levels

To limit continuing increases in noise levels, the amenity noise level within an area from industrial noise sources should not normally exceed the recommended amenity noise levels prescribed in the NPfI. The recommended amenity noise levels represent the objective for **total** industrial noise at a receiver location, whereas the **Proposal amenity noise level** represents the objective for noise from a **single** industrial development at a receiver location, defined as the **recommended noise levels** listed below (Table 2.2 of NPfI) **minus 5 dB.**

The amenity criteria have been established at the identified receivers based on the results of the unattended noise survey. The established amenity criteria applicable to the Proposal are presented in Table 3.9.

Based on the typical background noise levels provided in Table 2.3 of the NPfI and the measured RBLs presented in Table 2.3, the receivers located within NM02 may be considered as urban noise environment. For a conservative assessment, residential receivers within NCA01 and NCA02 have been classified as a suburban noise environment.

Table 3.9 Proposal Amenity Noise Levels

TYPE OF RECEIVER[1]	RECOMMENDED AMENITY NOISE LEVEL (ANL) dBA $L_{eq,\ period}$	PROPOSAL AMENITY NOISE LEVEL (ANL -5dB) dBA $L_{eq,\ period}$	PROPOSAL ADJUSTED ANL[2] dBA $L_{eq\ period}$		
			DAY	EVENING	NIGHT
Residential (Suburban) (NM01, NM02)	Day: 55 Evening: 45 Night: 40	Day: 50 Evening: 40 Night: 35	50	40	35
Commercial[1]	65	60	60	60	60
School classroom – internal	35	30	30	30	30

(1) Amenity levels for non-residential receivers apply when the premises are in use.

(2) Day: the period from 7.00 am to 6.00 pm Monday to Saturday; or 8.00 am to 6.00 pm on Sundays and public holidays; evening: the period from 6.00 pm to 10.00 pm; night: the remaining periods.

3.4.4 Proposal Noise Trigger Levels

In assessing the noise impact of the Proposal on residential receivers, both intrusiveness and amenity criteria must be considered. The most stringent trigger level forms the Proposal noise trigger level (PNTL).

As required in Section 2.2 of the NPfI, all Proposal noise trigger levels and limits are expressed as $L_{eq(15\ min)}$, unless otherwise expressed. In accordance with the NPfI, to standardise the time periods for the intrusiveness and amenity noise levels, the following conversion between $L_{eq,\ period}$ and $L_{eq\ (15\ min)}$ has been applied (as per Section 2.2 of the NPfI):

$$\textbf{dBA } L_{eq,\ 15\ min} = \textbf{dBA } L_{eq,\ period} + 3\ \textbf{dB}$$

A summary of the PTNLs applicable to the Proposal is presented in Table 3.10.

Table 3.10 NPfI Proposal Noise Trigger Levels (PNTL)

RECEIVER TYPE	NCA	TIME PERIOD[1,2]	NOISE LEVEL dBA $L_{eq(15min)}$		
			Intrusiveness	Amenity	PTNL
Residential (Suburban)	NCA01 (NM01)	Day	43	53	**43**
		Evening	43	43	**43**
		Night	39	38	**38**
Residential (Suburban)	NCA02 (NM02)	Day	51	53	**51**
		Evening	45	43	**43**
		Night	39	38	**38**
Commercial	All	When in use	-	63	**63**
School classroom – internal	All	When in use	-	33	**33**

(1) Trigger levels for non-residential receivers apply when the premises are in use.

(2) Time periods defined as Day: the period from 7.00 am to 6.00 pm Monday to Saturday; or 8.00 am to 6.00 pm on Sundays and public holidays; evening: the period from 6.00 pm to 10.00 pm; night: the remaining periods.

3.4.5 Sleep Disturbance

Due to the continual operation of new plant and equipment, the potential for sleep disturbance to residences from noise events from the premises during the night period needs to be considered. Potential impacts include sleep disturbance and sleep awakening reactions.

As outlined in the NPfI, where the development night time noise levels at a residential location exceed the following, a detailed maximum noise level event assessment should be undertaken:

- '$L_{Aeq,15min}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dBA or the prevailing RBL plus 15 dB, whichever is the greater.'

Table 3.11 summarises the operational noise sleep disturbance screening criteria for this Proposal.

Table 3.11 Sleep disturbance Proposal screening criteria (operations)[1]

NCA	NPFI SCREENING CRITERIA	RBL BASED SCREENING CRITERIA	PROPOSAL SCREENING CRITERIA
NCA 1	40 $L_{eq(15min)}$ dBA	*(34 + 5)*[2] 39	**40 dBA $L_{eq(15min)}$**
	52 L_{AFmax} dBA	*(34 + 15)*[3] 49	**52 dBA L_{Fmax}**
NCA 2	40 $L_{eq(15min)}$ dBA	*(34 + 5)*[2] 39	**40 dBA $L_{eq(15min)}$**
	52 L_{AFmax} dBA	*(34 + 15)*[3] *49*	**52 dBA L_{Fmax}**

(1) Sleep disturbance criteria apply to residential receivers only

(2) RBL + 5 as outlined in the NPfI

(3) RBL + 15 as outlined in the NPfI

4 Construction Noise and Vibration Assessment

This section outlines the assessment of construction noise and vibration impacts from the Proposal.

4.1 Construction Noise Assessment

To assess the potential noise impacts during construction, scenarios comprising typical plant and equipment have been developed based on indicative staging information.

4.1.1 Construction Stages and Duration

The Proposal would be constructed in stages with the stages occurring concurrently and at different times depending on the activity. Table 4.1 presents the assessed construction scenarios and working periods developed in consultation with TfNSW based on the indicative construction methodology. Out of hours works are expected to occur during six nominated 48-hour rail shutdowns throughout the construction program.

Table 4.1 Modelling scenarios

SCENARIO ID	STAGE	ACTIVITIES	TIMING	INDICATIVE DURATION (TOTAL)
SC01	Site establishment and enabling work	— establish site compounds (i.e. fencing, tree protection zones, site offices, amenities and plant/material storage areas) — establish temporary facilities as required (e.g. temporary toilets, temporary construction lights etc.) — erect site hoarding as required — service location and relocation as required.	Typically standard hours with some potential out-of-hours/ rail shutdown periods work	2 months
SC02	Lift installation	— excavation of lift pits (including temporary shoring if required) — piling/excavation work for lifts — waterproof, install reinforcement, formwork and concrete to form the lift pits — erect lift structures — install and commission lifts, including fit-out — construct lift landings in the underpass and on the platform.	Standard hours or rail shutdown periods	9 months

SCENARIO ID	STAGE	ACTIVITIES	TIMING	INDICATIVE DURATION (TOTAL)
SC03	Street parking, kiss and ride bay and pedestrian works	— reconfigure the existing roadway (kerb ramps, kerb alignment) to accommodate the proposed DDA car parking space and a new kiss and ride bay — line marking and surface finishing/regrading for DDA compliant parking space and kiss and ride space — reconfigure the existing roadway (kerb ramps, line marking, etc.) to accommodate the proposed DDA car parking space and a new kiss and ride bay — install new kerb ramps — upgrade of the existing footpath to create a ramp from Trafalgar Street — removal of the existing bicycle parking rack on Douglas Street (containing space for eight bicycles) and replacement with four new bicycle parking hoops (providing space for eight bicycles) — upgrade existing Douglas Street forecourt.	Typically standard hours with some potential out-of-hours/ rail shutdown periods work	6 months
SC04	Station building work	— reconfigure the existing bathrooms to accommodate the revised bathrooms and storeroom — installation of new main switchboard in the station office.	Typically standard hours with some potential out-of-hours/ rail shutdown periods work	9 months
SC05	Platform modification work	— regrade platform surface — install new yellow line and tactiles along platforms — install new platform canopies — modify stairs including installation of new nosings, hand railing and tactiles — install/relocate new Opal card readers as required — landscaping and garden planting works — Install ramps to waiting rooms	Standard hours or rail shutdown periods	6 months
SC06	Demobilisation	— install other ancillary features — remove hoardings — clear site — testing electrical, communications and signalling components.	Typically standard hours with some potential out-of-hours/ rail shutdown periods work	2 months

Construction compounds would be established within the construction boundary to contain construction amenities and materials laydown. Figure 1.1 presents the indicative location for the construction compound. The works area for each construction scenario are outlined in the figures presented in Appendix B.

The exact location of the compound and works areas would be finalised by the construction contractor and approved by TfNSW.

4.1.2 Working Hours

Construction work is expected to take place over a period of approximately 18 months, beginning in mid-2022.

Certain works may need to occur outside standard hours to maintain a safe work environment or to minimise impacts to operational transport infrastructure and services. Works outside standard hours would require approval from TfNSW for such works, and further assessment would be required.

4.1.3 Noise Source Levels

The nominated equipment for the construction work scenarios and the sound power level (SWL) of each item are detailed in Table 4.2. SWLs have ben sourced from the CNVS, *AS 2436:2010 - Guide to noise and vibration control on construction, demolition and maintenance sites*, and the *Department for Environment Food and Rural Affairs (United Kingdom), Update of noise database for prediction of noise on construction and open sites – Phase 3: Noise measurement data for construction plant used on quarries* (DEFRA noise database).

Table 4.2 Sound power levels

EQUIPMENT	SOUND POWER LEVEL, dBA	NO. OF EQUIPMENT PER SCENARIO					
		SC01	SC02	SC03	SC04	SC05	SC06
Chainsaw[1]	119		1				
Concrete pump	109			1	1		
Concrete saw[1]	123		1	1	1	1	
Concrete truck	109			1	1		
Concrete Vibrator[1]	118		1				
Coring machine	113		1				
Crane	108	1	1				1
EWP	98						
Excavator (1.7 to 10 tonne)	90						
Excavator (10 tonne)	100		1	1	1	1	
FEL	112						1
Forklift	111	1					
Generator	103	1					1
Grinders	110		1	1		1	
Hand tools	104	2	2	2	2	2	2
Hi rail EWP	98					1	
Hi-Rail Truck	103		1			1	

EQUIPMENT	SOUND POWER LEVEL, dBA	NO. OF EQUIPMENT PER SCENARIO					
		SC01	SC02	SC03	SC04	SC05	SC06
Impact wrenches	111		1				
Jack hammers[1]	113		1	1	1	1	
Pavement laying machine	114				1		
Piling (bored)	112		1				
Sucker truck	109			1	1		
Trucks (medium rigid)	103	1		1	1	1	1
Vibrating roller	114				1		
Water truck	107				1		
Scenario total SWL, dBA		114	126	124	125	124	115

(1) A +5 penalty has been applied for special audible characteristics as per the CNVS.

4.1.4 Noise Modelling Methodology

Prediction of construction noise impacts from the Proposal has been completed using SoundPLAN noise modelling software (version 8.2) using the Industrial Module and the ISO 9613-2 calculation method. A three-dimensional model of the Proposal was developed, including elevation contours, locations of sensitive receivers, noise-generating equipment and intervening buildings. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

The parameters used and values adopted in the noise modelling are presented in Table 4.3.

Table 4.3 Modelling parameters

PARAMETER	INPUT
Buildings	Building footprints and number of floors taken from aerial photography. Building heights and number of floors were estimated from Google Street View as follows: per floor 3 metres, pitched roof 2.5 metres.
Topography	Sourced from SIXMaps NSW (1 metre contour intervals)
Façade calculation	Impacts calculated at the most affected facade of nearby receivers
Prediction algorithm	ISO9613-2 1996
Meteorological conditions	Default meteorological conditions were used for all assessment periods, representative of downwind propagation conditions between 1 and 5 m/s, and equivalent to a moderate temperature inversion.
Ground surface / absorption	Model assumed a ground absorption coefficient of 0.6
Sources	All equipment has been modelled as point sources and all equipment per work stage has been modelled to operate simultaneously.
Source heights	Construction plant and equipment heights are modelled 2 metres above ground
NCA impacts	NCA noise impacts assessed at the most affected representative receiver

The noise modelling is considered to be conservative as it assumes all equipment operating simultaneously. Actual measured noise levels would be expected to be lower.

4.1.5 Predicted Noise Levels

The predicted noise levels for each scenario are presented in Table 4.4 outlining the noise level within each NCA for each representative receiver type. The predicted noise levels are presented as a range, which represents the calculated noise levels based on the noise sources being located at the closest distance to the receiver (first number) and when the noise source is located the furthest distance to the receiver (second number). Due to the large project area this measurement allows distinction between when the works would be close or far from the receiver. The highest noise levels were then compared with the relevant NMLs to quantify the noise impacts and assist with mitigation and management measures.

As plant with special audible characteristics, such as the concrete saws, are not expected to operate for the majority of the construction works, values have been presented as a worst case scenario (includes noise generated by plant items with special audible characteristics) and a typical scenario (does not include noise generated by plant items with special audible characteristics).

Predicted noise levels at buildings within each NCA were assessed and the results presented graphically in the form of exceedances of NMLs during Standard Hours in Appendix B.

Where a predicted noise level exceeds a less stringent management level (SH), it follows that the more stringent (OOHW) management levels are also exceeded.

The formatting of the construction noise assessment results (Table 4.4) indicates the following:

- The orange shaded cells show exceedances of the standard-hours day period.
- The green shaded cells show exceedances of the OOHW 1 period.
- The blue shaded cells exceedances of the OOHW 2 period.
- The cells with red text show exceedances of highly noise affected NMLs.

Table 4.4 Maximum predicted construction noise levels and indicative exceedances per scenario

			NML, dBA $L_{eq(15min)}$[1]				PREDICTED NOISE LEVEL PER SCENARIO, dBA $L_{eq(15min)}$[2,3]									
NCA	RECEIVER ID[6]	RECEIVER TYPE	SH	OOHW 1	OOHW 2	HNA	SC01	SC02		SC03		SC04		SC05		SC06
							TYPICAL[5]	WORST CASE[4]	TYPICAL[5]	WORST CASE[4]	TYPICAL[5]	WORST CASE[4]	TYPICAL[5]	WORST CASE[4]	TYPICAL[5]	TYPICAL
1	C1	Commercial	70	70	70	n/a	90-34	93-68	85-60	95-53	87-45	96-54	90-48	95-53	84-42	91-35
2	C2	Commercial	70	70	70	n/a	87-47	83-73	75-65	95-67	87-59	96-68	90-62	95-67	84-56	88-48
2	C3	Library	55	55	n/a	n/a	87-49	73-69	65-61	90-64	82-56	91-65	85-59	90-64	79-53	88-50
1	E1	Educational	55	n/a	n/a	n/a	72-37	77-58	69-50	83-52	75-44	84-53	78-47	83-52	72-41	73-38
1	E2	Educational	55	n/a	n/a	n/a	73-39	63-51	55-43	71-52	63-44	72-53	66-47	71-52	60-41	74-40
1	R1	Residential	48	43	39	75	86-27	69-63	61-55	72-49	64-41	73-50	67-44	72-49	61-38	87-28
1	R2	Residential	48	43	39	75	90-27	97-82	89-74	95-68	87-60	96-69	90-63	95-68	84-57	91-28
1	R3	Residential	48	43	39	75	84-34	73-67	65-59	89-62	81-54	90-63	84-57	89-62	78-51	85-35
1	R4	Residential	48	43	39	75	85-28	48-44	40-36	66-40	58-32	67-41	61-35	66-40	55-29	86-29
1	R5	Residential	48	43	39	75	82-30	54-42	46-34	60-41	52-33	61-42	55-36	60-41	49-30	83-31
2	R6	Residential	56	45	39	75	76-34	61-56	53-48	61-52	53-44	62-53	56-47	61-52	50-41	77-35
2	R7	Residential	56	45	39	75	76-43	65-59	57-51	65-52	57-44	66-53	60-47	65-52	54-41	77-44
2	R8	Residential	56	45	39	75	77-46	66-63	58-55	74-58	66-50	75-59	69-53	74-58	63-47	78-47
2	R9	Residential	56	45	39	75	75-40	73-68	65-60	93-60	85-52	94-61	88-55	93-60	82-49	76-41
2	R10	Residential	56	45	39	75	77-44	80-74	72-66	87-63	79-55	88-64	82-58	87-63	76-52	78-45
2	R11	Residential	56	45	39	75	77-41	71-66	63-58	72-52	64-44	73-53	67-47	72-52	61-41	78-42

(1) Time periods as defined in Section 3.1.1, HNA – Highly noise affected.

(2) Predicted noise levels are represented by a single point for each receiver type and noise catchment area for this preliminary assessment.

(3) Where a predicted noise level exceeds a less stringent management level (SH), it follows that the more stringent (OOHW) management levels are also exceeded. OOHW activities are SC02 (lift works), SC04 (station building works) and SC05 (platform modification works) only.

(4) Predicted noise levels include the operation of plant items with special audible characteristics (concrete saw, chainsaw).

(5) Values indicate a more typical predicted noise level where plant items with special audible characteristics are not used.

(6) Receiver locations as shown in Figure 1.2.

4.1.6 Standard Hours

The majority of construction activities are proposed to be completed within Standard Hours (Scenarios SC01 to SC06). It is noted that a number of the scenarios incorporate plant with annoying acoustic characteristics, which have resulted in the application of a noise penalty (refer to Section 4.1.3). This includes plant such as concrete saws and chainsaws, which are expected to be used very infrequently and over short periods over the construction period. It is highly unlikely that these items of equipment would be utilised on a regular basis throughout the construction works. Where these examples of equipment are not used, noise levels would be notably decreased in their impact to receivers (refer to Section 5). This assessment addresses the impacts of both cases, however impacts with annoying plant would be of short duration and impacts without such plant being operational are more indicative of any sustained impact over a given construction activity event.

The assessment of construction noise impacts at the nearest sensitive receivers indicates that noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in both NCA01 and NCA02 during all activities, with SC02 (lift works) to SC05 (platform modification works) presenting the greatest impact to sensitive receivers.

Within NCA01, the worst case construction noise levels (including relevant audible characteristics penalty) are predicted to exceed the NML for standard hours by up to 42 to 49 dBA when works are closest to each receiver (these predictions include noise generated by plant with special audible characteristics, as indicated in Table 4.4). Noise levels are predicted to result in exceedances of relevant criteria by up to 43 dBA during SC01 (site establishment) and SC06 (demobilisation) and 49 dBA during SC02 (lift works) to SC05 (platform modification works). The closest residences to the construction work are predicted to be highly noise affected when works are at their closest during most scenarios. As the works move further away from the receivers, they would no longer be highly noise affected.

Within NCA02, the worst case construction noise levels are predicted to exceed the NML for standard hours by up to 21 to 38 dBA when works are closest to each receiver (these predictions include noise generated by plant with special audible characteristics, as indicated in the table above). Noise levels are predicted to result in exceedances of relevant criteria by up to 24 dBA during SC01 (site establishment), SC02 (lift works) and SC06 (demobilisation) and 38 dBA during SC03 (parking modification works) to SC05 (platform modification works). The closest residences to the construction work are predicted to be highly noise affected when works are at their closest during most scenarios. As the works move further away from the receivers, they would no longer be highly noise affected.

For commercial receivers (C1 to C3), the worst case construction noise levels are predicted to exceed the NML for standard hours by up to 36 dBA when works are closest to each receiver. For educational receivers (E1 and E2), the worst case construction noise levels are predicted to exceed the NML for standard hours by up to 29 dBA when works are closest to each receiver.

It is noted that the exceedances are more significant during SC02 (lift works) to SC05 (platform modification works) due to the use of highly noisy plant items that have special audible characteristics. However, these plant items are not used frequently and therefore the noise levels that the affected receivers would typically experience would be much lower. Where these plant items are not in use the exceedances would reduce by 8 dBA during SC02 (lift works), 8 dBA during SC03 (parking modification works), 5 dBA during SC04 (station building works) and 11 dBA during SC05 (platform modification works).

Furthermore, noise levels presented in this assessment are conservative, with noise sources assumed to operate simultaneously. In reality noise impacts are likely to be lower as plant items may not be operating simultaneously at all times and therefore it would be likely that the predicted noise levels would be reduced for some receivers. Works are expected to take place intermittently over any construction period, so these exceedances would not be expected to occur continuously over the duration of the Proposal.

Based on the current design and construction methodology for the Proposal, noise impacts would be noticeable during standard hours at the nearest receivers to the works areas. It is noted that activities such as SC01 (site establishment) and SC06 (demobilisation) would be of relatively short duration (in the order of up to around two months). Additionally, noise impacts from the use of the construction compounds would be similar to those for SC01 (site establishment) and SC06 (demobilisation); however, would likely only occur for short periods of one hour each morning and afternoon.

The impacts associated with SC02 (lift works) and SC04 (station building works) are likely to occur intermittently over an estimated nine months period each and are expected to result in noticeable noise impacts at the nearby receivers. While noise levels are considered to be noticeable and intrusive when works are at their nearest to receivers, the use of high intensity plant such as concrete saws, jackhammers, chainsaws or excavation equipment for the lift shafts are not expected to be continuous and would only occur for short and discreet periods of the overall construction program. These activities would require specific noise management and mitigation measures to effectively manage impacts at receivers during these periods.

Impacts from SC03 (parking modification works) and SC05 (platform modification work) would also occur intermittently over six months and two months respectively and are expected to result in noticeable noise impacts at the nearest sensitive receivers. Noise levels would be noticeable and intrusive when works at their nearest to receivers, however high intensity plant such as concrete saws and jackhammers are not expected to be used continuously over the period and only for discrete construction activities.

As a result of the predicted exceedances, noise mitigation and management measures have been outlined in Section 5 to reduce the potential noise impacts.

4.1.7 Outside Standard Hours

Out of hours works are proposed during Scenarios SC02 (lift works), SC04 (station building works) and SC05 (platform modification works), generally limited to six 48-hour rail shutdowns.

These scenarios include some plant, such as concrete saws and chainsaws, with annoying acoustic characteristics which incur a noise penalty (refer to Section 4.1.3). Concrete saws and chainsaws are expected to be used infrequently and over short periods over the construction period. It is also highly unlikely that these items of equipment would be fully utilised during works, and would not likely be used during OOHW periods. While equipment such as concrete saws and chainsaws are not in use, noise levels would be notably decreased in their impact to receivers (refer to Section 5). This assessment considers the impacts of both cases, however impacts with annoying plant would be of short duration and impacts without such plant being operational are more indicative of any sustained impact over a given construction activity event.

The assessment of OOHW construction noise impacts at residential receivers indicates that noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all OOHW activities.

During OOHW period 1, noise levels are predicted to result in exceedances of the OOHW criteria by up to 54 dBA at receivers in NCA01 and 49 dBA in NCA02. Noise levels are predicted to result in exceedances of the relevant criteria by up to 48 dBA in NCA01 and 33 dBA in NCA02 during SC01 (site establishment) and SC06 (demobilisation). Exceedances up to 54 dBA are predicted in NCA01 and NCA02 during SC02 (lift works) to SC05 (platform modification works). The closest residences to the construction work are predicted to be highly noise affected when works are at their closest during most scenarios. As the works move further away from the receivers, they would no longer be highly noise affected.

During OOHW period 2, noise levels are predicted to result in exceedances of the OOHW criteria by up to 58 dBA at receivers in NCA01 and 55 dBA in NCA02. Noise levels are predicted to result in exceedances of relevant criteria by up to 52 dBA in NCA01 and 39 dBA in NCA02 during SC01 (site establishment) and SC06 (demobilisation). Exceedances up to 58 dBA are predicted in NCA01 and NCA02 during SC02 (lift works) to SC05 (platform modification works). The closest residences to the construction work are predicted to be highly noise affected when works are at their closest during most scenarios. As the works move further away from the receivers, they would no longer be highly noise affected.

For commercial receivers (C1 to C3), the worst case construction noise levels are predicted to exceed the OOHW criteria by up to 36 dBA when works are closest to each receiver.

Noise levels would exceed OOHW management levels for the majority of the works, however the implementation of mitigation measures and considering the spatial distribution of noise sources, impacts would be substantially lower than presented. Where equipment with annoying acoustic characteristics are in use, exceedances of relevant noise levels are notably above management levels, as a result it is recommended that works involving this equipment be strictly limited to standard hours where possible.

Noise levels presented in this assessment are conservative, with noise sources assumed to operate simultaneously. In reality, noise impacts are likely to be lower as plant items may not be operating simultaneously at all times. Works are expected to take place intermittently over any construction period, so these exceedances would not be expected to occur continuously over the duration of the Proposal.

Out of hours works would take place during rail shutdowns (occurring over a 48-hour period on a weekend) with only six rail shutdowns expected to occur over the 18-month duration of the Proposal. Other works may also be required to occur outside of standard hours which are not part of rail shutdowns, however the bulk of the works would occur during these shutdowns.

Based on the available project information, noise impacts would be noticeable outside Standard Hours at the nearest receivers to the works areas. It is noted that activities associated with Scenario SC05 (platform modification works) would occur over around a two month period. Works associated with Scenario SC02 (lift works) and Scenario SC04 (station building works) would occur over nine months.

As a result of the predicted exceedances during OOHW, further noise mitigation and management measures would be required in the event of OOHW works being undertaken, and an overview has been outlined in Section 5 to reduce the potential noise impacts for consideration.

4.1.8 Sleep Disturbance

Out of Hours Works have the potential to generate sleep disturbance impacts. These activities are proposed during Scenarios SC02 (lift works), SC04 (station building works) and SC05 (platform modification works) and would generally be limited to six 48-hour rail shutdowns.

The ICNG requires a quantitative assessment for construction works that extend over two consecutive nights. The maximum noise level assessment presented in Table 4.5 provides an indication for the potential for sleep disturbance at nearby residential receivers. The predicted noise levels have been assessed at the closest affected representative receiver within each NCA.

The formatting within the maximum noise level results (Table 4.5) indicates the following:

- The grey shaded cells show exceedances of the $L_{eq(15min)}$ criteria.
- The blue shaded cells show exceedances L_{max} and $L_{eq(15min)}$ criteria.

The potential for sleep disturbance impacts would be largely constrained to the six shutdowns periods, therefore the potential for sleep disturbance impacts would be of short duration, as any works undertaken during the night period would occur over two consecutive nights over the construction period.

Noise levels are predicted to result in exceedances of both the RNP screening criteria and the awakening goals.

The potential for work to generate maximum noise level events should be considered as part of the construction noise management plan for the works. Mitigation measures are discussed further in Section 5.

Table 4.5 Predicted sleep disturbance noise impacts (residences only)

NCA	RECEIVER ID[1]	ADDRESS	NML, dBA $L_{eq(15min)}$[1]		MODELLED MAXIMUM NOISE LEVEL PER SCENARIO, dBA $L_{eq(15min)}$[2]			
			RNP SCREENING CRITERION	RNP AWAKENING GOAL	SC02	SC03	SC04	SC05
1	R2	175 Trafalgar Street	49	65	97-82 (89-74)	95-68 (87-60)	96-69 (90-63)	95-68 (84-57)
2	R9	14 Douglas Street	49	65	73-68 (65-60)	93-60 (85-52)	94-61 (88-55)	93-60 (82-49)

(1) Sleep disturbance criteria applicable to residential receivers only.

(2) Predicted noise levels are represented by a single point for each receiver type and noise catchment area for this preliminary assessment.

4.2 Construction Traffic Noise

4.2.1 Introduction

The Proposal includes a site compound and an additional laydown area located in the south eastern corner and north eastern corner of the site, respectively. The site compound would be accessed via Railway Avenue to the north, while the additional laydown area will be accessed via an existing rail corridor access gate located along Trafalgar Street. Additionally, it is proposed that construction worker vehicles would utilise public parking spaces on the surrounding street network

4.2.2 Haulage Routes and Traffic Volumes

The construction traffic generated by the Proposal would be up to 20 to 30 light vehicles and 10 heavy vehicles per day during peak construction periods. Most of this construction traffic would be due to construction workers moving to and from site. The heavy vehicles would be required for the delivery and removal of materials, plants, and equipment.

Construction traffic is expected to travel along Trafalgar Street or Railway Avenue to reach the Proposal site and associated construction compounds. Trafalgar Street and Railway Avenue are both two-lane roads, with a speed limit of 50 km/h.

The final construction haulage route would be determined by the nominated construction contractor during the detailed design of the Proposal, however these routes have been adopted for the purpose of this assessment.

4.2.3 Traffic Noise Impacts

The potential for noise impacts to occur due to light and heavy vehicle movements on public roads generated by the construction work as a result of additional vehicle movements has been assessed. An approximate 60 per cent increase in traffic is required to increase traffic noise levels by more than 2 dB.

For construction traffic accessing compounds and laydown areas via Trafalgar Street or Railway Avenue, it is expected that up to 30 light vehicles and 10 heavy vehicles would be generated during peak construction. As a conservative assumption, it is assumed that these vehicles would enter and leave the site either through Trafalgar Street or Railway Avenue within a one hour period (the start or end of a working shift). Additionally, it is expected that the vehicles would slow down to turn into the site and therefore it is assumed that the vehicles travel at 30 km/h.

Based on the traffic volume and speeds specified above and the assumption that the most affected receivers are at a distance of 12 metres from the nearest carriage way, a sound pressure level of 53 dBA $L_{eq,\ 1hour}$ is predicted at the nearest affected receivers. It is noted that the actual noise levels during construction would be lower as construction traffic would be split between the Trafalgar Street and Railway Avenue access and all the vehicle movements would not occur within a one hour period; instead the vehicle movements would likely be staggered throughout the day.

Nevertheless, the predicted noise level complies with the day time RNP criteria and would not result in a 2 dB increase in traffic noise levels. Exact timings of these movements are yet to be confirmed, however where deliveries are made during night works (10.00 pm to 7.00 am), notable impacts are anticipated at the nearest residences.

Noise levels generated by construction vehicles are anticipated to comply with relevant road noise criteria during the day period, with notable impacts anticipated during the night time period and during rail shutdowns. As a result, mitigation and management measures are recommended, which should be outlined in a Traffic Management Plan for the project. It is recommended that heavy vehicle movements to and from the site be restricted to standard (daytime) hours where feasible. Other mitigation measures are presented in Section 5.

4.3 Construction Vibration Assessment

The major potential sources of vibration from the proposed construction activities are during pile boring, jackhammering and smooth drum (vibratory) roller equipment (SC02 to SC05).

4.3.1 Safe Working Distances for Vibration Intensive Plant

Table 4.6 presents the indicative minimum working distances for the nominated construction plant to minimise the risk of structural damage and human comfort for sensitive receivers, based on the data provided in the CNVS. The distances are based on the typical distance from receivers' work permitted to be carried out to meet the limits set out in Section 3.3.

Table 4.6 Recommended minimum working distances for vibration intensive plant

PLANT ITEM	RATING/ DESCRIPTION	MINIMUM WORKING DISTANCE		
		COSMETIC DAMAGE	HUMAN RESPONSE	HERITAGE
Piling Rig - Bored	≤ 800mm	2 metres (nominal)	N/A	5 metres
Vibratory roller	< 200 kN (typically 4-6 t)	12 metres	40 metres	15 metres
Jackhammer	Hand held	1 metre (nominal)	Avoid contact with structure	3 metres

The distances are indicative only and results may vary depending on the activity, equipment, local geotechnical conditions. They apply to typical buildings under typical geotechnical conditions.

The construction footprint is located approximately 10 metres from residential dwellings in NCA01 and within 20 metres of residential receivers in NCA02. No activities are proposed within the cosmetic damage minimum working distances for residential receivers, therefore structural impacts are not anticipated as a result of the construction works. However, there may be instances where the vibratory roller is used within the human response minimum working distance and therefore may affect the amenity for nearby sensitive receivers (within 40 metres of the construction works). Given that there is potential for receivers to be affected by vibration intensive plant, vibration mitigation measures have been provided in Section 5. If minimum working distances are complied with, no adverse impacts are expected for cosmetic damage or human response on nearby sensitive receivers.

Stanmore Station and the Victorian style dwelling at 153 Trafalgar Street are classified as having heritage significance. Vibration management and mitigation measures are required where vibration generating works are within the nominated safe working distances of the station structure itself.

No other heritage items or buildings with the potential for structural damage were identified within the safe working distances of the footprint, therefore vibration impacts to heritage structures are not considered further in this assessment. This should be confirmed as part of a Construction Noise and Vibration Management Plan (CNVMP) which should include management at these locations before the commencement of construction activities and after construction is completed. Structures that are potentially at risk of threshold or cosmetic damage would be identified by the contractor prior to the commencement of construction works.

5 Construction Noise and Vibration Mitigation and Management

5.1 Standard Construction Noise and Vibration Mitigation

The CNVS outlines standard measures for mitigating and managing construction noise and vibration to be implemented across all TfNSW Infrastructure and Place (I&P) construction proposals where reasonable and feasible. These standard measures are outlined in Appendix C.

Prior to commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) would be prepared and implemented in accordance with the requirements of the ICNG and CNVS. The CNVMP would take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable.

The CNVMP would outline measures to reduce the noise impact from construction activities. Reasonable and feasible noise mitigation measures which would be considered include:

- Avoiding any unnecessary noise when carrying out manual operations and when operating plant.
- Ensuring spoil is placed and not dropped into awaiting trucks.
- Avoiding/limiting simultaneous operation of noisy plant in discernible range of a sensitive receiver where practicable.
- Switching off any equipment not in use for extended periods e.g. heavy vehicles engines would be switched off whilst being unloaded.
- Restriction of heavy vehicle movements to and from the site to standard (daytime) hours where feasible and avoiding deliveries at night/evenings wherever practicable.
- No idling of delivery trucks.
- Keeping truck drivers informed of designated routes, parking locations and acceptable delivery hours for the site.
- Compounds, refuelling areas and work areas designed to promote one-way traffic so that vehicle reversing movements are minimised.
- Minimising talking loudly; no swearing or unnecessary shouting, or loud stereos/radios onsite; no dropping of materials from height where practicable, no throwing of metal items and slamming of doors.
- Maximising offset distances between noisy plant and adjacent sensitive receivers and determining safe working distances.
- Using the most suitable equipment necessary for the construction works at any one time.
- Directing noise-emitting plant away from sensitive receivers.
- Regularly inspecting and maintaining plant to avoid increased noise levels from rattling hatches, loose fittings etc.
- Using non-tonal reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms for all plant used regularly onsite (greater than one day), and for any out of hours works.
- Use of quieter and less vibration emitting construction methods where feasible and reasonable.

The most applicable standard management measures are outlined as follows:

- Construction hours and scheduling:
    - Works would generally be carried out during standard construction hours (i.e. 7.00 am to 6.00 pm Monday to Friday; 8.00 am to 1.00 pm Saturdays). Any works outside these hours may be undertaken if approved by TfNSW and the community is notified prior to these works commencing. An Out of Hours Work application form would need to be prepared by the Contractor and submitted to the TfNSW Senior Environment and Sustainability Officer or Manager for approval prior to any works outside normal hours.
- Respite periods:
    - Where the $L_{Aeq\ (15min)}$ construction noise levels are predicted to exceed 75 dBA and/or 30 dB above the Rating Background Level at nearby affected sensitive receivers, respite periods would be observed, where practicable, and in accordance with the CNVS. This would include restricting the hours that very noisy activities can occur.
- Vibration monitoring:
    - It is proposed that community consultation should be undertaken for any residents located within the human comfort minimum working distance. The community consultation may include the following:
        - Undertake a letterbox drop outlining construction methods, duration and timing of events – as a guide, any potentially affected receivers located within the human comfort minimum working distance should be notified. Notification to be provided a minimum 7 days prior to commencement of works.
        - A contact number should be provided to the public through both the letterbox drop and via a sign erected on the site boundary, so that information can be received, or complaints made in relation to vibration (or noise). A log of complaints would be maintained and actioned.
    - To avoid structural impacts as a result of vibration or direct contact with structures, the Proposal would be undertaken in accordance with the safe work distances and attended vibration monitoring or vibration trials would be undertaken where these distances are required to be challenged.
    - Property conditions surveys would be completed prior to any vibration intensive work being carried out at or within the minimum distances set out in the CNVS. Minimum working distances should be confirmed prior to carrying out any vibration intensive work on site.
    - Vibration-sensitive heritage structures that are potentially at risk of threshold or cosmetic damage would be identified by the contractor prior to the commencement of construction works and confirmed as part of a CNVMP. Vibration resulting from construction and received at any structure outside of the Proposal would be managed in accordance with:
        - For structural damage vibration - British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings.*
        - For human exposure to vibration the acceptable vibration - values set out in the *Environmental Noise Management Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) which includes British Standard BS *6472:1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz).*

Table 5.1 provides indicative benefits of typical engineering control mitigation measures for construction activities, based on guidance in AS 2436 and experience on similar construction proposals.

Table 5.1 - Indicative noise reduction from construction controls

ENGINEERING CONTROLS	POSSIBLE NOISE REDUCTION, dB
Portable temporary screens	5-10
Screen or enclosure for stationary equipment	10-15
Maximising the offset distance between noisy plant items and sensitive receivers.	3-6
Avoiding using noisy plant simultaneously and/or close together, adjacent to sensitive receivers.	2-5
Orienting equipment away from sensitive receivers.	3-5
Carrying out loading and unloading away from sensitive receivers.	3-5
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5-10
Selecting site access points and roads as far as possible away from sensitive receivers	3-6

5.2 Site Specific Construction Noise Mitigation

The following site-specific construction noise mitigation measures should be considered:

- During site establishment (SC01), temporary barriers should be erected to ensure that work would be conducted behind temporary hoardings/screens wherever practicable. The installation of construction hoarding would take into consideration the location of sensitive receivers to ensure that 'line of sight' is broken, where feasible. This has the potential to reduce noise levels between 5 and 10 dB.
- During SC02 to SC05, the concrete saw is the main contributor to construction noise. Without the concrete saw, the total activity noise level is reduced by 5-11 dB. It is recommended that the use of these plant items is limited where possible, and works are undertaken during Standard Hours and avoid sensitive time periods. Where work is required outside of standard hours, the use of this equipment is to avoid sensitive periods such as after midnight and before 7 am.
- Due to the high exceedances of NMLs during SC02 (lift works) to SC05 (platform modification works), when a concrete saw is to be used near sensitive receivers it is recommended that a temporary screen or enclosure (10-15 dB reduction) is placed around the works in conjunction with temporary barriers.
- Activities at the nearest residential receivers are likely to fluctuate over the course of the day, therefore, it is recommended that consultation be undertaken with operators to determine feasible construction staging to manage impacts, effectively communicate likely impacts, potential periods of high intensity works, and to develop a schedule of consultation to program intensive works outside the most active periods. Respite periods should be negotiated and a community consultation strategy developed to ensure a complaints hotline and feedback pathway is established.
- A traffic management plan is to be prepared to manage construction noise impacts, particularly during rail shutdowns. This should include delivery schedules, speed limits and circulation recommendations (measures to promote one-way traffic).

5.3 Additional Construction Noise Mitigation

Where all reasonable and feasible standard mitigation measures have been applied and exceedances are still predicted to occur, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver depending on level of exceedance for the predicted noise level above the NML. Additional mitigation measures and their associated acronyms are outlined in Appendix C. Table 5.2 outlines when to implement the additional noise management measures.

Table 5.2 Implementation of additional management measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	dB ABOVE RBL	dB ABOVE NML	ADDITIONAL MANAGEMENT MEASURES[1]
Standard Hours	Noticeable	5 to 10	0	-
Monday-Friday (7.00 am-6.00 pm)	Clearly audible	> 10 to 20	< 10	-
Saturday (8.00 am-1.00 pm)	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 30	PN, V
	75dBA or greater	N/A	N/A	PN, V, SN
OOHW Period 1	Noticeable	5 to 10	< 5	-
Monday-Friday (6.00 pm-10.00 pm)	Clearly audible	> 10 to 20	5 to 15	PN, RP[2], DR[2]
Saturday (7.00 am-8.00 am, 1.00 pm-10.00 pm)	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO, RP[2], DR[2]
Sunday/PH (8.00 am-6.00 pm)	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP[2], DR[2]
OOHW Period 2	Noticeable	0 to 10	< 5	PN
Monday-Saturday (12.00 am-7.00 am, 10.00 pm-12.00 am)	Clearly audible	> 10 to 20	5 to 15	PN, V, SN, RO[3], RP[2], DR[2]
Sunday/PH (12.00 am-8.00 am, 6.00 pm-12.00 am)	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO[3], RP[2], DR[2]
	Highly intrusive	> 30	> 25	PN, V, SN, RO[3], RP[2], DR[2], AA

(1) PN = Project notification, SN = Specific notification, individual briefings, or phone call, V = Verification monitoring, DR = Duration Reduction, RP = Respite Period, RO = Project specific respite offer, AA = Alternative accommodation

(2) Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays / Public Holidays 8am-6pm)

(3) Respite offers during OOHW Period 2 are only applicable for evening periods (i.e. Sundays / Public Holidays (6pm-10pm), and may not be required if a respite offer has already been made for the immediately preceding OOHW Period 1.

5.4 Traffic Management

This assessment has demonstrated that the Proposal would generate a minor increase in traffic noise on affected roads associated with the construction activities, however levels are expected to remain within RNP criteria. The Proposal's construction traffic is not expected to be significant compared with the existing traffic volumes.

Traffic management would be required on public roads to manage the impacts of traffic diversions during construction. Management of these impacts would be determined by the nominated construction contractor during the detailed design.

As best practice, it is recommended that a Traffic Management Plan be developed for the proposal, and its findings used to inform the CNVMP.

5.5 Additional Construction Vibration Mitigation

Where vibration intensive activities occur within the minimum working distances, all reasonable and feasible standard mitigation measures have been applied, and exceedances of vibration management levels are expected, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver. Additional mitigation measures and the associated acronyms are outlined in Appendix C.

Table 5.3 outlines how to implement the additional vibration management measures.

Table 5.3 Implementation of additional vibration management measures

CONSTRUCTION HOURS	RECEIVER PERCEPTION	ABOVE VIBRATION LIMIT	ADDITIONAL MANAGEMENT MEASURES[3]
Standard hours	Human disturbance	> HVML[1]	PN, V, RO
	Building damage	> DVML[2]	V, AC
OOHW Period 1	Human disturbance	> HVML[1]	PN, V, SN, RO, RP, DR
	Building damage	> DVML[2]	V, AC
OOHW Period 2	Human disturbance	> HVML[1]	PN, V, SN, RO, AA, RP, DR
	Building damage	> DVML[2]	V, AC

(1) Human vibration management level – see maximum vibration dose values for human comfort outlined in Section 3.3

(2) Damage vibration management level – see screening criteria for cosmetic damage outlined in Section 3.3

(3) AA = alternative accommodation, V = verification, IB = individual briefing, N = notification, R2 = respite period, DR = duration respite, R1 = respite period 1, PC = phone calls, SN = specific notifications

6 Operational Noise Assessment

6.1 Operational Noise Assessment

With the exception of the proposed reconfiguration, the operation of Stanmore Station would remain unchanged as a result of the Proposal. There would be no expected changes to the operation of the railway line and, as such, this has not been assessed.

New plant and equipment associated with the upgrade to Stanmore Station would include a new lift, equipment for the communications/equipment room and provision of a family accessible toilet.

The noise associated with the operation of the DDA car parking space and the new kiss and ride bay located along Douglas Street may impact nearby sensitive receivers. Given that road traffic regularly travels along Douglas Street, the noise associated with the operation of the DDA car parking space and the kiss and ride bay are considered negligible and therefore have not been considered further.

Operational noise from the Proposal would need to be designed to meet the NPfI noise goals presented in Section 3.4.

6.2 Operational Noise Mitigation Measures

Mechanical plant details are yet to be finalised. It is expected that mechanical noise emissions would not have a significant impact on the surrounding environment, and that the use of standard controls such as quiet plant selection, and duct lining and/or attenuators, would allow mechanical plant noise to be reduced to acceptable levels.

If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with operational noise criteria as per the NPfI.

7 Conclusion

WSP has undertaken a noise and vibration assessment for the proposed Stanmore Station upgrade. The assessment was conducted with reference to the *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2019). A qualitative assessment of operational noise has also been completed.

Sensitive receivers surrounding the Proposal include residential, commercial, and educational receivers; these receivers have been categorised into noise catchment areas for assessment purposes.

Background noise levels surrounding the Proposal were determined using attended and unattended noise surveys. These background noise levels were used to derive the project specific noise criteria for residential and non-residential receivers.

To assess the potential noise impacts during construction, six representative construction scenarios were developed based on indicative staging information. Precise construction methodology would be confirmed by the construction contractor, however potential noise impacts associated with an indicative construction staging has been conservatively assessed to facilitate community consultation and effective noise management and mitigation prioritisation.

The assessment of construction noise impacts indicates that noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all activities, with Scenarios SC02 (lift works), SC03 (parking modification works), SC04 (station building work), and SC05 (platform modification work) presenting the greatest impact to sensitive receivers. The closest residences to the construction works are predicted to be highly noise affected when works occur at the closest distance to the sensitive receivers. Generally the receivers would be highly noise affected for very short periods (up to or less than a day) as it is not anticipated that the works would be located at the closest distance to the receivers throughout the proposed works. Construction noise levels are predicted to exceed relevant NMLs for the identified commercial (C1 to C3) and educational receivers (E1 and E2). It is noted that the exceedances are due to the use of highly noisy plant items that have special audible characteristics being used close to the sensitive receivers. This includes plant such as concrete saws and chainsaws, which are expected to be used infrequently and over short periods over the construction period. These plant items are not used frequently and therefore the noise levels that the affected receivers would typically experience would be much lower.

Out of hours works are proposed during Scenarios SC02 (lift works), SC04 (station building works) and SC05 (platform modification works). These activities are to be generally limited to six rail shutdowns over the duration of the Proposal (i.e. up to around 18 months). It is noted that some other works may be required to occur outside of standard hours which are not part of rail shutdowns. The assessment of OOHW construction noise impacts at residential receivers indicates that noise levels are predicted to exceed relevant NMLs at the nearest sensitive receivers in NCA01 and NCA02 during all OOHW activities. Again, exceedances are associated with the use of highly noisy plant items that have special audible characteristics which are expected to be used infrequently and over short periods over the construction period. As a result of the magnitude of these predicted exceedances during OOHW works, further noise mitigation and management measures would be required in the event of OOHW works being undertaken.

Any night time works are likely to generate sleep disturbance impacts at residential receivers adjacent to the construction footprints. These activities are proposed during Scenarios SC02 (lift works), SC04 (station building works) and SC05 (platform modification works) and would generally be limited to six 48-hour rail shutdowns. The potential for sleep disturbance has been identified in this report, and noise management and mitigation measures would be required to manage OOHW works.

Proposal-related construction traffic noise impacts are expected to comply with the daytime road traffic criteria, however impacts will be noticeable on local roads during night time periods. It is recommended that heavy vehicle movements to and from the site be restricted to Standard (daytime) Hours where feasible. Mitigation and management measures are presented in this report.

The construction footprint is located approximately 10 metres from receivers in NCA01 and 20 metres from receivers in NCA02. There may be instances where the vibratory roller is used within the human response minimum working distance for the nearest residential dwellings within NCA01 and NCA02.

Additionally, the station is listed as a State Heritage item and therefore works would occur within the proposed heritage minimum working distances. Where vibration intensive works occur within the proposed minimum working distances management and mitigation measures are required as discussed in this report.

Noise mitigation and management measures have been outlined to reduce the potential noise impacts from construction noise and vibration associated with the Proposal.

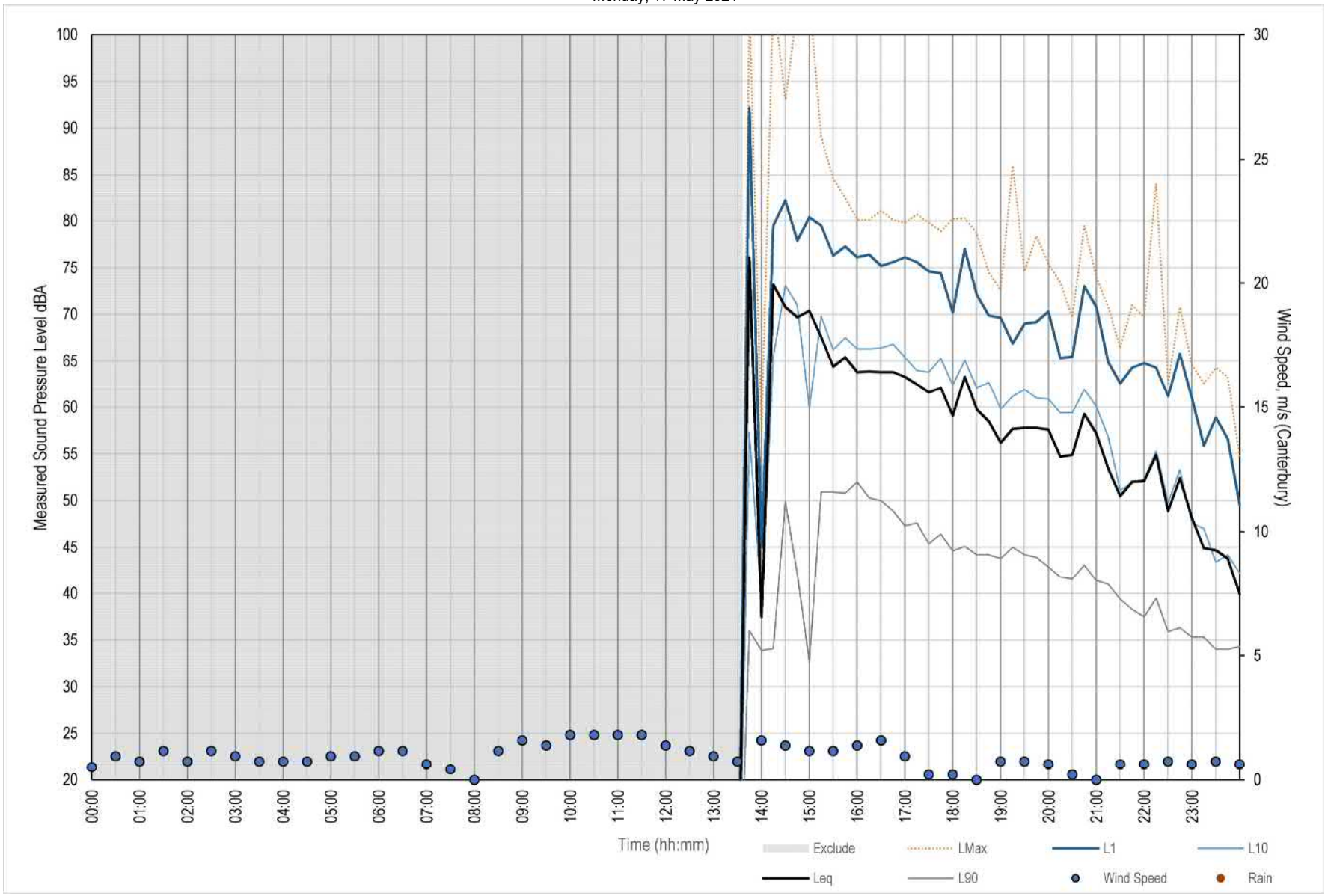
Specifications for operational equipment has not yet been finalised for the project. Mechanical plant is not expected to substantially impact the existing environment, and standard noise controls are expected to reduce noise emissions to acceptable levels as outlined in the NPfI. Operational noise emissions should be designed to meet the NPfI noise triggers derived in this report.

Appendix A

Noise Monitoring Graphs

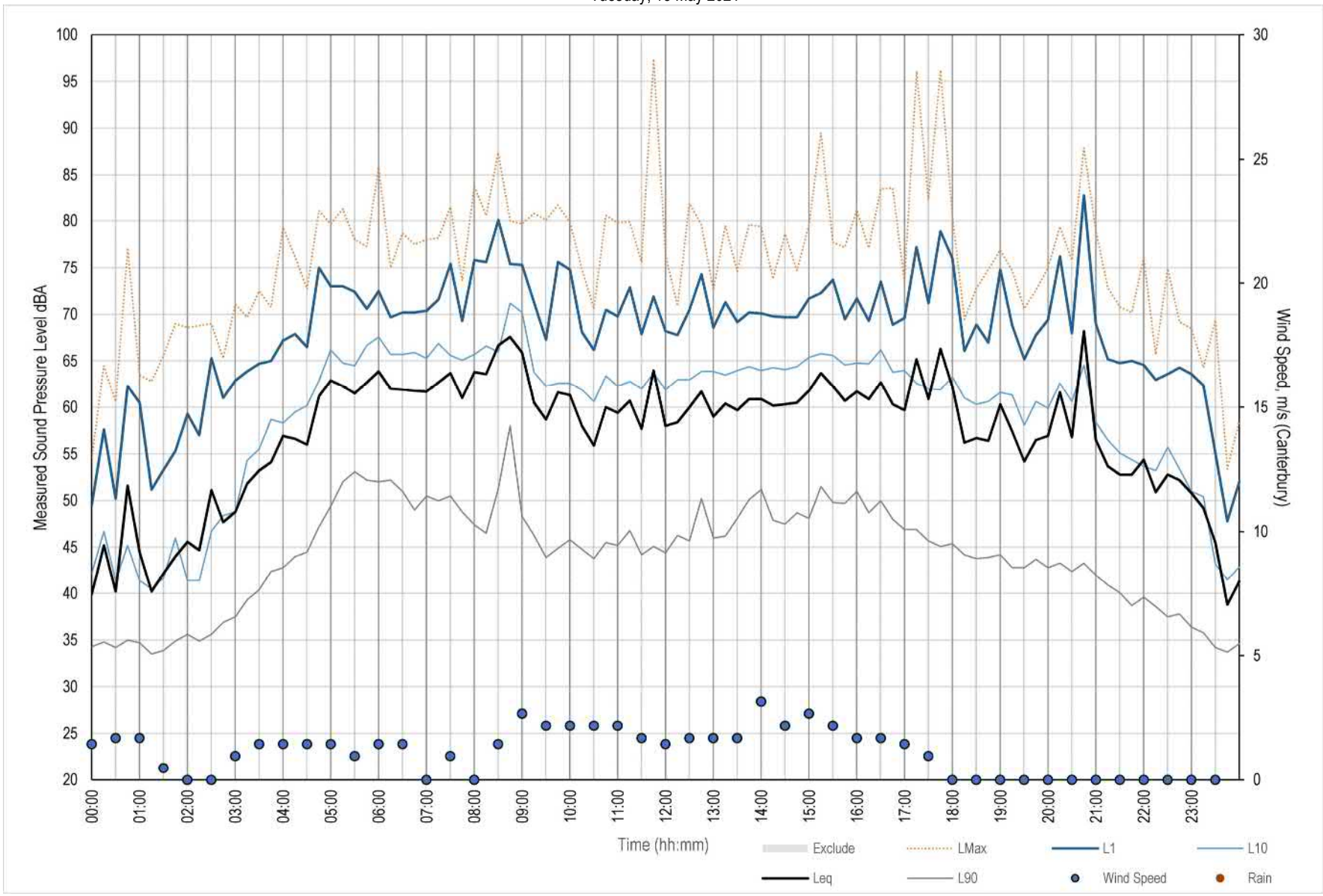
Measured Noise Levels - 14 Douglas Street

Monday, 17 May 2021



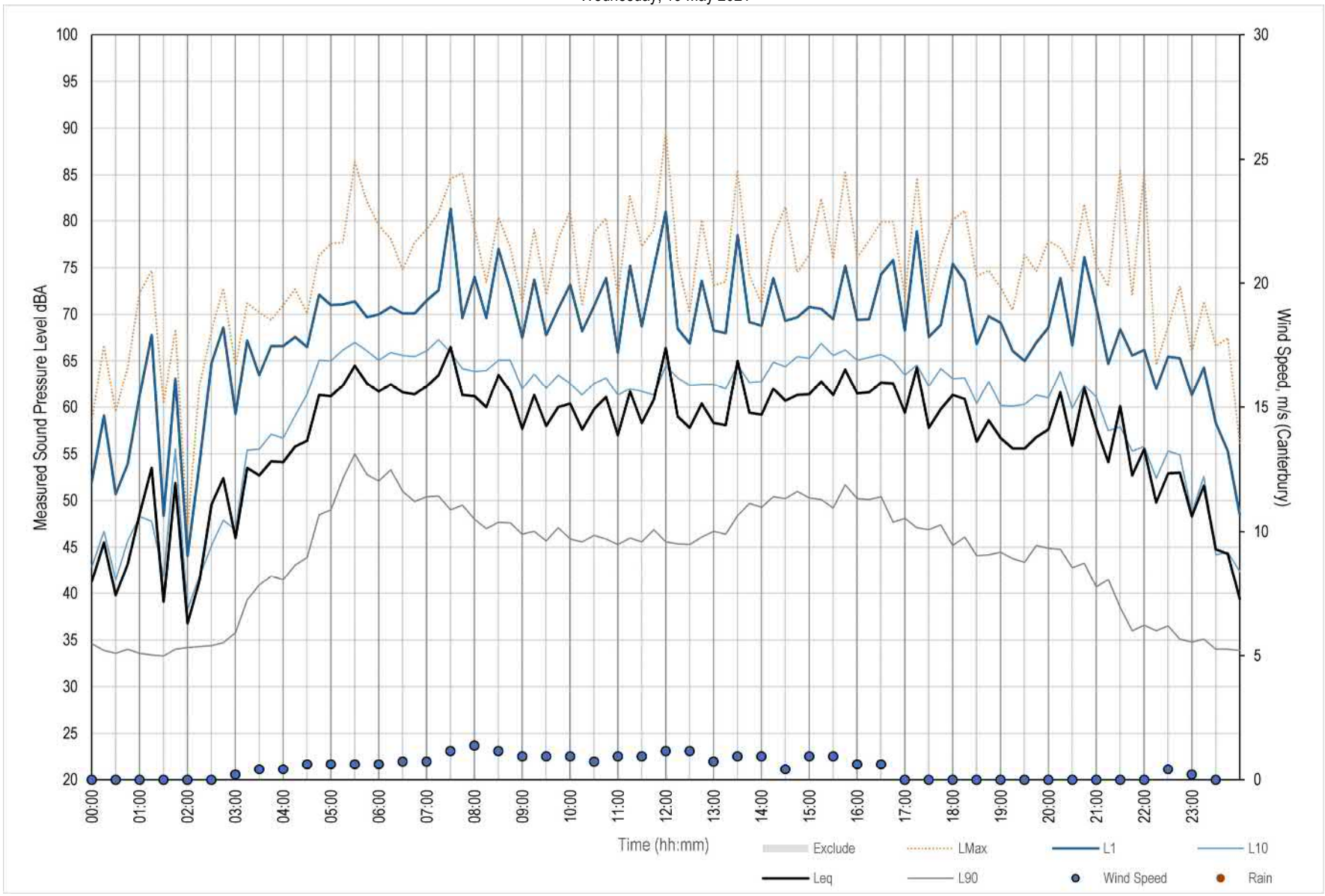
Measured Noise Levels - 14 Douglas Street

Tuesday, 18 May 2021



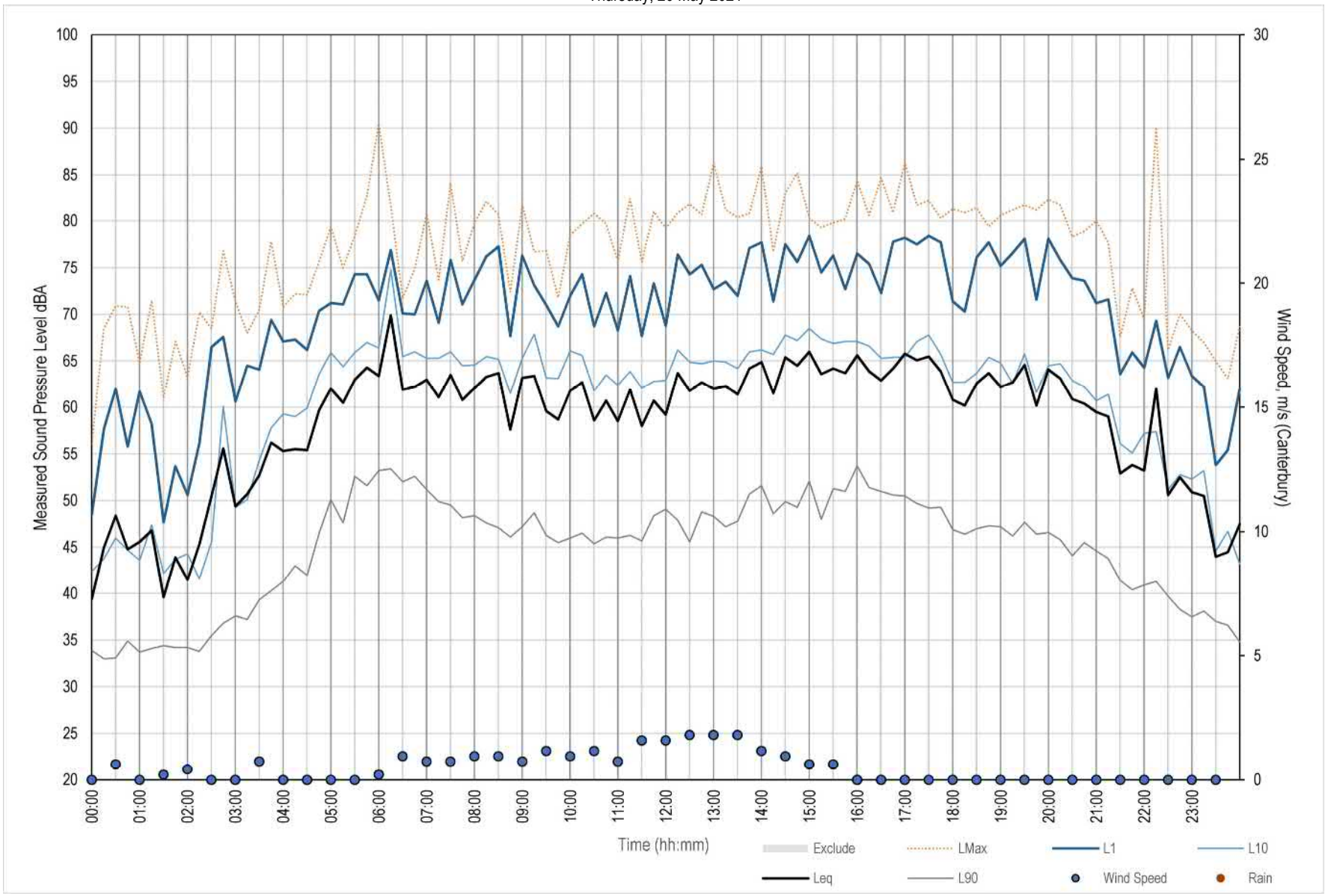
Measured Noise Levels - 14 Douglas Street

Wednesday, 19 May 2021



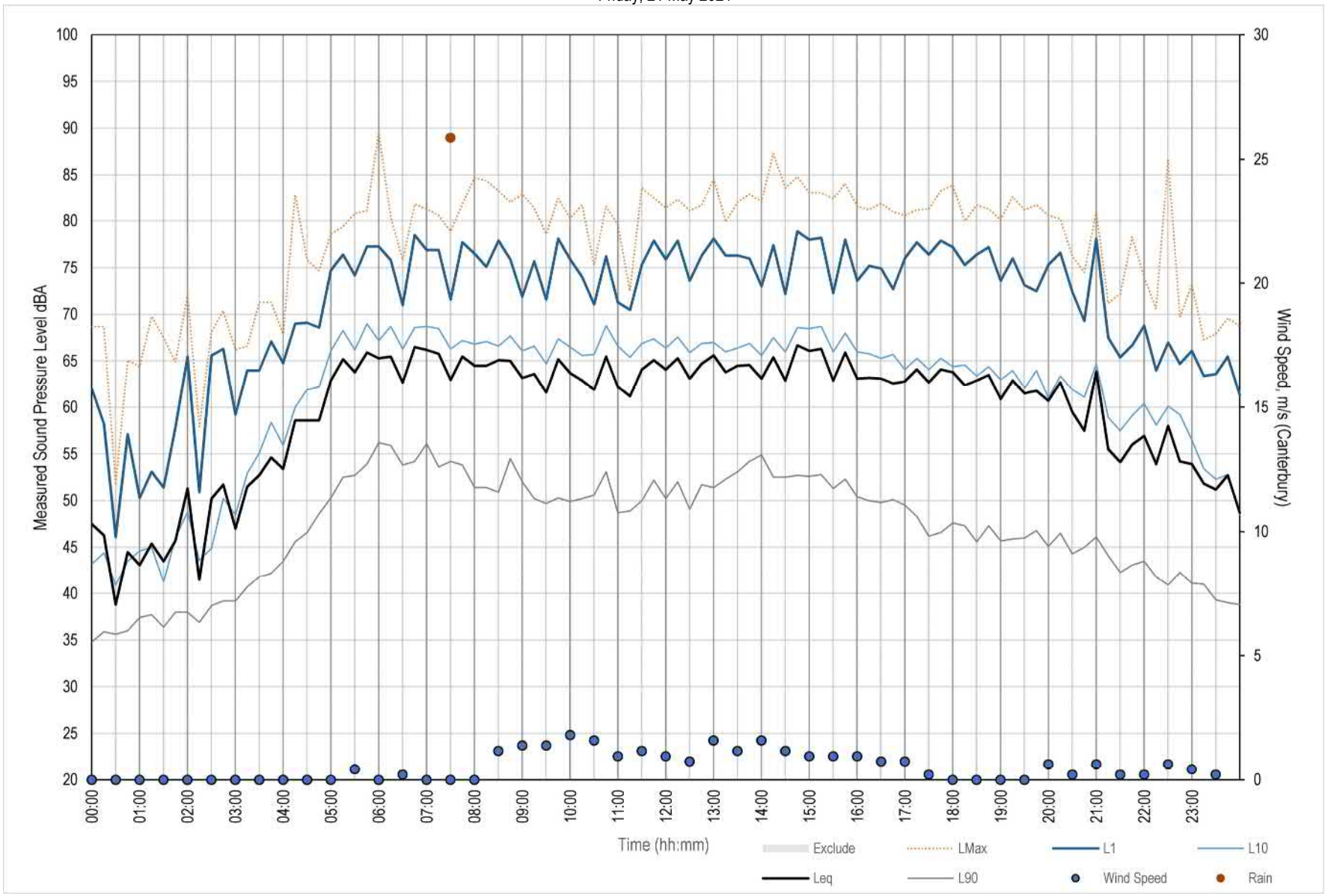
Measured Noise Levels - 14 Douglas Street

Thursday, 20 May 2021



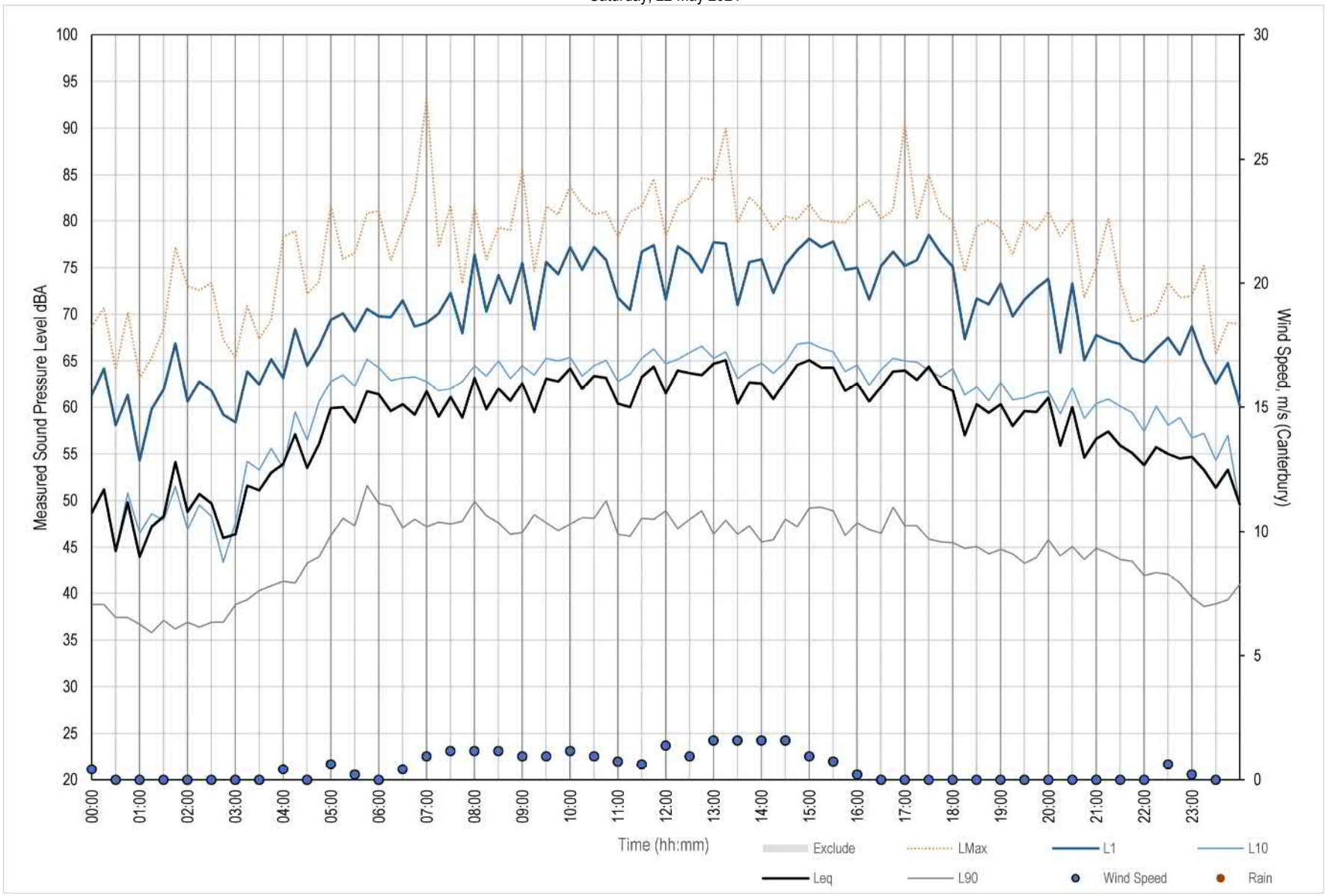
Measured Noise Levels - 14 Douglas Street

Friday, 21 May 2021



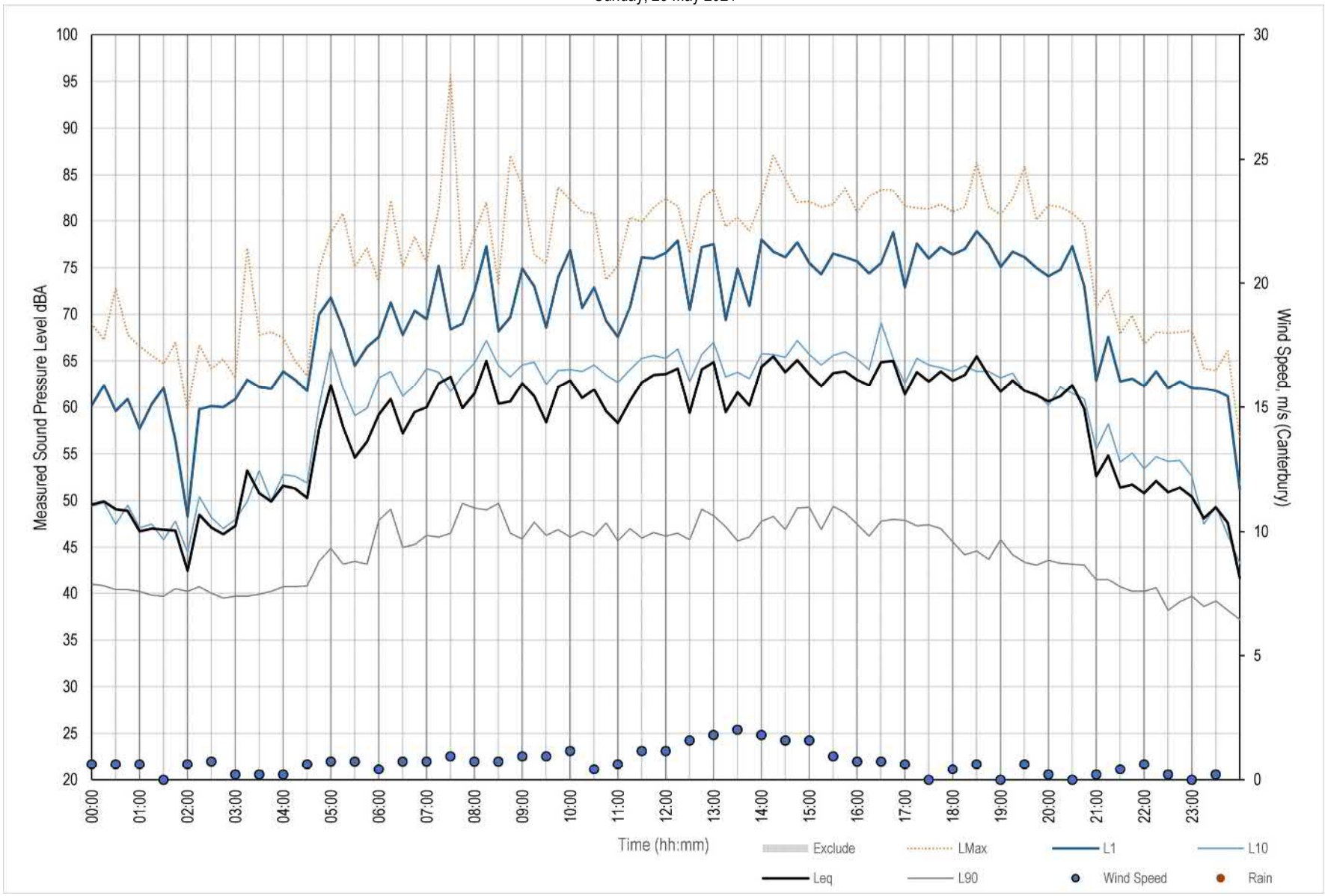
Measured Noise Levels - 14 Douglas Street

Saturday, 22 May 2021



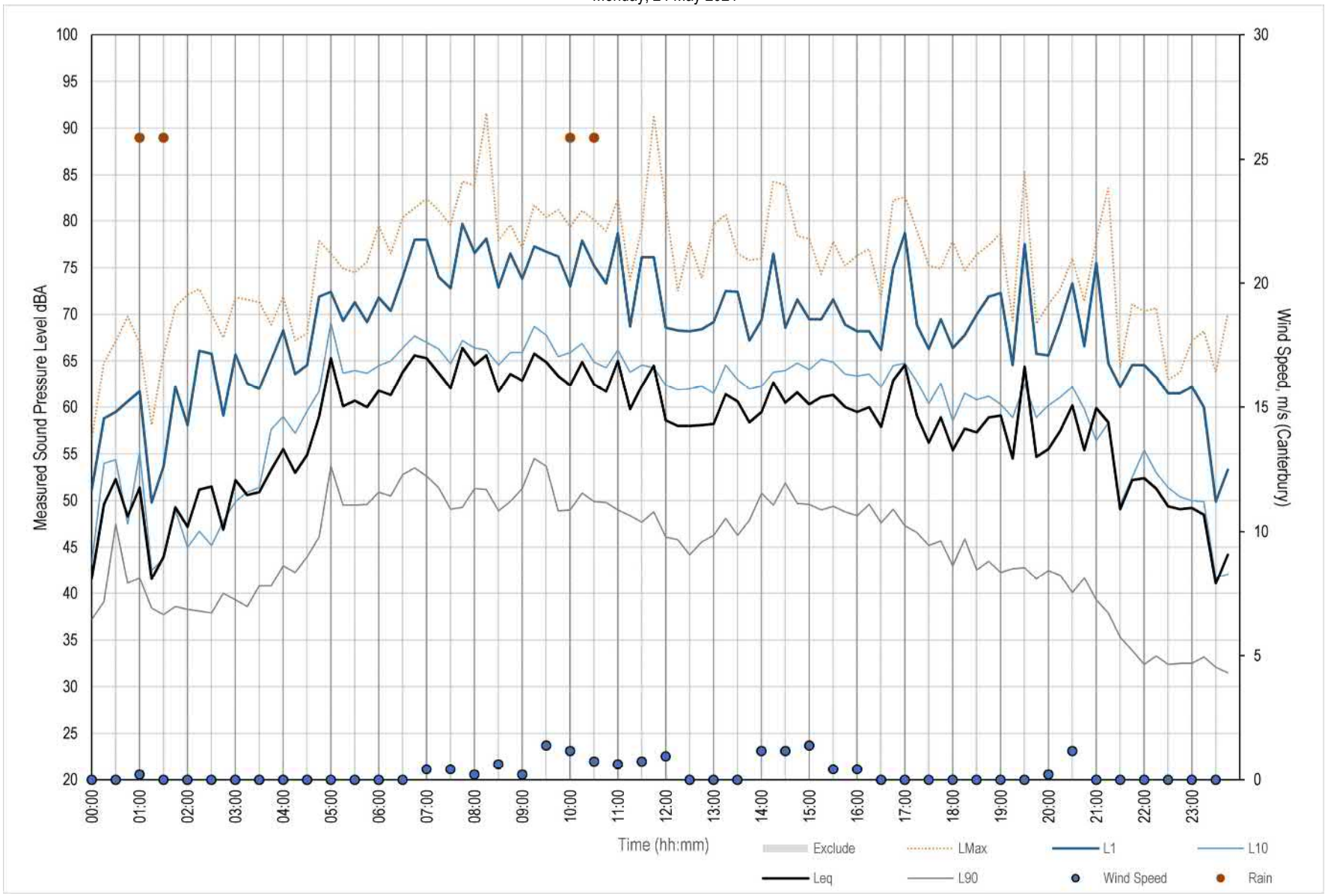
Measured Noise Levels - 14 Douglas Street

Sunday, 23 May 2021



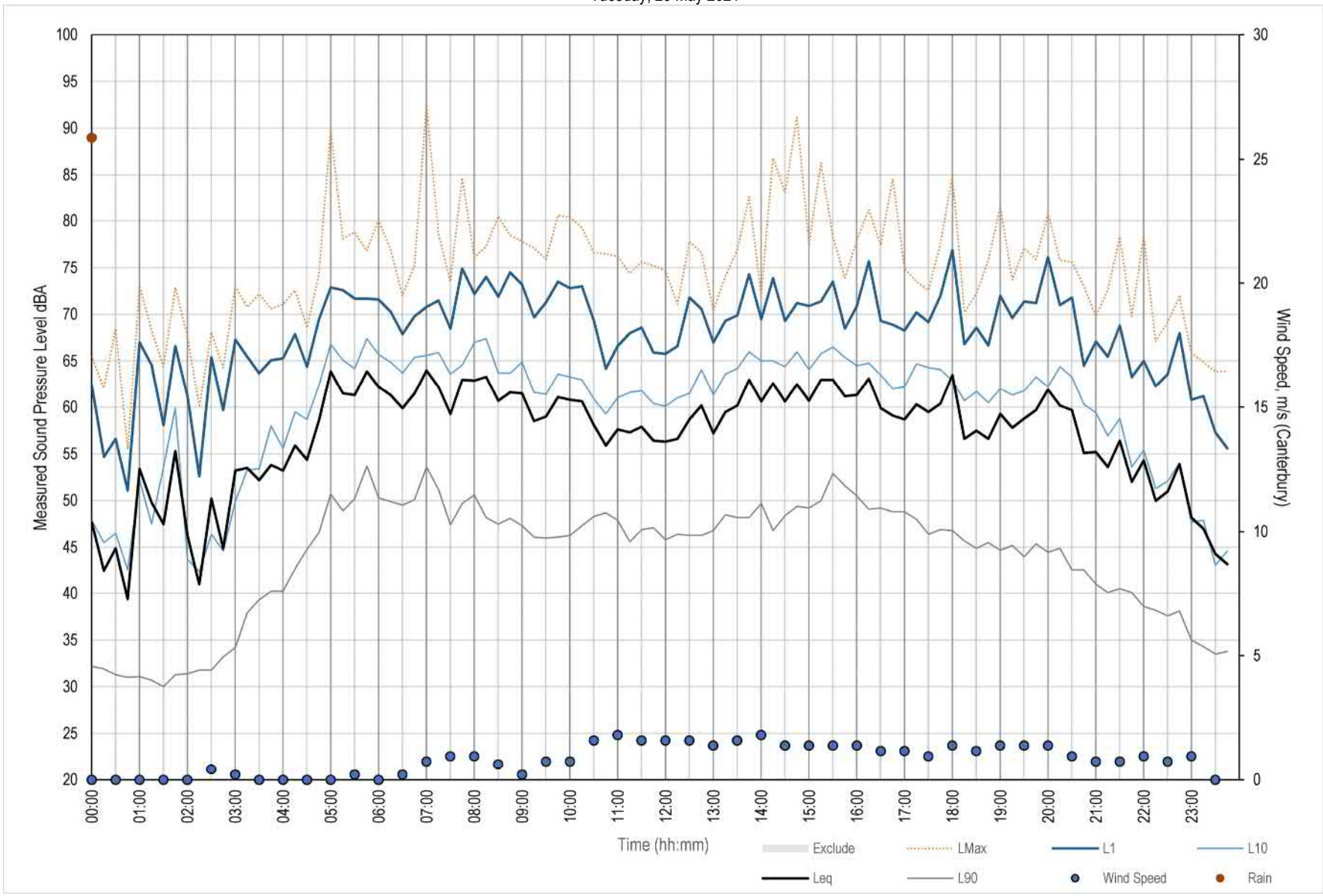
Measured Noise Levels - 14 Douglas Street

Monday, 24 May 2021



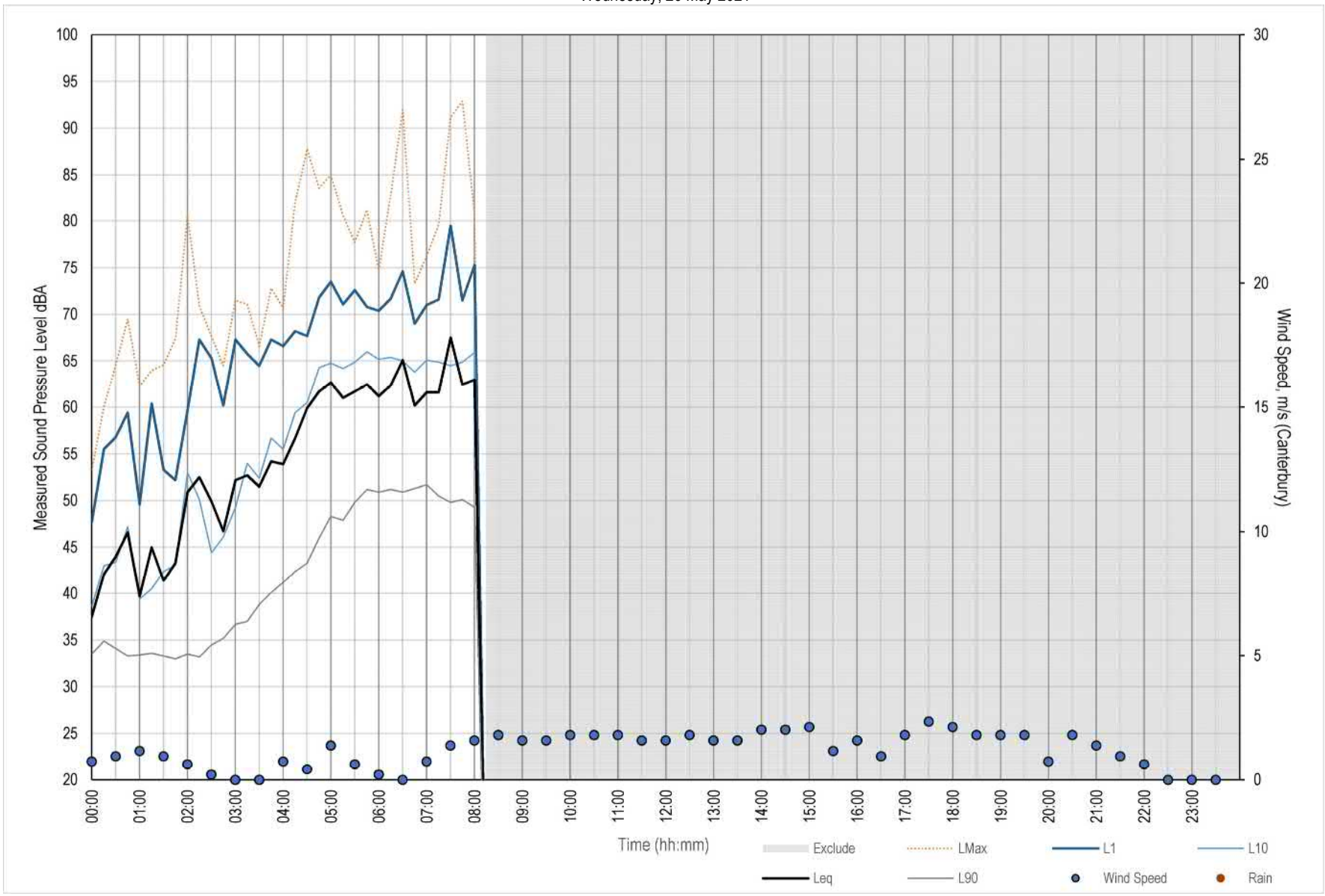
Measured Noise Levels - 14 Douglas Street

Tuesday, 25 May 2021



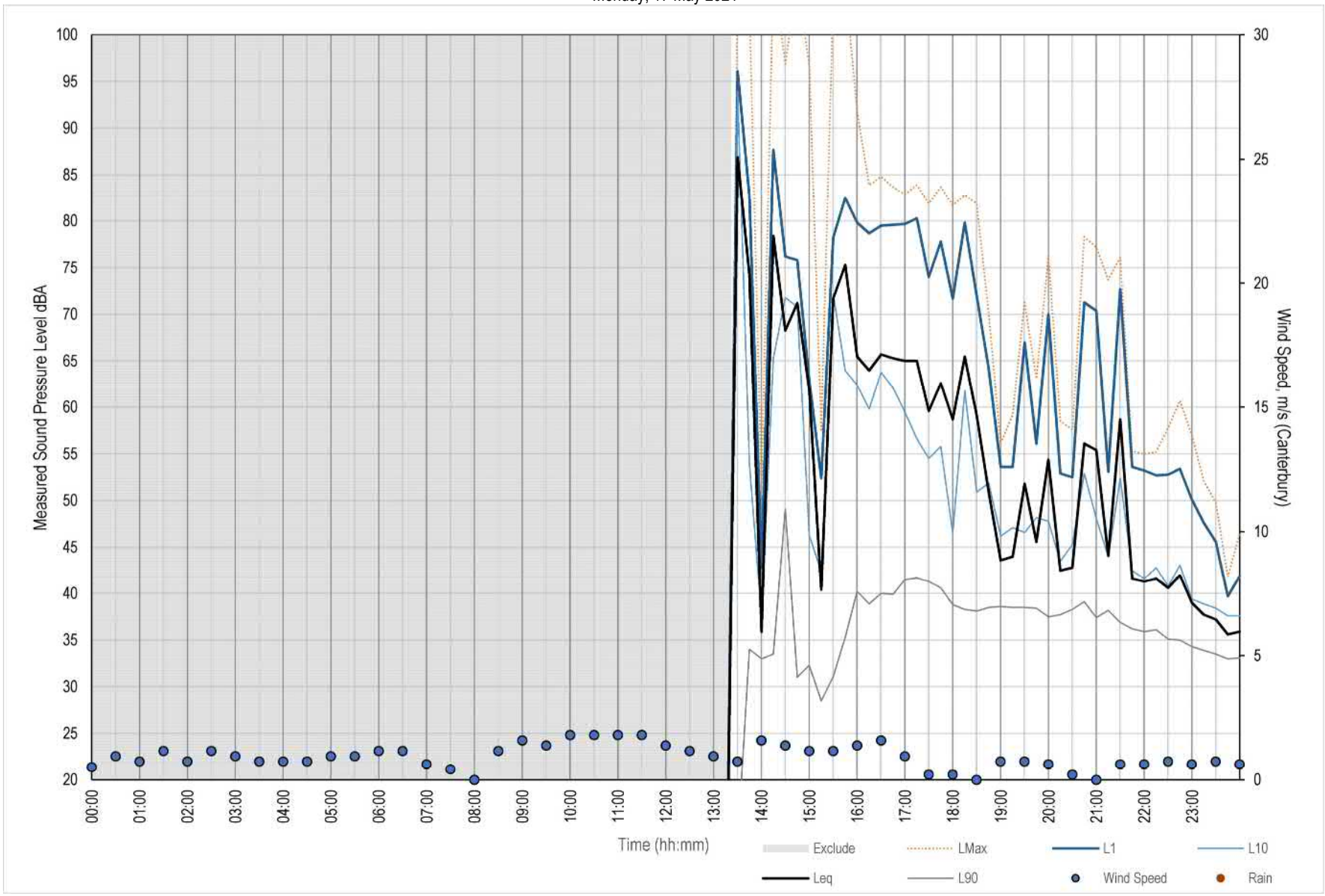
Measured Noise Levels - 14 Douglas Street

Wednesday, 26 May 2021



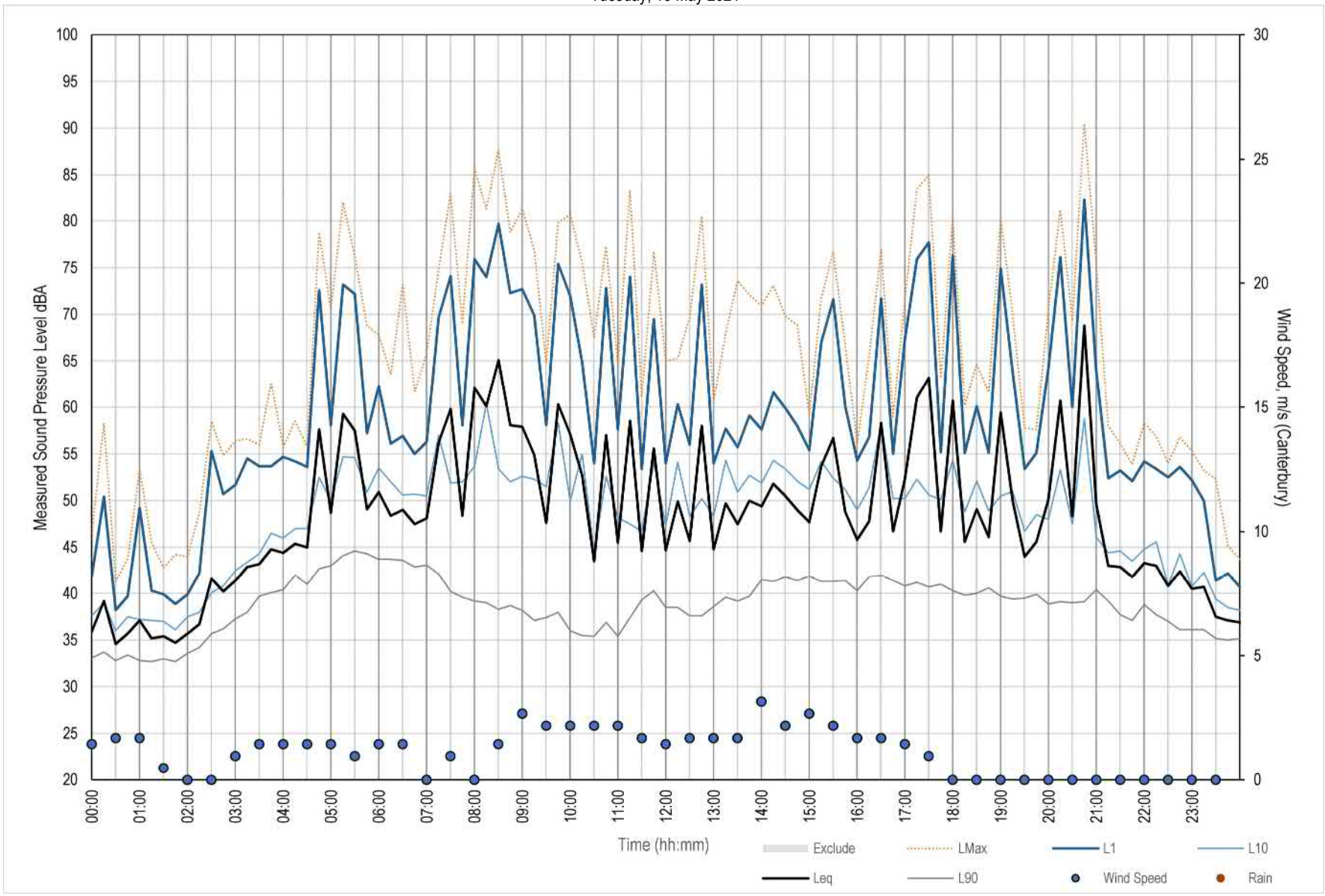
Measured Noise Levels - 139 Cavendish Street

Monday, 17 May 2021



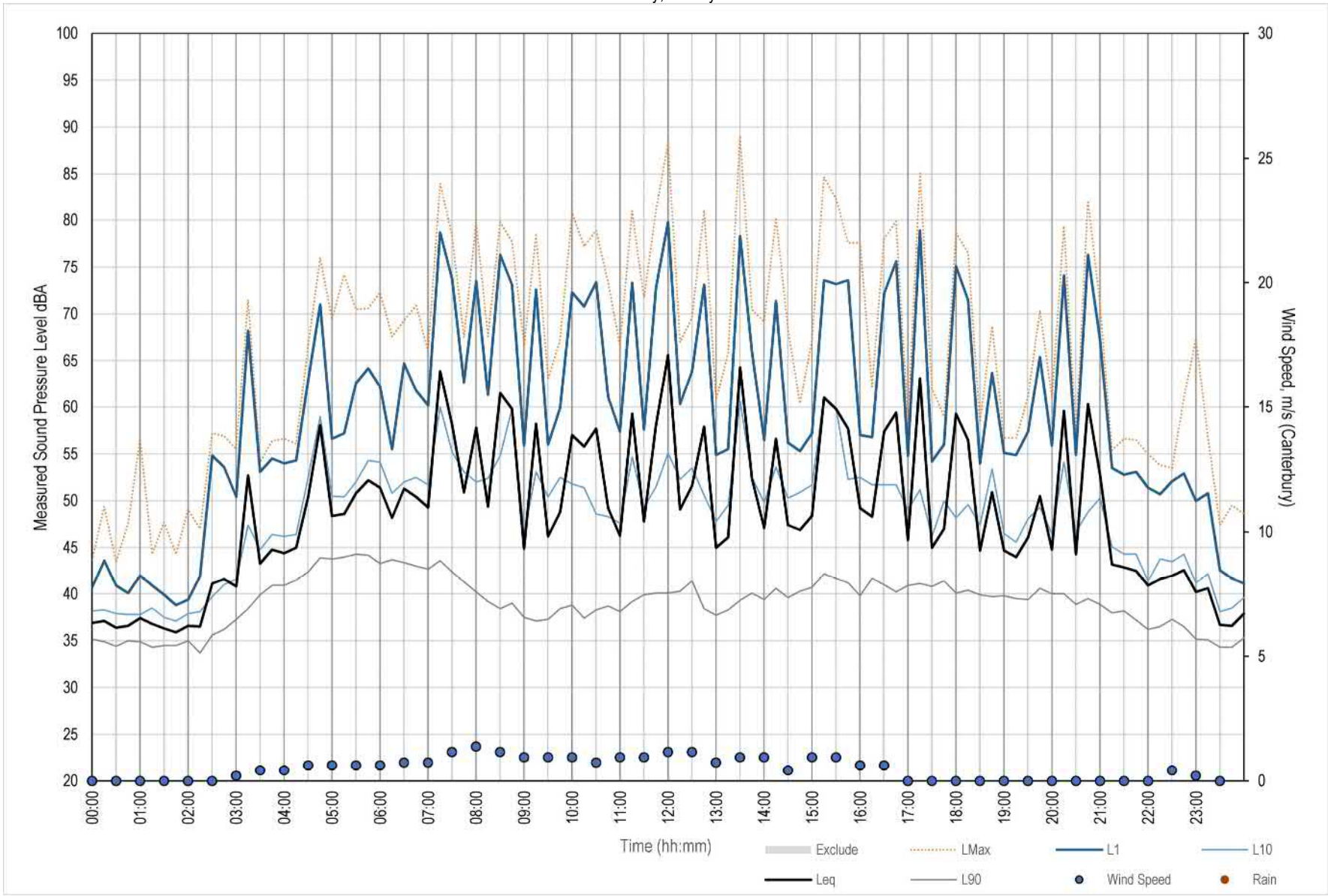
Measured Noise Levels - 139 Cavendish Street

Tuesday, 18 May 2021



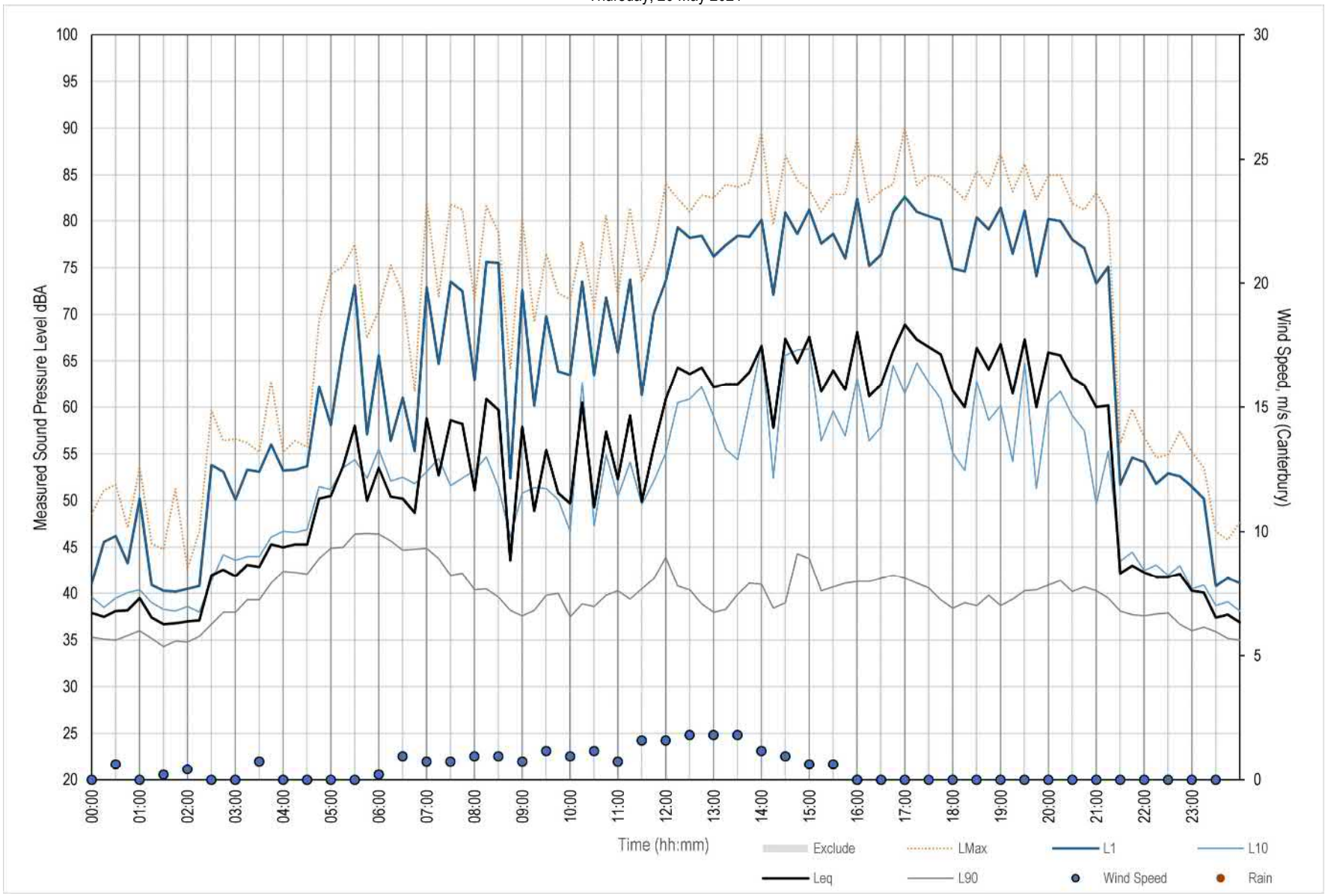
Measured Noise Levels - 139 Cavendish Street

Wednesday, 19 May 2021



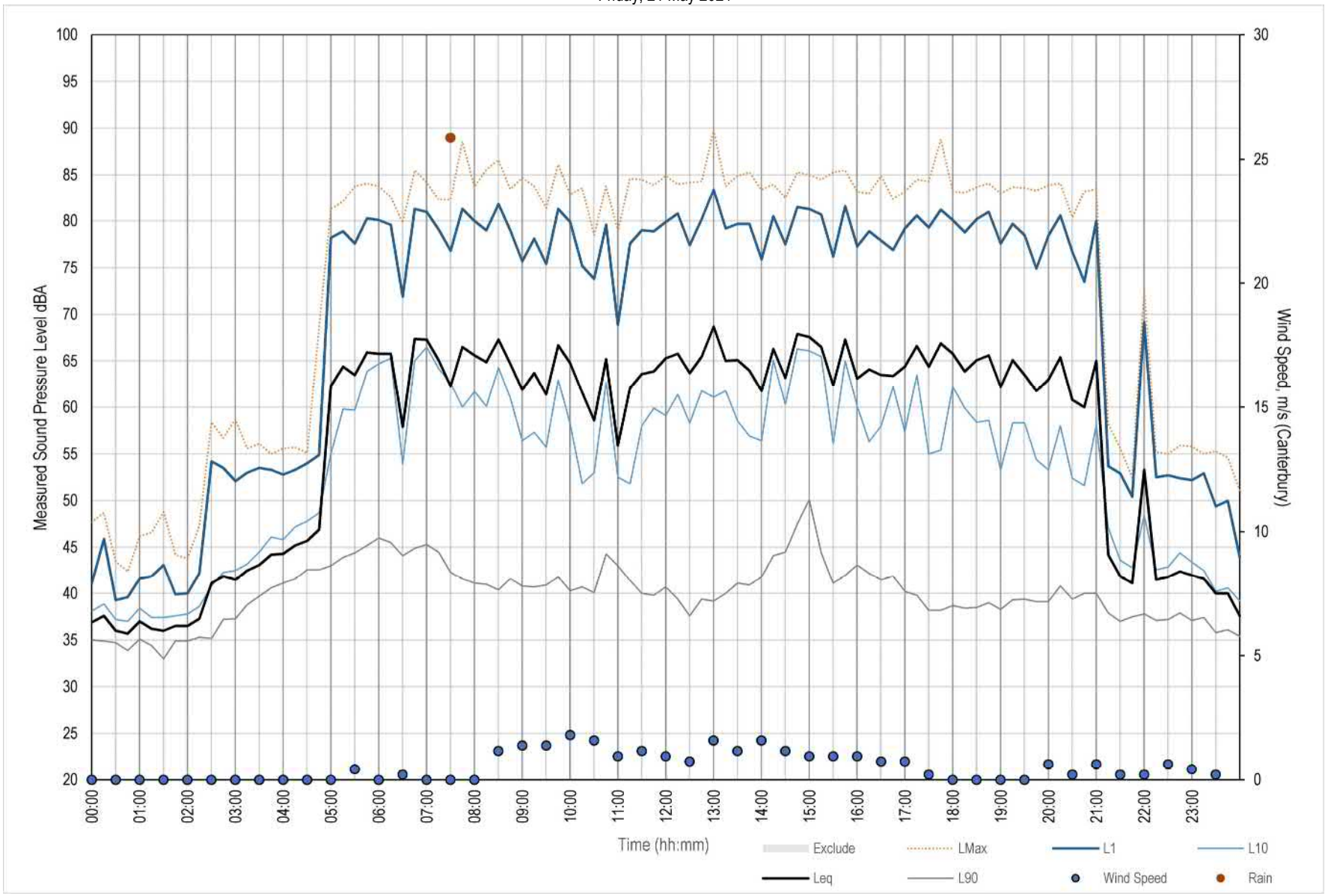
Measured Noise Levels - 139 Cavendish Street

Thursday, 20 May 2021



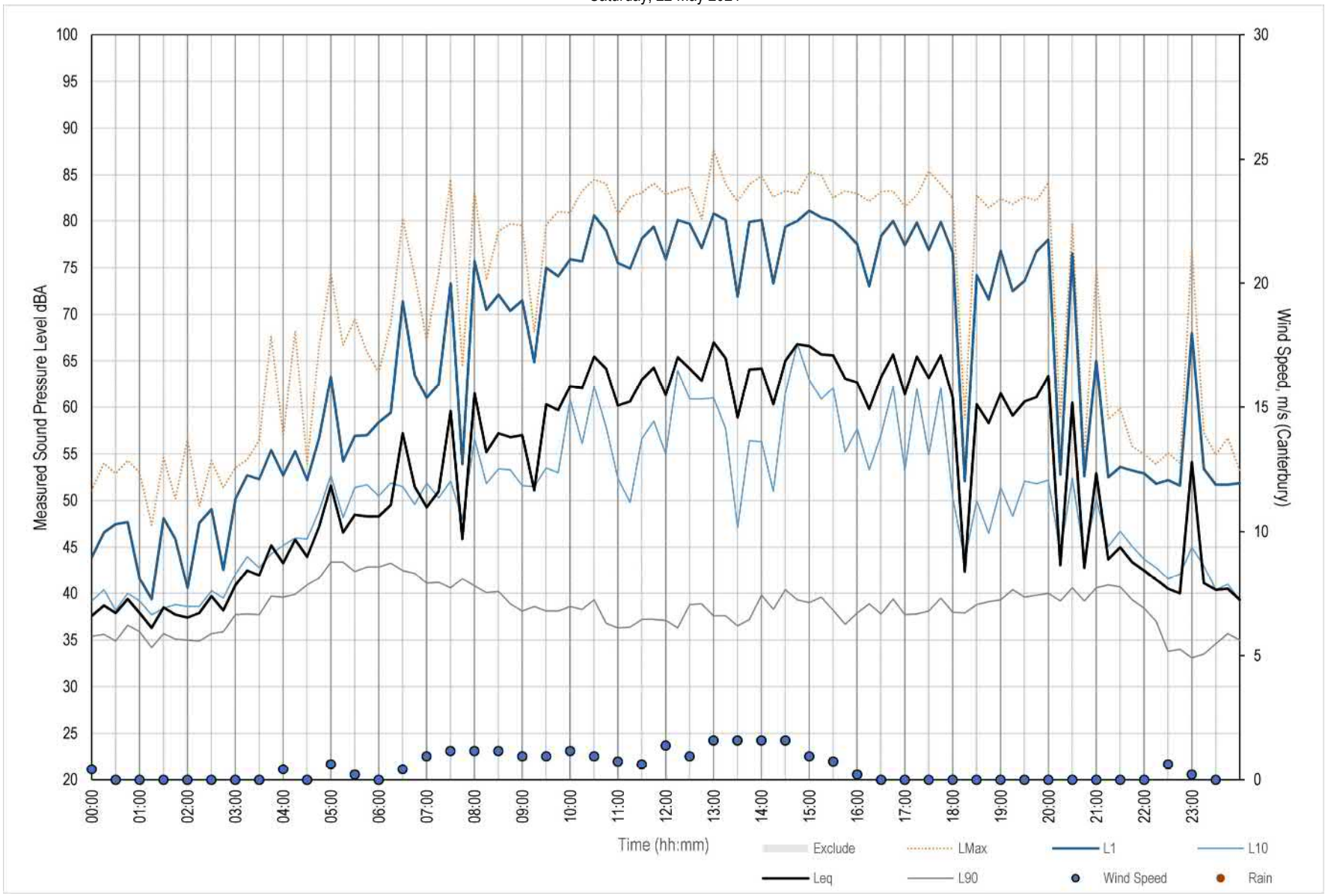
Measured Noise Levels - 139 Cavendish Street

Friday, 21 May 2021



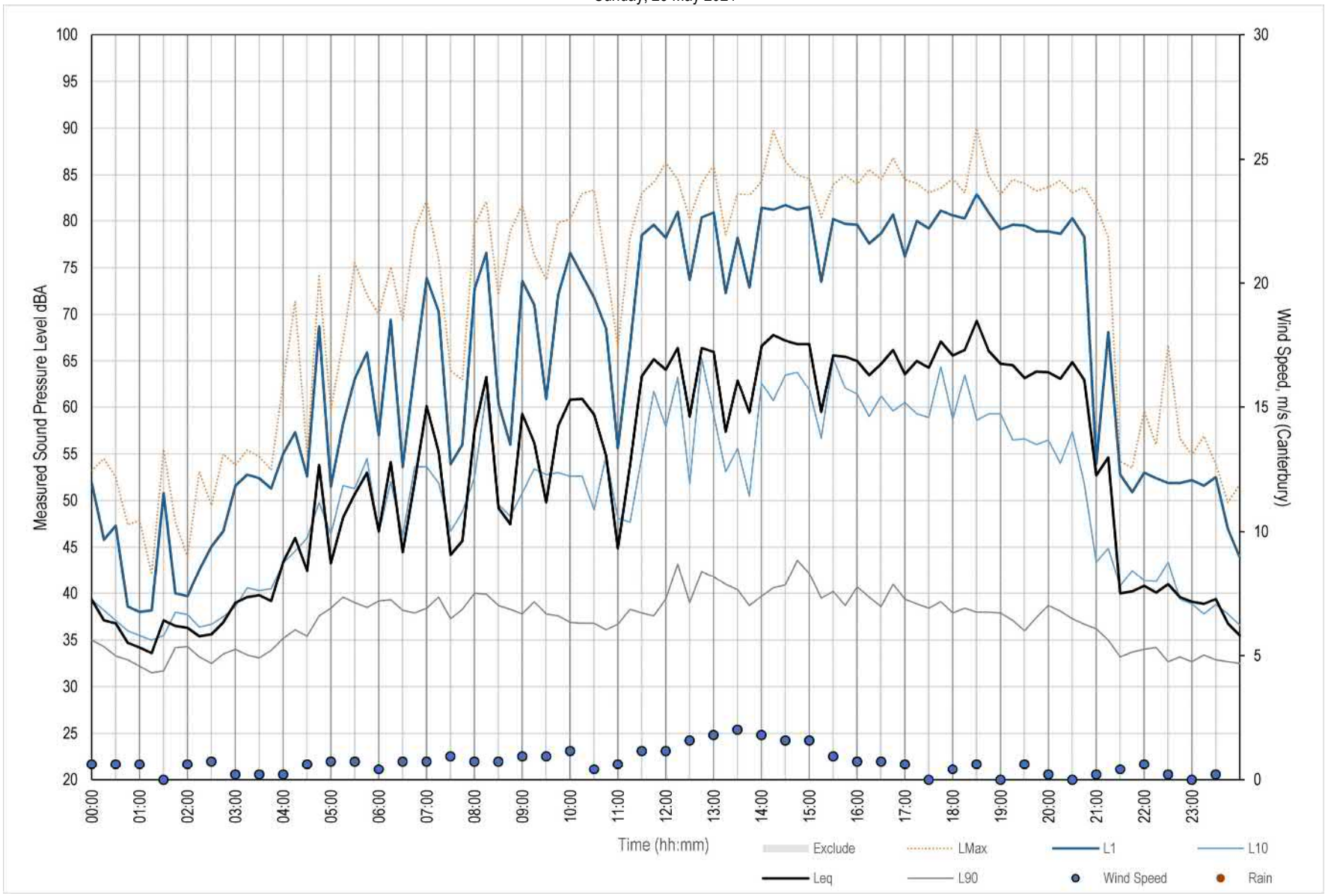
Measured Noise Levels - 139 Cavendish Street

Saturday, 22 May 2021



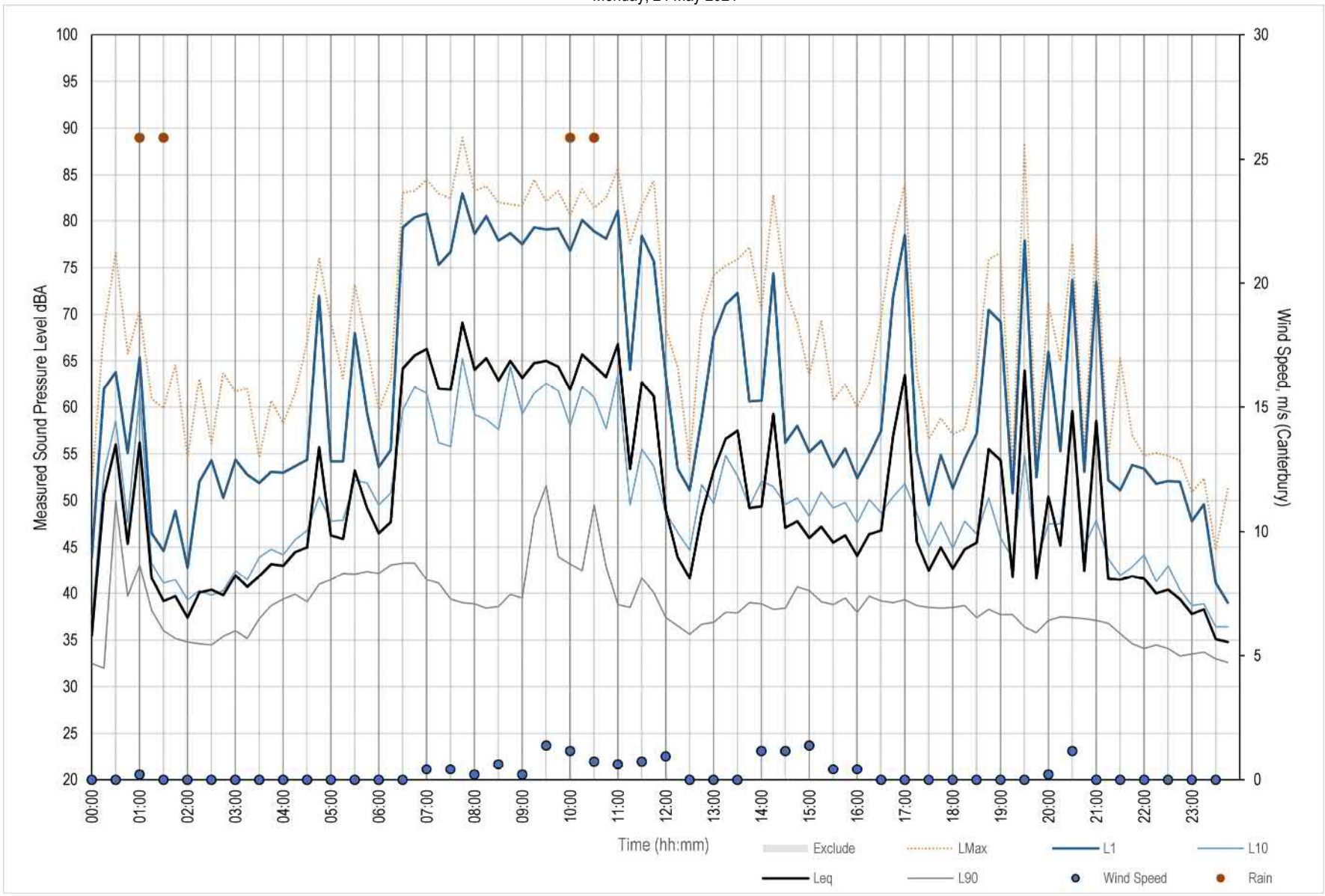
Measured Noise Levels - 139 Cavendish Street

Sunday, 23 May 2021



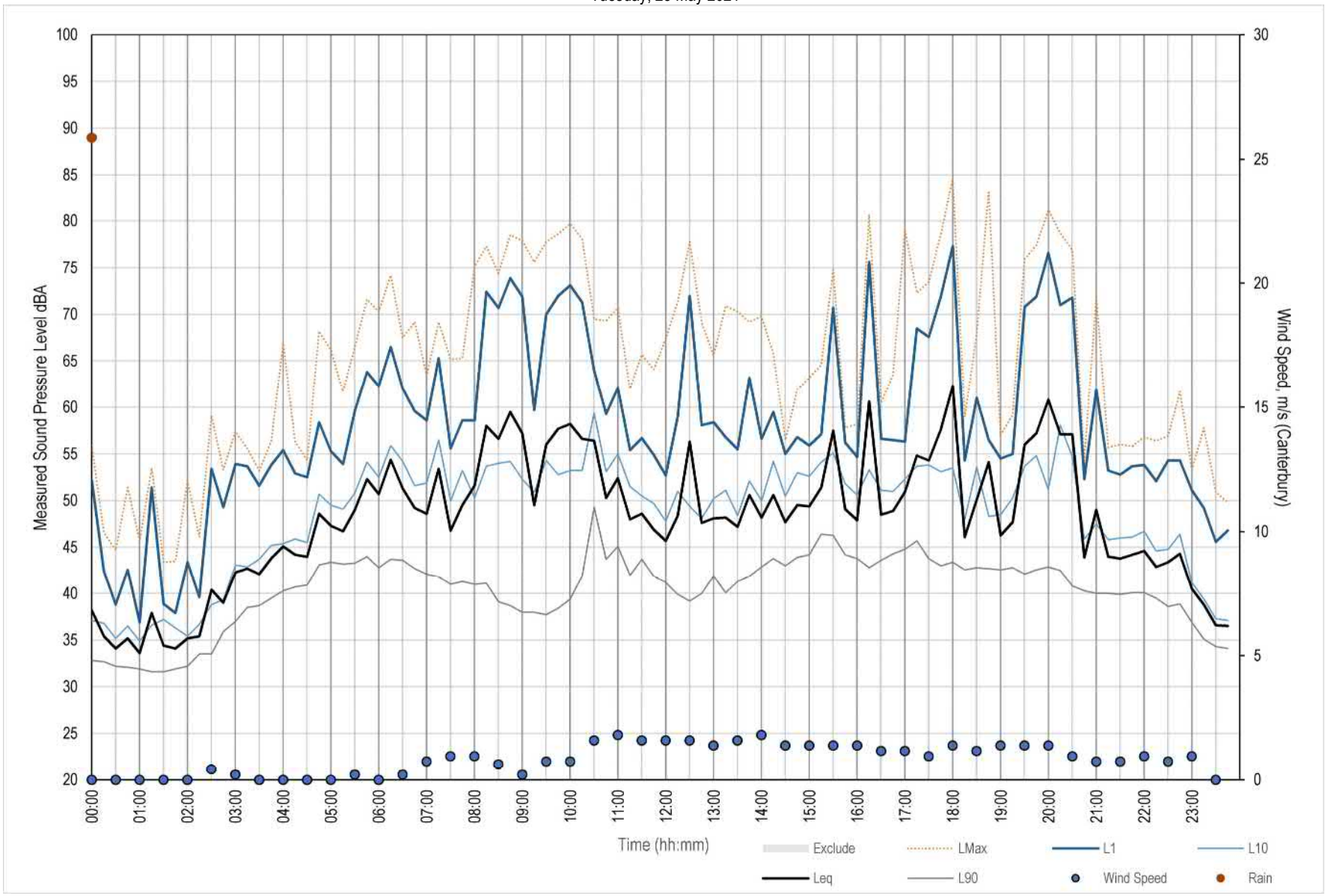
Measured Noise Levels - 139 Cavendish Street

Monday, 24 May 2021



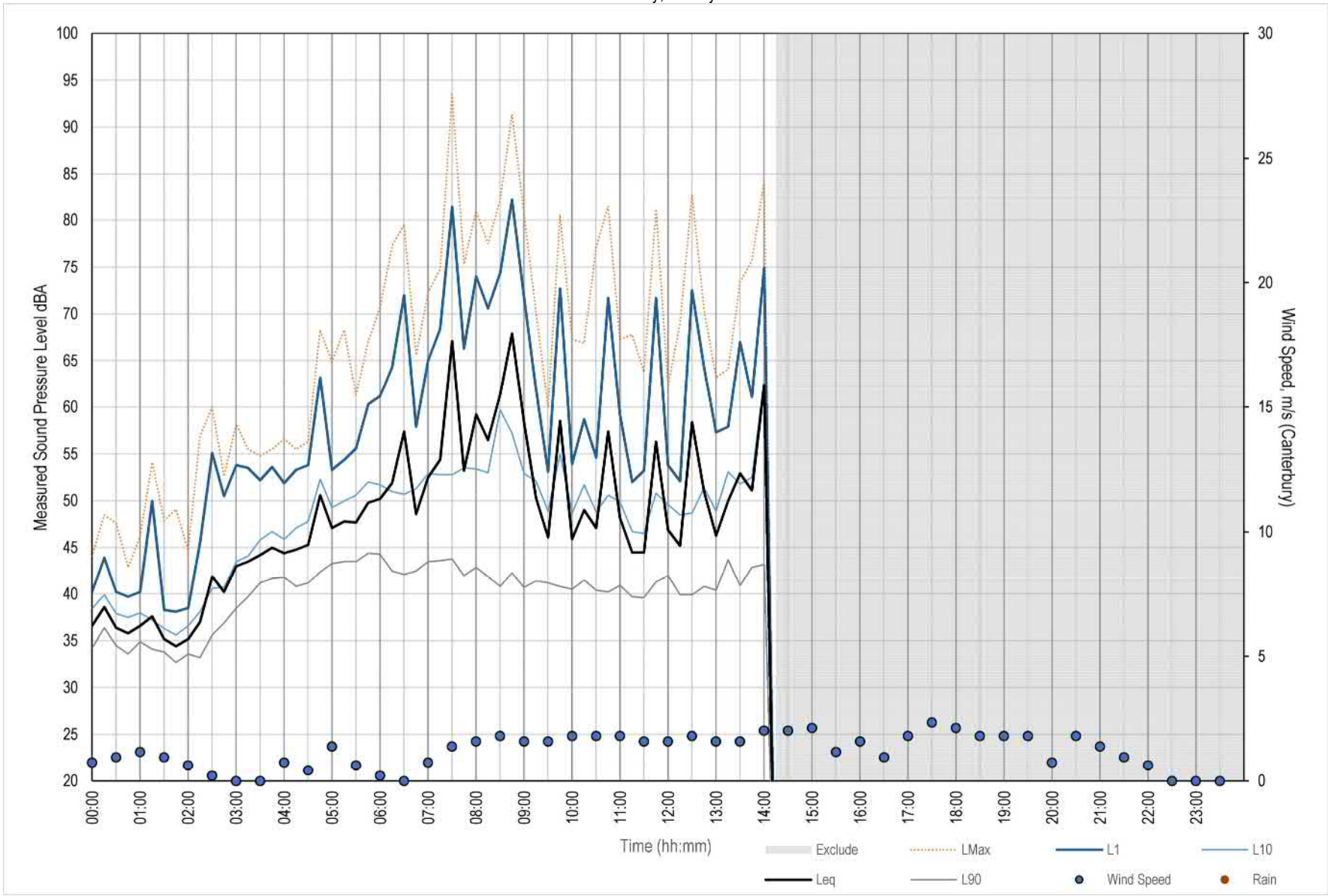
Measured Noise Levels - 139 Cavendish Street

Tuesday, 25 May 2021



Measured Noise Levels - 139 Cavendish Street

Wednesday, 26 May 2021



Appendix B

Predicted Noise Exceedance Maps

NCA 02

NCA01

	Author: NM
Date: 19/11/2021	Approved by: RW

N

0 30 60 90 m

1:2,500 at A3

Legend

- 0 to 10 dB (Clearly audible)
- 10 to 20 dB (Moderately intrusive)
- >20 (Highly intrusive)
- Highly noise affected
- Works Area

STANMORE TAP - Noise Level Exceedances

Scenario 1 - Site Establishment

To be read in conjunction with WSP document: PS124523-ACO-REP-01-TAP Stanmore

Map Source: NSW SIX Maps

NCA 02

NCA01

	Author: NM
Date: 16/11/2021	Approved by: RW

N

0 30 60 90 m

1:2,500 at A3

Legend

- 0 to 10 dB (Clearly audible)
- 10 to 20 dB (Moderately intrusive)
- >20 (Highly intrusive)
- Highly noise affected
- Works Area

STANMORE TAP - Noise Level Exceedances

Scenario 2 - Lift Works

To be read in conjunction with WSP document: PS124523-ACO-REP-01-TAP Stanmore

Map Source: NSW SIX Maps

NCA 02

NCA01

	Author: NM
Date: 16/11/2021	Approved by: RW

N

0 30 60 90 m

1:2,500 at A3

Legend

- 0 to 10 dB (Clearly audible)
- 10 to 20 dB (Moderately intrusive)
- >20 (Highly intrusive)
- Highly noise affected
- Works Area

STANMORE TAP - Noise Level Exceedances

Scenario 3 & 5 - Parking Modification Works and Platform Modification Works

To be read in conjunction with WSP document: PS124523-ACO-REP-01-TAP Stanmore

Map Source: NSW SIX Maps

	Author: NM	N
Date: 16/11/2021	Approved by: RW	

To be read in conjunction with WSP document: PS124523-ACO-REP-01-TAP Stanmore

Map Source: NSW SIX Maps

0 30 60 90 m

1:2,500 at A3

Legend

- 0 to 10 dB (Clearly audible)
- 10 to 20 dB (Moderately intrusive)
- >20 (Highly intrusive)
- Highly noise affected
- Works Area

STANMORE TAP - Noise Level Exceedances

Scenario 4 - Station Building Works

NCA 02

NCA01

	Author: NM
Date: 19/11/2021	Approved by: RW

N

0 30 60 90 m

1:2,500 at A3

Legend

- 0 to 10 dB (Clearly audible)
- 10 to 20 dB (Moderately intrusive)
- >20 (Highly intrusive)
- Highly noise affected
- Works Area

STANMORE TAP - Noise Level Exceedances

Scenario 6 - Demobilisation

To be read in conjunction with WSP document: PS124523-ACO-REP-01-TAP Stanmore

Map Source: NSW SIX Maps

Appendix C

Standard and Additional Noise and Vibration Mitigation Measures

C1 Standard Mitigation Measures

Table C.1 Standard management measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Implementation of any proposal specific mitigation measures required	Airborne noise Ground-borne noise & vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the EIA documentation (e.g. REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement stakeholder consultation measures (refer to Sections 8.2.1 and 8.3 for further details of community consultation measures)	Airborne noise Ground-borne noise & vibration	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted on a case-by-case basis: • Project Specific Website • Project Infoline • Construction Response Line • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings and • Community Based Forums (if required by approval conditions).
Register of noise and vibration sensitive receivers	Airborne noise Ground-borne noise & vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similar document and maintained in accordance with the requirements of this plan.
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise & vibration Airborne noise	Noise with special audible characteristics and vibration generating activities (including jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling) may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise approved by the relevant authority.
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics

ACTION REQUIRED	APPLIES TO	DETAILS
Site inductions ***continued***		• Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.
Monitoring	Airborne noise Ground-borne noise & vibration	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements shall be undertaken at all buildings within 25 metres of vibration generating activities when these activities commence to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to major project construction activities with the potential to cause property damage.

Table C.2 Standard source measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Equipment selection	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable, see APPENDIX C. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in APPENDIX C.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the allowable noise levels in APPENDIX C.
Use and siting of plant	Airborne-noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work, including delivery vehicles.

ACTION REQUIRED	APPLIES TO	DETAILS
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur *as far as possible* from sensitive receivers.
Minimise disturbance arising from delivery of goods to construction sites *continued*		Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction Related Traffic	Airborne noise	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as 'City' Model Rammer Hammers Air Parking brake engagement is silenced.
Prefabrication of materials off-site	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.
Engine compression brakes	Airborne noise	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.

Table C.3 Standard path measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

C2 Additional Mitigation Measures

Table C.4 Additional mitigation measures

MEASURE	DESCRIPTION	ABBREVIATION
Periodic Notification	For each I&P project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au). Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the I&P Community Engagement Team in cases where AMMM are not triggered as shown in Tables 9 to 11, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the I&P Community Engagement Team will determine the community engagement strategy on a case-by-case basis.	PN
Verification Monitoring	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise). The purpose of monitoring is to confirm that: • construction noise and vibration from the project are consistent with the predictions in the noise assessment • mitigation and management of construction noise and vibration is appropriate for receivers affected by the works Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Refer to Section 8.4 for more details.	V
Specific Notification	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. • Letters may be letterbox dropped or hand distributed • Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs • Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.	SN
Respite Offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre- purchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all IP projects.	RO

MEASURE	DESCRIPTION	ABBREVIATION
Alternative Accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative construction methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance withthe VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC
Respite Period	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week, except where there is a Duration Respite. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol (Section 6). Note; this management measure does not apply to OOHW Period 1 – Days (See Table 1).	RP
Duration Reduction	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all I&P projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with I&P Community Engagement Representatives.	DR

ABOUT US

WSP is one of the world's leading professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors and environmental specialists, as well as other design, program and construction management professionals. We design lasting solutions in the Transport & Water, Property & Buildings, Earth & Environment, and Mining & Power sector as well as offering strategic Advisory, Engagement & Digital services. With approximately 6,100 talented people in more than 50 offices in Australia and New Zealand, we engineer future ready projects that will help societies grow for lifetimes to come. www.wsp.com/en-au/.