RENZO TONIN & ASSOCIATES
inspired to achieve

Acoustics
Vibration
Structural Dynamics

C433GGEE - PAKINGTON ST & GORDON AVE, GEELONG WEST

Acoustic Report

7 February 2025

City of Greater Geelong

ME567-01F01 Acoustic Report (r1).docx

40 YEARS 1982-2022 ACOUSTIC ENGINEERING EXCELLENCE

Melbourne Sydney Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 30 117 463 297
Level 2, 7 Meaden Street, Southbank VIC 3006
P (03) 9690 6005 melbourne@renzotonin.com.au www.renzotonin.com.au

Document details

Detail	Reference
Doc reference:	ME567-01F01 Acoustic Report (r1).docx
Prepared for:	City of Greater Geelong
Address:	PO Box 104 Geelong VIC 3220
Attention:	

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
17.01.2025	Draft for comment		0			
07.02.2025	Issued		1			

File Path: M:\AssocMelbProjects\ME551-ME600\ME567 np Pakington Street & Gordon Ave - UDF\1 Docs\ME567-01F01 Acoustic Report (r1).docx

Executive summary

Renzo Tonin & Associates was engaged to undertake an acoustic assessment of existing noise levels in the combined Pakington Street Urban Design Frameworks study area, Geelong West, and to advise on sensitive land use matters and mitigation measures. Specifically the scope of works is focused on two of the three overall precincts – the Pakington North Precinct (in red) and the Gordon Avenue Precinct (in blue) shown in Section 2.1.

Renzo Tonin and Associates (RTA) understand that an acoustic assessment to address the EPA letter (dated 9 October 2024) is required.

In conducting the acoustic assessment, Renzo Tonin & Associates has:

- Quantified relevant noise and vibration criteria: EPA 1826-P1 'Noise Protocol', noise peaks from train passage, Passenger Rail Infrastructure Noise Policy' external noise thresholds, Victoria Planning Provision Clause 58.04 / 55.07 / Better Apartments Design Standards, Vibration values for human comfort
- Analysed the noise monitoring and measurements to determine existing noise conditions
- Analysed the vibration monitoring to determine existing vibration conditions and compare to human comfort values for continuous and impulsive/intermittent vibration
- Determined noise limits in accordance with the relevant legislation and guidelines
- Constructed a three-dimensional noise model of the Subject Development, to assess various noise impacts (described within this report)
- Assessed and compared predicted levels to noise limits for existing and future conditions
- Provided commentary on predicted levels compared with noise limits, and potential mitigation measures/strategies

Renzo Tonin & Associates have conducted a conservative assessment of the noise impacts predicted for the proposed precincts, and while these current noise emissions exceed the determined noise limits (including the proposed changes to zoning), in accordance with the EPA regulations and guidelines, the implementation of noise mitigation measures such as building siting and design (details in Section 6) can ensure the subject area is suitable for sensitive uses.

The assessment has reviewed the proposed zoning changes, and the implications of these changes. While clearly showing the determined noise limits (i.e. EPA Pub 1826.4) will be lower, due to the increase in sensitive uses, it also indicates that there is a general ability to support sensitive uses. While specifics regarding mitigation strategies do not form part of this assessment, guidance is provided as a hierarchy of controls that seek to implement the best order of solutions (i.e. the effectiveness of controls goes from elimination of noise impacts to providing acoustic treatment).

Section 5 details the results of the predictive modelling and provides markups to assist with understanding where these noise impacts are within the subject area and Section 6 provides a summary of these results. As this assessment is aimed at providing guidance to the suitability for sensitive uses only, and not detailed design, specific recommendations for acoustic mitigation have been omitted. These markups can be translated into the Design & Development Overlays (DDOs) to direct development.

Based on the above, the proposed precincts will need to consider a combination of acoustic design options and mitigation measures to ensure that any new sensitive use is not unreasonably affected by existing noise from road and rail networks, as well as any future commercial/industry noise. Renzo Tonin & Associates are confident that with reasonable design and mitigation strategies the development can conform with all nominated criteria.

Contents

List of tables

List of figures

1 Introduction

Renzo Tonin & Associates was engaged to undertake an acoustic assessment of the proposed precinct C433ggee – Pakington St & Gordon Ave, Geelong West, within the Pakington North Precinct (in red) and the Gordon Avenue Precinct (in blue)shown in Section 2.1.

Renzo Tonin and Associates (RTA) understand that an acoustic assessment to address the EPA letter (dated 9 October 2024) is required.

EPA letter dated 9 October 2024 sets out the following key comments:

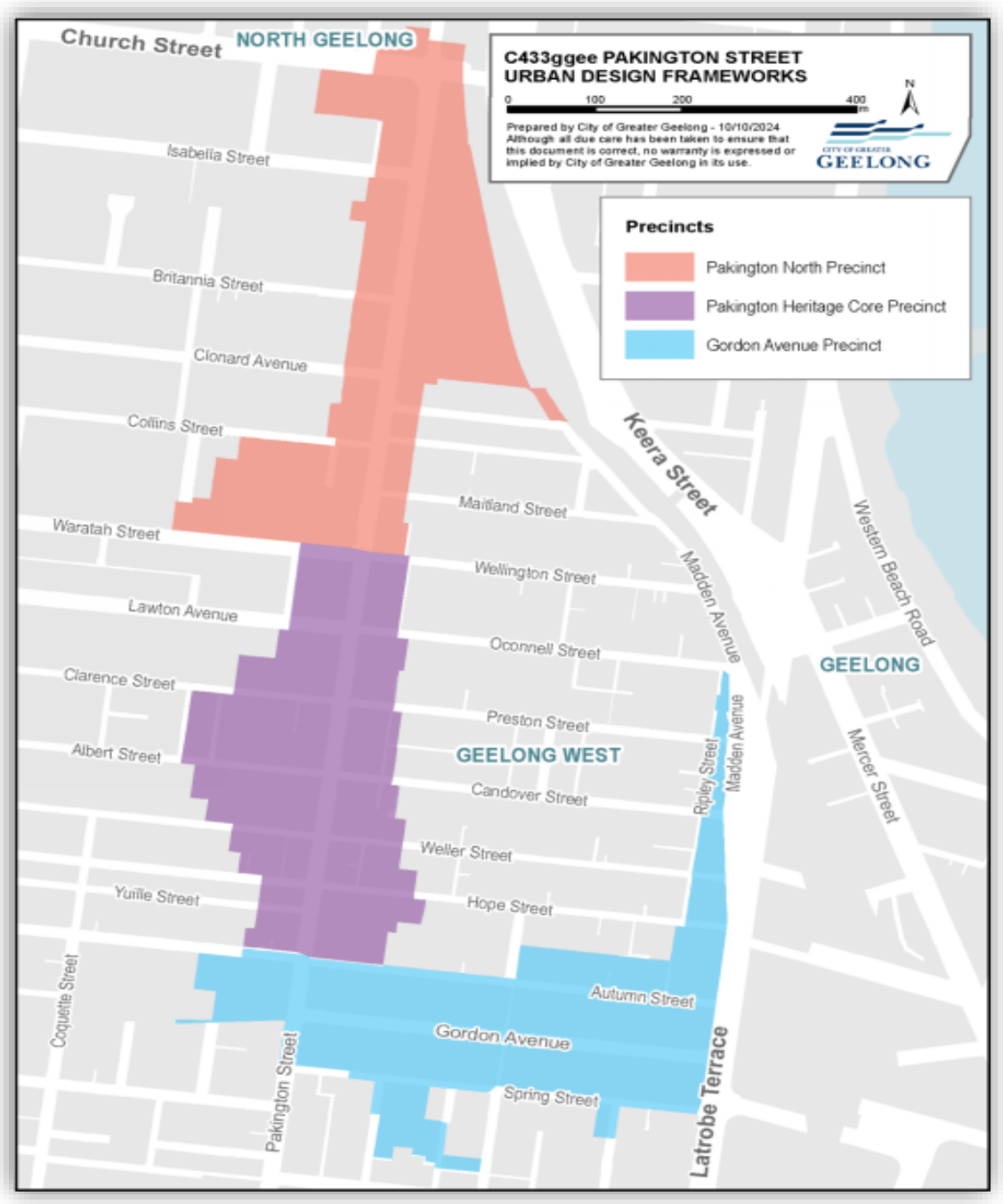
> *… EPA does not consider it is appropriate to defer the assessment of noise impacts for this precinct. EPA recommends that an acoustic assessment is completed prior to the Amendment progressing. This will achieve the following objectives:*
>
> 1. *Assess noise from the rail siding yard in accordance with the Noise Protocol.*
> 2. *Assess the implication on the zoning levels and the noise limits that apply at the surrounding properties.*
> 3. *Identify where land is affected by noise and where attenuation measures are required.*
> 4. *Inform the location, design, and orientation of the sensitive land uses within the PNP.*
> 5. *Inform planning controls.*
>
> *EPA considers that controls such as suitable setback distances, use of sound barriers, orientation and positioning of bedroom and living areas away from the rail siding yard should be prioritised in the acoustic assessment. These measures should be implemented before considering façade treatments, to address both internal and external noise levels for sensitive land uses.*
>
> *…assessment must address the road traffic noise from Princes Highway, with respect to outdoor amenity for apartments, and 'other' sensitive land uses not assessed under Clauses 57 and 58, as well as the PRINP, with respect to rail noise. This acoustic assessment should ensure it considers Section 7 'policy principles' of the PRINP.*

APPENDIX A contains a glossary of acoustic terms used in this report.

2 Development overview

2.1 Subject development precincts

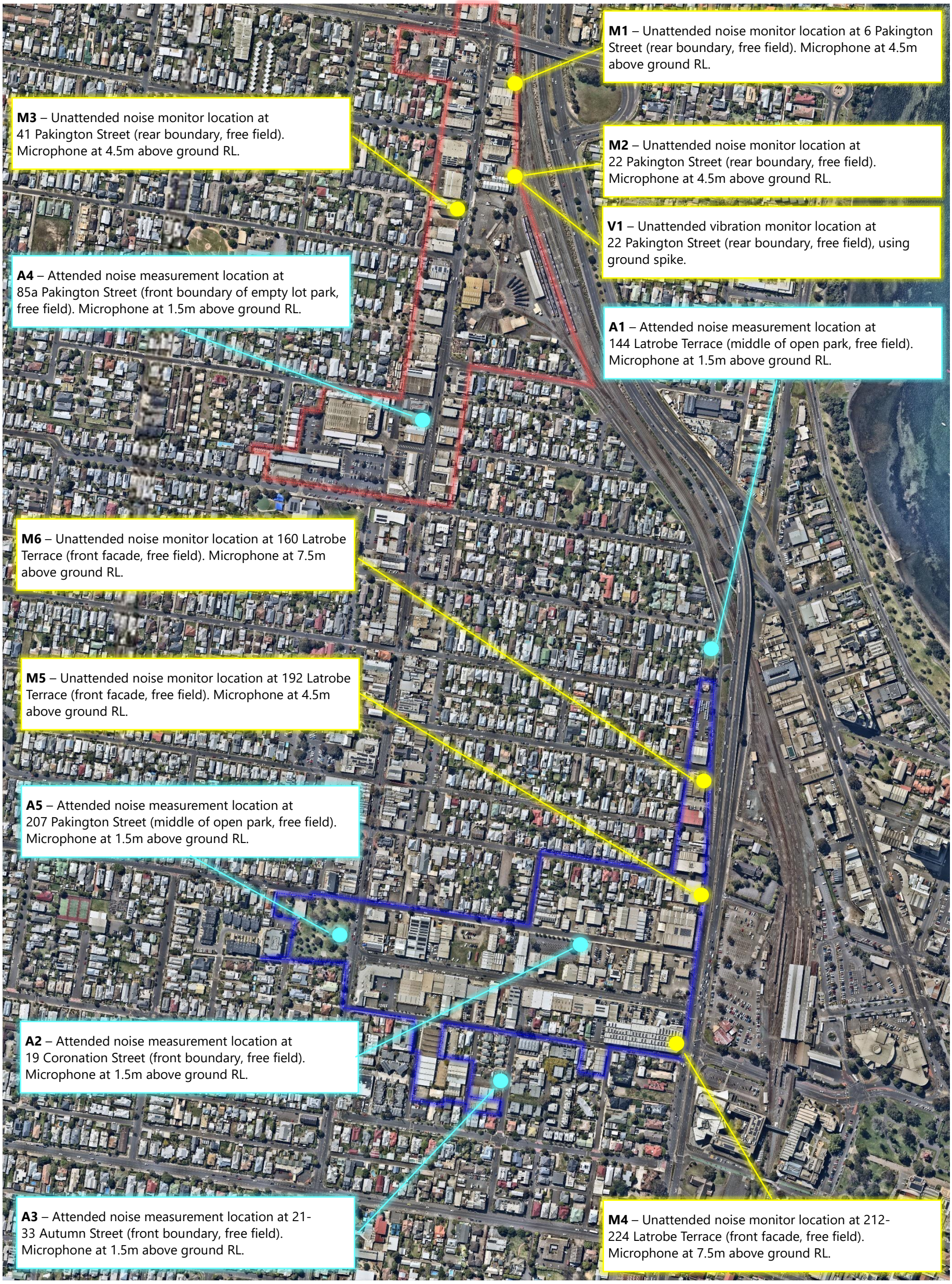
The Subject Development is indicatively shown below, with the Pakington North Precinct and the Gordan Avenue Precinct the focus of our acoustic assessment.



2.2 Subject development overview, monitoring and measurement locations

Figure 1 present an overview of the Subject Development Precincts, unattended monitoring and attended measurement locations.

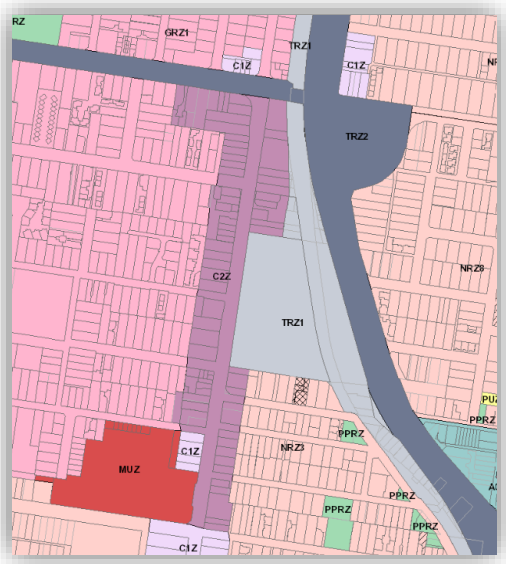
Figure 1: Development Site, unattended monitoring and attended measurement locations

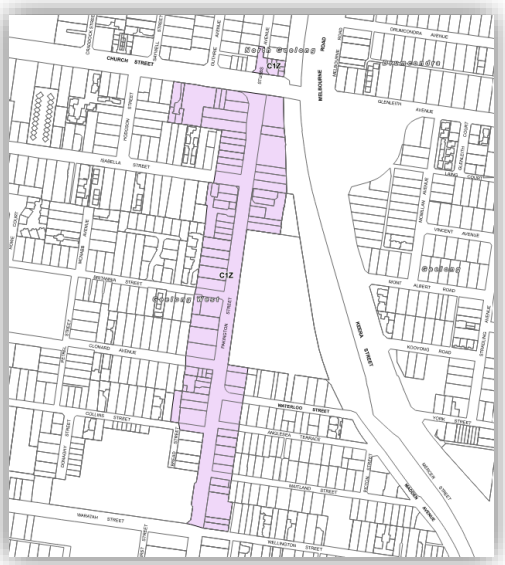


2.3 Proposed zoning changes

As part of the precinct redevelopment, there are proposed land use changes (zoning) that has the potential to impact the development of individual locations within these precincts, shown below:

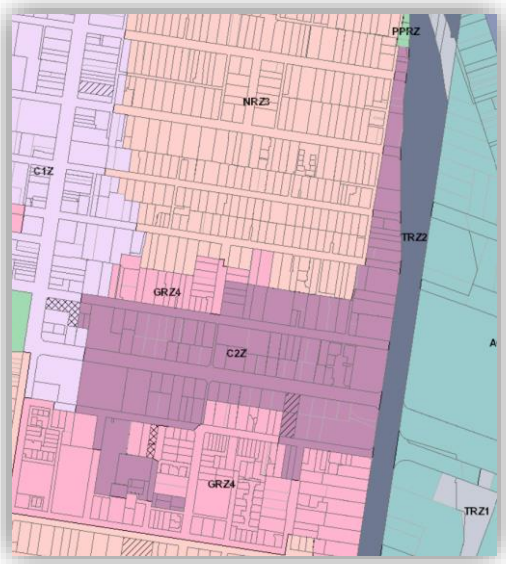
Pakington North Precinct





The only change to the zoning for Pakington North Precinct is that the existing Commercial Zone 2 (C2Z) (type 3 designation with respect to EPA Pub. 1826.4) is proposed to be changed to Commercial Zone 1 (C1Z) (type 2 designation with respect to EPA Pub. 1826.4).

Gordon Avenue Precinct



A few zoning changes are proposed for Gordon Avenue Precinct, with Commercial Zone 2 (C2Z) (type 3 designation with respect to EPA Pub. 1826.4) change to Mixed Use Zone (MUZ) and Commercial Zone 1 (C1Z) (both type 2 designation with respect to EPA Pub. 1826.4) and Residential Growth Zone 5 (RGZ5) & Public Parks & Recreation Zone (PPRZ) (both type 1 designation with respect to EPA Pub. 1826.4).

3 Noise and vibration measurements

3.1 Unattended long-term noise monitoring

To quantify the existing noise levels in the area, Renzo Tonin & Associates conducted unattended noise monitoring as detailed below. RT&A conducted door knocking, to seek permission to place the monitoring equipment within the private property (as a safe and secure location) for the duration. The monitoring and measurement locations are shown in Figure 1 and described in Table 1 and Table 4. APPENDIX B presents graphs of the unattended monitored noise levels at each location.

Table 1: Noise monitoring locations

ID	Location	Details
M1	6 Pakington Street (background monitoring location) Representative of the most affected residential receivers directly overlooking rail corridor and Princes Highway	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • The microphone was set up 4.5 metres above ground level on the rear boundary (western end). • Generally low wind and limited precipitation for the duration of the monitoring. • The noise environment was dominated by road traffic noise on Princes Highway. Other noise sources include rail traffic noise from the passenger line and the rail siding yard.
M2	22 Pakington Street (background monitoring location) Representative of the most affected residential receivers directly overlooking rail corridor and Princes Highway	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • The microphone was set up 4.5 metres above ground level on the rear boundary (western end). • Generally low wind and limited precipitation for the duration of the monitoring • The noise environment was dominated by road traffic noise on Princes Highway. Other noise sources include rail traffic noise from the passenger line and the rail siding yard.
M3	41 Pakington Street (background monitoring location) Representative of the most affected residential receivers on Pakington Street	• Monitoring period: Tuesday 10 to Tuesday 17 December 2024 • The microphone was set up 4.5 metres above ground level on the front awning (western end) direct to Pakington Street. • Generally low wind and limited precipitation for the duration of the monitoring • The noise environment was dominated by road traffic noise on Princes Highway. Other noise sources include rail traffic noise from the passenger line and the rail siding yard, and local traffic along Pakington Street.
M4	212-224 Latrobe Terrace (background monitoring location) Representative of the most affected residential receivers direct to Princes Highway	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • The microphone was set up 7.5 metres above ground level on the front awning (western end) direct to Latrobe Terrace. • Generally low wind and limited precipitation for the duration of the monitoring • The noise environment was dominated by road traffic noise on Princes Highway.

ID	Location	Details
M5	192 Latrobe Terrace (background monitoring location) Representative of the most affected residential receivers direct to Princes Highway	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • The microphone was set up 4.5 metres above ground level on the front awning (western end) direct to Latrobe Terrace. • Generally low wind and limited precipitation for the duration of the monitoring • The noise environment was dominated by road traffic noise on Princes Highway. Other noise sources include rail traffic noise from the passenger line.
M6	160 Latrobe Terrace (background monitoring location) Representative of the most affected residential receivers direct to Princes Highway	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • The microphone was set up 7.5 metres above ground level on the front boundary (western end) direct to Madden Avenue and Princes Highway. • Generally low wind and limited precipitation for the duration of the monitoring • The noise environment was dominated by road traffic noise on Princes Highway. Other noise sources include rail traffic noise from the passenger line.

Notes: • The monitors were set to record broadband and spectral noise descriptors, and audio for noise source verification

Table 2 presents the representative background noise levels, determined in accordance with EPA Pub. 1997 methodology, relevant for derivation of noise limits.

Table 2: Representative period average background noise levels

ID	Location	Representative period background noise level, L_{90} dB(A)		
		Day	Evening	Night
M1	6 Pakington Street	63	60	54
M2	22 Pakington Street	59	58	55
M3	41 Pakington Street	56	56	48
M4	212-224 Latrobe Terrace	60	56	51
M5	192 Latrobe Terrace	63	61	53
M6	160 Latrobe Terrace	63	58	49

EPA 1826 Period Definitions:
Day: Monday-to-Saturday 7am-to-6pm; Sundays N/A
Evening: Monday-to-Saturday 6pm-to-10pm; Sundays 7am-to-10pm
Night: All days 10pm-to-7am

Notes: NTI XL2 Class 1 noise monitors were used for the campaign. The calibration of the device was checked in the field immediately before and after the measurement using a Brüel & Kjær Type 4231 calibrator; no drift in calibration was observed. The noise monitors conform with IEC 61672-1:2013 and IEC 61260-1:2014; the sound calibrator conforms with IEC 60942:2017, and all carry manufacturers certification or NATA certification detailing Standard conformance testing within the last two years and one year respectively.

3.2 Unattended long-term vibration monitoring

To quantify the existing vibration levels at the most affect location to the rail corridor, Renzo Tonin & Associates conducted unattended vibration monitoring as detailed below. RT&A conducted door knocking, to seek permission to place the monitoring equipment within the private property (as a safe and secure location) for the duration. The monitoring location is shown in Figure 1 and described in Table 3.

Table 3: Vibration monitoring location

ID	Location	Details
V1	22 Pakington Street (background measurement location) Representative of the most affected residential receivers direct to rail corridor	• Monitoring period: Tuesday 10 to Thursday 19 December 2024 • Monitor was set up directly next to noise monitor location M2. • The monitor was set up using a ground spike on the rear boundary (western end).

3.2.1.1 Attended noise measurements

To assist with identifying the existing noise sources in the area, Renzo Tonin & Associates conducted attended noise measurements on two separate occasions: Tuesday 10 December 2024 and Thursday 19 December 2024. The measurement locations (A1-A5) are shown in Figure 1 and described in Table 4. These measurements provide a greater understanding of the surrounding environment, local noise sources and the potential noise impacts at sensitive receiver locations.

Table 4: Attended noise measurement locations

ID	Location	Measured noise level[1], dB(A)		Details of site selections
		L_{Aeq}	L_{A90}	
A1	144 Latrobe Terrace (within an open park)	61	56	• Conducted on Tuesday 10 December 2024 between 2:00pm & 3:00pm • Provide context for unattended noise monitoring along Latrobe Terrace. • Calm meteorological conditions • Dominant noise source observed was road traffic noise from Latrobe Terrace /Princes Highway.
A2	19 Coronation Street (within an open car park space)	50	40	• Conducted on Tuesday 10 December 2024 between 1:00pm & 3:00pm • Provide context for sensitive areas away from Latrobe Terrace. • Calm meteorological conditions • Dominant noise source observed was distant road traffic noise from Latrobe Terrace /Princes Highway. • Other noise sources observed included: - Birds / wildlife - Local traffic
A3	21-33 Autumn Street (on the boundary of an open car park space)	55	47	• Conducted on Thursday 19 December 2024 between 12:00pm & 2:00pm • Provide context for sensitive areas away from Latrobe Terrace. • Calm meteorological conditions • Dominant noise source observed was distant road traffic noise from Latrobe Terrace /Princes Highway. • Other noise sources observed included: - Birds / wildlife - Local traffic
A4	85a Pakington Street (front boundary of open vacant lot)	58	52	• Conducted on Thursday 19 December 2024 between 12:00pm & 2:00pm • Provide context for sensitive areas away from Latrobe Terrace. • Calm meteorological conditions • Dominant noise source observed was local traffic on Pakington Street • distant road traffic noise from Latrobe Terrace /Princes Highway • Other noise sources observed included: - Distant road traffic noise from Latrobe Terrace /Princes Highway - Rail siding and passenger rail traffic operations
A5	207 Pakington Street (setback in open recreation park)	56	50	• Conducted on Thursday 19 December 2024 between 11:45am & 12:00pm • Provide context for sensitive areas away from Latrobe Terrace. • Calm meteorological conditions • Dominant noise source observed was distant local traffic noise from Pakington Street and Gordon Avenue.

4 Legislation and guidelines

With a range of guidelines and legislation that is used to assess environmental noise, Renzo Tonin & Associates have identified the following sources that will impact on the proposed redevelopment:

•	Traffic noise from Princes Highway/Latrobe Terrace
•	Rail noise from the Geelong passenger railway line
•	Rail noise associated with the rail sidings yard
•	Traffic noise from Pakington Street and Gordon Avenue and other local roads

Note: * Noise from commercial operations in the areas was not part of the scope nominated by EPA and therefore is not assessed in this report.

The long-term unattended and onsite observations during attended measurements confirm that the dominant noise sources are Princes Highway traffic noise and the commercial use and operation of the rail siding yard. These external noise sources will drive the insulation requirements for the acoustic design of building envelopes within the proposed development, with other noise sources expected to comply with the relevant statutory legislation or acceptable guidelines. The relevant guidance is discussed below.

4.1 EPA Publication 1826.4 Noise Protocol – Commercial noise limits

Within the Melbourne metropolitan region, noise from commercial plant and activities affecting residential properties is governed by the Victorian Part 1 of EPA Publication 1826 *'Noise Limit and Assessment Protocol for the Control of Noise from Commercial, Industrial and Trade Premises and Entertainment Venues'* (1826-P1), legislated by way of the Environment Protection Act 2017 (VIC); to protect beneficial domestic uses, in particular sleep during the night period. EPA 1826-P1 noise limits are calculated from zoning and; background noise levels measured within an area, in absence of intrusive commercial noise sources. In Addition, where applicable, the effective noise level is determined, for noise from commercial, industrial and trade premises.

The effective noise level is calculated using the following equation:

$$\mathbf{ENL = L_{Aeq} + (A_{dur}) + (A_{tone}) + (A_{imp}) + (A_{int}) + (A_{refl}) + (A_{ind})}$$

The ENL is determined as a 30-minute equivalent sound pressure level $L_{Aeq,30min}$ adjusted, where relevant for:

a. duration (A_{dur})

10 log10 (total time source operating / measurement period) dB

b. noise character

i. tonality (A_{tone})	ii. impulse (A_{imp})	iii. intermittency (A_{int})
+2dB for just-detectable tonal character	*+2dB for just-detectable impulsive character*	*+3dB for >10dB change in noise levels during day, twice in a half hour period*
+5dB for prominent tonal character	*+5dB for prominent impulsive character*	*+3dB for 5-10dB change in noise levels or +5dB for >10dB change in noise levels during evening or night, twice in a half hour period*

c. measurement position

i. reflection (A_{refl})	ii. indoor (A_{ind})
-2.5 dB for measurements between 1 & 2 metres from an acoustically reflective surface	*+20 dB if assessment is undertaken indoors within a sensitive premises meeting BCA 2006 energy efficiency requirements. "The indoor adjustment is not meant to be used to determine or assess the effectiveness of the design response and construction of buildings affected by noise from commercial, industry and trade premises."*

4.1.1 Noise limits at noise monitoring locations with existing zoning

Table 5 presents the applicable noise limits which have been calculated in accordance with the EPA 1826-P1.

Table 5: EPA 1826-P1 Noise Protocol limits – major urban area – existing zoning

Period	Zoning level, L_{eq} dB(A)	Background L_{90} dB(A)	Background classification	EPA 1826-P1 limit L_{eq} dB(A) (Existing zoning)
M1 @ 6 Pakington Street				
Day	*64*	*63*	*High Background*	**69**
Evening	*57*	*60*	*High Background*	**63**
Night	*52*	*54*	*High Background*	**55**
M2 @ 22 Pakington Street				
Day	*63*	*59*	*High Background*	**65**
Evening	*56*	*58*	*High Background*	**61**
Night	*51*	*55*	*High Background*	**55**
M3 @ 41 Pakington Street				
Day	*60*	*56*	*High Background*	**62**
Evening	*54*	*56*	*High Background*	**59**
Night	*49*	*48*	*High Background*	**51**
M4 @ 212-224 Latrobe Terrace				
Day	*63*	*60*	*High Background*	**66**
Evening	*56*	*56*	*High Background*	**59**
Night	*51*	*51*	*High Background*	**54**
M5 @ 192 Latrobe Terrace				
Day	*62*	*63*	*High Background*	**69**
Evening	*55*	*61*	*High Background*	**64**
Night	*50*	*53*	*High Background*	**55**
M6 @ 160 Latrobe Terrace				
Day	*60*	*63*	*High Background*	**69**
Evening	*53*	*58*	*High Background*	**61**
Night	*48*	*49*	*High Background*	**52**

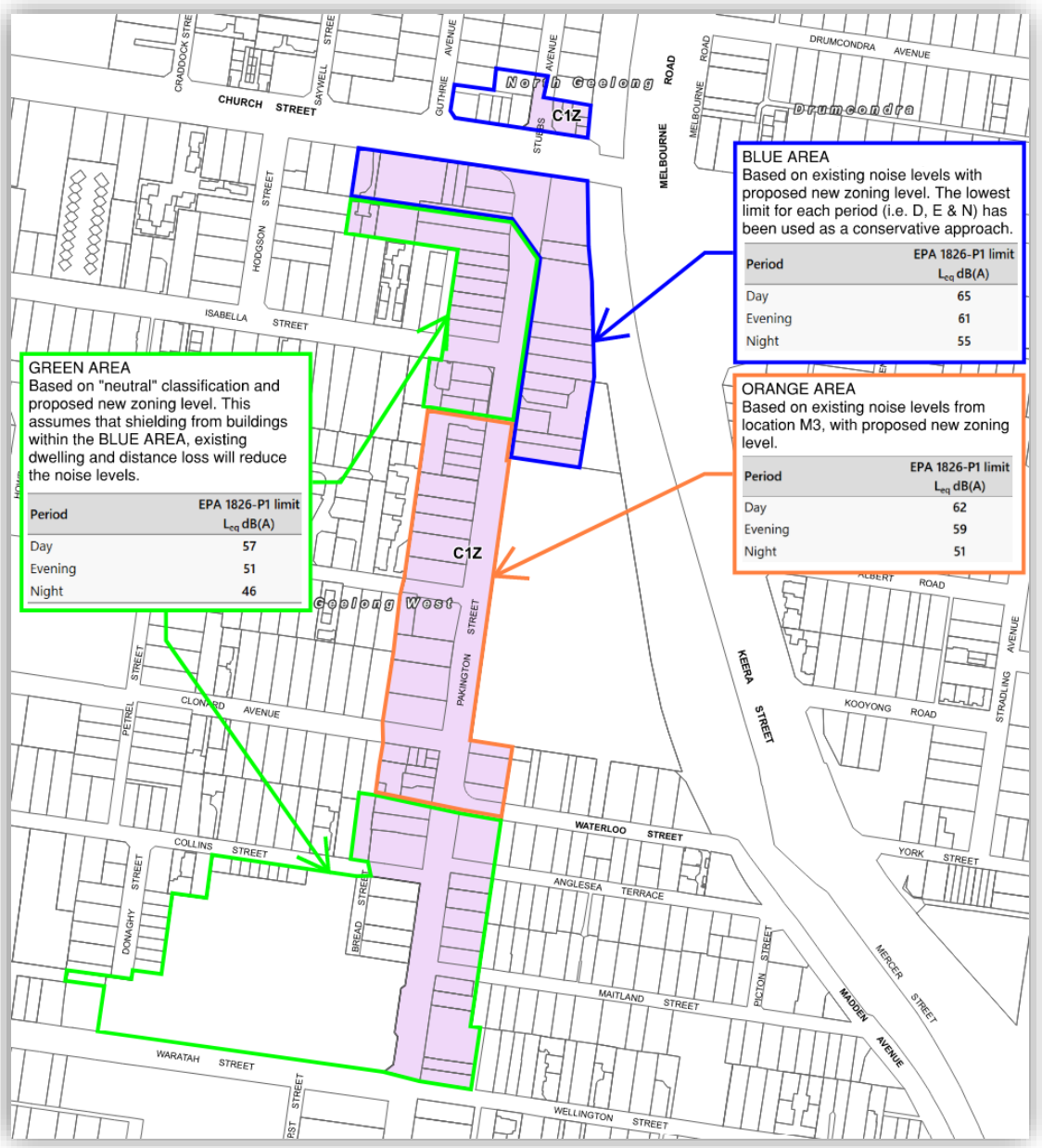
EPA 1826 Period Definitions:			
	Day:	Monday-to-Saturday 7am-to-6pm;	Sundays N/A
	Evening:	Monday-to-Saturday 6pm-to-10pm;	Sundays 7am-to-10pm
	Night:	All days 10pm-to-7am	

4.1.2 Noise limits at key areas with proposed zoning

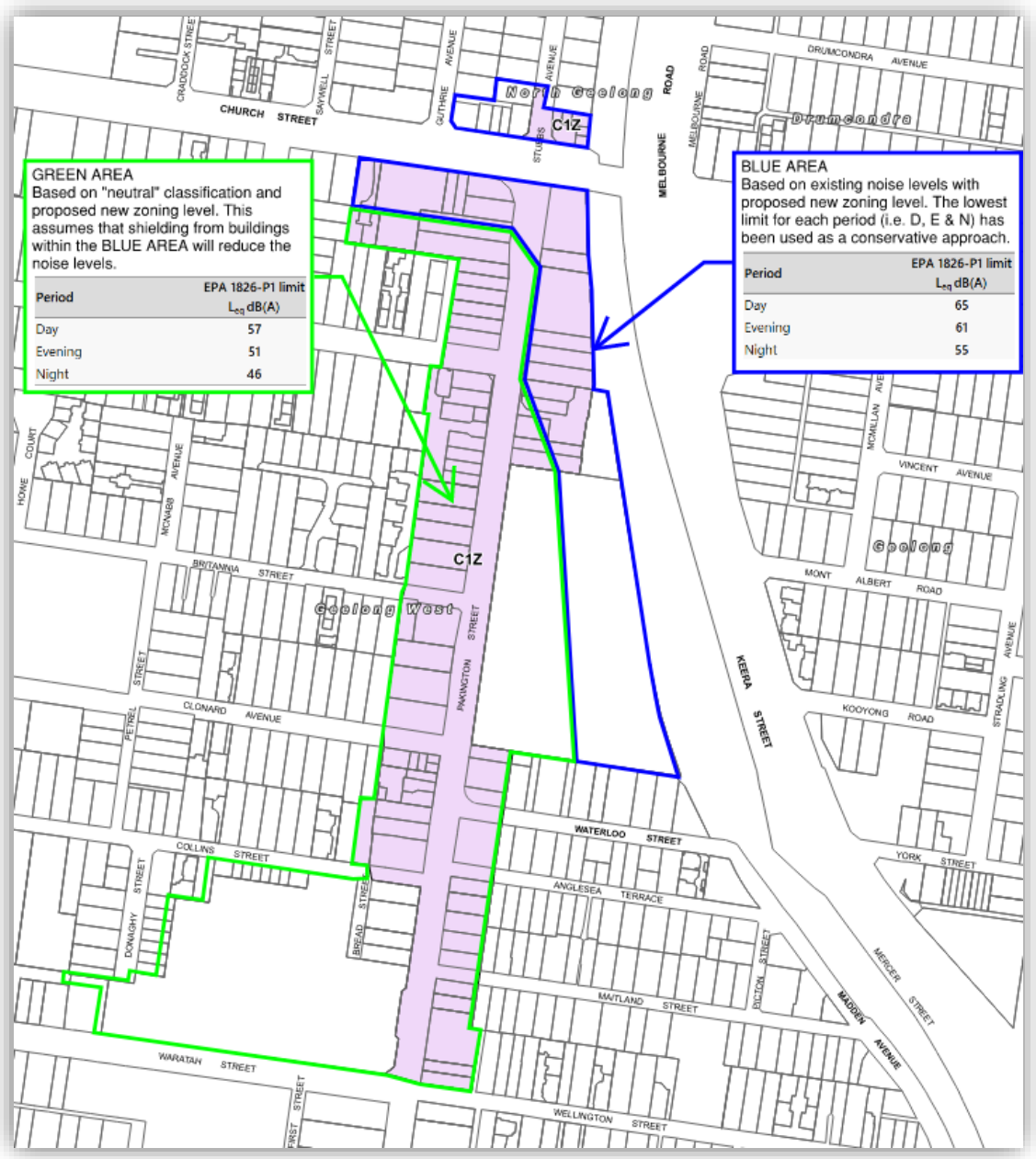
With consideration to the proposed zoning changes detailed in Section 2.3, Renzo Tonin & Associates has analysed the indicative proposed building heights and had calculated noise limits for key areas within each of the precincts that are considered conservative. These noise limits are considered appropriate given the distance setback from the dominant noise sources, shielding from the proposed development building heights and based on neutral background noise classification.

Three markups are provided below showing the proposed precinct, new zoning and the key areas with new calculated noise limits. Additionally the markup provides some assumptions to contextualise the approach to the new noise limits for the key areas.

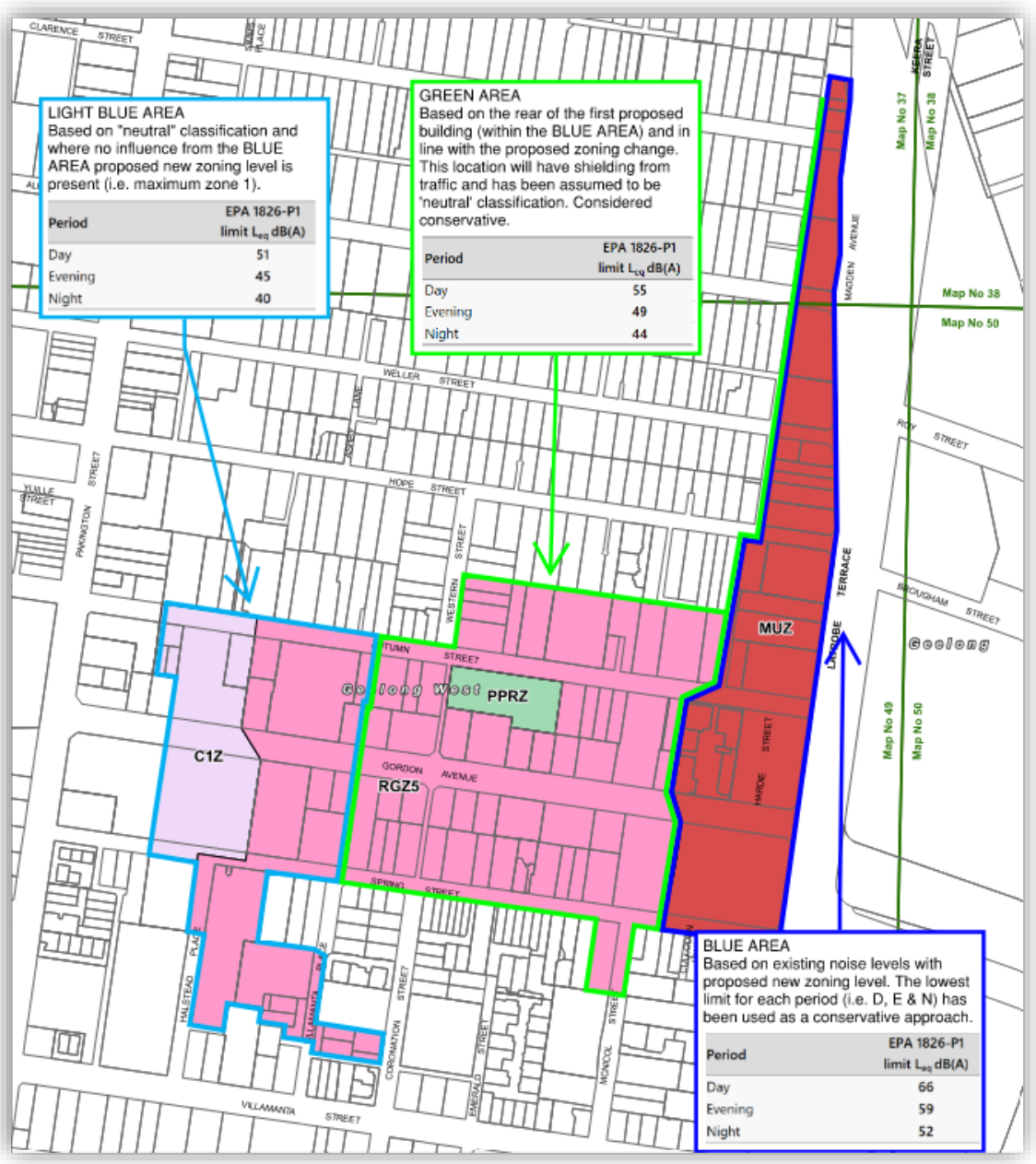
Pakington North Precinct (with the rail siding yards)



Pakington North Precinct (with no rail siding yards)



Gordon Avenue Precinct



4.2 DOT Passenger Rail Infrastructure Noise Policy (PRINP 2013)

Attachment 2 Table B of the PRINP provides the investigation thresholds for change in land use near an existing rail corridor, and has been reproduced below:

Time	Type of receiver	Investigation threshold(s)
Day (6am – 10pm) dB(A) External	• Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks • Noise sensitive community buildings including schools, kindergartens, libraries	65 L_{Aeq} **or** 85 L_{Amax}
Night (10pm – 6am) dB(A) External	• Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks	60 L_{Aeq} **or** 85 L_{Amax}

Attachment 3 of the PRINP provides policy principles that should be considered when investigation thresholds are predicted to be exceeded, and have been summarised below:

Integrated early consideration Impact of noise from rail projects and options for noise reduction should be considered early in the development of a proposal for new/redevelopment of passenger rail infrastructure or a change in land use, and an integrated approach should be taken to identify the options to avoid or reduce noise and its impacts.
Balancing objectives Decisions about managing the impact of rail noise should balance economic, social and environmental objectives within the context of the wider objectives of a passenger rail project or change to land use.
Best fit solutions All reasonable efforts to limit impacts of noise should be made taking account of what is practicable, reasonable and cost effective, given the specific local circumstances and the broader public good.

4.3 VCAT peer professional practice – noise peak objectives

Renzo Tonin & Associates has designed the noise peaks assessment from passenger rail noise with consideration of VCAT '*Richmond Icon Pty Ltd v Yarra CC [2011] VCAT 2175 (8 November 2011),* where design of developments for rail corridors with typical rail traffic volume, to Bedrooms L_{max} 55 dB(A), Living rooms L_{max} 60 dB(A).

4.4 Victoria Planning Provision Clause 58.04 / 55.07 / Better Apartments Design Standards

The Better Apartments Design Standards (BADS) is the source document of criteria in Victoria Planning Provision 58.04 and 55.07, provides target criteria for environmental noise impacts on new apartment developments in Victoria, for noise from road, rail and industrial noise sources. Table 6 presents the corresponding noise criteria.

To assess to the noise criteria, a given noise source must operate continuously for a significant portion of the day-evening (6am-to-10pm) or night (10pm-to-6am).

Table 6: VPP Clause 58.04 / 55.07 / BADS - internal noise level criteria

Type of occupancy / activity	Internal noise level criterion, dB(A)
Sleeping areas, $L_{eq,\ 8h}$ (from 10pm-to-6am)	≤ 35
Living areas, $L_{eq,\ 16h}$ (from 6am-to-10pm)	≤ 40

4.5 Vibration guidelines for human comfort (internal)

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the DECC '*Assessing Vibration; a technical guideline*' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1-80Hz)*'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 7.

Table 7: Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

5 Noise and vibration assessment

5.1 Noise propagation model (Cadna-A version 2024)

A Cadna-A three-dimensional noise model, implementing ISO 9613 noise propagation algorithms was built to calculate noise propagation from the various noise sources measured during the noise monitoring campaign within the proposed redevelopment site. The following propagation effects were included in the predictive Cadna-A model:

- Indicative building heights from the UDF incorporated into the future development scenario.
- Mitigation of noise with distance, including geometrical spreading and air absorption (20°C, 70% RH & 3m/s wind)
- Reflections from buildings and environment (3 orders of reflection where used.)
- Barrier effects due to obstructions between noise sources and residential receivers
- Ground absorption effects (G= 0 was used for hard surfaces (including buildings, roads, hardstands etc. G=0.5 was used for all other surfaces, where G=0 is fully reflective and G=1 is fully absorptive)
- Local topographical changes (10m elevation contours taken from Datashare Vic, as open-source data)

5.2 Passenger rail noise assessment

Audio analysis of noise monitoring location M1 provided clear pass-by measurements of passenger trains, with the assistance of the Vline timetable (V/Line - Regional public transport for Victoria - Train & coach timetables).

Table 8: Measured Passenger Rail pass-by noise levels

Location ID	Descriptor	Average noise level L_{eq} dBA	
		$L_{Aeq, 16hr}$ (Day)	$L_{Aeq, 8hr}$ (Night)
M1[1]	Train pass-by	70	65

Notes: 1. M2 is approximately 12 meters from the closest and 16 meters from the farthest passenger rail line.

Table 9 presents the measured 95th percentile noise level L_{max} dB(A) noise level and corresponding spectrum, applied for acoustic assessment per typical Victorian acoustic industry practice (see '*Richmond Icon Pty Ltd v Yarra CC [2011] VCAT 2175 (8 November 2011))*.

Table 9: Measured passenger rail pass-by noise spectra

Location ID	Descriptor	Overall dBA	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
M1	95th Percentile L_{max}	87	80	86	92	96	93	86	81	79	75

The above noise spectrum has been used in the analysis and predictive modelling. The results of the modelling provide the following predictions in Table 10 compared to the investigative threshold.

Table 10: Predicted passenger rail pass-by noise level and threshold comparison

ID[1]	Location address	Predicted noise level, dB(A)		Complies with PRINP Investigative threshold L_{Aeq} (✓,×)	
		Day	Night	Day (6am – 10pm)	Night (10pm – 6am)
M1	6 Pakington Street (rear boundary)	70[2]	65[2]	65 (×)	60 (×)
M2	22 Pakington Street (rear boundary)	65	60	65 (✓)	60 (✓)
M3	41 Pakington Street (front boundary)	58	53	65 (✓)	60 (✓)
M4	212-224 Latrobe Terrace (front boundary)	60	55	65 (✓)	60 (✓)
M5	192 Latrobe Terrace (front boundary)	64	59	65 (✓)	60 (✓)
M6	160 Latrobe Terrace (front boundary)	63	58	65 (✓)	60 (✓)

Notes:
1. Noise levels at other more distant locations/dwellings are lower than the noise levels presented above, as a result of greater distance from the Passenger rail line.
2. Measured noise levels used to calibrate noise model and provide predictions

As shown, predicted maximum pass-by noise levels are predicted to comply with EPA 1826-P1 noise limits at all locations, with the exception of:

Location **M1**	For the day period	+5dB predicted exceedance
	For the night period	+5dB predicted exceedance

Exceedance of PRINP investigative thresholds, triggers requirement for further acoustic assessment.

5.2.1.1 Rail corridor noise peak assessment

Table 11 presents the analysis of maximum noise levels from the passenger rail noise and compares to acoustic peer professional objectives at the noise monitoring locations, noting that location M1 and M2 are considered worst case locations from noise impacts from the rail noise.

Table 11: Predicted passenger rail noise peaks and criterion comparison

ID[1]	Location address	Predicted maximum noise level, dB(A) inside closed window[2]	Does predicted noise level comply with sleep disturbance criterion? (✓,×) (L_{max} internal with closed window)	
			Bedroom	Living rooms
M1	6 Pakington Street (rear boundary)	67	55 (×)	60 (×)
M2	22 Pakington Street (rear boundary)	62	55 (×)	60 (✓)
M3	41 Pakington Street (front boundary)	55	55 (✓)	60 (✓)
M4	212-224 Latrobe Terrace (front boundary)	53	55 (✓)	60 (✓)

ID[1]	Location address	Predicted maximum noise level, dB(A) inside closed window[2]	Does predicted noise level comply with sleep disturbance criterion? (✓,×) (L_{max} internal with closed window)	
			Bedroom	Living rooms
M5	192 Latrobe Terrace (front boundary)	54	55 (✓)	60 (✓)
M6	160 Latrobe Terrace (front boundary)	55	55 (✓)	60 (✓)

Notes:
1. Noise levels at other more distant locations/dwellings are lower than the noise levels presented above, as a result of greater distance from the Passenger rail line.
2. Includes +20dB indoor adjustment for minimum transmission loss through a façade (i.e. window) post 2006 BCA build, as per EPA Pub. 1826.4

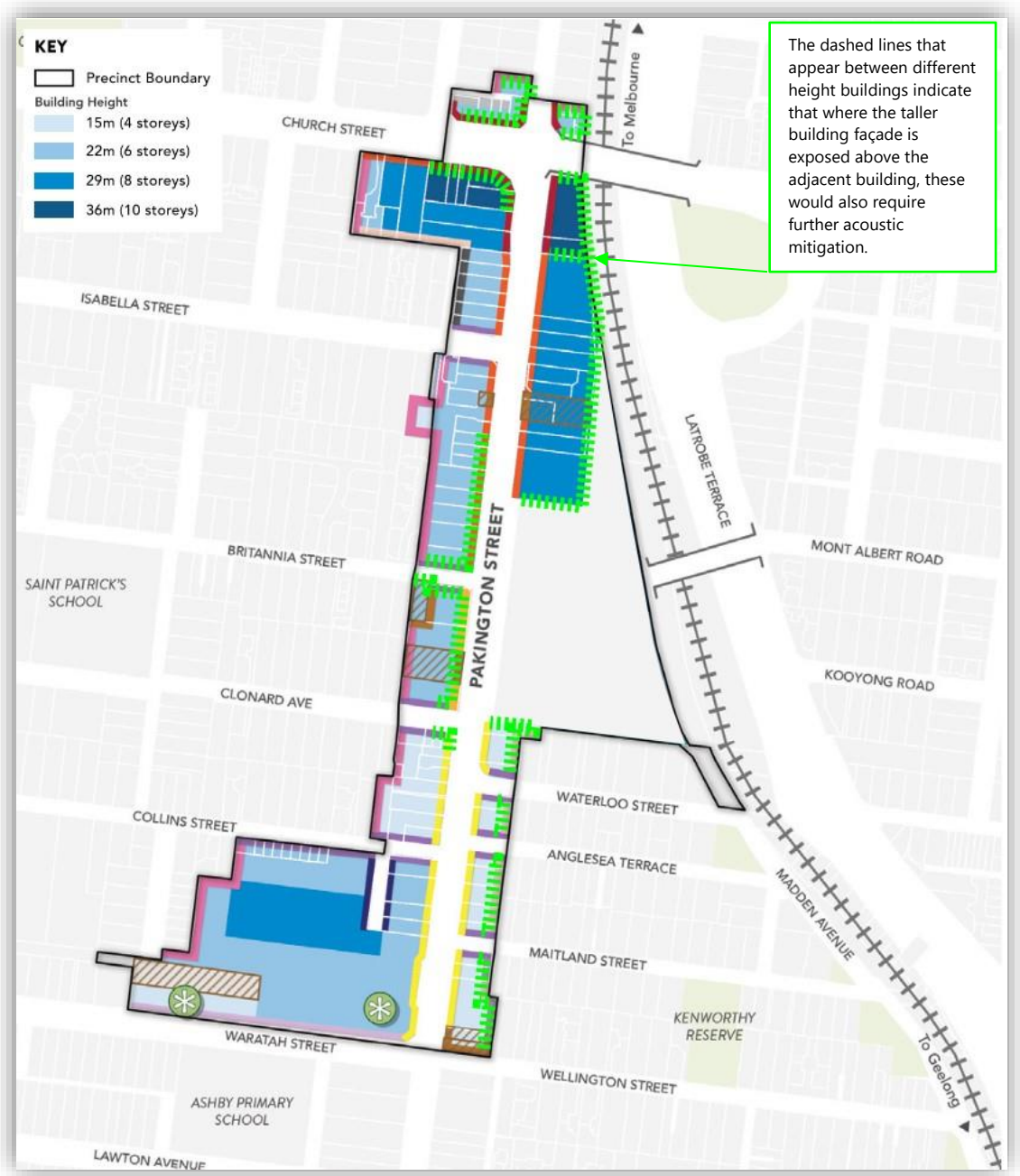
As shown, the worst case measured maximum pass-by noise levels are predicted to comply with EPA 1826-P1 noise limits at all locations, with the exception of:

Location **M1**	For bedrooms (during the night period)	+12dB predicted exceedance
	For living rooms (during all other periods)	+7dB predicted exceedance
Location **M2**	For bedrooms (during the night period)	+7dB predicted exceedance

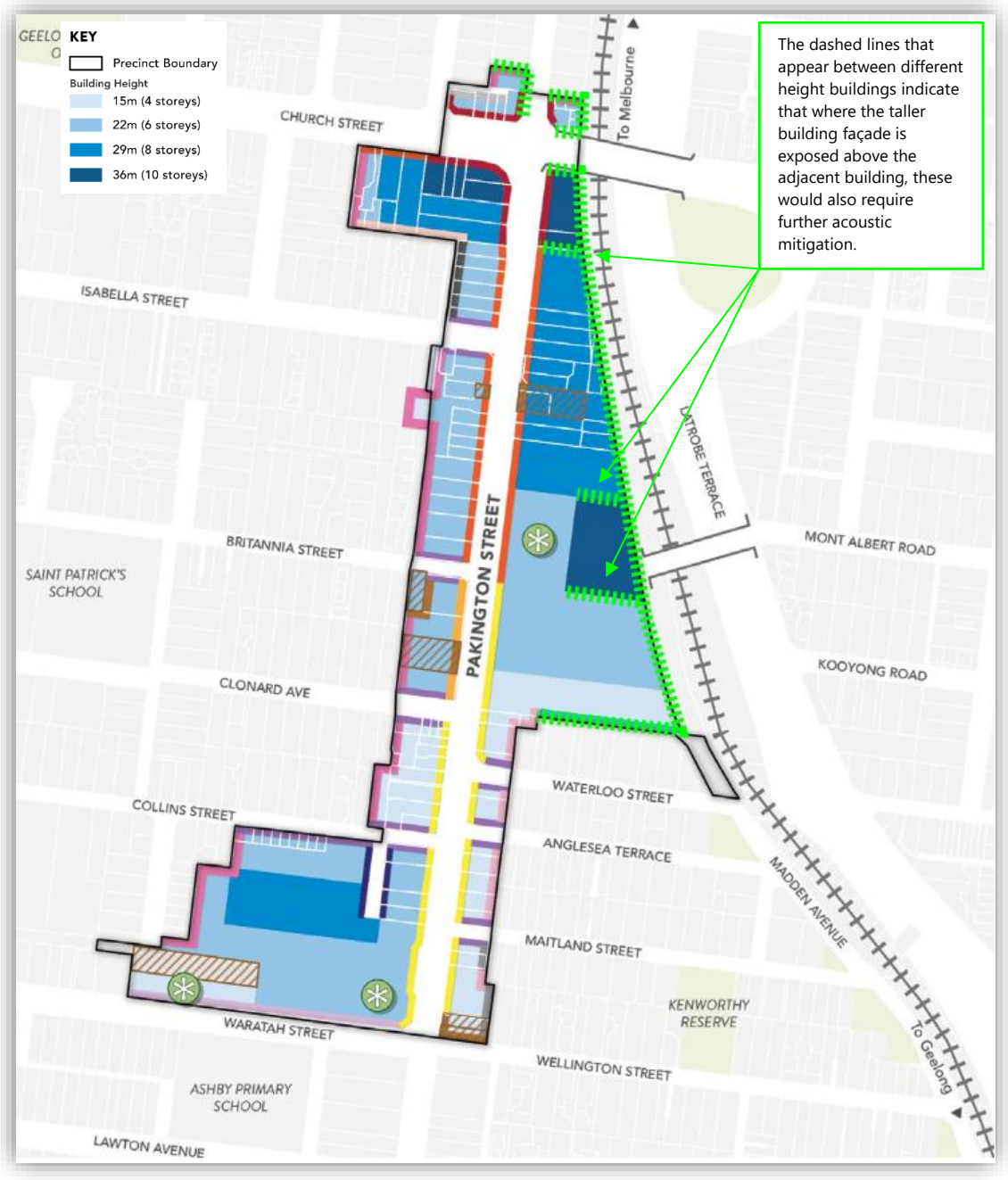
With consideration to the above predicted exceedances, Renzo Tonin & Associates has taken a map of the indicative building heights and layout (from the Urban Design Framework (UDF)) and provides a markup below showing (in bright green dashed lines) the key facades that would require further acoustic mitigation. Noting that the indicative modelling is based on buildings utilising 100% of the space shown, to allow for a worst-case scenario.

These predicted exceedances are typical of many, if not most developments proposed near major roads or other noise sources such as those measured in this assessment. Therefore the proposed zoning changes to allow for an increase in sensitive uses, is considered suitable and achievable through typical mitigation measures.

Pakington North Precinct (with the rail siding yards still operating)



Pakington North Precinct (with no rail siding yards)



Renzo Tonin & Associates provides a summary of results and discussion regarding acoustic mitigation options to be considered for the future developments in Section 6.

5.3 Rail sidings yard noise assessment

Activity noise associated with the rail sidings yard were observed via audio analysis, where the dominant noise sources include train movements, idling, air brake release and horn noises.

Table 12 provides a summary of the average overall noise levels for rail sidings yard activities.

Table 12: Measured rail sidings yard activity noise levels

Location ID	Activity	Average noise level $L_{eq,30mins}$ dBA
M2[1]	Train movements, idling, air brakes and horns	70[2,3]

Notes:
1. M2 is approximately 12 meters from the closest siding rail line.
2. Based on the loudest single 30-minute measurement of continuous activity during the night period.
3. A 5dB 'tonality' adjustment and a 5dB 'impulsiveness' adjustment has been applied, consistent with observed operational noise levels

Table 13 presents the predicted noise impacts from the rail sidings yard activities at the monitoring locations (considered worst case specifically at M2) and compares them with the determined conservative EPA Pub. 1826-P1 noise limits.

Table 13: Predicted rail sidings yard activity noise

ID[1]	Location address	Predicted Effective Noise Level (ENL), L_{eq} dB(A)[3]			Complies with EPA 1826-P1 limits for Day/Eve/Night?(✓,×) Proposed zoning
		Day	Evening	Night	
M1	6 Pakington Street (rear boundary)	63	63	63	*65 / 61/ 55* (✓ / × / ×)
M2	22 Pakington Street (rear boundary)	70	70	70	*65 / 61 / 55* (× / × / ×)
M3	41 Pakington Street (front boundary)	64	64	64	*57 / 51/ 46* (× / × / ×)
M4	212-224 Latrobe Terrace (front boundary)	<40	<40	<40	*66 / 59 / 52* (✓ / ✓ / ✓)
M5	192 Latrobe Terrace (front boundary)	<40	<40	<40	*66 / 59 / 52* (✓ / ✓ / ✓)
M6	160 Latrobe Terrace (front boundary)	<40	<40	<40	*66 / 59 / 52* (✓ / ✓ / ✓)

Notes:
1. Noise levels at other more distant locations/dwellings are lower than the noise levels presented above, as a result of greater distance from the rail sidings yard.
2. Noise character adjustments for tonality and impulsiveness for identified items of equipment detailed in Table 12.

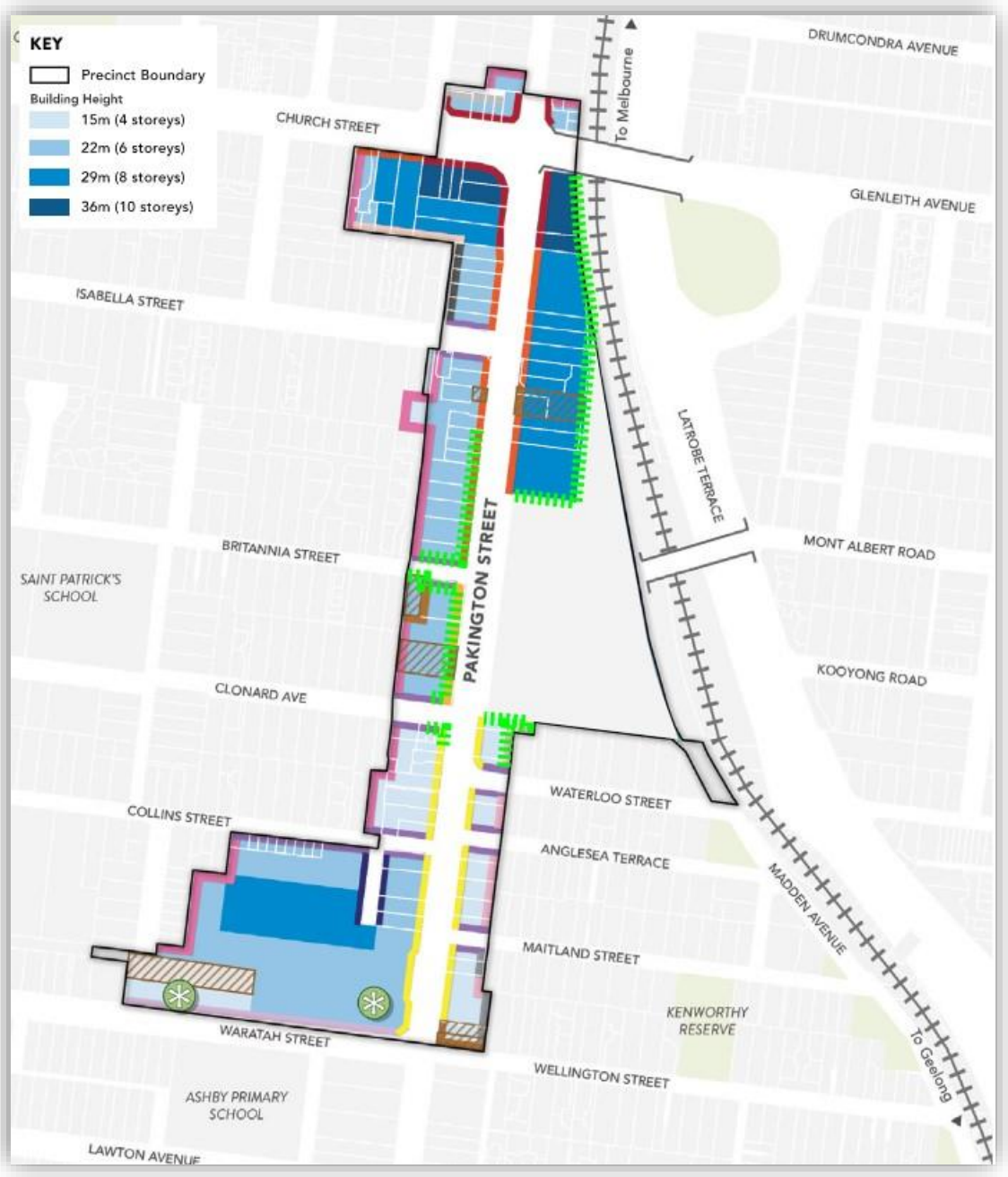
As shown, the worst case measured operations are predicted to comply with EPA 1826-P1 noise limits (for the proposed zoning) at locations M4, M5 & M6, with the exception of:

Location M1	during the evening period	+2dB predicted exceedance
	during the night period	+8dB predicted exceedance
Location M2	during the day period	+5dB predicted exceedance
	during the evening period	+9dB predicted exceedance
	during the night period	+15dB predicted exceedance
Location M3	during the day period	+7dB predicted exceedance
	during the evening period	+13dB predicted exceedance
	during the night period	+18dB predicted exceedance

Assuming the rail sidings yard continues to operate (i.e. remains), Renzo Tonin & Associates has taken a map of the indicative building heights and layout (from the UDF) with the exclusion of any buildings

proposed within the rail sidings yard site and provides a markup below showing (in bright green dashed lines) the key facades that would require further acoustic mitigation. Noting that the indicative modelling is based on buildings utilising 100% of the space shown, to allow for a worst-case scenario.

Pakington North Precinct (with the rail siding yards still operating)



Renzo Tonin & Associates provides a summary of results and discussion regarding acoustic mitigation options to be considered for the future developments in Section 6.

5.3.1 Rail sidings yard noise low frequency noise assessment

Using EPA Publication 1996 outdoor low frequency threshold criterion (Table 3 of the publication), we have compared our predicted results for the potentially most affected sensitive receivers. Using 1/3 octave spectral data from the monitoring at location M2 (most affected by rail sidings yard noise), the levels are above those in the 1/3 octave low frequency noise threshold levels from 10Hz to 160Hz (see below).

Outdoor 1/3 octave low frequency noise comparison													
1/3 Octave (Hz)	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**
Threshold levels, L_{eq} (dB)	92	89	86	77	69	61	54	50	50	48	48	46	44
Measured levels, L_{eq} (dB)	46	48	49	49	51	51	52	55	56	55	56	52	56
Complies (✓,×)	✓	✓	✓	✓	✓	✓	✓	× (5)	× (6)	× (7)	× (8)	× (6)	× (12)

Renzo Tonin & Associates has set out in-principle acoustic mitigation approaches to be considered for the future developments in Section 6.

5.4 Cumulative noise assessment

The proposed precincts and redevelopment seek to provide residential accommodation, therefore the cumulative noise impacts on any proposed sensitive receivers from road, rail and industrial noise sources has been calculated from the noise monitoring, from monitors that were strategically located to capture worst case noise levels.

Table 14 presents the measured noise levels at the monitoring locations and the corresponding noise criteria.

To assess to the noise criteria, a given noise source must operate continuously for a significant portion of the day-evening (6am-to-10pm) or night (10pm-to-6am).

Table 14: Predicted cumulative noise levels and VPP Clause 58.04 / 55.07 / BADS criteria comparison

ID[1]	Location address	Predicted maximum noise level, dB(A) inside closed window[2]		Complies with VPP Clause 58.04 / 55.07 / BADS - internal noise level criteria (✓,×)	
		Day (6am – 10pm)	Night (10pm – 6am)	Living areas, $L_{eq,\ 16h}$ (6am – 10pm)	Sleeping areas, $L_{eq,\ 8h}$ (10pm – 6am)
M1	6 Pakington Street (rear boundary)	50	45	40 (×)	35 (×)
M2	22 Pakington Street (rear boundary)	45	42	40 (×)	35 (×)
M3	41 Pakington Street (front boundary)	45	38	40 (×)	35 (×)
M4	212-224 Latrobe Terrace (front boundary)	51	47	40 (×)	35 (×)

ID[1]	Location address	Predicted maximum noise level, dB(A) inside closed window[2]		Complies with VPP Clause 58.04 / 55.07 / BADS - internal noise level criteria (✓,×)	
		Day (6am – 10pm)	Night (10pm – 6am)	Living areas, $L_{eq,\ 16h}$ (6am – 10pm)	Sleeping areas, $L_{eq,\ 8h}$ (10pm – 6am)
M5	192 Latrobe Terrace (front boundary)	54	49	40 (×)	35 (×)
M6	160 Latrobe Terrace (front boundary)	50	45	40 (×)	35 (×)

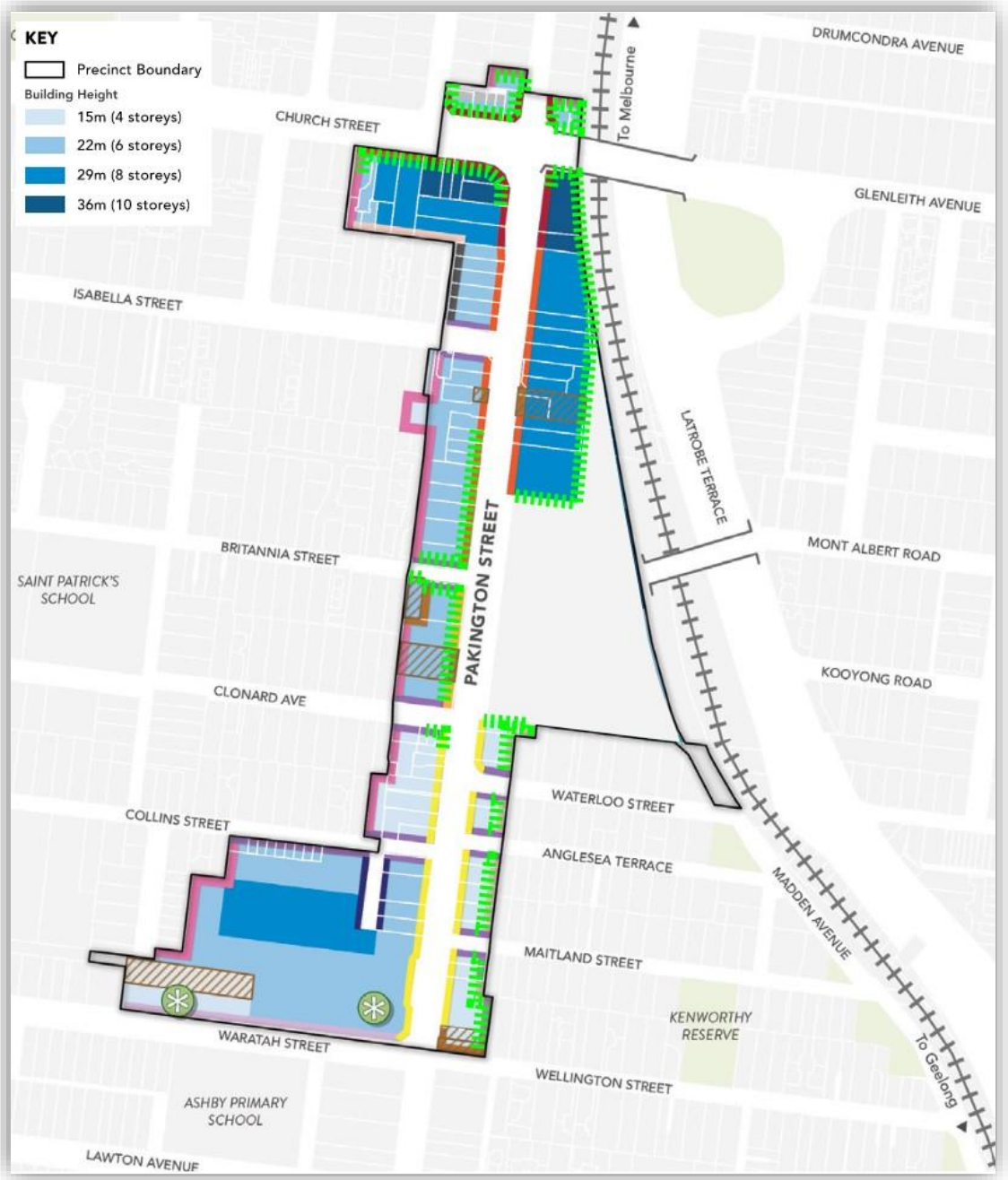
Notes:
1. Noise levels at other more distant locations/dwellings are lower than the noise levels presented above, as a result of greater distance from the Passenger rail line.
2. Includes +20dB indoor adjustment for minimum transmission loss through a façade (i.e. window) post 2006 BCA build, as per EPA Pub. 1826.4

As shown, the measured cumulative noise levels are predicted to exceed the VPP Clause 58.04 / 55.07 / BADS - internal noise level criteria at all locations, summarised below:

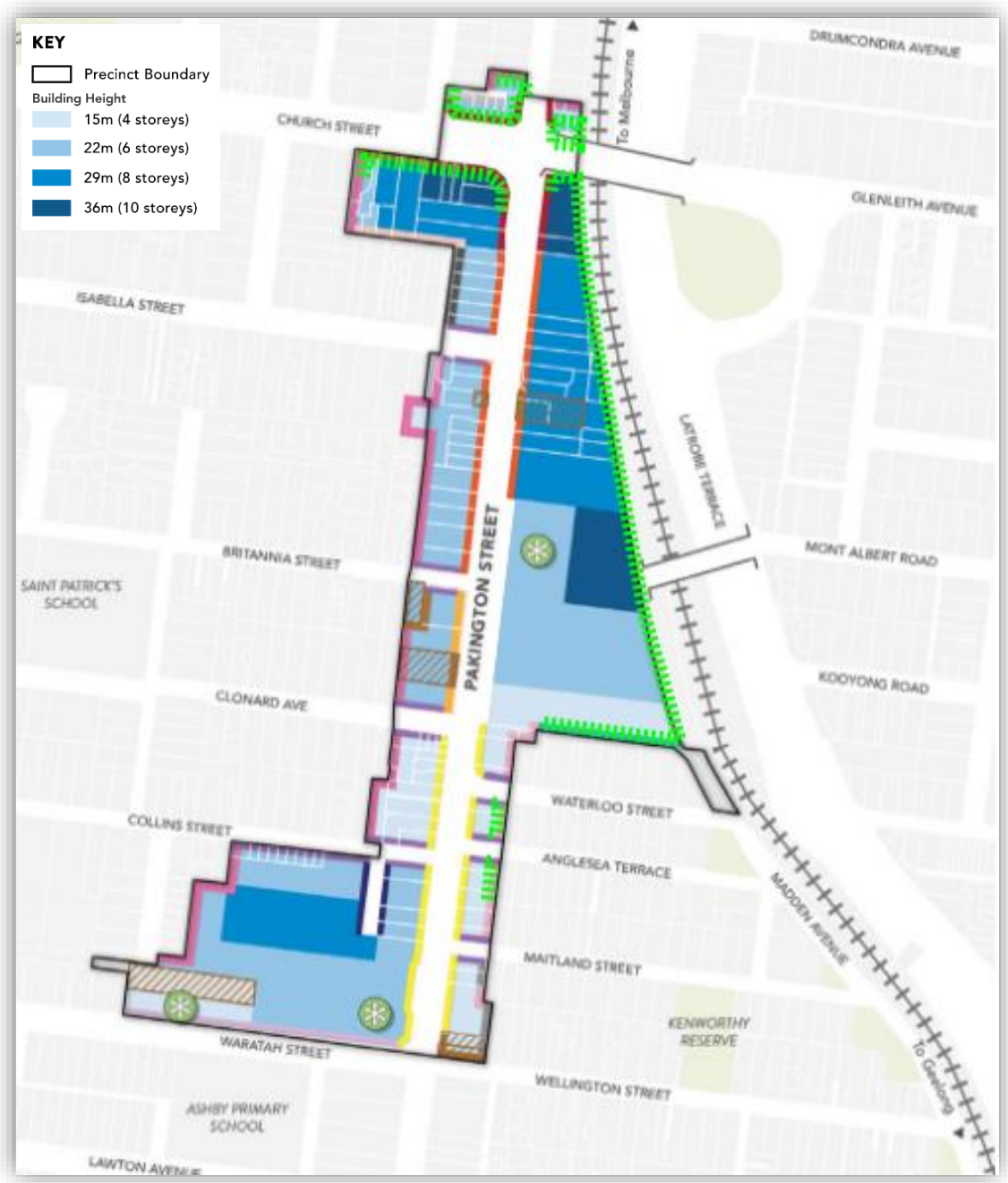
Location M1	For living rooms (during all other periods)	+10dB predicted exceedance
	For bedrooms (during the night period)	+10dB predicted exceedance
Location M2	For living rooms (during all other periods)	+5dB predicted exceedance
	For bedrooms (during the night period)	+7dB predicted exceedance
Location M3	For living rooms (during all other periods)	+5dB predicted exceedance
	For bedrooms (during the night period)	+3dB predicted exceedance
Location M4	For living rooms (during all other periods)	+11dB predicted exceedance
	For bedrooms (during the night period)	+12dB predicted exceedance
Location M5	For living rooms (during all other periods)	+14dB predicted exceedance
	For bedrooms (during the night period)	+14dB predicted exceedance
Location M6	For living rooms (during all other periods)	+10dB predicted exceedance
	For bedrooms (during the night period)	+10dB predicted exceedance

With consideration to the above predicted exceedances, Renzo Tonin & Associates has taken a map of the indicative building heights and layout (from the Urban Design Framework (UDF)) and provides a markup below showing (in bright green dashed lines) the key facades that would require further acoustic mitigation. Noting that the indicative modelling is based on buildings utilising 100% of the space shown, to allow for a worst-case scenario.

Pakington North Precinct (with the rail siding yards still operating)



Pakington North Precinct (with no rail siding yards)



Gordon Avenue Precinct

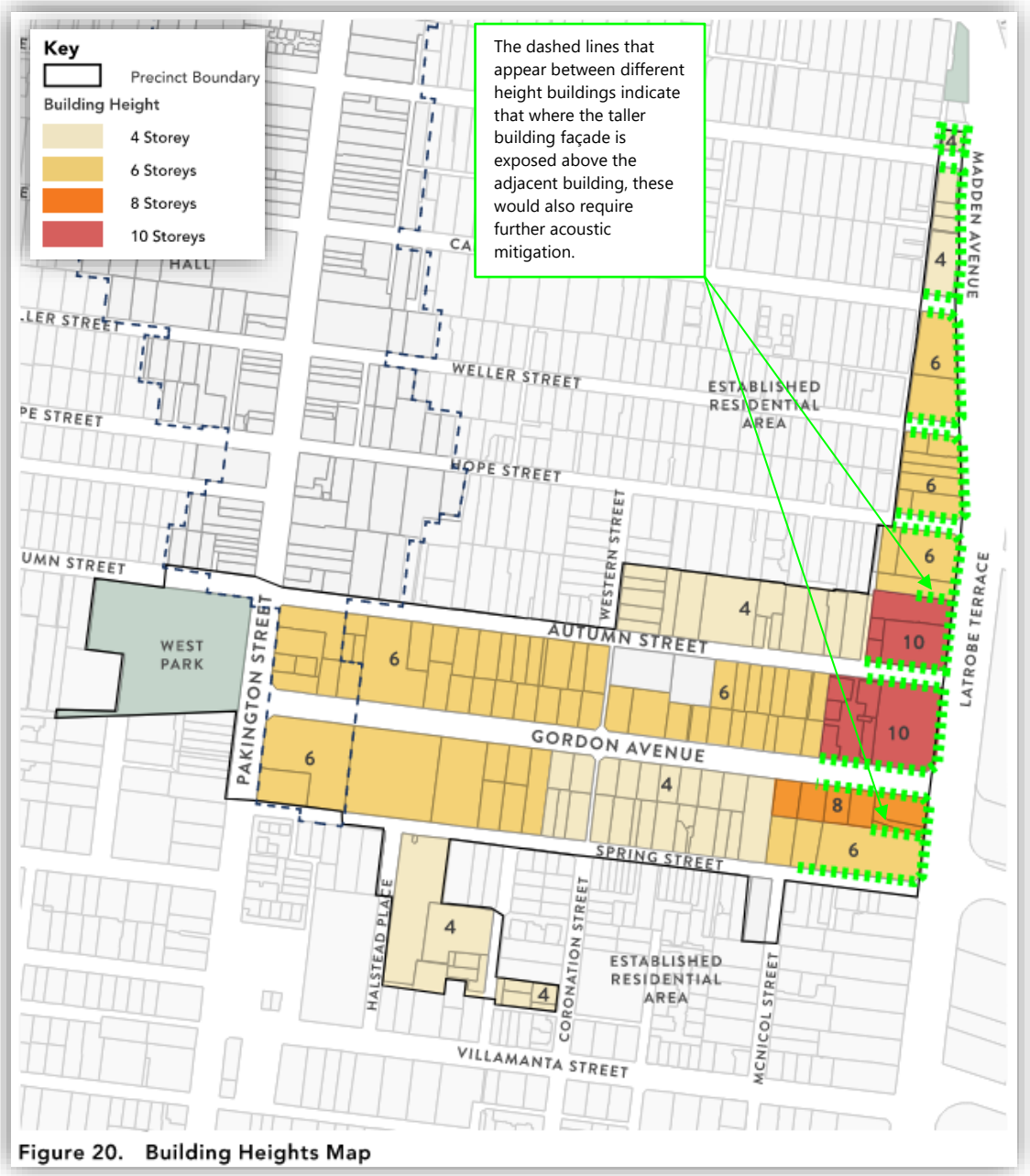


Figure 20. Building Heights Map

Renzo Tonin & Associates provides a summary of results and discussion regarding acoustic mitigation options to be considered for the future developments in Section 6.

5.5 Environment Reference Standard objectives

Renzo Tonin & Associates have considered the Environment Reference Standard objectives for typical ambient sound level values for outdoor spaces as part of the assessment, noting that they are not noise limits nor noise design criteria, more so, a benchmark to assist in reducing noise impacts as far as reasonably practicable.

Renzo Tonin & Associates understands that in planning and designing a development it is important that noise be considered, and balanced against other design considerations, such as solar access, privacy, and security.

With that in mind, specific detail and recommendations are more appropriate during the individual application stages. For the overall proposed precinct redevelopment, the understanding that external noise is likely to impact future sensitive uses, and that at the planning stage general design strategies and mitigation options have been considered, and where appropriate been incorporated.

5.6 Rail sidings yard vibration assessment

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the DECC '*Assessing Vibration; a technical guideline*' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1-80Hz)*'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 7.

Location	Maximum measured weighted RMS acceleration, m/s^2, 1-80Hz	
	z-axis	x- and y-axis
Measured **continuous** vibration (baseline)	0.001 (✓)	0.001 (✓)
Measured **impulsive** vibration (rail pass-bys)	0.160 (✓)	0.125 (✓)

As shown above, maximum measured baseline and rail pass-by vibration levels were found to be lower than the maximum continuous and impulsive RMS acceleration values as presented in Table 15.

Table 15: Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Measured Continuous vibration	Day				
	Night				
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	**0.014**	**0.010**

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	**0.20**	**0.14**
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
3. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
4. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

6 Summary and discussion of preliminary results

Renzo Tonin & Associates conducted a preliminary assessment of the noise impacts on the proposed precinct development. As part of this assessment we have undertaken long term unattended noise monitoring at key locations that have provided worst case noise levels to allow for a conservative assessment. Attended measurements were also conducted in other areas to assist with noise source identification, and general environmental noise levels.

The assessment considers a number of noise criteria, objectives, and limits that are used to assess various noise sources, including passenger rail noise, rail sidings yard operational noise, road traffic noise and noise peak/sleep disturbance.

Additionally, land use changes (zoning) are proposed for parts of the precinct development that change the determined zoning limits and in turn the overall noise limits for rail sidings yard operational noise.

The preliminary results clearly indicate that there are likely exceedances of most of the various noise criteria, objective and limits at certain areas within the precincts. The assessment predictions are based on modelling designed to provide worst-case scenarios, which are then used to inform potential noise impacts. These impacts (exceedances) indicate the severity of the risk associates with the noise impacts.

Section 5 details the results of the predictive modelling and provides markups to assist with understanding where these noise impacts are within the subject area. The markups are indicative only and should be used as an indicator to trigger future acoustic assessments. (i.e. if the markup is anywhere on a specific property, then that development should have an acoustic assessment)

As this assessment is aimed at providing guidance to the suitability for sensitive uses only, and not detailed design, specific recommendations for acoustic mitigation have been omitted. However, it is clear from the assessment, including site measurements and observations, that the North Pakington Precinct could benefit from acoustic barriers (i.e. boundary fences) along the rail corridor and rail siding yard.

Guidance on appropriate steps to take for mitigating these impacts are provided below, in order:

- Building siting and design. This could include:
  - Minimum setbacks
  - Acoustic barriers/fences
  - Carparking and/or commercial premises on ground floor locations
  - Internal layout of residential spaces to minimise bedrooms direct to rail corridor
  - High performance glazing

Amendment C433ggee, which implements the Pakington Street Urban Design Frameworks, includes Design and Development Overlays for both precincts where noise monitoring has taken place. The following requirement is included in the draft DDOs, with amendments in green proposed by Renzo Tonin & Associates for consideration:

Any application for subdivision or development of land for Accommodation, Education Centre (other than Tertiary institution and Employment training centre) or Hospital, must be accompanied by an acoustic assessment report prepared by a qualified acoustic engineer or other suitably skilled person to the satisfaction of the responsible authority which:

- *Applies the following objectives:*
  - *Not greater than 35dB $L_{Aeq,8h}$ when measured within a sleeping area between 10pm and 6am.*
  - *Not greater than 40dB $L_{Aeq,16h}$ when measured within a living area between 6am and 10pm.*
  - *For areas other than sleeping and living areas, not greater than the median value of the range of recommended designed sound levels of Australian Standard AS/NZ 2107:2016 (Acoustics – Recommended design sound levels and reverberations times for building interiors).*
  - *Train airborne noise received at new residential or other noise sensitive uses is attenuated to achieve a noise level of 55 dBA, L_{max} in bedrooms at night and a noise level of 60 dBA, L_{max} in living areas. These noise levels are to be measured at the expected occupancy position(s) in the space relevant to the noise of interest with doors and windows closed. The preferred positions are at least 1 m from the walls or other major reflecting surface, 1.2 m to 1.5 m above the floor and about 1.5 m from windows. -The measurements should be undertaken using a 'fast' meter time weighting and must be achieved for 95% of train pass- bys (i.e. 5%, 1 in 20 trains may exceed).*
- *Noise levels should be assessed:*
  - *Considering the cumulative noise from all sources impacting on the proposal including road traffic noise and industry noise, as well as potential other potential noise sources;*
  - *Industrial noise received at new residential or other noise sensitive uses achieves internal noise levels assessed in accordance with the Noise Protocol (EPA Publication 1826.4) with the implementation of an indoor adjustment of 20 dB, while allowing for operable windows. These noise levels are to be measured internally at the expected occupancy position(s) in the space relevant to the noise of interest with doors and windows closed. The preferred positions are at least 1 m from the walls or other major reflecting surface, 1.2 m to 1.5 m above the floor and about 1.5 m from windows;*
  - *Operation of the rail sidings yard with respect to EPA Pub. 1826.4 Noise Protocol, where any new proposed sensitive uses constitutes the Agent of Change, and as such measures must be undertaken at sensitive uses to maintain EPA Pub. 1826.4 conformance of rail sidings yard; and*
  - *In unfurnished rooms with a finished floor and the windows closed and be based on average external noise levels measured as part of a noise level assessment.*
- *Addresses noise compatible design for buildings, with siting, orientation, and internal layout, to be considered prior to setting building envelope performance requirements.*
- *Addresses potential noise character (such as tonality, impulsiveness or intermittency) is addressed wherever relevant, including through the application of adjustments to the internal noise levels that are determined using the procedures to adjust industry noise levels of the Noise Protocol.*

7 Conclusion

Renzo Tonin & Associates was engaged to undertake an acoustic assessment of existing noise levels in the combined Pakington Street Urban Design Frameworks study area, Geelong West, and to advise on sensitive land use matters and mitigation measures. Specifically the scope of works is focused on two of the three overall precincts – the Pakington North Precinct (in red) and the Gordon Avenue Precinct (in blue) shown in Section 2.1.

Renzo Tonin and Associates (RTA) understand that an acoustic assessment to address the EPA letter (dated 9 October 2024) is required.

In conducting the acoustic assessment, Renzo Tonin & Associates has:

- Quantified relevant noise and vibration criteria: EPA 1826-P1 'Noise Protocol', noise peaks from train passage, Passenger Rail Infrastructure Noise Policy' external noise thresholds, Victoria Planning Provision Clause 58.04 / 55.07 / Better Apartments Design Standards, Vibration values for human comfort
- Analysed the noise monitoring and measurements to determine existing noise conditions
- Analysed the vibration monitoring to determine existing vibration conditions and compare to human comfort values for continuous and impulsive/intermittent vibration
- Determined noise limits in accordance with the relevant legislation and guidelines
- Constructed a three-dimensional noise model of the Subject Development, to assess various noise impacts (described within this report)
- Assessed and compared predicted levels to noise limits for existing and future conditions
- Provided commentary on predicted levels compared with noise limits, and potential mitigation measures/strategies

Renzo Tonin & Associates have conducted a conservative assessment of the noise impacts predicted for the proposed precincts, and while these current noise emissions exceed the determined noise limits (including the proposed changes to zoning), in accordance with the EPA regulations and guidelines, the implementation of noise mitigation measures such as building siting and design (details in Section 6) can ensure the subject area is suitable for sensitive uses.

The assessment has reviewed the proposed zoning changes, and the implications of these changes. While clearly showing the determined noise limits (i.e. EPA Pub 1826.4) will be lower, due to the increase in sensitive uses, it also indicates that there is a general ability to support sensitive uses. While specifics regarding mitigation strategies do not form part of this assessment, guidance is provided as a hierarchy of controls that seek to implement the best order of solutions (i.e. the effectiveness of controls goes from elimination of noise impacts to providing acoustic treatment).

Section 5 details the results of the predictive modelling and provides markups to assist with understanding where these noise impacts are within the subject area and Section 6 provides a summary of these results. As this assessment is aimed at providing guidance to the suitability for sensitive uses only, and not detailed design, specific recommendations for acoustic mitigation have been omitted. These markups can be translated into the Design & Development Overlays (DDOs) to direct development.

Based on the above, the proposed precincts will need to consider a combination of acoustic design options and mitigation measures to ensure that any new sensitive use is not unreasonably affected by existing noise from road and rail networks, as well as any future commercial/industry noise. Renzo Tonin & Associates are confident that with reasonable design and mitigation strategies the development can conform with all nominated criteria.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.		
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.		
Assessment period	The time period in which an assessment is made. e.g. Day 7am-6pm.		
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.		
Attenuation	The reduction in the level of sound or vibration.		
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.		
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{A90} noise level if measured as an overall level or an L_{90} noise level when measured in octave or third-octave bands.		
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.		
Berm	Earth or overburden mound.		
Buffer	An area of land between a source and a noise-sensitive receiver and may be an open space or a noise-tolerant land use.		
Bund	A bund is an embankment or wall of brick, stone, concrete or other impervious material, which may form part or all of the perimeter of a compound.		
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:		
	threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away

dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies. The dB(C) level is not widely used but has some applications.
Diffraction	The distortion of sound waves caused when passing tangentially around solid objects.
EPA	Environment Protection Authority
Flanking	Flanking is the transfer of sound through paths around a building element rather than through the building element material directly. For example, sound travelling through a gap underneath a door or a gap at the top of a wall.
Fluctuating Noise	Noise that varies continuously to an appreciable extent over the period of observation.
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{Aeq} or L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the L_{Aeq}.
L_{max}	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the $L_{Amax.}$
L_{min}	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the $L_{Amin.}$
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Noise	Unwanted sound
Noise Sensitive Area	(NSA) is that part of the land within the boundary of a parcel of land that is (i) within 10 metres of the outside of the external walls of a dwelling (including residential aged care, hospitals, hotels and motels, child care centre, primary and secondary schools) Noise sensitive residential use has the same meaning as in the VPP.
Reflection	Sound wave reflected from a solid object obscuring its path.

R_w	Weighted Sound Reduction Index A measure of the sound insulation performance of a building element. It is measured in very controlled conditions in a laboratory. The term supersedes the value STC which was used in older versions of the Building Code of Australia. R_w is measured and calculated using the procedure in ISO 717-1. The related field measurement is the $D_{nT,w}$. The higher the value the better the acoustic performance of the building element.
R'_w	Weighted Apparent Sound Reduction Index. As for R_w but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The higher the value the better the acoustic performance of the building element.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L_{eq} sound levels over any period of time and can be used for predicting noise at various locations.
Sound absorption	The ability of a material to absorb sound energy by conversion to thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 mico Pascal.
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.

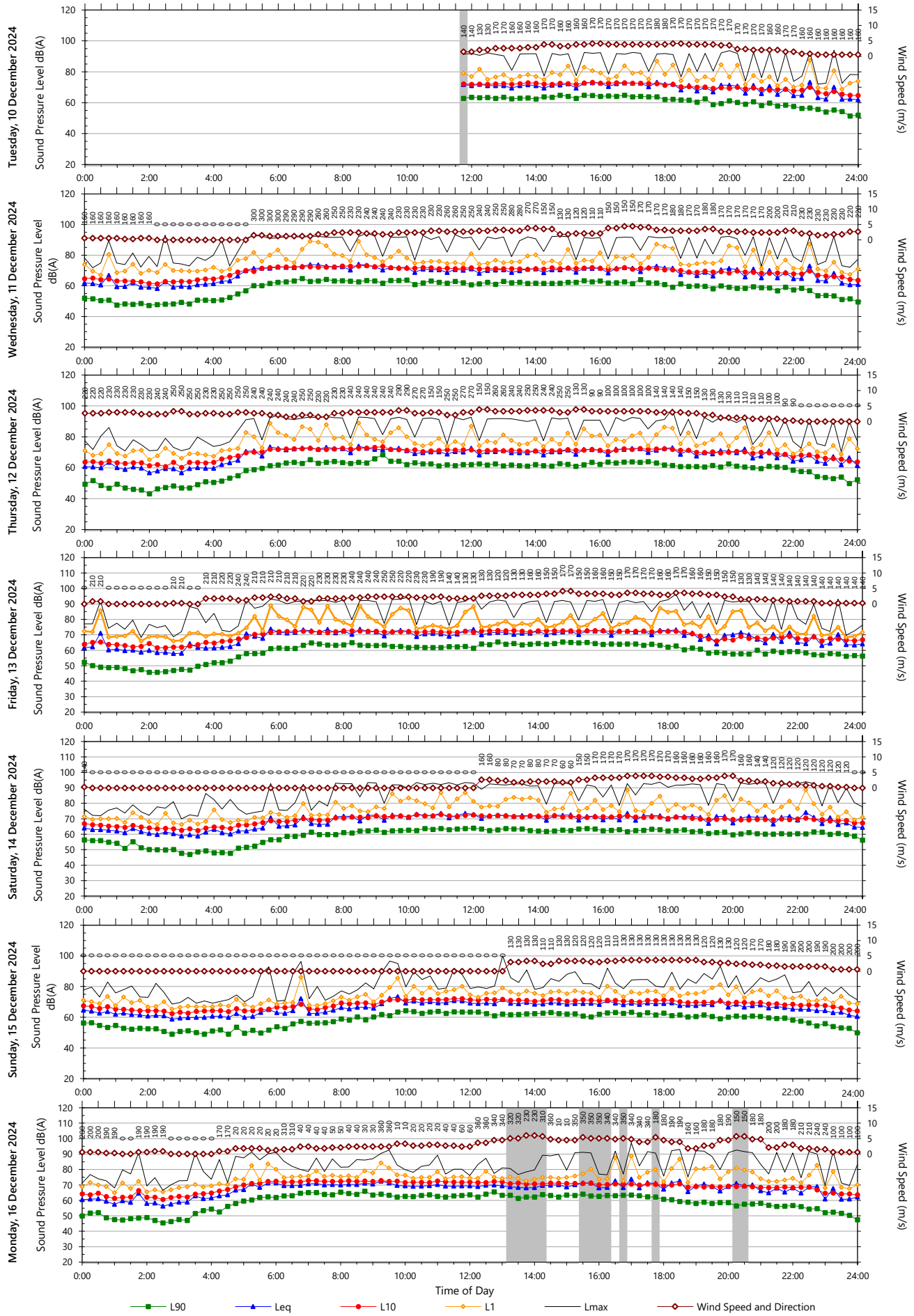
APPENDIX B Noise monitoring

B.1 M1 – 6 Pakington Street (rear boundary at 4.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 6 Pakington St - M1

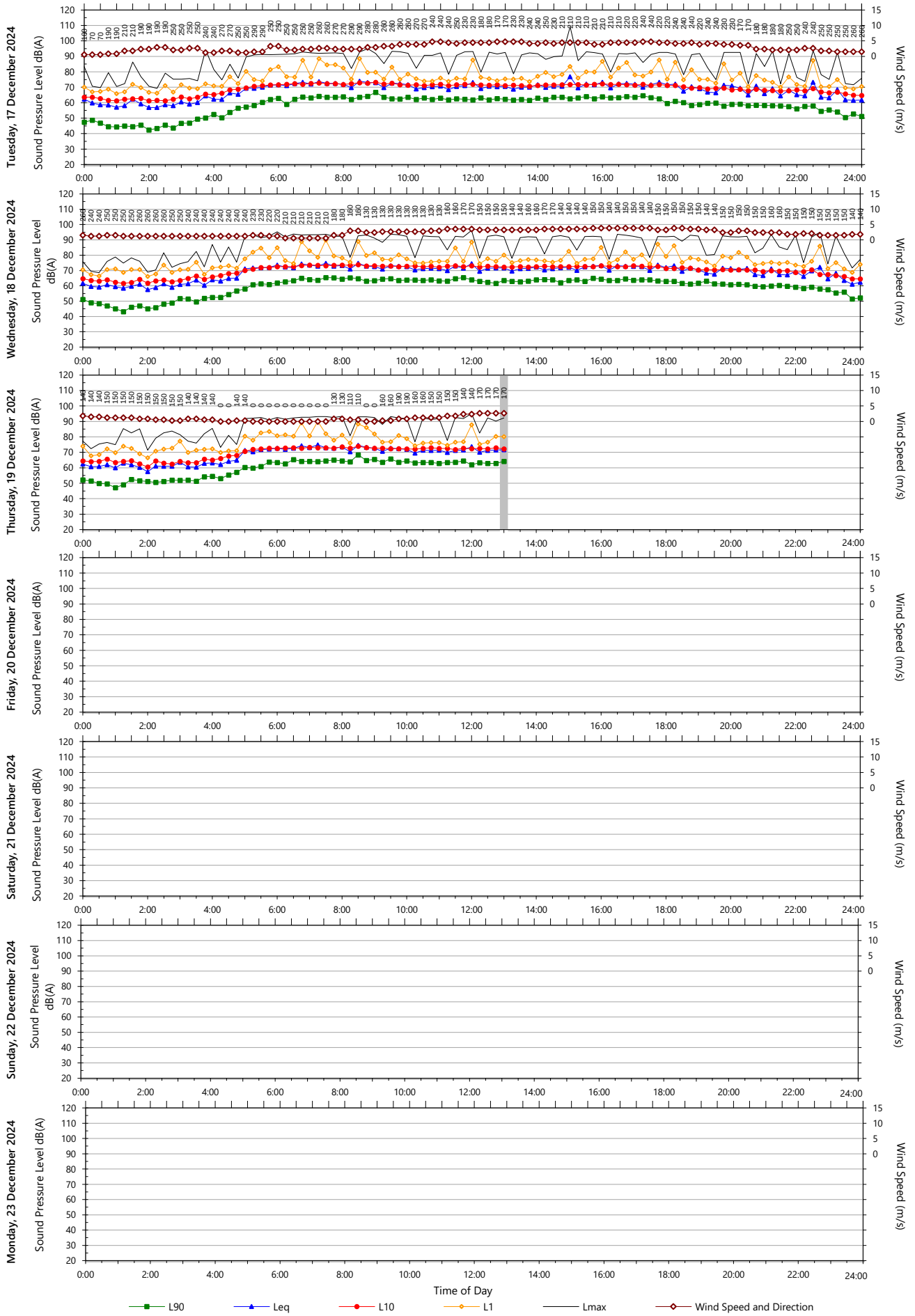


Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 6 Pakington St - M1



Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

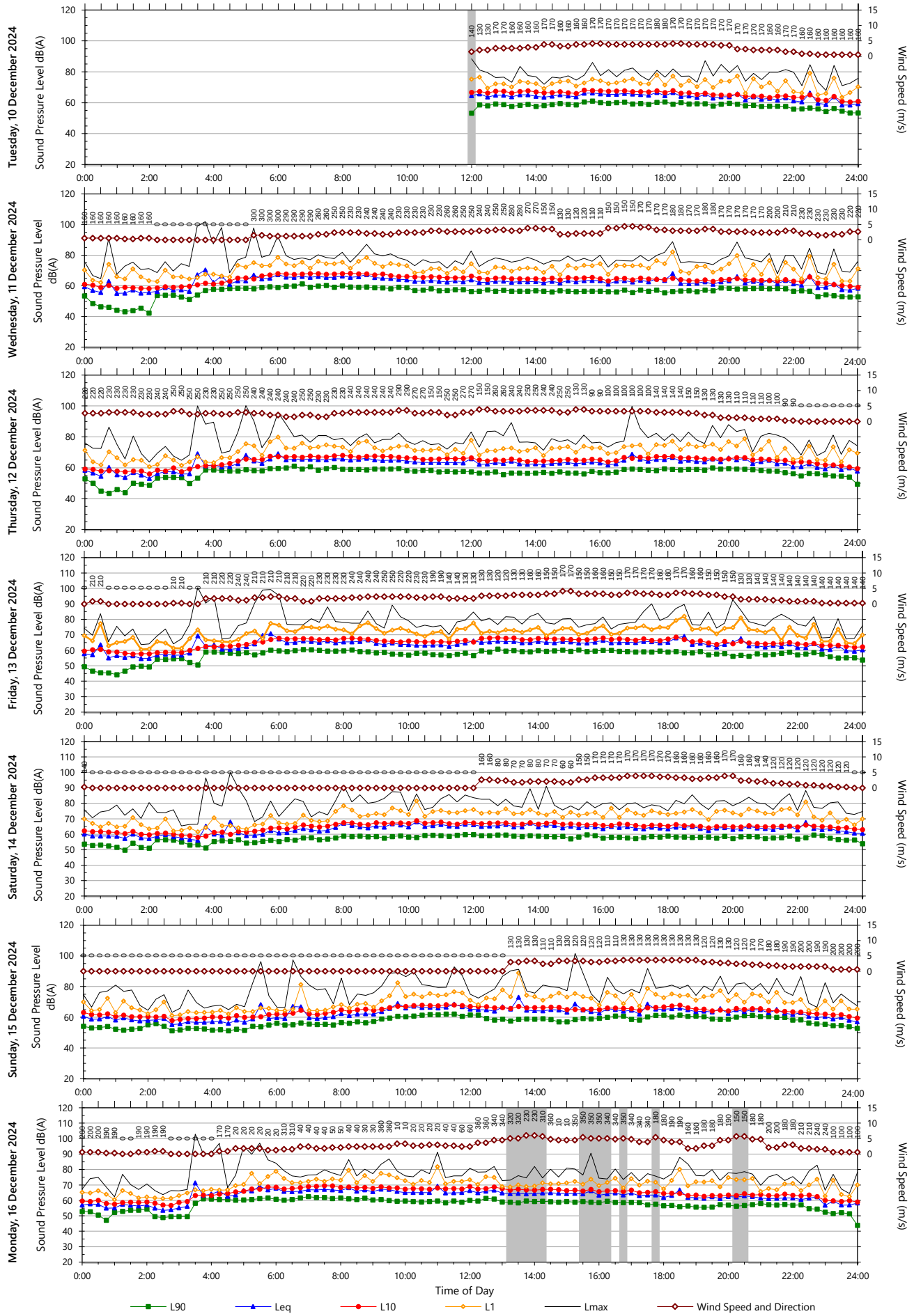
Template: QTE-26 Logger Graphs Program (r45)

B.2 M2 – 22 Pakington Street (rear boundary at 4.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 22 Pakington St - M2

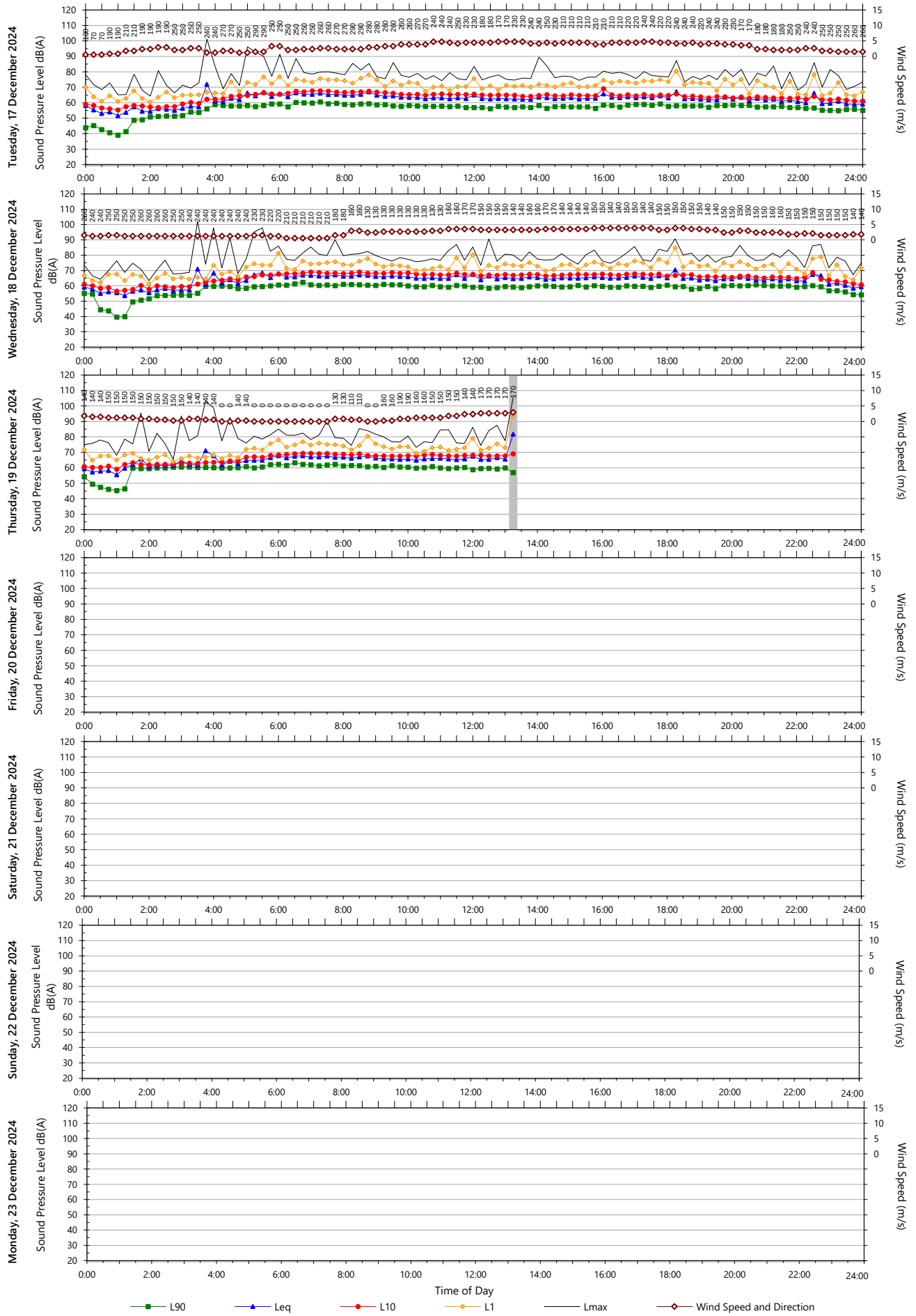


Data File: 2024-12-10_SLM_002_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 22 Pakington St - M2



Data File: 2024-12-10_SLM_002_123_Rpt_Report.txt

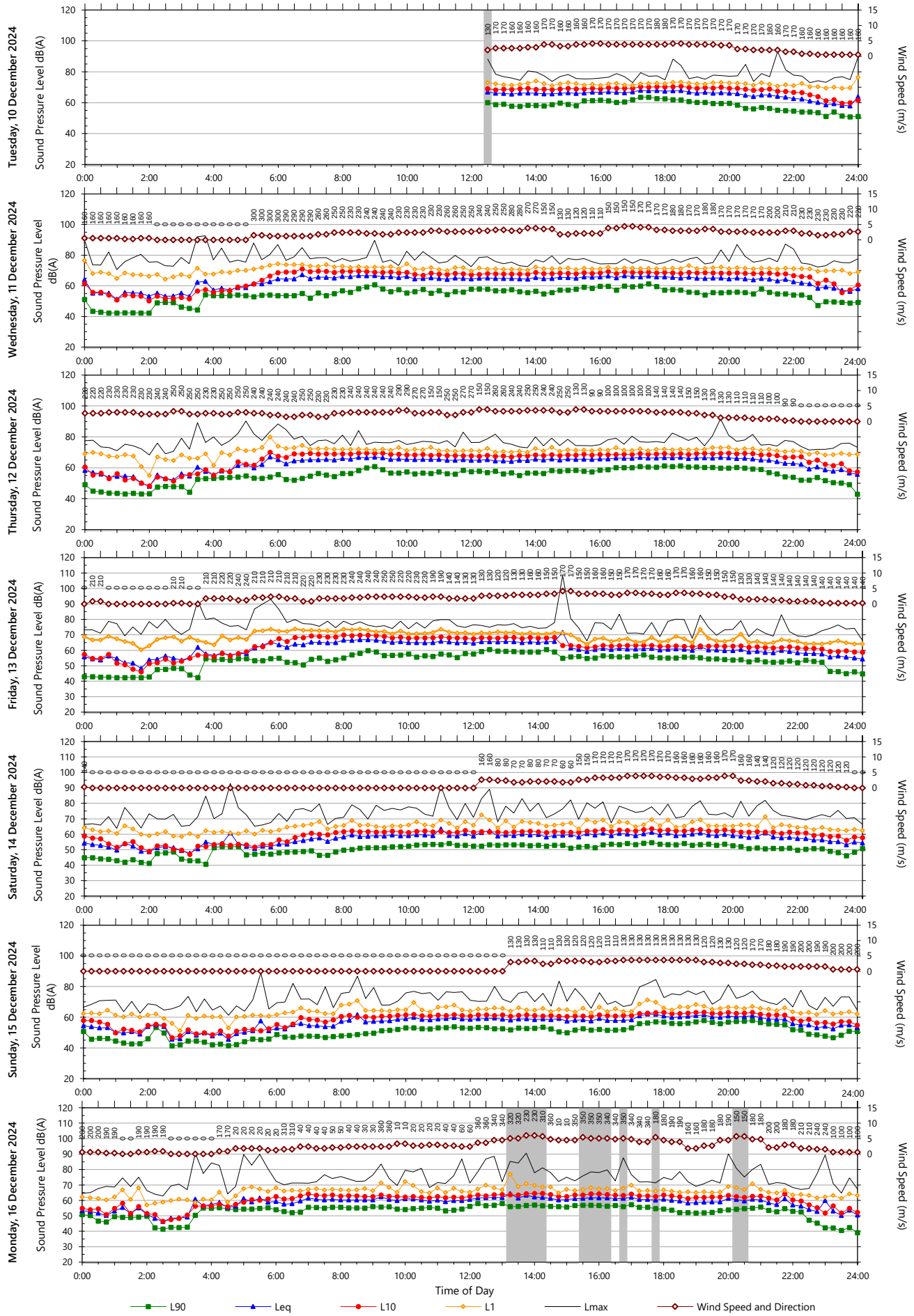
Template: QTE-26 Logger Graphs Program (r45)

B.3 M3 – 41 Pakington Street (front awning at 4.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 41 Pakington St - M3

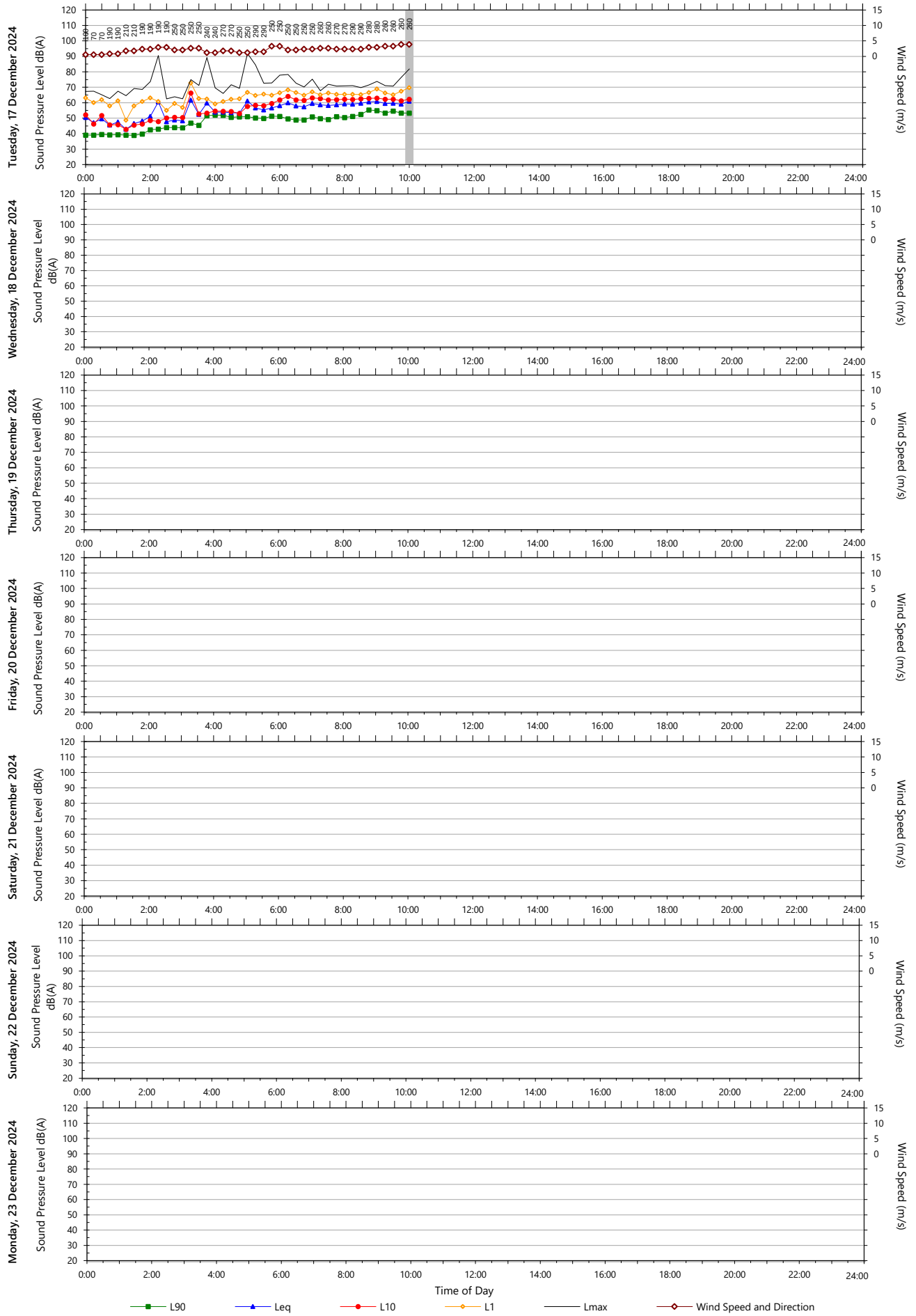


Data File: 2024-12-10_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 41 Pakington St - M3



Data File: 2024-12-10_SLM_000_123_Rpt_Report.txt

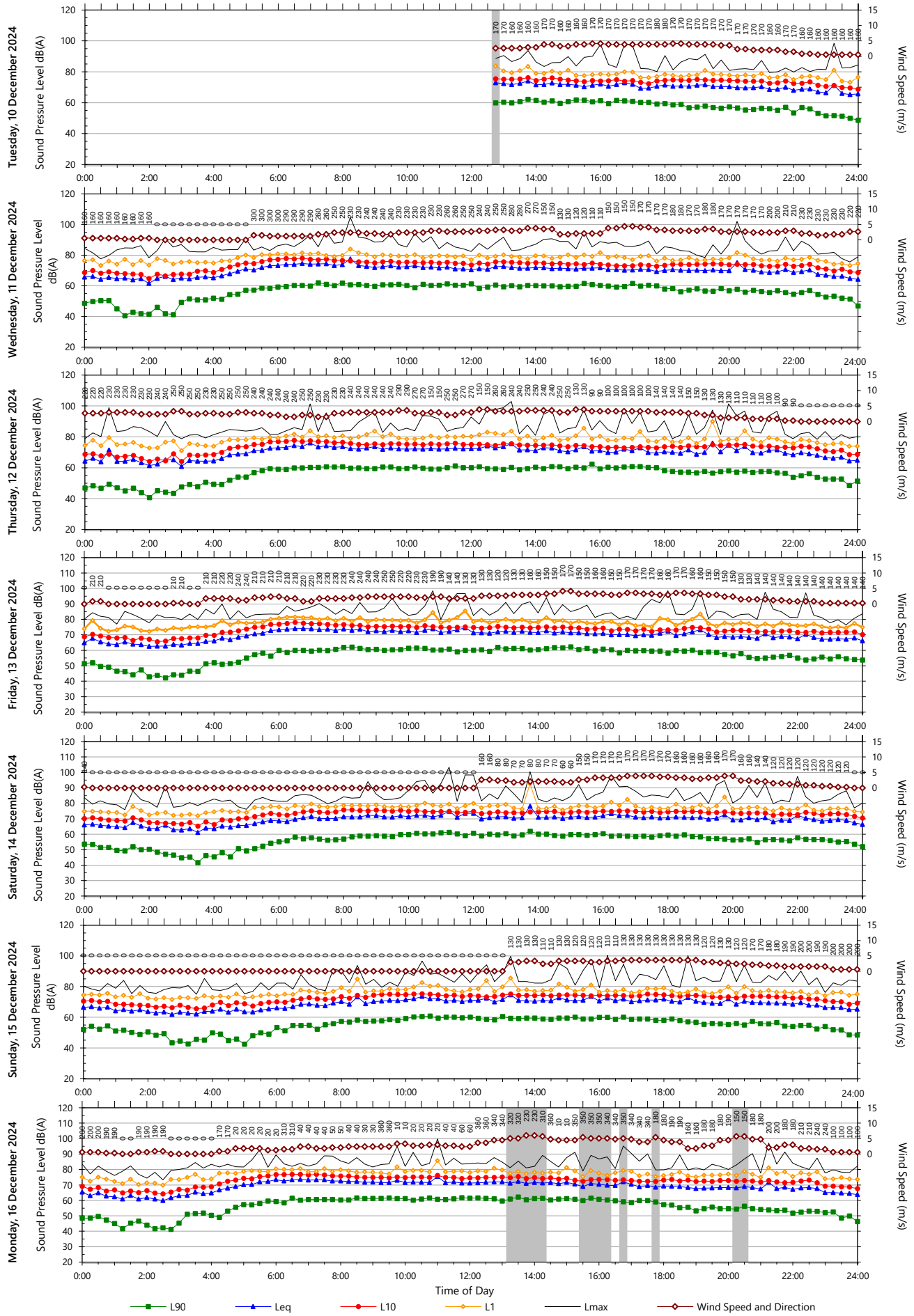
Template: QTE-26 Logger Graphs Program (r45)

B.4 M4 – 212-224 Latrobe Terrace (front boundary at 7.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 212-224 Latrobe Tce - M4

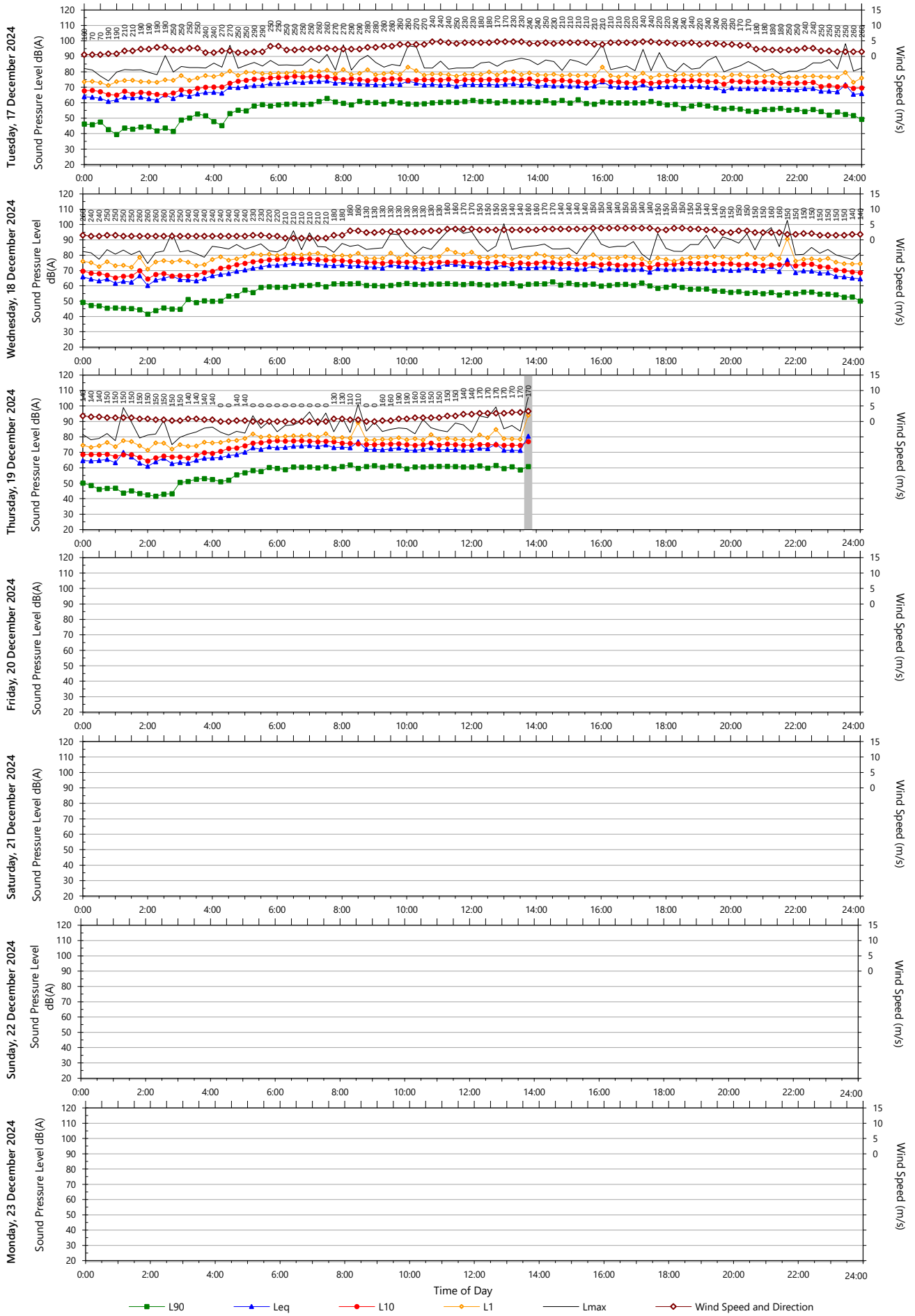


Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 212-224 Latrobe Tce - M4



Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

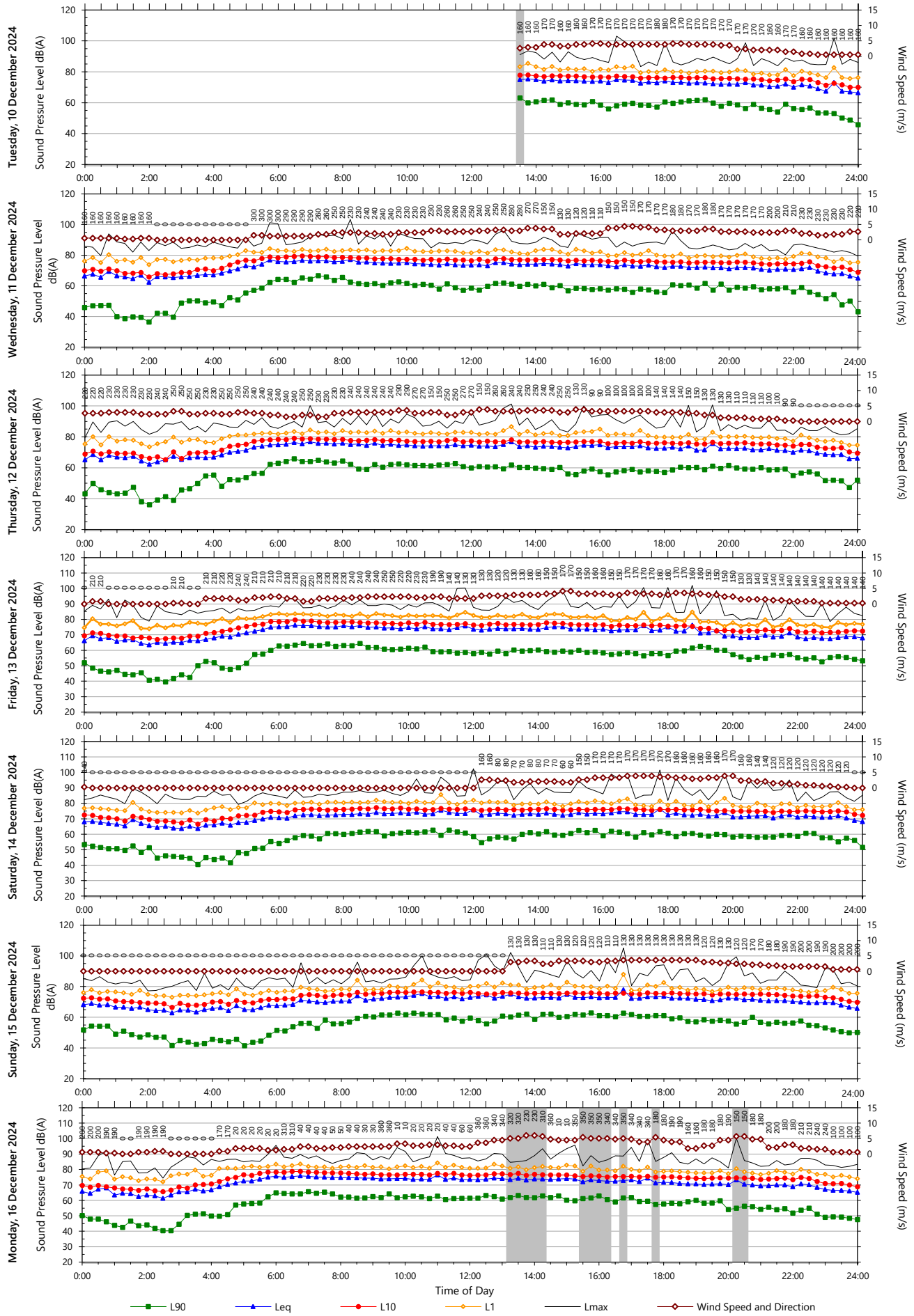
Template: QTE-26 Logger Graphs Program (r45)

B.5 M5 – 190 Latrobe Terrace (front boundary at 4.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 192 Latrobe Tce - M5

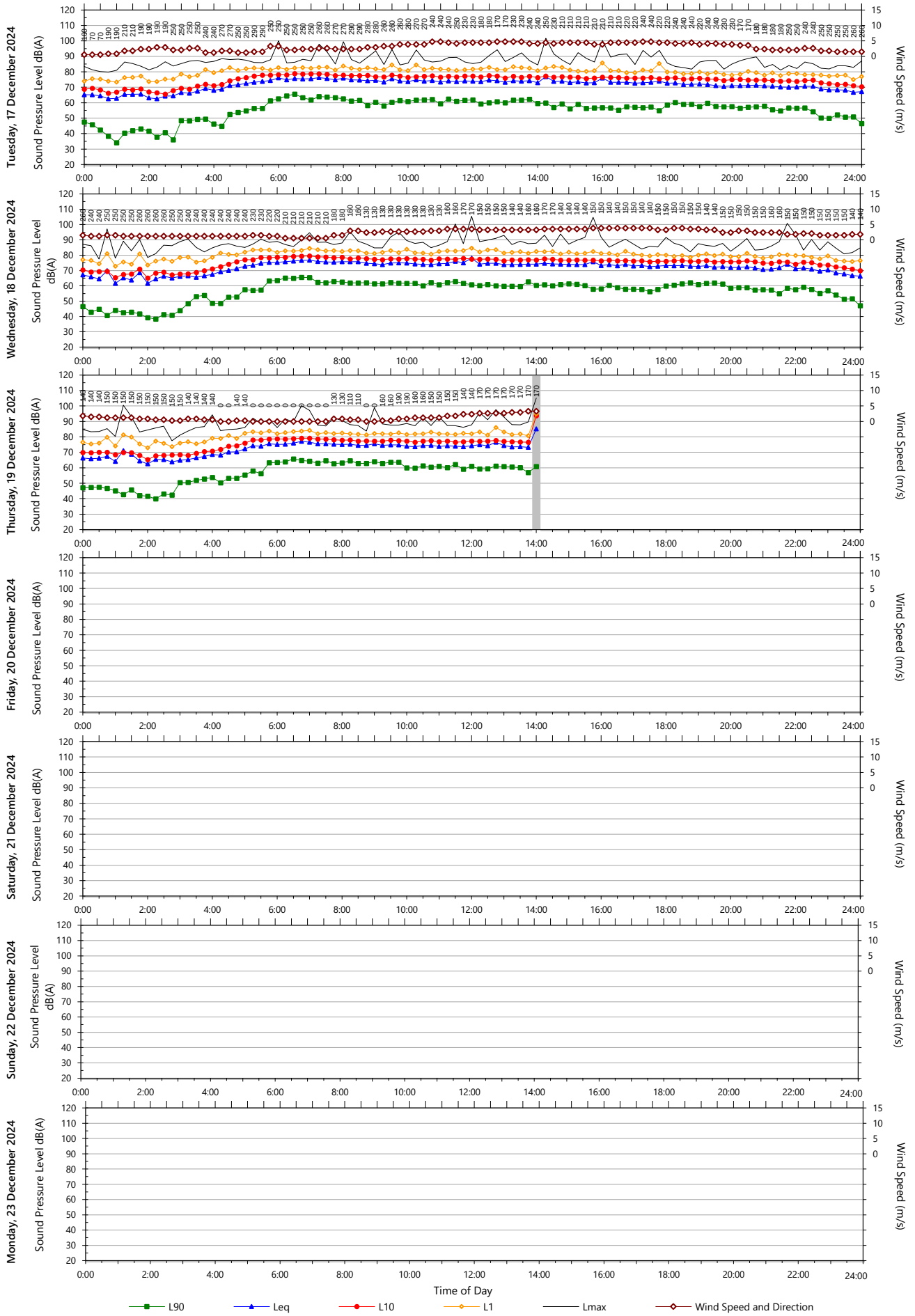


Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 192 Latrobe Tce - M5



Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

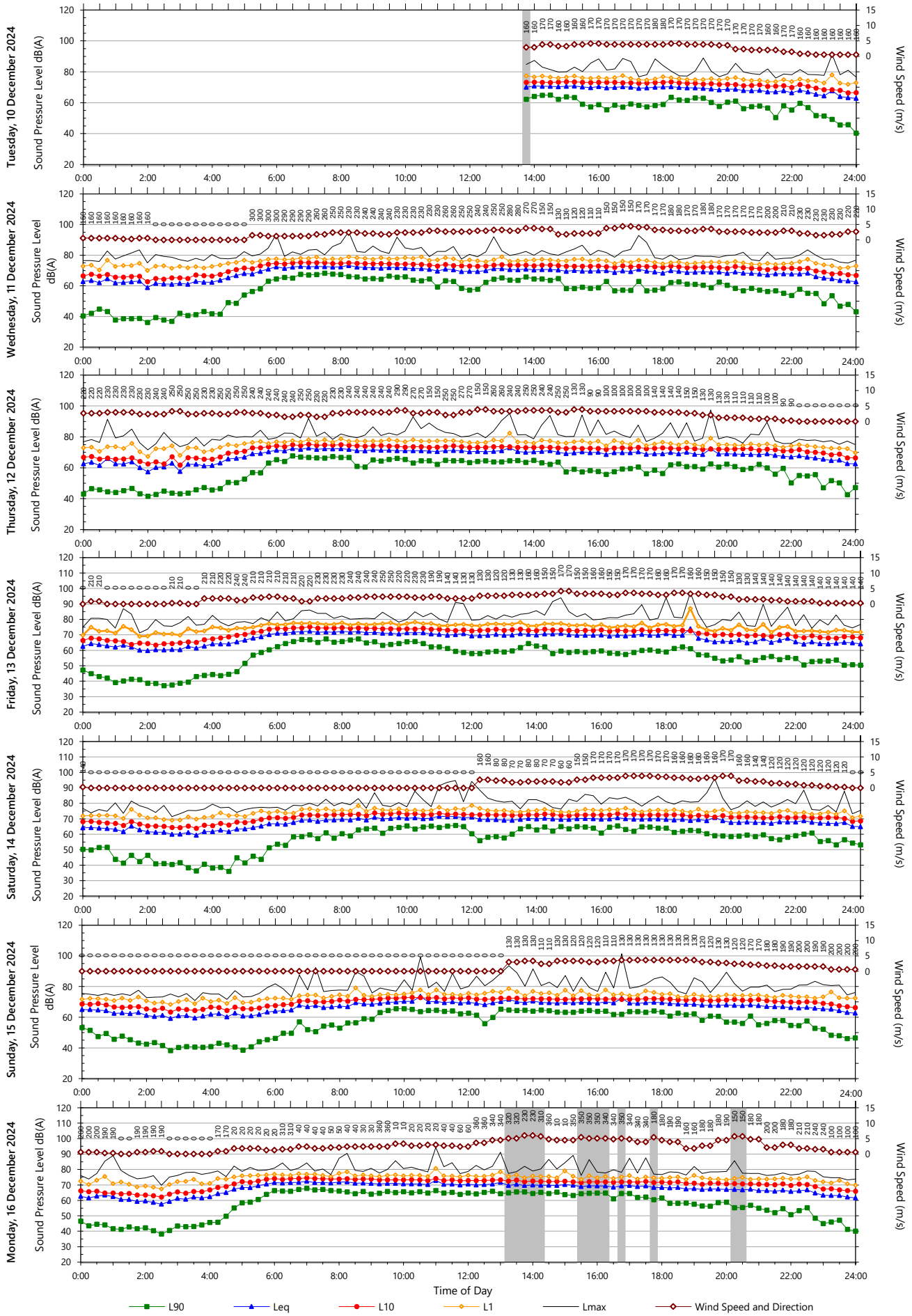
Template: QTE-26 Logger Graphs Program (r45)

B.6 M6 – 190 Latrobe Terrace (front boundary at 7.5m RL)

Greyed out periods in noise monitoring charts correspond to times of precipitation or excessive wind, referenced from Bureau of Meteorology Geelong Racecourse (Station ID: 087184) Weather Station.

Unattended Monitoring Results

Location: 160 Latrobe Tce - M6

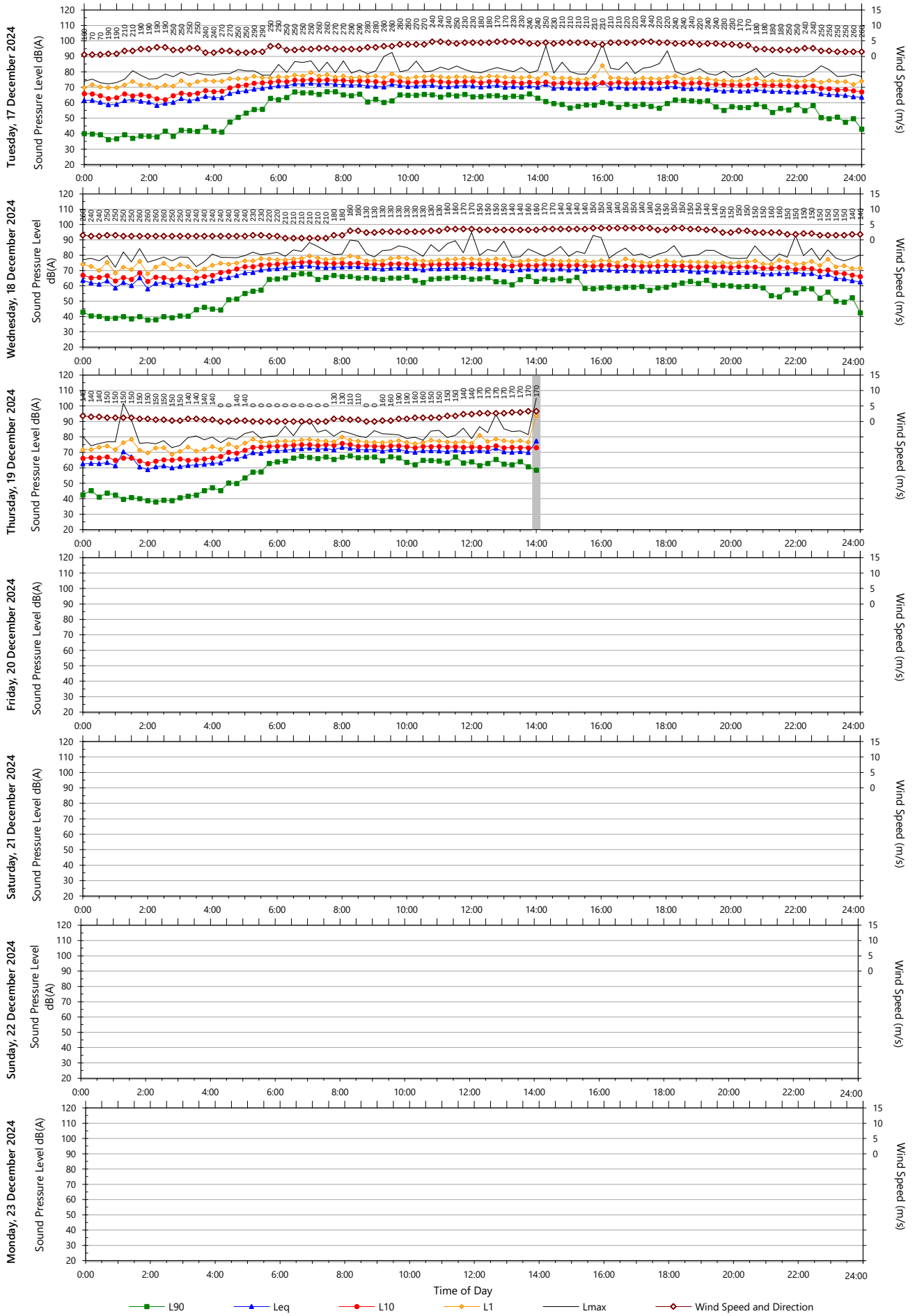


Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)

Unattended Monitoring Results

Location: 160 Latrobe Tce - M6



Data File: 2024-12-10_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r45)