Appendix R – Noise and Vibration Report – Queens Park Station prepared by ALUA

VICTORIA PARK TO CANNING

LEVEL CROSSING REMOVAL PROGRAM

PTA 200140

NOISE & VIBRATION REPORT

QUEENS PARK STATION

PTA NUMBER: LXR-ALUA-NV-RPT-00001

ALUA NUMBER: LXR-P2-Z3-QP-PM-EN-RPT-00001

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Document Control Record

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Document Control

Report Title	Noise & Vibration Report – Queens Park Station
Client	Office of Major Transport Infrastructure Delivery (OMTID)

Rev	Date	Revision Details / Status	Author	Reviewer	Approver	SEM
A	21-06-22	Reference Design	Rachel Foster	Simon McHugh	David Peoples	
B	18-01-23	Final Detailed Design	Rachel Foster	David Peoples	Ben Hoy	Ben Hoy

Current Revision	B

Approval

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1 Introduction

1.1 Document Exclusions

This report encompasses the acoustic design for the Queens Park Station only. The acoustic assessment for other stations is provided in separate reports. This report represents the acoustic assessment for the Final Design Development phase of the project.

The following items are excluded from this design document, which will be addressed in separate packages:

- Enabling works (Temporary works).
- Road and rail noise and vibration.
- Maintenance, corrective work and replacement work with no design.
- Construction methodology.
- Construction – Construction Area Plan (CAP).
- Construction – Work Area Plan (WAP).
- Construction – Inspection and Test Plans (ITP).
- Commissioning.

1.2 Abbreviations and Acronyms

TABLE 1-1 – ABBREVATIONS AND ACRONYMS

Abbreviation	Description
AD	Alliance Development
AS	Australian Standard
CER	Communications Equipment Room
EPNR	Environmental Protection (Noise) Regulations
EST	Essential Supply Transformer
FDD	Final Design Development
FSL	Finished Surface Level
IFC	Issued For Construction
IDC	Interdisciplinary Design Check
IDD	Intermediate Design Development
IDR	Interdisciplinary Design Review
IFC	Issued for Construction
IV	Independent Verifier
LCR	Lobby Communications Room

Abbreviation	Description
LLPA	Long Line Public Address
LXR	Level Crossing Removal
MCR	Main Cable Route
N&I	Network and Infrastructure
N&V	Noise & Vibration
OMTID	Office of Major Transport Infrastructure Delivery
OSHR	Occupational Safety and Health Regulations
PA	Public Address
PTA	Public Transport Authority
PPV	Peak Particle Velocity
RD	Reference Design Development
RFI	Request for Information
RT60	Reverberation Time (60 seconds)
SER	Signalling Equipment Room
SMCR	Station Major Communications Room
SPL	Sound Pressure Levels
SPP 5.4	State Planning Policy 5.4
STI	Speech Transmission Index
SWL	Sound Power Level
SWTC	Scope of Works and Technical Criteria
TSER	Trackside Equipment Room
WAPC	Western Australian Planning Commission
WC	Water Closet

1.3 Terminologies and Definitions

TABLE 1-2 – TERMINOLOGIES AND DEFINITIONS

Term	Definition
'A' weighted	A frequency filter is applied to measured noise levels to represent how humans hear sounds.
Ambient sound	The all-encompassing sound at a point is a composite of sounds from near and far.
Background sound	The ambient sound in the absence of the sound is under investigation.
'C' weighted	Frequency filter which does not discriminate against low frequencies and measures uniformly over the frequency range of 30 to 10,000 Hz
dB	The decibel (dB) is a logarithmic unit of measurement that is commonly used to express sound pressure level. An increase of 3 dB corresponds to an approximate doubling of sound power. When applied to sound, an increase of 10 dB corresponds approximately to a perceived doubling of loudness; typically 0 dB is the threshold of hearing and 120 dB is the threshold of pain.
dB(A)	'A' weighted overall sound pressure level.
D_W	Weighted Level Difference – Single number that represents the noise reduction for sound passing between two adjoining enclosed spaces. It is a field measurement that relates to the R_W laboratory measurement for the dividing partition, but also includes all building elements and flanking paths and acoustic absorption in the receiving room. The result includes the actual noise reduction for the installed partition and ceiling systems. The higher the D_W, the greater the noise isolation between enclosed spaces. D_W has superseded NIC as the Australian Standard for acoustically rating room to room noise isolation.
$D_{nc,w}$ / CAC	Weighted ceiling noise reduction index/ceiling attenuation class. This is the ability of a ceiling to prevent the transmission of sound. The $D_{nc,w}$/CAC is a measure of sound reduction between rooms with a common ceiling plenum (or space).
$D_{nt,w}$	Weighted standardised field level difference: the D_W rating normalised to a standard room volume and room absorption (or reverberation time). The higher the $D_{nt,w}$ rating, the better the insulation performance.
Flanking transmission	The noise transmission between two rooms sharing a common partition via all paths except that through the common partition.
Free field	A sound field sufficiently far from solid objects, other than the ground, so as to be free from the effects of sound reflections.
Frequency (Hz)	The human ear responds to sound in the frequency range of 20 hertz (Hz) to 20,000 Hz. A combination of sound pressure and frequency determines perceived loudness. The centre frequency of an octave is double the frequency of the lower octave. Sound measurements are usually taken at 16 one-third octave bands between 50 Hz and 5,000 Hz.
Impact sound transmission level	In a given frequency band, between two rooms situated one above the other: the average octave band sound pressure level, throughout the lower room, is produced by impacts delivered by a standard tapping machine to the floor of the upper room.
Intermittent noise	A noise whose sound pressure level suddenly drops to the background level several times during the period of observation, the time during which the level remains at a constant value different from that of the background level being of the order of 1 s or more.

Term	Definition
$L'_{nt,w}$	The single number quantity is used to characterise the impact sound insulation of floors over a range of frequencies. See bs EN ISO140-7:1998
L_{10}	The noise level exceeded 10% of the measurement period. This represents the upper intrusive noise level and is often used to represent traffic or music noise.
L_{90}	The noise level exceeded 90% of the measurement period. This represents the background noise level excluding nearby sources. The L_{90} level is commonly referred to as the background noise level.
$L_{Aeq,8h}$	The 8-hour equivalent continuous a-weighted sound pressure level in decibels (dB(A)) i.e. The steady noise level which would, in the course of an 8-hour period, cause the same a-weighted sound energy which would be caused by the actual noise during an actual working day.
$L_{C,\ peak}$	The C-weighted peak noise level.
L_{eq}	Energy averaged noise level over the measurement period. This measure is commonly used when comparing the noise level with relevant standards for air conditioning noise.

1.4 Scope of this report

This report comprises the acoustic deliverable for the Queens Park Station. The contents of the report will serve to:

- Confirm with the architectural discipline that the appropriate wall/partition/door/window constructions to achieve the required acoustic separation and external noise ingress requirements have been documented.
- Confirm with the architectural discipline that the appropriate surface materials and treatments to achieve the required reverberation control requirements have been documented.
- Confirm with the communications consultant that the appropriate public address (PA) speaker locations to achieve appropriate speech intelligibility requirements have been documented.
- Confirm with the building services disciplines (mechanical, electrical, hydraulic) that noise mitigation requirements to achieve the internal noise level requirements have been documented.
- Confirm with the traffic and civil design disciplines that noise mitigation requirements (if deemed necessary) to achieve the acoustic standards for car parks and bus interchanges/movements have been documented.
- Confirm that controls required (if deemed necessary) to achieve appropriate noise emission from the station to adjacent noise-sensitive premises have been documented.

2 Design Development

2.1 Key Changes

2.1.1 Reference Design (RD) to Final Design (FD)

- The building services noise and associated environmental noise emissions have been revised in accordance with the FD mechanical services drawings, specifications, and schedules.
- The acoustic design for partition constructions/wall types/surface treatments was reviewed and coordinated with the architects in accordance with the FD architectural services drawings, specifications and schedules.
- The assessment of noise impacts from the station to nearby noise-sensitive receivers from passengers, PA systems, car parking, and bus movements have been assessed and the results have been incorporated into this report.
- Vibration levels in the platform areas have been assessed and the results have been incorporated into this report.

2.1.2 Final Design (FD) to Issued for Construction (IFC)

This section will be developed following the completion of the Final Design Development.

2.2 Deviations

No non-compliances with standards in relation to acoustics are currently anticipated.

2.3 Departures

Expected departures from the SWTC requirements identified are listed below:

- SWTC Book 4 Part 3 Section 13.8.2 “Noise Criteria for Ambient Noise Levels within Passenger Station Areas” as follows:

Area	Scenario	Maximum acceptable noise level (dB)
Platforms, at any position within 1.5m of the platform edge or centreline (whichever is closer to the track), and more than 8 metres from portals	Moving trains	L_{ASmax} 80

This departure is currently being investigated and Departure DEV_0018 will be progressed in the event that non-compliance with this SWTC requirement remains.

3 Acoustic Scope and Standards

3.1 Acoustic Scope

The objective of the acoustic design is to provide an appropriate degree of acoustic comfort for the users, public and operators alike, as well as a control station and bus/parking noise to nearby noise-sensitive receivers. To achieve this, several items were considered:

- Key acoustic materials and finishes within the station building fabric.
- Partition construction (internal and external).
- Building services (mechanical/hydraulic/electrical) as appropriate.
- Public address (PA) systems.
- Station patrons.
- Car park vehicle movements.
- Bus movements within the station area.

The design is developed in accordance with the PTA and SWTC requirements, the relevant Australian Standards and the requirements of the *Environmental Protection (Noise) Policy*.

3.2 Design Standards and Codes

In addition to the *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* (SWTC) and the Public Transit Authority of Western Australia (PTA)-specific requirements referenced, the codes and standards required to develop the acoustic design include the following:

TABLE 3-1 – DESIGN STANDARDS AND CODES

Reference	Title
AS 1428.2-1992	Design for access and mobility Part 2: Enhanced and additional requirements - Buildings and Facilities
AS 1670.4 (2018)	Fire detection, warning, control and intercom systems – System design, installation and commissioning Part 4: Emergency warning and intercom systems
AS NZS 1668.1 -1998	*The use of ventilation and air conditioning in buildings Part 1: Fire and smoke control in multi-compartment buildings*
AS / NZS 2107:2016	Acoustics - Recommended design sound levels and reverberation times for building interiors
AS 2436-2010	Guide to noise and vibration control on construction, maintenance and demolition sites
AS 2670.1	Evaluation of human exposure to whole-body vibration - General requirements
AS 2670.2	Evaluation of human exposure to whole-body vibration - Continuous and shock-induced vibration in buildings (1 to 80 Hz)

Reference	Title
AS/RISSB 7532:2016	Railway Rolling Stock - Audible Warning Devices
BS 6472	Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz)
BS 7385.2	Evaluation and Measurement for Vibrations in Buildings – Part 2 Guide to Damage Levels from Ground-Borne Vibration
CR NOI TSI	Technical specification for interoperability relating to the subsystem 'rolling stock – noise' of the trans-European conventional rail system, adopted by the Commission Decision 2011/229/EU, April 2011
Dev WA Development Policy 3	Development Policy 3 – Sound and Vibration Attenuation
DIN 4150.3	Part 3: Structural Vibration in Buildings: Effects on Structures
EPNR 1997	Western Australia Environmental Protection (Noise) Regulations
ISO GUIDE 98-3	Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)
ISO 3095	Acoustics - Railway applications - Measurement of noise emitted by rail-bound vehicles - Third Edition, August 2013
ISO 3381	Railway applications - Acoustics - Measurement of noise inside rail-bound vehicles
ISO 8041	Human response to vibration – Measuring instrumentation
ISO 14837	Mechanical vibration - Ground-borne noise and vibration arising from rail systems
ISO/IEC Guide 98-3	Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (ISO GUM:1995)
NCC	National Construction Code
NSWRING	New South Wales Rail Infrastructure Noise Guideline, NSW EPA, May 2013
OSHR 1996	Western Australia Occupational Safety and Health Regulations
SPP 5.4	State Planning Policy No. 5.4 Road and Rail Noise 2019
SPP 5.4 Road and Rail Noise Guidelines	Road and Rail Noise Guidelines, September 2019
8190-600-009	American Railway Engineering and Maintenance-of-Way Association (AREMA) Communications and Signals Manual

The above list is not exhaustive but is provided to note the key guides and standards to which the design shall align.

4 Acoustic Criteria

4.1 Noise Criteria for Impacts on Surrounding Noise-Sensitive Premises

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *Stations and associated infrastructure (e.g. carparks, plant rooms etc) must be designed to comply with the requirements of the Environmental Protection (Noise) Regulations 1997 (WA).*

Noise criteria for both steady-state and discrete noise emissions from the Queens Park Station are nominated in this section. The setting of noise emission criteria is intended to protect the acoustic amenity of nearby sensitive receivers.

Environmental noise impacts resulting from the Queens Park Station are addressed through the Environmental Protection Act 1986 with the prescribed standards detailed in the Western Australia *Environmental Protection (Noise) Regulations* 1997 (EPNR) as shown in Table . The regulations are based on maximum allowable noise levels termed the 'assigned noise level'. The regulations require that:

> *Noise emitted from any premises when received at other premises must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind.*

Noise emission is taken to 'significantly contribute to' a level of noise if the noise emission exceeds a value that is 5 dB below the assigned level at the point of reception.

TABLE 4-1 – ASSIGNED LEVELS BY THE WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION (NOISE) REGULATION 1997

Type of premises receiving noise	Time of Day	Environmental Emission Criterion Level dB(A)		
		$L_{A,10}$	$L_{A,1}$	$L_{A,max}$
Nearest noise-sensitive receiver: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sundays and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours every day	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise-sensitive premises: any area other than a highly sensitive area	All hours	60	75	80
Commercial Premises	All hours	60	75	80
Industrial premises	All hours	65	80	90

The regulations also apply penalties on noise levels that contain annoying characteristics such as tonal components. Where these characteristics do exist and cannot be practicably removed, then the measured levels are adjusted according to the penalties as follows:

- Where tonality is present: +5 dB.
- Where modulation is present: +5 dB.
- Where impulsiveness is present: +10 dB.

The noise adjustments apply up to a maximum cumulative total of 15 dB.

The influencing factor is applied to account for higher noise areas as a result of nearby industrial and commercial areas and major roads. The influencing factor is determined by considering the land use within two circles having a radius of 100 m and 450 m from the noise-sensitive premises of concern and proximity to major and minor roads as defined in the EPNR. The nearest noise-sensitive receivers on each side of the Queens Park Station have been identified and are summarised below in Table .

TABLE 4-2 – ENVIRONMENTAL DESIGN CRITERIA – NOISE-SENSITIVE RECEIVERS

Location	Noise Sensitive Receiver	Receiver Type
Northeast	148 – 154 Railway Parade, Queens Park	Residential
Northwest	179 Sevenoaks Street, Cannington	Residential
South	205-207 Sevenoaks Street, Cannington	Residential

Note: Selection of noise-sensitive premises is based on Schedule 1 – Part C of the EPNR

FIGURE 1 ENVIRONMENTAL DESIGN CRITERIA – LOCATION OF NOISE-SENSITIVE RECEIVERS

Transport factors of 6 dB(A) and 2 dB(A) are applied to noise-sensitive receivers if major roads are located within 100 m and 450 m respectively. A transport factor of 2 dB(A) is applied to noise-sensitive receivers if a secondary road is located within 100 m of a noise-sensitive receiver.

A major road is defined as having vehicle traffic flows in excess of 15,000 vehicles per day. A secondary road is defined as having traffic flows of 6,000 to 15,000 vehicles per day.

The major roads and secondary roads within 100 m and 450 m of the noise-sensitive receivers are identified below in Table .

TABLE 4-3 – ENVIRONMENTAL DESIGN CRITERIA – MAJOR / SECONDARY ROADS

Location	Major Road Within 100 m	Secondary Road Within 100 m	Major Road Within 450 m
Northeast	-	Sevenoaks Street	-
Northwest	-	Sevenoaks Street	-
South	-	Sevenoaks Street	-

The area surrounding the Queens Park Station is predominantly residential, with educational (Goodstart Early Learning, St Norbert College) and community (Hope Church, True Jesus Church, St Joseph Priory) premises and some commercial properties adjacent to the rail corridor and to the west of Derisleigh Street. The road and rail reserves associated with the existing rail corridor and Sevenoaks Street are considerable. The zoning plans for the City of Canning have been used to identify the zoning around the station. To determine the influencing factor, existing roads and land uses have been considered. The influencing factors at the nearest noise-sensitive receivers are summarised in Table , and the corresponding environmental noise criteria as given in Table

TABLE 4-4 – ENVIRONMENTAL DESIGN CRITERIA – INFLUENCING FACTORS

Location	% Industrial Area Use		% Commercial Area Use		Transport Factor	Influencing Factor
	100 m	450 m	100 m	450 m		
Northeast	50	18	0	0	2	9
Northwest	49	14	0	0	2	8
South	45	15	0	0	2	8

TABLE 4-5 – ENVIRONMENTAL DESIGN CRITERIA – QUEENS PARK STATION ASSIGNED NOISE LEVEL, dB(A)

Premises receiving noise	Time of Day	Environmental Emission Criterion Level dB(A)		
		$L_{A,10}$	$L_{A,1}$	$L_{A,max}$
Northeast	0700 to 1900 hours Monday to Saturday	54	64	74
	0900 to 1900 hours Sundays and public holidays	49	59	74
	1900 to 2200 hours all days	49	59	64
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours	44	54	64

Premises receiving noise	Time of Day	Environmental Emission Criterion Level dB(A)		
		$L_{A,10}$	$L_{A,1}$	$L_{A,max}$
	Sunday and public holidays			
Northwest	0700 to 1900 hours Monday to Saturday	53	63	73
	0900 to 1900 hours Sundays and public holidays	48	58	73
	1900 to 2200 hours all days	48	58	63
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	43	53	63
South	0700 to 1900 hours Monday to Saturday	53	63	73
	0900 to 1900 hours Sundays and public holidays	48	58	73
	1900 to 2200 hours all days	48	58	63
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	43	53	63

Note: A noise emission from premises is considered to not significantly contribute to the noise at a receiver if the noise emission is 5 dB below the overall noise emission criteria for the area.

It is noted that the EPNR does not specifically identify that the above environmental noise criteria are applicable to noise from rail passengers and patrons of the Queens Park Station; however, an assessment is made to quantify the likely impacts of these sources on adjacent noise-sensitive receivers.

4.2 Noise Criteria for Impacts from Station Entry Roads and Bus Movements

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *The Alliance must design road works and any associated noise mitigation controls to meet the requirements of State Planning Policy No. 5.4 Road and Rail Noise (SPP 5.4) (WAPC, 2019).*

Table sets out the environmental noise criteria referred to.

TABLE 4-6 – ENVIRONMENTAL DESIGN CRITERIA – NEW AND UPGRADED PUBLIC ROADS AND BUS LANES

Type of premises receiving noise	Time of Day	New Road	Upgraded Road
Noise-sensitive land use (existing and planned development)	Day (6 am–10 pm)	$L_{Aeq\ (Day)}$ = 55 dB(A)	$L_{Aeq\ (Day)}$ = 60 dB(A)
	Night (10 pm–6 am)	$L_{Aeq\ (Night)}$ = 50 dB(A)	$L_{Aeq\ (Night)}$ = 55 dB(A)

For the Queens Park Station, this includes bus movements into and out of the station precinct. It is noted that there is no bus interchange at Queens Park Station.

It is noted that the assessment of rail noise to adjacent noise-sensitive receivers is being addressed separately for the ALXR project and does not form part of this scope.

4.3 Noise Criteria for Ambient Noise Levels within Passenger Station Areas

The following criteria are based on the requirements set out in the document *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria.*

Current NCC, environmental or industry standard criteria at the time of detailed design shall apply, in addition to the indicative criteria summarised in Table .

TABLE 4-7 – INTERNAL DESIGN CRITERIA - NOISE

Source	Receiver	Noise criterion, dB(A)
Building services and plant noise	Ticket sales areas	L_{Aeq} 45
	General office areas	L_{Aeq} 45
	Staff crib rooms	L_{Aeq} 45
	Public waiting areas, kiosks	L_{Aeq} 45
	Toilets and amenities	L_{Aeq} 45 - 55
	Parking and waste storage areas	L_{Aeq} 65
	Plantrooms	L_{Aeq} 85 at 1 m from plant L_{Aeq} 65 overall
	All other areas	Table 1, AS/NZS 2107:2000 ‘Satisfactory’ values plus 5dB
Stationary trains, and auxiliary equipment operating as normal	Platforms, at any position within 1.5 m of the platform edge or centreline (whichever is closer to the track), and more than 8 metres from portals	L_{Aeq} 70
Moving trains		L_{ASmax} 80
Building services and plant (ventilation, etc.)		L_{Aeq} 55
Emergency smoke fan systems		L_{Aeq} 85
Hydraulic services in amenities	Publicly accessible area	Inaudible

Source	Receiver	Noise criterion, dB(A)
Hand dryers in amenities	2 m from the amenity entrance	Inaudible

4.4 Noise and Vibration Ingress into Passenger Station Areas

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *The Alliance must comply with the following requirements:*
>
> - *External noise ingress from all associated road and rail traffic sources is controlled according to the requirements of the State Planning Policy No 5.4 Road and Rail Noise (SPP 5.4) (WAPC 2019).*
> - *Floor vibration levels within publicly accessible areas from plant, equipment or external sources do not exceed $L_{v, RMS,1s}$ 112 dB.*
> - *External noise ingress from adjacent road traffic sources must be assessed and considered when designing and constructing all stations to ensure that the public address systems within passenger station areas achieve the minimum sound level and speech intelligibility requirements of clauses 4.3.4 and 4.3.6 of AS 1670.4 for all representative locations, environmental conditions and passenger levels.*

SPP5.4 provides noise targets for residential buildings. For other noise-sensitive land use and/or development, such as passenger station areas, SPP5.4 states that indoor noise targets may be reasonably drawn from Table 1 of AS/NZS 2107:2016.

4.5 Reverberation within Passenger Station Areas

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *The Alliance must comply with the following requirements:*
>
> - *Within platform areas, the spatial average reverberation time (RT60) values for the full octave bands with centre frequencies 500Hz and 1kHz do not exceed 1.3 seconds for the scenario where 100 patrons are present, or 1.6 seconds when empty.*
> - *At all other areas, spatial average reverberation time (RT60) values for the full octave bands with centre frequencies 500Hz and 1 kHz be in accordance with AS/NZS 2107:2000 given the usage of each space.*

Therefore, the reverberation time criteria applicable to the Queens Park Station are shown in Table .

TABLE 4-8 – INTERNAL DESIGN CRITERIA - REVERBERATION TIME

Criterion	Receiver	Reverberation time criteria at 500 Hz and 1 kHz, seconds
Reverberation	General office	0.4 - 0.6
	Retail	Minimised as far as practicable
	All circulation, back of house areas	-
	Toilets and amenities	-
	Ticket sales areas	0.6 – 0.8
	Platform areas	1.3 with 100 patrons present 1.6 when empty

Criterion	Receiver	Reverberation time criteria at 500 Hz and 1 kHz, seconds
	Staff crib rooms	< 0.8
	Public waiting areas, kiosks	Minimised as far as practicable

4.6 Public Address Systems within Passenger Station Areas

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *The Alliance must ensure that the PA systems achieve the minimum sound level and speech intelligibility requirements of clauses 4.3.4 and 4.3.6 of AS 1670.4 for all representative locations, environmental conditions and passenger levels.*

AS 1670.4 requires that the A-weighted sound pressure level shall:

- Exceed the ambient sound pressure level by 10 dB(A) when averaged over a period of 60 seconds.
- Shall not be less than 65 dB(A).
- Shall not be more than 105 dB(A).
- When under stand-by power source operation shall not cause audible emergency signals to fall by more than 6 dB sound pressure level below the required sound level when tested after 24 hours of quiescent operation.

Additionally, AS 1670.4 requires that:

- Where ambient noise figures are less than 85 dB(A), the speech transmission index (STI) shall be ≥ 0.5.
- The average speech SPL shall not exceed 100 dB(A).
- When under stand-by power source operation the CIS index is not to fall below 0.65 (0.45 STI) when tested after 24 hours of quiescent operation.

4.7 Acoustic Sound Insulation within Passenger Station Areas

The *Inner Armadale Line Level Crossing Removal Program (LXR) – Delivery Scope of Work and Technical Criteria* states the following:

> *Airborne sound insulation targets are given in terms of the weighted level difference, Dw between two spaces. The Alliance must ensure that the design complies with the following general in-situ airborne sound insulation targets:*
>
> *Dw ≥ 35dB between normally occupied enclosed spaces.*
>
> *Dw ≥ 28dB between normally occupied spaces where the common partition includes a door.*

The SWTC also presents criteria that supersede these general requirements for specific occupied spaces. Where two different space types are adjacent to one another, the Alliance must ensure that the more onerous target applies. These are given in Table .

TABLE 4-9 – INTERNAL DESIGN CRITERIA – ACOUSTIC SOUND INSULATION

Space Type / Occupancy	Minimum Weighted Sound Level Difference, D_w, dB	
Between normally occupied back-of-house offices and crib rooms	Generally,	40
	Where the common partition at the interface includes a door	30
	Generally,	42

Space Type / Occupancy	Minimum Weighted Sound Level Difference, D_W, dB	
Toilets and amenities in nearby public areas	Where the common partition at the interface includes a door	25
	Where the common partition at the interface has no door	16

The D_W rating is the 'weighted standardised field level difference' and represents the required installed performance between two spaces to achieve the different levels of acoustic separation, inclusive of all flanking paths.

The D_W rating relates to the final installed acoustic performance measured on-site. Accordingly, the result will include a contribution from noise leaking along flanking paths such as joints between walls and ceilings, joints between walls and other external and internal walls, leakage associated with services penetrations, along ductwork and via glazing and doors.

The difference between the result tested in a laboratory (R_W), and the result achieved on site (D_W) normally varies between 3 and 8 dB depending on how well the flanking paths can be controlled, and the receiving room size and absorptive characteristics. Flanking paths tend to have a greater impact on higher-performing partitions – i.e. the impact is likely to be greater for an R_W 50 partition than for an R_W 40 partition.

In order to account for the likely degradation in performance arising from this leakage, a laboratory performance (R_W) has been recommended that is approximately 5 dB higher than the typically required field performance.

In addition to the above separation requirements, walls and doors should be designed to limit noise transmission from noise-generating spaces, such as plant rooms, to meet the noise levels presented in Section 4.3.

4.8 Occupational Safety and Health

The Western Australia *Occupational Safety and Health Regulations 1996* (OSHR) provides the following exposure standards for noise:

- $L_{Aeq,8h}$ of 85 dB(A).
- $L_{C,\ the\ peak}$ of 140 dB(C).

These standards are applicable at a measurement position of a person's ear without taking into account any protection which may be provided to the person by personal hearing protectors.

4.9 Construction Noise and Vibration

The EPNR clarifies that the environmental noise criteria outlined in Table are not applicable to noise emitted from a construction site where works are carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if it is shown that the construction works are generally carried out in accordance with the controls identified in Section 4 of AS 2436-2010 *Guide to noise and vibration control on construction, maintenance and demolition sites* and if construction work is carried out in accordance with an approved management plan.

It is noted that a specific construction noise and vibration management plan is being addressed separately for the ALXR project, which will include relevant site clearing and construction works associated with the Queens Park Station, and does not form part of this scope.

5 Acoustic Solutions

5.1 Noise Impacts on Surrounding Noise-Sensitive Premises

The area surrounding the Queens Park Station is predominantly residential, with educational (Goodstart Early Learning, St Norbert College) and community (Hope Church, True Jesus Church, St Joseph Priory) premises and some commercial properties adjacent to the rail corridor and to the west of Derisleigh Street.

These noise-sensitive residences in the vicinity of Queens Park Station are already affected by noise from the existing passenger railway line, station and station car park, and from road traffic on Sevenoaks Street. However, the environmental noise emissions from the new station and associated car parking/bus movements will need to be considered for these receivers adjacent to the station.

5.1.1 Building Services

Mechanical services plant selections for the Queens Park Station comprise:

- Small, ducted exhaust fans to ablution facilities and electrical plant spaces.
- Small outdoor air fans.
- Plant room, pump room and electrical room extract systems.
- Air conditioning to comms rooms and electrical rooms incorporating split systems with wall-mounted indoor units, and external condensing units.
- 50/75/100 kVA Essential Supply Transformer (EST).

The proposed equipment locations and layout are as shown in the following mechanical services drawings:

- LXR-P2-Z3-SN_ME-00012
- LXR- P2-Z3-SN_ME-00013
- LXR- P2-Z3-SN_ME-00020
- LXR- P2-Z3-SN_ME-00021

With the specified noise levels and acoustic treatments as identified in the mechanical and electrical specifications (acoustic lining to exhaust ductwork, location of equipment, etc.), the predicted noise levels from all duty equipment in operation at the noise-sensitive receptors are less than 30 dB(A).

Therefore, the night-time environmental noise criteria given in Table 9 are predicted to be achieved, and no additional acoustic mitigation is required.

The predicted noise levels from the Queens Park Station when equipment is operating in emergency mode (gas suppression fans, fire pump enclosure) are as follows.

- Northeast 40 dB(A)
- Northwest 41 dB(A)
- South 50 dB(A)

The predicted noise levels are lower than the night time enviromental criteria for receivers to the north west and north east of the station, but higher than the night time criterion at the receiver to the south. However, the environmental noise criteria are not strictly applicable under emergency scenarios, and are lower than the permissible noise levels under emergency services on platforms (85 dB(A)), and are therefore considered acceptable under emergency situations.

It is noted that the onus of management of the noise emission from the Western Power substation within the vicinity of the Queens Park Station lies with Western Power.

The acoustic performance requirements presented in Section 5.7 provide the minimum acoustic ratings for partitions and doors to control environmental noise emission from the transformers to meet the relevant environmental noise requirements.

5.1.2 Public Address (PA) System

The design of the public address system is described in detail in the Communications reporting (report LXR-P2-Z3-QP-SN-SC-RPT-00003 / LXR-ALUA-EC-RPT-00013) and is not repeated here. The published noise data for the selected speaker types are as follows:

- Ceiling speakers: CM20DTS: Maximum continuous SPL 88 dB at 5m.
- Column speakers: RayOn 70: Maximum continuous SPL 103 dB at 1m.

Ambient Noise Compensation devices and associated microphones are installed in the station's public areas (Platforms and Concourse). These devices allow the LLPA speakers to be dynamically adjusted to the ambient noise and to remain at a defined level (generally between 3- and 10-dB SPL) above the ambient noise level. Figure 19 of the Communications reporting indicates an average sound pressure level on the platform area of 74 dB. Based on this speaker output, the predicted maximum continuous noise levels from the speakers at the nearest noise-sensitive receivers is as follows:

- Northeast 59 dB(A)
- Northwest 61 dB(A)
- South 64 dB(A)

However, the predicted levels represent the noise levels at the noise-sensitive receivers for the PA system in continuous operation. The EPNR requires a “representative assessment period” of not less than 15 minutes or more than 4 hours. As the PA system operation is intermittent rather than continuous, consideration is given to the actual duration of PA announcements across the day and night periods.

The PTA uses the LLPA for different types of announcements:

- Next service departure (2, 5 and 10 min before departure)
- Non-smoking message (every 5 min)
- Luggage unattended type message (every 5 min)
- Other scheduled or unscheduled messages for specific train operations
- Unscheduled messages for safety, security or other purposes

The average announcement duration is given as 5 seconds.

Announcements are muted at night-time to minimise disturbance to the neighbours. Only messages for critical purposes (from the Central Monitoring Room) or safety (non-stopping train approaching) are allowed during these times.

The PTA’s design guidelines 8803-700-005 *GUIDELINE Public Address and Voice Evacuation for PTA Facilities* for these systems include procedural mitigation to manage the use of PA speakers when passenger numbers are low (as would be expected outside of daytime hours). Specifically, the Guidelines state that:

> *The Passenger Information Network (PIN) uses the timetable and track sensors to estimate when a train is arriving/departing at a station and controls the PA system to play automated messages. This system is turned off when the station is frequented by fewer than 5 passengers / 30 minutes.*

These result in the worst-case normal operational duration-adjusted noise levels at the nearest noise-sensitive receivers as presented in Table .

TABLE 5-1 – PREDICTED DURATION-ADJUSTED PA SYSTEM NOISE LEVELS

Location	Predicted Noise Level $L_{Aeq,15min}$ (Day)	Predicted Noise Level $L_{Aeq,15min}$ (Night)
Northwest	49 dB(A)	41 dB(A)
Northeast	48 dB(A)	39 dB(A)
South	47 dB(A)	39 dB(A)

These predicted noise levels achieve the day and night environmental noise criteria outlined in Table .

5.1.3 Car Park

The car parking associated with Queens Park Station is proposed to have a maximum capacity of over 90 bays. The PTA's 'SmartParker' system outputs for the current Queens Park Station car park indicate the highest night-time car park movements (10pm to 7am) occur between 6am and 7am; the highest day time movements (7am to 10pm) occur between 7am and 8am. With a future capacity of 90 bays, these equate to 4 and 14 movements for the peak night and day hours respectively.

TABLE 5-2 – PREDICTED CAR PARK NOISE LEVELS

Location	Predicted Noise Level $L_{Aeq,15min}$ (Day)	Predicted Noise Level $L_{Aeq,15min}$ (Night)
Northwest	37 dB(A)	30 dB(A)
Northeast	36 dB(A)	28 dB(A)
South	26 dB(A)	< 20 dB(A)

The presented noise levels take into account a full parking movement, including vehicle movement, shunting, door/boot opening/closing and engine start-up.

These predicted noise levels achieve the day and night environmental noise criteria outlined in Table .

5.1.4 Passenger Noise

The Queens Park Station is anticipated to have around 3210 passengers per day by 2051. The highest passenger volume is expected during the morning peak hour period, with 100 boardings and 207 alighting's between 08:00 and 08:15 a.m. This equates to around 307 passengers on the station platform for the peak 15-minute period.

The highest passenger volume for the night-time period occurs from 06:30 a.m. to 06:45 a.m., having 47 boardings and 11 alighting's. This equates to around 58 passengers on the station platform for this 15-minute period.

On the basis that the gender split is 50%/50%, and that half the passengers would be speaking in normal voices at any one point in time, the predicted noise levels from passengers at the nearest noise-sensitive receptors are as given in Table .

TABLE 5-3 – PREDICTED PASSENGER NOISE LEVELS

Location	Predicted Noise Level $L_{Aeq,15min}$ (Day)	Predicted Noise Level $L_{Aeq,15min}$ (Night)
Northwest	38 dB(A)	31 dB(A)
Northeast	36 dB(A)	29 dB(A)
South	36 dB(A)	29dB(A)

These predicted noise levels meet or are below the daytime and night-time environmental noise criteria, and therefore noise from passengers on the Queens Park Station platform is not expected to cause disturbance to the nearby noise-sensitive receivers.

5.1.5 Total Station Noise Impact

The total predicted noise levels at the nearest noise-sensitive receivers to the Queens Park Station are presented in Table .

TABLE 5-4 – TOTAL PREDICTED NOISE LEVELS FROM QUEENS PARK STATION

Location	Predicted Noise Level $L_{Aeq,15min}$ (Day)	Predicted Noise Level $L_{Aeq,15min}$ (Night)
Northwest	50 dB(A)	42 dB(A)
Northeast	48 dB(A)	40 dB(A)
South	47 dB(A)	39 dB(A)

These predicted noise levels are below the daytime and night-time environmental noise criteria, and therefore noise from the Queens Park Station is not expected to cause disturbance to the nearby noise-sensitive receivers.

5.2 Noise Impacts from Bus Movements

The bus movements through Queens Park Station are required to be assessed against the road traffic requirements of SPP 5.4. It is noted that there is no bus interchange at Queens Park Station. Only one bus service (Route 201) serves the station; this has six bus movements per day on weekdays and none on weekends or public holidays. Therefore, noise from bus movements associated with the Queens Park Station will achieve the day-time and night-time environmental noise criteria.

5.3 Ambient Noise Levels within Passenger Station Areas

Ambient noise levels within the Queens Park Station areas will be dominated by road and rail traffic noise intrusion and by building services such as fans and air conditioning.

The mechanical services being provided to Queens Park Station are identified in Section 5.1.1. Utilising the data in the mechanical services specification and incorporating the acoustic mitigation advice documented (additional duct lengths, internal duct lining) the predicted noise levels within the Queens Park Station are as shown in Table .

TABLE 5-5 – PREDICTED STATION NOISE LEVELS FROM BUILDING SERVICES

Room		Predicted Noise Level dB(A)	Criterion dB(A)
Normal Operation			
GF.41	SMCR	43	65
GF.46	Elec 01	54	65
GF.52	Elec 02	54	65
GF.56	Main Elec	52	65
GF.61	LCR	52	65
GF.62	CER 02	51	65
GF.68	Emergency Stair 1	43	55
GF.72	TSER	40	65
GF.73	CER 01	51	65
GF.74	Staff WC	40	55
Emergency Operation			

Room		Predicted Noise Level dB(A)	Criterion dB(A)
GF.41	SMCR	84	85
GF.72	TSER	83	85
GF.56	Main Elec	79	85
GF.84	Service Corridor	65	85
-	Platform	50	85

Therefore, noise levels in all areas served by mechanical services are predicted to achieve the relevant internal noise criteria given in Table .

It is also noted that the predicted noise level on the nearest footpath when equipment is operating under emergency requirements (gas suppression fans, fire pump enclosure) is 65 dB(A). As this is also below the niose level required on the platforms under emergency operations, this is considered acceptable.

EASE modelling has also shown that the acoustic requirements of AS 1670.4 are achieved for the PA system operating in emergency mode (refer to the Communications report LXR-P2-Z3-QP-SN-SC-RPT-00003 / LXR-ALUA-EC-RPT-00013).

5.4 Noise and Vibration Ingress into Passenger Station Areas

5.4.1 Noise

The acoustic performance requirements presented in Section 5.7 provide the minimum acoustic ratings for partitions and doors to control noise ingress from road and rail noise to meet the relevant internal noise level requirements.

Noise measurements were undertaken at Queens Park Station on 17 January 2023 gave the following results:

TABLE 5-6 – MEASURED NOISE LEVELS FROM TRAIN MOVEMENTS – QUEENS PARK STATION

Train Movement	Measurement Location (1.5m from platform edge)		
	Northern Platform End	Centre of Platform	Adjacent Doors/Air Conditioning Equipment
Through trains	L_{ASmax} 85 – 89 dB	L_{ASmax} 83 – 89 dB	-
Stopping trains – arrival/departure	L_{ASmax} 65 – 83 dB	L_{ASmax} 74 – 86 dB	-
Stopping trains – idling	-	-	L_{Aeq} 61 – 68 dB

It is noted that previous studies have also identified that the maximum acceptable noise level (L_{ASmax} 80 dB) cannot be reasonably or practicably achieved at all locations on the platforms.

The conclusion in relation to compliance with the SWTC requirements outlined in Table is therefore:

TABLE 5-7 – MEASURED NOISE LEVELS FROM TRAIN MOVEMENTS – COMPLIANCE WITH SWTC REQUIREMENTS

SWTC requirement	Situation	Criterion	Satisfied?
Platforms, at any position within 1.5m of the platform edge or centreline	Stationary trains, and auxiliary equipment operating as normal	L_{Aeq} 70 dB	Satisfied

SWTC requirement	Situation	Criterion	Satisfied?
(whichever is closer to the track), and more than 8 metres from Portals	Moving trains	L_{ASmax} 80 dB	Not satisfied

SWTC Departure DEV_0018 is currently being progressed to obtain the PTA approvals for this deviation from the SWTC.

5.4.2 Vibration

Vibration measurements of the existing passenger rail line were carried out between 17 and 19 May 2022, at two separate locations and a distance of 10 metres from the track (refer ONVDR LXR-PW-Z0-GN-00001). The results showed a 95th percentile PPV of 113 – 114 dB. A vibration assessment was undertaken based on these measured vibration results and with consideration of the proposed track mounting and structural connection arrangements between the track and the station platform at the viaducts. It was determined that the station vibration criterion of $L_{v, RMS,1s}$ 112 dB as given in Section 4.4 is achieved.

5.5 Reverberation within Passenger Station Areas

An acoustic review of the architectural package for the Queens Park Station has been undertaken. The following drawings were reviewed for general compliance with the acoustic design intent:

- LXR-QP-SN-AR-DWG-00142
- LXR-QP-SN-AR-DWG-00143
- LXR-QP-SN-AR-DWG-00144
- LXR-QP-SN-AR-DWG-00145
- LXR-QP-SN-AR-DWG-00146
- LXR-QP-SN-AR-DWG-00147
- Queens Park Materials and Finishes Schedule

The above drawings have been reviewed for general compliance with the reverberation time requirements. Acoustically absorptive materials have been determined by the Communications consultant (refer to Section 3 of report LXR- P2-Z3-QP-SN-SC-RPT-00003), and are reproduced in the figures below.

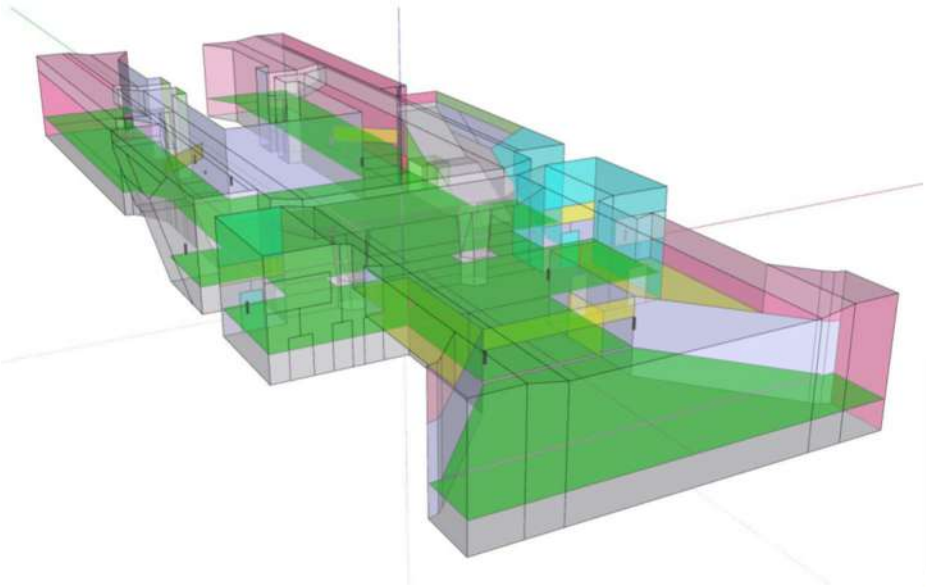

FIGURE 9 LOBBY SKECTCHUP ACOUSTIC MODEL

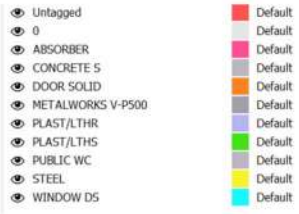

FIGURE 10 LOBBY SKETCHUP MATERIALS

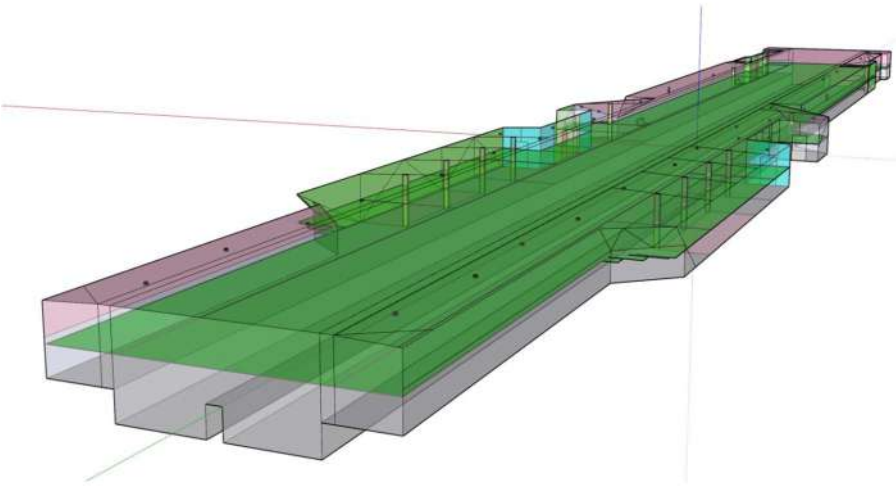

FIGURE 5 PLATFORMS REVERBERATION SKETCHUP MODEL

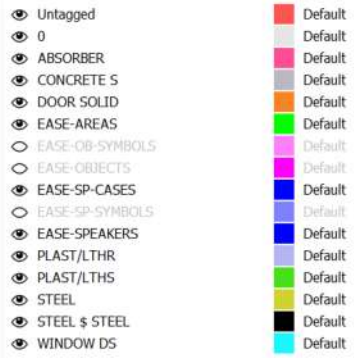

FIGURE 6 PLATFORMS SKETCHUP MATERIALS

FIGURE 2 ACOUSTICALLY ABSORPTIVE FINISHES

With the surface types documented in the abovementioned sketches and Communications report, the predicted reverberation times in critical occupied spaces are as shown in Table .

TABLE 5-8 – PREDICTED REVERBERATION TIMES IN CRITICAL SPACES

Room	Predicted Reverberation Time (s)	Criterion (s)
Platform	< 0.58 (100 patrons)	1.3
	0.58 (empty)	1.6
Lobby / Concourse	1.12 (100 patrons)	1.3
	1.15 (empty)	1.6

Therefore, is it predicted that the reverberation time criteria will be achieved.

5.6 Public Address Systems within Passenger Station Areas

The design of the public address system is described in detail in the Communications report and is not repeated here.

EASE modelling was undertaken to ensure that the public address system design achieves the requirements outlined in Section 4.6.

Figure 18 of the Communications report indicates that the sound pressure level (SPL) criteria on the platform areas are achieved; Figure 20 indicates that the speech transmission index (STI) criteria on the platform areas are achieved.

Figure 20 of the Communications report indicates that the SPL criteria in the concourse areas are achieved; Figure 22 indicates that the STI criteria in the concourse areas are achieved.

5.7 Acoustic Sound Insulation

Minimum Weighted Sound Reduction (R_w) ratings to meet acoustic separation requirements are provided for the partitions and doors below.

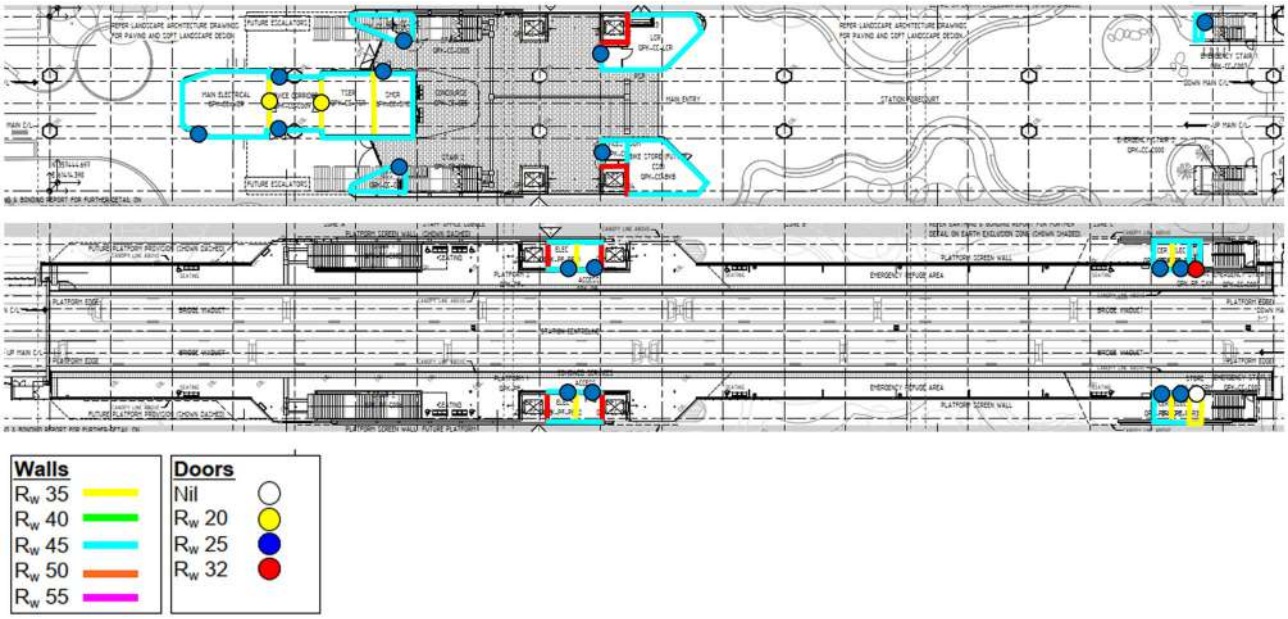

FIGURE 3 MINIMUM R_W REQUIREMENTS

An acoustic review of the architectural package for the Queens Park Station has been undertaken. The following drawings were reviewed for general compliance with the acoustic design intent:

- LXR-QP-SN-AR-DWG-00120
- LXR-QP-SN-AR-DWG-00121
- LXR-QP-SN-AR-DWG-00122
- LXR-QP-SN-AR-DWG-00123
- LXR-QP-SN-AR-DWG-00124
- LXR-QP-SN-AR-DWG-00125
- LXR-QP-SN-AR-DWG-00255
- LXR-QP-SN-AR-DWG-00256
- LXR-QP-SN-AR-DWG-00265
- LXR-QP-SN-AR-DWG-00270
- LXR-QP-SN-AR-DWG-00271

The above drawings have been reviewed for general compliance with the acoustic separation requirements.

Partition Construction

A review of the wall-type schedule for the Queens Park Station is presented in Table .

TABLE 5-9 – WALL TYPE SCHEDULE ACOUSTIC REVIEW

Partition Type	Partition Construction	Estimated R_W Rating	Comment
WT-01	1x13mm IMPACTCHEK PLASTERBOARD. 1x92mm STEEL STUD WITH R2.8 INSULATION. 150mm CAVITY TYPICAL	< 30	Overall partition R_W rating will depend on the substrate

Partition Type	Partition Construction	Estimated R_W Rating	Comment
WT-02	1x9mm CEMINSEAL WALLBOARD (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION. 150mm CAVITY TYPICAL	< 35	Overall partition R_W rating will depend on the substrate
WT-03	3x16mm FYRCHEK FIRE-RATED LINING (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION. 150mm CAVITY TYPICAL	< 40	Overall partition R_W rating will depend on the substrate
WT-04	1x13mm IMPACTCHECK PLASTERBOARD (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION. 1x13mm IMPACTCHEK PLASTERBOARD (OR EQUAL APP)	44	
WT-06	1x13mm FLUSH IMPACTCHEK PLASTERBOARD (INTERNAL FACE); 1x13mm FLUSH PLASTERBOARD. 1x92mm STEEL STUD WITH R2.8 INSULATION. 9mm CEMINSEAL WALLBOARD (OR EQUAL APP)	47	
WT-08	2x13mm FYRCHEK FIRE-RATED LINING (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION. 2x13mm FYRCHEK FIRE-RATED LINING (OR EQUAL APP)	51	
WT-09	110mm FACE BRICK.	45	
WT-13	CL-01 ALUMINIUM PANEL (CONCEAL FIXED) ON 35mm TOP-HATS. R2.8 INSULATION.	< 30	Overall partition R_W rating will depend on the substrate

Partition Type	Partition Construction	Estimated R_W Rating	Comment
	150mm STUD AT NOM 600mm CTS		
WT-14	1x13mm FLUSH IMPACTCHEK PLASTERBOARD (INTERNAL FACE); 1x13mm FLUSH PLASTERBOARD. 1x92mm STEEL STUD WITH INSULATION. 35mm TOP HAT. ALUMINIUM CLADDING PANEL	50	
WT-15	1x13mm FLUSH IMPACTCHEK PLASTERBOARD (INTERNAL FACE); 1x13mm FLUSH PLASTERBOARD. 1x92mm STEEL STUD WITH INSULATION 1x13mm FLUSH PLASTERBOARD (OR EQUAL APP)	49	
WT-16	RS-01 ROOF SHEETING (CONCEALED FIXED) ON RHS SUPPORTS (PURLIN/GIRTS) AT NOM 1200 CTS WITH VAPOUR BARRIER	< 20	Overall partition R_W rating will depend on the substrate
WT-18	1x9mm CFC CLADDING PANEL (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION; 1x9mm CFC CLADDING PANEL (OR EQUAL APP	49	
WT-22	35mm TOP HAT; ALUMINIUM PANEL	20	Overall partition R_W rating will depend on the substrate
WT-23	35mm TOP HAT; PAINTED CFC PANEL	35	Overall partition R_W rating will depend on the substrate
WT-24	METAL SHEETING; STRUCTURE; 35mm TOP HAT; PAINTED CFC PANEL	35	Overall partition R_W rating will depend on the structure

Partition Type	Partition Construction	Estimated R_W Rating	Comment
WT-25	METAL SHEETING; STRUCTURE; ALUMINIUM PANEL	20	Overall partition R_W rating will depend on structure and presence of insulation
WT-26	9mm CEMINSEAL WALLBOARD (OR EQUAL APP) - FLUSH JOINTS; 1x13mm FYRCHEK PLASTERBOARD (OR EQUAL APP); 1x92mm STEEL STUD WITH R2.8 INSULATION 1x13mm FYRCHEK PLASTERBOARD (OR EQUAL APP); 9mm CEMINSEAL WALLBOARD (OR EQUAL APP) - FLUSH JOINTS	55	
WT-27	2x13mm IMPACTCHEK PLASTERBOARD; 1x92mm STEEL STUD WITH INSULATION; 35mm TOP HAT; 12mm CEMINSEAL WALLBOARD (OR EQUAL APP)	55	
WT-28	35mm TOPHAT; 1x9mm PAINTED CFC PANEL; 1x92mm STEEL STUD	35	Overall partition R_W rating will depend on the substrate
WT-29	92mm STUD; ALUMINIUM PANEL	20	Overall partition R_W rating will depend on substrate/structure and the presence of insulation
WT-30	1x9mm CFC CLADDING PANEL (OR EQUAL APP); 35mm TOP HAT; 1x92mm STEEL STUD WITH R2.8 INSULATION; 1x9mm CFC CLADDING PANEL (OR EQUAL APP)	50	

Notes:

- 13 mm impact-rated plasterboard is to have a minimum density of 10.3 kg/m^2
- 9 mm fibre cement sheet is to have a minimum density of 13.5 kg/m^2

Review of Set-out Plans

Documented partition types achieve the required acoustic separation requirements.

Door Construction

A review of the door type schedule for the Queens Park Station is presented in Table .

TABLE 5-10 – DOOR TYPE SCHEDULE ACOUSTIC REVIEW

Door Type	Door Construction	Estimated R_W Rating	Comment
D01	Solid Core 40mm thick Acoustic / fire/weather seals No door grilles/louvres	32	
D02	Solid Core 40mm thick Weather seals	30	No louvres/grilles where acoustic rating required
D03	Solid Core 40mm thick Acoustic / weather seals	32	No louvres/grilles where acoustic rating required
FD01	Solid Core 40mm thick Fire/weather seals	30	No louvres/grilles where acoustic rating required
FD02	Solid Core 40mm thick Acoustic / fire/weather seals	32	No louvres/grilles where acoustic rating required
RD01	Metal roller shutter	<20	
MD01	Metal	-	R_W controlled by grilles/louvres
MD02	-	-	R_W controlled by grilles/louvres
LD02	Metal	-	R_W controlled by grilles/louvres

Review of Door Schedule

Documented door types achieve the required acoustic separation requirements.

5.8 Occupational Safety and Health

The predicted noise levels in all enclosed spaces, platform and concourse areas of the Queens Park Station shown in Sections 5.3 and 5.4.1 achieve the relevant noise criteria. All of these criteria are below the $L_{Aeq,8h}$ 85 dB(A) criterion of the OSHR. Therefore, the OSHR criteria are achieved.