

Operational Noise and Vibration Review (ONVR) for Public Use

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Executive summary

This Operational Noise and Vibration Review (ONVR) has been prepared for the Sydney Metro Western Sydney Airport in accordance with the requirements of SSI-10051 Instrument of Approval and revised performance outcomes in section 7.2 of the Sydney Metro Western Sydney Airport - Submissions Report [1].

The Operational Noise and Vibration Review is to be prepared and submitted to the Planning Secretary to satisfy the requirements of Critical State Significant Infrastructure CSSI Approval - 10051 Instrument of Approval Condition E58.

This ONVR presents the assessment and design outcomes relating to noise and vibration emissions to the surrounding environment from the proposed fixed facilities including stations, stabling and maintenance facility (SMF) as well as train operations between St Marys and Aerotropolis (Bradfield City) station.

The noise and vibration assessment in this ONVR is consistent with the assessment undertaken in the Environmental Impact Assessment (EIS) [2] and the Sydney Metro – Western Sydney Airport Submissions Report [1]. These reports included detailed noise and vibration predictions which were reviewed by the NSW Department of Planning, Housing, Industry (DPHI) prior to the Minister for Planning granting the Project Approval. This ONVR builds on these previous environmental assessments of noise and vibration including:

- Confirming the operational noise and vibration objectives applicable to each component of the Project;
- Predicting the operational noise and vibration impacts at affected receivers based on the final design of the Project;
- Identifying the proposed mitigation measures to meet the applicable design objectives;
- Including a consultation strategy with directly affected receivers on mitigation measures; and,
- An independent verification conducted by third party.

Project overview

The Western Sydney Airport Metro line is 23 km long spanning between St Marys and the new Bradfield City Centre, passing through the proposed Western Sydney Aerotropolis. There are six stations in total including St Marys, Orchard Hills, Luddenham, Airport Terminal, Airport business Park, Aerotropolis and a Stabling Maintenance Facility located between Orchard Hills and Luddenham station. Noise sources from the metro line to the environment will include mechanical services, electrical equipment, public announcement systems and rail operations, all addressed in this report.

Criteria

The ONVR presents the land use assessment conducted identifying existing and future land uses surrounding the fixed facilities and the rail alignment. Baseline monitoring was carried out to quantify existing noise levels surrounding the fixed facilities and were used alongside the land use assessment to produce existing and future noise level criteria in accordance with the *Noise Policy for Industry (NPfI)* [3] as required by the SSI-10051 Condition E58 (a). Fixed facilities vibration emission predictions are assessed against the criteria produced with the *Assessing Vibration: a Technical Guideline (DECC)* [4], while rail operational noise and vibration is assessed against the *Rail Infrastructure Noise Guidelines* [5], DECC and additional project requirements.

Assessment methodology

Noise and vibration emission assessments have been conducted for fixed facilities and rail operations, adhering to the established noise and vibration criteria. The noise emissions were analysed using 3D noise prediction modelling, which considered all pertinent design elements, including buildings, surrounding land topography, noise source locations and characteristics, operational scenarios, and the locations of sensitive receivers. Results from the noise model determined necessary noise mitigation for the Project to satisfy condition E58 (c).

Mitigation measures

Noise mitigation measures have been established as required by Condition E58 (e) and ONV1 of *SMWSA Submissions Report* [1] to address compliance with the established noise and vibration criteria.

Source mitigation measures include low noise plant and equipment selections, acoustic linings and attenuators, room acoustic treatments and building envelope design considerations.

Trackform and rail fastener systems of varying stiffness have been included to meet the airborne (ABN), ground-borne noise (GBN) and vibration requirements. A detailed wheel-rail interface strategy and study have been prepared and will be reviewed during operations to maintain rail roughness and consequently keeping airborne noise and vibration levels below the maximum values.

Compliance is achieved at all locations with the exception of residual exceedances from

- the SMF during the night period; and,
- operational exceedances due to PA emissions from the stations.

All feasible and reasonable mitigation measures were considered in the assessments to minimise potential noise and vibration impacts at the receivers.

The residual exceedances predicted at receivers within close proximity at SMF were ≤ 2 dB and below the project amenity criteria. Accordingly, based on the NPfI, the residual exceedances are categorised as negligible and the need for at-property treatment is not required. No 'at-property' noise mitigation requirements have been identified for existing development.

The exceedances from PA emissions are predicted to predominantly affect the future potential residential receivers within close proximity to the Stations. Noise impacts will be addressed through operational management measures included within this report.

Regarding potential future development in proximity of the rail corridor, Stations and SMF, the ONVR contains assessment locations located 30 m or at the nearest receiver boundary lot (whichever is furthest) from the boundary of stations, service facilities and electrical substations. Furthermore, rail operation assessment includes receivers within 100 m to 200 m of the alignment and/or within 5 dB of the criteria.

While mitigation measures have been implemented in the design, further assessment and mitigation of future development of unknown location could be required depending on its proximity to the rail infrastructure. Assessment of future development will be required in accordance with the requirements of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* [6].

Compliance and complaints management

In accordance with SSI Condition E60, operational noise levels shall be reviewed within 12 months of commencement of operations of the CSSI.

In accordance with SSI Condition E58 (g), the Operator is committed to a program of customer engagement to encourage ongoing feedback that will be used in the continual improvement of the Sydney Metro Western Sydney Airport services. The procedures for managing complaints should follow the Overarching Community Communication Strategy approved by DPHI in July 2021 [7], this document can be found online at the DPHI major projects website.

1. Introduction

1.1 Project overview

The Sydney Metro – Western Sydney Airport project is part of the biggest urban rail infrastructure investment in Australian history – Sydney Metro. The **Project** is being delivered under the Western Sydney City Deal, a partnership between the NSW and Australian governments and eight councils of the Western Parkland City. The Project will connect existing and future infrastructure, including residential communities, commercial hubs, recreational areas, and the new airport along a new rail alignment, as shown schematically in Figure 1.

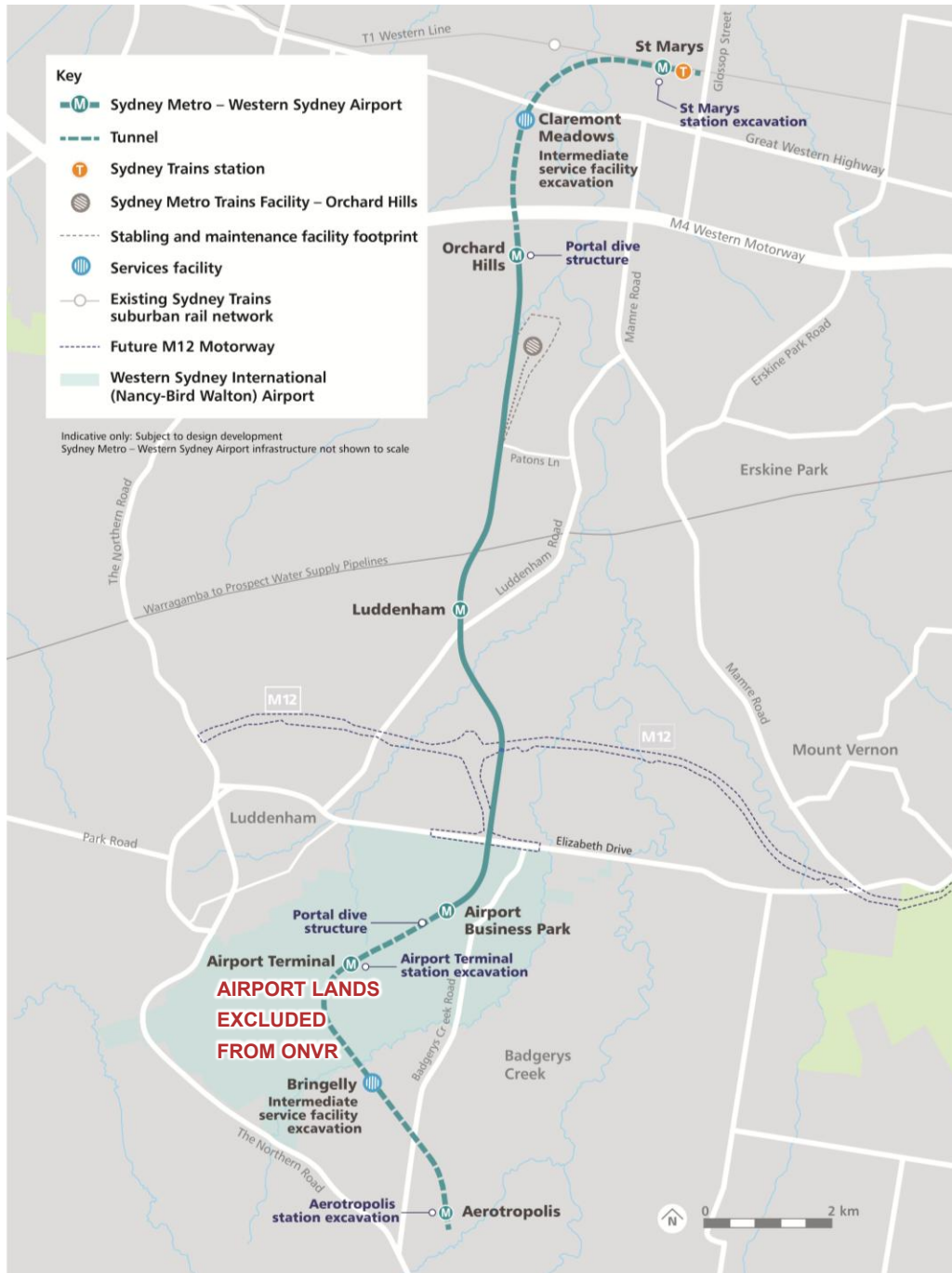


FIGURE 1: OVERVIEW OF PROJECT

The project includes:

- Six new metro stations at St Mary's, Orchard Hills, Luddenham Road, Airport Business Park, Airport Terminal and Aerotropolis;
- A new train fleet;
- All stabling and maintenance facilities required to support and operate the Train fleet;
- Local area works, including new precinct streets, street and intersection modifications, landscaping and provision of new and upgrade transport interchange infrastructure at selected locations; and
- Property works and utility services works.

1.2 ONVR requirements

This ONVR has been prepared to address the relevant operational noise and vibration conditions outlined in the SSI-10051 Instrument of Approval and revised performance outcomes in section 7.2 of the Sydney Metro Western Sydney Airport - Submissions Report [1]. The CSSI Infrastructure Approval states that it only applies only to land in the City of Penrith and City of Liverpool local government areas. The ONVR does not assess operational noise and vibration as it relates to development within the Western Sydney International (Nancy-Bird Walton) Airport lands, i.e. Airport Business Park (ABP) and Airport Terminal (ATL) stations, as identified in Figure 1.

A summary of the SSI-10051 conditions and where these have been addressed within this ONVR is provided in Table 1.

TABLE 1: ONVR REQUIREMENTS

Item	Requirement	Where addressed in ONVR
SSI-10051		
E58	Noise mitigation – operational noise and vibration measures	
	<i>The Proponent must prepare an Operational Noise and Vibration Review (ONVR) to confirm noise and vibration mitigation measures that would be implemented for the Operation of the CSSI for the ultimate service. The ONVR must be prepared as part of the iterative design development and in consultation with the EPA, relevant council(s), other relevant stakeholders and must:</i>	Section 9 provides a summary of the consultation undertaken with the Department, relevant council(s), and other relevant stakeholders.
	<i>(a) identify appropriate Operational noise and vibration objectives and levels for surrounding development, including existing and potential future (as known at the time of ONVR preparation) sensitive land use(s);</i>	A land use survey has been undertaken to identify the location of existing sensitive receivers potentially impacted by the operational noise and vibration. A buffer zone has also been established for future development with consideration of the known land uses where confirmed. For each sensitive receiver type, noise and vibration objectives have been established on the basis of the relevant guidelines and other project requirements. The results of the land use survey are presented in Appendix B. Noise and vibration criteria for the sensitive receivers are presented in: • SMF – Section 5.2.2 and 5.2.3 • STM – Section 6.4.4 • OHE – Section 6.5.3 • LDN – Section 6.6.3

Item	Requirement	Where addressed in ONVR
		• AEC – Section 6.7.3 Rail Operations – Section 7.1.2
	<i>(b) confirm the operational noise and vibration predictions based on the expected final design. Confirmation must be based on an appropriately calibrated noise model;</i>	The assessment methodology including the input parameters for the noise models: • SMF – Section 5.3, Table 10 • Stations – Section 6.3, Table 25 • Rail Operations – Section 7.2, 7.3
	<i>(c) identify sensitive land uses that are predicted to exceed:</i> <i>(i) noise criteria set out in the Rail Infrastructure Noise Guideline (EPA, 2013), Noise Policy for Industry (EPA, 2017); and</i> <i>(ii) vibration goals for human exposure for existing sensitive land use(s), as presented in Assessing Vibration: A Technical Guideline (DECC, 2006);</i>	The predicted exceedances of operational noise and vibration levels are summarised in: • SMF – Section 5.6.1 • STM – Section 6.4.6 • OHE – Section 6.5.5 • LDN – Section 6.6.5 • AEC – Section 6.7.5 • Rail Operations – Appendix J.1 and Appendix J.2
	<i>(d) identify all noise and vibration mitigation measures including location, type and timing of mitigation measures, with a focus on:</i> <i>(i) source control and design;</i> <i>(ii) at the receiver (if relevant); and</i> <i>(iii) 'best practice' achievable noise and vibration outcome for each activity;</i>	A summary of the fixed facilities noise and vibration mitigation measures that will be implemented for the operation of the CSSI are presented in: • SMF – Section 5.6.2 • STM – Section 6.4.7 • OHE – Section 6.5.6 • LDN – Section 6.6.6 • AEC – Section 6.7.6 • Rail Operations – Section 7.4
	<i>(e) describe how the final suite of mitigation measures will achieve:</i> <i>(i) the noise criteria outlined in the Rail Infrastructure Noise Guideline (EPA, 2013) and Noise Policy for Industry (EPA, 2017); and</i> <i>(ii) vibration goals for human exposure for existing sensitive land use(s), as presented in Assessing Vibration: a Technical Guideline (DECC, 2006);</i>	The predicted operational noise and vibration levels are summarised in • SMF – Section 5.5 • STM – Section 6.4.6 • OHE – Section 6.5.5 • LDN – Section 6.6.5 • AEC – Section 6.7.5 • Rail Operations – Appendix J.1 and Appendix J.2
	<i>(f) include a consultation strategy to seek feedback from directly affected landowners on the noise and vibration mitigation measures being offered;</i>	Section 9.3 includes the consultation strategy to seek feedback from affected landowners.
	<i>(g) include procedures for operational noise and vibration complaints management, including investigation and monitoring (subject to complainant agreement).</i>	Section 10.2 details the procedure of operational noise and vibration complaint management.
	<i>The ONVR must be verified by an independent acoustic expert and submitted to the Planning Secretary for approval before the implementation of any operational noise mitigation measures.</i> <i>The Proponent must implement the identified noise and vibration control measures and make the ONVR publicly available.</i> <i>Note: The design of noise barriers and the like must be undertaken in consultation with the relevant stakeholders,</i>	Section 11 in which the ONVR has reviewed by an independent Acoustic Peer Reviewer and will be publicly displayed on the project website. The ONVR will be made publically available once approved by the Planning Secretary. Section 7.4.4 addresses noise barriers.

Item	Requirement	Where addressed in ONVR
	<i>including affected landowners and businesses (or a representative of a business), Western Parklands City Authority and relevant council(s) as part of the Place, Urban Design and Corridor Landscape Plan required under Condition E79</i>	
E59	<i>Operational noise mitigation measures as identified in Condition E58 that will not be physically affected by work, must be implemented within six months of submitting the ONVR, unless otherwise agreed by the Planning Secretary. Where implementation of operational noise mitigation measures are not proposed to be implemented in accordance with this requirement, the Proponent must submit to the Planning Secretary a report providing justification as to why, along with details of temporary measures that would be implemented to reduce construction noise impacts, until such time that the operational noise mitigation measures are implemented.</i> <i>The report must be submitted to the Planning Secretary within six months of submitting the ONVR.</i> <i>Note: Not having finalised detailed design is not sufficient justification for not implementing the proposed mitigation measures</i>	Addressed in Section 8
SMWSA Submissions Report - Revised performance outcomes		
Section 7.2	<i>Operational noise and vibration levels from rail operations are managed in accordance with the Rail Infrastructure Noise Guidelines and Airports (Environment Protection) Regulations 1997</i> <i>Operational noise levels for the stabling and maintenance facility, stations and other fixed infrastructure are managed in accordance with the Noise Policy for Industry 2017</i>	Noise criteria derived from NPfI and RING for fixed facilities and rail operations are located in Section 5.2, 6.2 and 7.1.
Section 7.3: ONV1	<i>An Operational Noise and Vibration Review would be prepared during design development to confirm the mitigation measures required to manage:</i> <i>airborne and ground-borne noise impacts from rail operations</i> <i>airborne noise impacts from the stabling and maintenance facility</i> <i>airborne noise impacts from fixed industrial sources, including stations and services facilities</i> <i>The Operational Noise and Vibration Review would consider existing and potential future land use to establish Project Noise Trigger Levels.</i> <i>The EPA would be consulted during preparation of the Operational Noise and Vibration Review.</i>	References to the table of mitigation measures implemented in the design is located above. Noise and vibration criteria established are in Section 5.2, 6.2 and 7.1. The consultation process is presented in Section 8.

1.3 Structure of report

TABLE 2: STRUCTURE SUMMARY OF REPORT

Section	Summary
1 Introduction	Purpose and overview of the ONVR.
2 ONVR overview	Provides an overview of operational noise and vibration for fixed facilities and rail operations with relation to required policies and guidelines.
3 Land use assessment	Identifies sensitive receivers and noise catchment areas to establish noise and vibration criteria for relevant receivers.
4 Baseline monitoring	Presents long-term unattended baseline noise monitoring used to establish operational noise criteria at sensitive receivers affected by fixed facilities.
5 Stabling and Maintenance Facility (SMF) noise and vibration assessment	The SMF and station noise and vibration assessment respectively evaluate cumulative noise emissions from various operational activities against derived criteria, considering both current and future scenarios with mitigation measures.
6 Station noise and vibration assessment	
7 Rail operations noise and vibration criteria	Outlines criteria and methods for assessing and mitigating ground-borne noise and vibration from railway operations, ensuring compliance with environmental standards and detailing design recommendations.
8 Implementation of mitigation measures (E59)	No mitigation measures for the Project have been identified as relevant to the requirements of E59.
9 Consultation with stakeholders	Describes the process of consultation meetings with various stakeholders were held to discuss SSI Condition E58 requirements, including noise and vibration assessments, baseline monitoring, and future development impacts
10 Noise monitoring and complaints management	Operational noise levels will be reviewed within 12 months of starting operations, a customer engagement program will be developed to manage complaints and improve services.
11 Independent verification of noise and vibration study	Outlines the independent verification of the ONVR undertaken by a noise and vibration expert.
12 Conclusion	Summarises the fulfilment of the purpose of the ONVR.

2. Operational noise and vibration overview

2.1 Project components

Operational noise and vibration requirements for the project differ dependent on their characteristics and location, and this is reflected in the application of separate policy and criteria. There are two primary categories of operational activity, being fixed facilities (relating to Stations and the SMF) and railway operations.

Noise and vibration associated with road traffic and construction activities is not addressed in the ONVR.

2.1.1 Fixed facilities

The noise generating equipment and operations associated with the SMF and Stations are categorised as fixed facilities and assessed in accordance with the *Noise Policy for Industry* (NPfI) [3].

Noise generating activities within the SMF and Stations relevant to the environmental assessment are presented in the Table 3. Noise emission from emergency systems or maintenance activities are not included. The Intermediate Service Facilities (Claremont Meadows service facility and Bringelly services facility) that were identified in the EIS [8] no longer include permanent facilities with operational noise sources.

TABLE 3: NOISE GENERATING ACTIVITIES IN FIXED FACILITIES

Fixed facility	Noise generating activities
Stabling Maintenance Facility (SMF)	- Mechanical equipment serving the Substation, OCC, and Maintenance/Administration Building - Stabling roads and associated train movements within the SMF - Train wash - Wheel lathe - Carpark movements - High voltage electrical equipment - Maintenance operations - Bulk supply substation and traction substation - PA system (pseudo emergency announcements only, not included in assessment) - Train hazard warning system (THWS)
Stations	- Mechanical and electrical plant - Tunnel ventilation and draught relief systems - Public Address systems (PA System) - High-voltage transformers and other equipment within electrical substations

2.1.2 Rail operations

The assessment and management of airborne and ground-borne noise from railways is carried out in accordance with the NSW *Rail Infrastructure Noise Guideline* (RING) [5]. To assess and manage potential noise impacts from rail projects, the RING provides noise triggers for residential and other sensitive receivers. Where predicted rail noise levels are above the noise triggers, reasonable and feasible noise mitigation measures should be provided to achieve the trigger levels.

The NSW Department of Environment and Conservation (DEC) document *Assessing Vibration: a technical guideline* (AVTG) [6] outlines requirements for operational rail vibration levels for the Project. ISO 14837-1 [9] provides guidance

and parameters used to quantify and predict ground borne noise and vibration and their effects on human occupants of buildings, very sensitive equipment and in extreme cases the risk of damaging building structures.

Key noise and vibration sources associated with rail operations include:

- Wheel rail rolling noise from interaction at the wheel/rail interface during operation;
- Discontinuities in the track due to turnouts creates a localised increase in noise levels;
- Wheel rail rolling noise due to track curve;
- Viaduct structure radiated noise levels;
- Rolling stock mechanical and electrical systems, including air conditioning; and,
- Noise from rolling stock acceleration and deceleration.

In accordance with the RING, noise emission from emergency and rail maintenance activities are excluded.

2.2 Types of noise and vibration

2.2.1 Airborne noise

Airborne noise propagates between the source and the receiver through the air. This is the primary form of noise that occurs on surface railway tracks and is the most common form of noise experienced by people during operation. Common noise sources from the fixed facilities include mechanical plants and tunnel ventilation equipment, emergency and PA systems noise spill.

2.2.2 Ground-borne noise

Ground-borne noise is the term used to describe the process where vibrational energy from the railway propagates through the ground, which transfers into the building walls and floors and re-radiates as noise which can be heard by occupants. Ground-borne noise has the potential to be evident where railway tracks are underground or in deep cuttings, where the airborne noise path is not present or negligible.

2.2.3 Ground-borne vibration

Ground-borne vibration relates to vibration transmitted from a source such as train operations, surface tracks, and mechanical plant, to a receiver through intervening structures and the ground and perceived or registered as vibration in the receiving development. The potential impacts of ground-borne vibration in buildings fall into three main categories: human comfort (disturbance); impacts on building contents; and structural damage. People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. The controlling vibration design objectives during operations are therefore the human comfort goals. Ground-borne vibration levels are assessed for residential receivers and other sensitive receiver locations above or near to the proposed Project alignment within the Project area.

2.2.4 Structure-borne noise

Structure-borne noise results from the excitation of building fabric or bridge/viaduct structures by structure-borne vibration, which re-radiates as noise.

2.2.5 Structure-borne vibration

Structure-borne vibration is similar to ground-borne vibration, only the transmission path from the railway to receiver does not include the ground. This phenomenon would arise where a development is built directly atop an underground station such that there is a direct path from track or vibrating plant to receiver through the structure of the station and development.

3. Land use assessment

The Land Use Assessment supports the Operational Noise and Vibration Review required by SSI-10051 Instrument of Approval Condition E58. The land use assessment has been informed by desktop evaluation via current satellite imagery, land use planning resources and ground-truthing.

3.1 Receiver classification

3.1.1 Land use categories

The following land use categories (receiver types) have been established based on the noise and vibration assessment criteria and receivers identified through the land use survey.

Maps in Appendix B show the different land use zones along the alignment.

TABLE 4: NOISE AND VIBRATION LAND USE CATEGORIES

Noise and vibration land use category	Category ID
Childcare centres	CCC
Commercial (Private offices and conference rooms)	COM
Educational institutions (schools)	EDU
Hotels	HTL
Industrial (Workshops)	IND
Open space - passive use	OSP
Retail areas	RET
Residential	RES
TransGrid 5A1/5A2 Structure 266 Footing	TGT
Telstra Exchange	TEL

3.1.2 Noise catchment areas (NCA)

For residential areas surrounding the fixed facilities, operational noise objectives are established based on the baseline noise environment. Noise Catchment Areas (NCAs) have been established for areas with similar acoustic environment to associate residential receivers with the nearest most relevant baseline monitoring results and established noise targets. NCA IDs and boundaries are displayed in the attached Land Use Maps. Where fixed facility criteria do not apply to receivers due to their distance from fixed facilities, NCA00 has been adopted.

TABLE 5: NOISE CATCHMENT AREAS

Nearest Stations/Fixed Facility	Noise Catchment Areas
St Marys (STM)	STM01
	STM02
	STM03
Orchard Hill (OHE)	OHE01
Stabling and Maintenance Facility (SMF)	SMF01
	SMF02
	SMF03

Nearest Stations/Fixed Facility	Noise Catchment Areas
Luddenham Road (LDN)	LDN01
Aerotropolis Core (AEC)	AEC01
	AEC02
Receivers outside of Fixed Facility NCAs but assessed for rail operations	NCA00

3.1.3 Existing and future receiver development

Condition E58 requires that the ONVR ‘*identify appropriate Operational noise and vibration objectives for potential future (as known at the time of ONVR preparation)*’. In consultation with Sydney Metro and DPHI, the following approach has been adopted for the assessment of potential future receivers that may be built near to the SM-WSA.

The established noise and vibration criteria are discussed in more detail in Section 5.2 and Section 6.1. The following has been identified as part of the land use survey:

- Existing receivers are defined as receivers currently present or with a development approval at the time of the Environmental Documents [8], being 23 July 2021.
- Potential future land use types near fixed facilities have been determined based on land use planning resources (see Section 3.2). Criteria has been established at a minimum 30 m distance from the fixed facilities or nearest receiver lot boundary (whichever is furthest). Future assessment buffer locations have been identified in the land use survey.
- Potential future land uses near to the rail corridor, both above ground and tunnel sections are to be addressed via existing assessment requirements of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* (TISEPP) [6] and Sydney Metro Corridor Protection requirements including *Sydney Metro Underground Corridor Protection Technical Guidelines* [10] and *Sydney Metro At Grade and Elevated Sections Corridor Protection Guidelines* [11]. Regarding ground-borne noise and vibration from rail operations in tunnels, maximum limits for track system stiffnesses have been defined to aid in minimising impact to future development. It should be noted that maximum limits of the track system have not been identified for future receivers within the land use survey.

3.2 Receiver nomenclature

The following nomenclature has been used for each receiver:

25750	-125	U	-RES	-EX	-NCA
↑	↑	↑	↑	↑	↑
Track chainage perpendicular to the centre of the receiver building	Distance (m) from nearest point of receiver building to nearest track centreline	Nearest track direction (U for Up, D for Down)	Land use category ID per Table 4	Existing receiver (EX), Future Assessable (FA) receiver	Noise catchment area for residential receiver (e.g. OHE01).

3.3 Data sources

Receiver identification has been based on the following information:

- Geoscape: Building footprints and heights (updated from previous EIS dataset [8]).
- Metromap aerial imagery dated 01/08/2023.
- Ground truthing conducted on 26/07/2023.
- Property acquisitions along the alignment confirmed by Sydney Metro
- Near St Marys Station (STM):
 - Precinct master plan dated 23 Aug 2023.
 - Penrith City Council - St Marys Town Centre Structure Plan – November 2022 (endorsed by PCC) [12].
- Near Orchard Hills Station (OHE): Precinct master plan dated 20 Sep 2023.
- Near Luddenham Station (LDN): Precinct master plan dated 18 Oct 2023.
- Near Aerotropolis Station: (AEC): Precinct master plan dated 23 Oct 2023.
 - Regarding *State Environmental Planning Policy (Precincts—Western Parkland City) 2021*, as this came into force on 2 December 2021, the land use maps do not reflect the latest zoning within the precinct. The land use zoning is for context only.

4. Baseline noise monitoring

Long-term unattended baseline noise monitoring has been used to establish operational noise criteria at residential receivers near fixed facilities in accordance with the NSW *Noise Policy for Industry* [3]. Baseline vibration monitoring is not required for the establishment of project criteria.

The following noise monitoring data has been used, as further detailed in Table 6:

- Noise monitoring carried out by Parklife Metro between 24 March 2023 to 6 April 2023 in accordance with the methodology outlined in Appendix C.
- “M2A, Sydney Metro Western Sydney Airport – Technical Paper 2: Noise and Vibration,” Sydney Metro, 2020. (SMWSA EIS) [1]
- “Patons Lane Resource Recovery Centre – Integrated Water and Leachate Plant Modifications”, RWDI, 2022 (PLRRC) [13].

The measured noise levels were analysed in accordance with the NPfI [3] to derive the Rating Background Level (RBL) and L_{Aeq} noise levels for the time periods for the following standard time periods:

- Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays.
- Evening: 18:00-22:00 Monday to Sunday & Public Holidays.
- Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays.

A summary of the baseline monitoring is presented in Table 6, visual location of the noise monitoring location (NML) is presented in Appendix B.

TABLE 6: BASELINE NOISE MONITORING RESULTS

NCA	Noise monitoring location (NML)		Rating Background Level (RBL) dBL _{A90,period}			Ambient Noise Level dBL _{Aeq,period}		
	Monitor ID	Address	Day	Evening	Night	Day	Evening	Night
NCA-STM01	NML-PLM01	32 Cedar Crescent, St Marys	41	41	38	53	50	48
NCA-STM02	NML-PLM02	1 Camira Street, St Marys	39	39 ¹ (42)	38	62	62	62
NCA-STM03	NML-PLM03	82 Hobart Street, St Marys	44	41	34	57	56	54
NCA-OHE01	NML-PLM05	8 Lansdowne Road, Orchard Hills	41	41	38	52	50	47
NCA-LDN01	NML-PLM09	48 Portrush Crescent, Luddenham	36	36 ¹ (38)	36	52	49	50
NCA-AEC01	NML-PLM10	105 Badgerys Creek Road, Badgerys Creek	42	42 ¹ (45)	38	70	64	66
NCA-AEC02	NML-EIS13 ²	80 Mersey Road, Bringelly	38	35	34	58	52	51
NCA-SMF01								
SMWSA EIS	NML-EIS08 ²	7 Bordeaux Place, Orchard Hills	31	32 ¹ (31)	30	52	48	40
PLRRC	NML-PLRRC2 ³	Roughwood Park	32	35	32	47	43	41
NCA-SMF02								
SMWSA EIS	NML-EIS09 ²	246 Luddenham Road, Orchard Hills	40	39	34	61	57	54
PLRRC	NML-PLRRC2 ³	Roughwood Park	32	35	32	47	43	41

Notes:

1. Where evening or night background noise levels exceed that of the previous period, they have been set at the background noise level of the previous period, in line with the NPfI, to reflect community's expectation for greater noise control during more sensitive periods.
2. Noise monitoring data from EIS [8].
3. Noise monitoring data from PLRRC [13]

5. SMF noise and vibration assessment

5.1 Design year scenario

Condition E58 requires the ONVR “to confirm noise and vibration mitigation measures that would be implemented for the Operation of the CSSI for the ultimate service.”. Ultimate service is defined in SSI 10051 as the use of 4-car train sets achieving headways of 3 minutes for the peak hour and 6 minutes for off-peak periods. The Ultimate service is also limited to the extent of the SSI 10051 approval, being operations of SM-WSA between St Marys and Aerotropolis Station..

Table 7 set out the train fleet size for both Day 1 and Ultimate service operations. Detailed scheduling of activities related to train departures and arrivals etc, from the SMF are outlined in Appendix E.1 and Appendix E.2.

TABLE 7: TRAIN FLEET SIZE FOR DESIGN YEARS

Scenario	SMWSA train fleet size	Cars per train set	Number of trains operating
Day 1	12	3 cars	10
Ultimate service	18	4 cars	16

5.2 Noise and vibration objectives

5.2.1 Land use assessment

The existing land use survey has found that the SMF is surrounded predominantly by residential land with an existing industrial site to the southwest and proposed industrial zone to the southeast.

5.2.1.1 Future receivers

Other than the proposed industrial zone to the southeast, there are no other future developments planned in the vicinity of the Project.

5.2.2 Noise criteria

The derived NPfI Project Specific Noise Trigger Levels (PSNTLs) are presented in Table 8 and includes the single Rating Background Levels (RBL) and relevant NPfI intrusiveness, amenity, and sleep disturbance noise criteria applied to the nearest affected receivers.

The established noise goals are based on the baseline monitoring noise levels as described in Appendix C and derived in accordance with the NPfI as detailed in Appendix D. It was noted that the measured baseline noise levels have not been traffic affected.

TABLE 8: DERIVATION OF SMF NOISE CRITERIA

NCA	Noise monitoring ID	Location name:	NPfl receiver category:	Measured RBL (dBL _{AF90})			Assessment RBL (dBL _{AF90})			Recommended Amenity Noise Level (RANL)			Project Intrusiveness Noise Level (dBL _{Aeq,15min})			Project Amenity Noise Level ¹ (dBL _{Aeq,15min})			Project Specific Noise Trigger Level (PSNTL)			Sleep Disturbance (Resi Only)	
				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N – L _{Aeq}	N – L _{Amax}
SMF-01	NML-PLRRC2	PLRRC BG2	Resi - Suburban	32	35	32	35	35	32	55	45	40	40	40	37	55	45	40	40	40	37	40	52
SMF-02	NML-PLRRC2	PLRRC BG2	Resi – Rural	32	35	32	35	35	32	50	45	40	40	40	37	50	45	40	40	40	37	40	52
SMF-03	NML-PLRRC2	PLRRC BG2	Resi – Rural	32	35	32	35	35	32	50	45	40	40	40	37	50	45	40	40	40	37	40	52

Notes:

1. The PANL_{15min} criteria has been established with the consideration of other existing/proposed industrial sites in the vicinity of the most affected receiver within the NCA's and adding the 3 dB conversion from L_{Aeq,period} to L_{Aeq,15min} as per the NPfl:

- a. SMF01 – PLRRC (PANL_{period} = RANL – 3 dB)
- b. SMF02 – PLRRC (PANL_{period} = RANL – 3 dB)
- c. SMF03 – one potential industrial site in the future (PANL_{period} = RANL – 3 dB)

The NPfl defines day, evening and night-time period as follows:

- **D** - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- **E** - Evening: the period from 6 pm to 10 pm, Monday to Sunday & Public Holidays.
- **N** - Night: from 10 pm to 7 am, Monday to Saturday, or 10 pm to 8 am on Sunday & Public Holidays.

5.2.3 Vibration criteria

Operational vibration criteria for existing external receivers surrounding the SMF has been established in accordance with the 'Assessing vibration: a technical guideline' [4] and is presented in Table 9.

TABLE 9: VIBRATION CRITERIA FOR RECEIVERS SURROUNDING SMF

Land Use Receiver Type	ID	Continuous Z-axis preferred		Impulsive Z-axis - preferred		Intermittent - preferred	
		Day (m/s ²)	Night (m/s ²)	Day (m/s ²)	Night (m/s ²)	Day (m/s ^{1.75})	Night (m/s ^{1.75})
Residential	RES	0.01	0.007	0.30	0.10	0.20	0.13

Plant equipment within the SMF buildings will be vibration isolated to achieve the internal vibration criteria for sensitive spaces. Given the proximity of these internal spaces to the building services equipment, the internal vibration criteria govern the design requirements. When factoring additional attenuation provided by the building structure (floors/foundation coupling loss), ground propagation and distance to the nearest residences (~400 m), vibration impacts to these receivers will be insignificant and will readily meet the vibration criteria at external receivers. Accordingly, no quantitative assessment has been carried out.

Vibration emissions from train operations (entering and exiting the SMF) will have no impact to the surrounding external receivers and therefore a detailed assessment has been deemed not to be warranted.

5.3 Noise assessment inputs and methodology

Table 10 summarises the SMF noise emissions modelling methodology.

TABLE 10: SUMMARY OF SMF NOISE EMISSION MODELLING METHODOLOGY

Input parameters	Inputs								
Noise modelling software	SoundPLAN Version 8.1.								
Noise propagation model	ISO 9613-2 (1996) Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation [14] The Propagation of Noise From Petroleum and Petrochemical Complexes To Neighbouring Communities (CONCAWE) [15]								
Service scenarios	The following scenarios are to be assessed: • Stage 1 – Day 1: 12 x 3 car sets (2 of the 12 are in maintenance) in the Stabling Yard as shown in Figure 2. • Stage 1 Ultimate Service: 18 x 4 car sets (2 of the 18 are in maintenance). Based on PLM Service Performance Modelling for 3 min peak headways (6-minute off peak) and no extensions of SM-WSA per CSSI 10051 approval.								
SMF buildings	Building dimensions and footprints are based on architectural drawings.								
Noise modelling scenarios	The following worst-case scenarios were modelled for Stage 1 – Day 1 and Ultimate: <table><tr><th>SMF Scenario</th><th>Brief description of activities</th><th>Period</th><th>Time</th></tr><tr><td>Preparation for start of service</td><td> • RST Sleep mode • Start of revenue service • Maintenance activities • Carpark movements </td><td>Night</td><td>3:30 am – 4:00 am</td></tr></table>	SMF Scenario	Brief description of activities	Period	Time	Preparation for start of service	• RST Sleep mode • Start of revenue service • Maintenance activities • Carpark movements	Night	3:30 am – 4:00 am
SMF Scenario	Brief description of activities	Period	Time						
Preparation for start of service	• RST Sleep mode • Start of revenue service • Maintenance activities • Carpark movements	Night	3:30 am – 4:00 am						

Input parameters	Inputs
	First trains departure for morning service - Start of revenue service - Trains departing for start of service - Maintenance activities - Workshop activities Preparation for evening peak service - Start of revenue service - Maintenance activities - DPPS - Workshop activities - UFWL - Automatic Train Wash Trains departure before evening peak service - Start of revenue service¹ - Trains departing for evening service - Maintenance activities - DPPS - Workshop activities - UFWL - Automatic Train Wash Trains returning after evening peak service - Train readiness (MOS inspection) - Automatic Train Wash - Graffiti Biowash - UFWL - Maintenance activities - Carpark movements
	Night4:00 am – 4:15 am Day3:15 pm – 3:45 pm Day3:45 pm – 4:00 pm Evening7:00 pm – 8:00 pm
	Notes: Applies to Ultimate service only.
	Refer to Appendix E.1 and Appendix E.2 for detailed description of each scenario.
Meteorological Conditions	Refer to Section 5.4 for details on which noise-enhancing meteorological conditions apply to the assessment.
Noise sources	Figure 2 illustrates noise sources within SMF that have been used in the noise model. It is noted that the SMF also includes a Train Hazard Warning System (THWS) which is proposed to use audio (pink noise) and visual equipment to provide staff with advanced warnings of approaching trains, at the following non-UTO zones and cleaning access areas, being Stabling Yard 1 area, Maintenance Road 7 & 8 and IMV Stabling Road. The loudspeakers will emit pink noise at specific intervals with a total warning duration of approximately 25 seconds for each approach and leaving movements. While the concept design has been approved, details regarding the loudspeaker layouts and proposed noise levels of the THWS have not yet been finalised. A noise budget of Design Noise Level (DNL) minus 10 dB at existing receivers in SMF01, SMF02 and SMF03 is allocated to ensure that the environmental requirements are met.
Train movements	Refer to Appendix E.1 and Appendix E.2 for detailed description of train movements for each Scenario.
Buildings	Existing buildings are included in the noise model. No future buildings outside of the project site are included.

Input parameters	Inputs								
Worst-case Receivers	The following nearest worst-case noise sensitive receivers were assessed: <table> <tr> <th>NCA</th><th>Receiver Location</th></tr> <tr> <td>SMF01</td><td>23824-247U-RES-EX-SMF01</td></tr> <tr> <td>SMF02</td><td>24376-471D-RES-EX-SMF02 24717-720D-RES-EX-SMF02</td></tr> <tr> <td>SMF03</td><td>23063-208D-RES-EX-SMF03</td></tr> </table> The locations of the above receivers relative to the SMF are shown in Figure 3.	NCA	Receiver Location	SMF01	23824-247U-RES-EX-SMF01	SMF02	24376-471D-RES-EX-SMF02 24717-720D-RES-EX-SMF02	SMF03	23063-208D-RES-EX-SMF03
NCA	Receiver Location								
SMF01	23824-247U-RES-EX-SMF01								
SMF02	24376-471D-RES-EX-SMF02 24717-720D-RES-EX-SMF02								
SMF03	23063-208D-RES-EX-SMF03								
Receiver heights	1.5 m above floor level of each receiver building for each relevant floor level.								
Receiver building facade correction	Building reflection losses are set to 3 dB. This is conservative as a 10 dB loss would be required to completely exclude reflections of own buildings in accordance with the free-field assessment requirements of the NPfl.								
Ground topography	Civil pavement model for the SMF Ultimate Service Stabling Yard area and 250 m on either side of the track alignment. The ground topography covers the nearest residential receivers to the north, east, and west. SoundPLAN triangulates the data to create a Digital Ground Model (DGM).								
Ground absorption	A ground absorption factor of $G=0.6$ has been adopted based on the project environment.								
Safety Factor	An additional 3 dB safety factor has been applied to the predicted noise levels, as per common industry practice.								



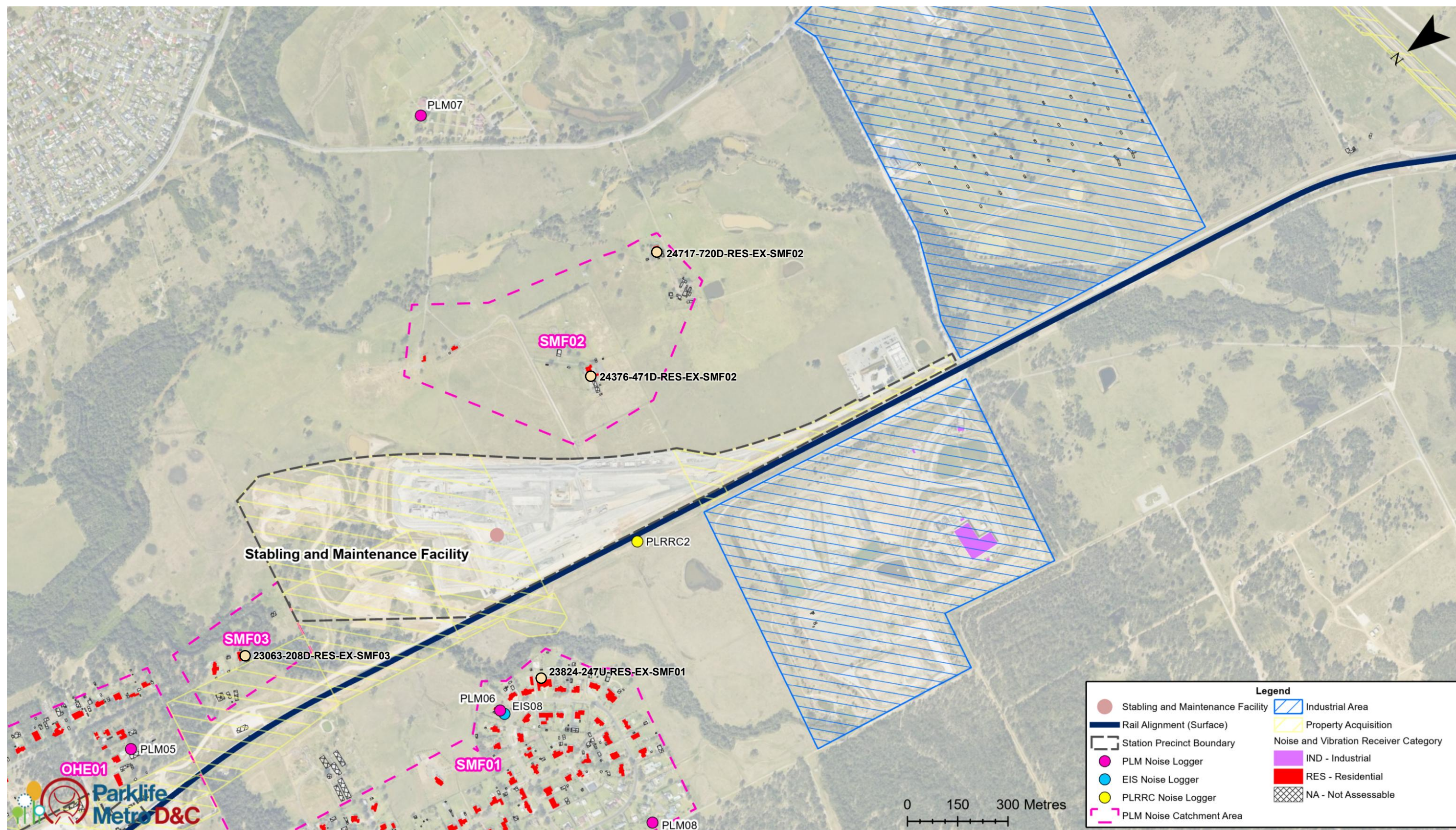


FIGURE 3: SMF NEAREST NOISE SENSITIVE RECEIVERS WITH OTHER INDUSTRIAL SITE BOUNDARIES INDICATED IN BLUE

5.4 Overview

Operational noise emission from the SMF is assessed cumulatively, taking into account all of the noise sources and operational activities that form normal daily operations of the facility. Noise emissions from the SMF are assessed against the operational noise criteria outlined in Section 5.2.2 at the nearest receivers.

It is expected that noise sources associated with normal operations at the SMF would consist of the following, but not limited to:

- Trains undertaking start-up sequence during commencement of daily service;
- Train arriving and departing the stabling yard;
- Activities within the Maintenance Building, Tandem Under Floor Wheel Lathe and Graffiti Biowash;
- Train washing plant;
- Carpark movements
- Mechanical equipment serving the Substation, OCC, and Maintenance/Administration Building; and
- High voltage electrical equipment, e.g. transformers at the substation.

5.4.1 Noise-enhancing weather conditions

Fact Sheet D of the NPfI [3] describes the approach for factoring in weather conditions that enhance noise, such as temperature inversions and wind gradients, which can significantly raise noise levels. It is understood that the occurrence of temperature inversions is linked to low wind speeds. When wind speeds are low (below 3 m/s), stable atmospheric conditions are more likely, leading to temperature inversions.

Significance of source-receiver wind conditions for the closest noise-sensitive receivers at SMF has been determined using the Noise Enhancement Wind Analysis tool [16] by the EPA. Significance is determined based on a threshold of >30% occurrence at each assessment period (day, evening, night) in any season using historical meteorological data.

Meteorological data was acquired through the Bureau of Meteorology. Table 11 outlines the details of the weather station that was used for this assessment.

TABLE 11: WEATHER STATION DETAILS

Site Name	Badgerys Creek AWS
BoM Station Number	067108
Latitude	33.90 °S
Longitude	150.73 °E
Elevation	81 m
Observation range	April 2014 – April 2024

Table 12 summarises results from the NEWA program, showing occurrences where light wind speeds are significant. The analysis indicates that a significant occurrence of noise enhancing wind is observed only during the night period in the winter months at the closest receiver to the north of the site (23063-208D-RES-EX-SMF03).

TABLE 12: SIGNIFICANCE OF NOISE-ENHANCING WIND CONDITIONS (BELOW 3 M/S) – APRIL 2014 TO APRIL 2024

Receiver ID	23824-247U-RES-EX-SMF01			24376-471D-RES-EX-SMF02			23063-208D-RES-EX-SMF03		
Assessment period	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Summer	5.7%	2.8%	5.2%	13.6%	27.5%	23.7%	7.30%	3.60%	18.4%
Autumn	8.3%	8.5%	10.7%	13.8%	25.1%	16.2%	13.2%	14.7%	27.5%

Receiver ID	23824-247U-RES-EX-SMF01			24376-471D-RES-EX-SMF02			23063-208D-RES-EX-SMF03		
Assessment period	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Winter	12.8%	18.9%	19.6%	8.3%	13.5%	7.9%	18.0%	27.2%	37.1%
Spring	6.7%	6.4%	8.4%	9.7%	26.8%	18.6%	8.0%	9.1%	23.1%

Notes:

Highlighted cells indicate where light wind conditions are considered to be significant (>30%).

The NPfI defines day, evening, and night-time periods as:

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

The noise assessment has adopted the default assumptions in the NPfI for temperature inversion which are more conservative than noise enhancing wind conditions. Further, temperature inversions have the potential to affect all source-receiver directions and applies to both the evening and night periods.

Table 13 presents a summary of applicable meteorological conditions that have been used for this assessment.

TABLE 13: SMF NOISE MODELLING METEOROLOGICAL PARAMETERS

Assessment period	Assessment scenario	Meteorological condition	Wind speed	Pasquill-Guilford Stability category
Day	• Preparation for evening peak service • Trains departure before evening service	Standard conditions	0.5 m/s	D
Evening Night	• Trains returning after evening peak service • Trains preparation for start of service • First trains departure for morning service	Noise-enhancing conditions	2.0 m/s	F

To model the noise-enhancing meteorological conditions, the Concawe algorithm has been utilised. However, as an additional sensitivity analysis, ISO-9613.2 [14] algorithms have been included as an alternative Noise-enhancing conditions prediction as they include for average downwind conditions and are equivalent to average propagation under a well-developed moderate ground-based temperature inversion, which commonly occurs on clear, calm nights.

5.4.2 Noise sources

Table 14 presents the most contributing noise sources and their sound power levels for the worst-case scenario in the SMF for Day 1 operations.

TABLE 14 SMF DAY 1 OPERATION NOISE SOURCES

Scenario/ period	Activity as per Appendix E.1	Noise source as per Table 10	Quantity or Source Area m ²	Modelled noise source	Details	L _w / unit	Sub-Item Qty	% operation	Total dBL _{wAeq,15min}
First trains departure for morning service 4:00 am – 4:15 am	Start of revenue service	RST - Stabling Yard	2 trains	HVAC	Partial cooling	80	6 per train set	100	88
				Aux power supply (APS)	Reduced operation of rpm fan	80	2 per train set	100	83
				Air Supply Units (inc. compressors)	Max nominal operation	85	1 per train set	33.3	80
	Train departing	RST – Departure ²	4 trains (Sweeper)	HVAC	Partial cooling	80	6 per train set	100	44 L _w / m
				MT (Main Transformer) RF Transformer	Reduced operation	85	1 per train set	100	50 L _w / m
				Traction Inverter Container (TIC) RF inversion	Reduced operation	83	2 per train set	100	
				TM (Traction Motor) RF drive unit	Acceleration 0 - 40 km/hr Deceleration 40 - 0 km/hr	86	8 per train set	100	
				Aux power supply (APS)	Reduced operation of rpm fan	80	2 per train set	100	
	Maintenance activities	Maintenance Building - Vertical Glazing with high level openings on 3 ridgelines facing East i.e. towards SMF02	~300 m ²	-	-	-	-	-	69 L _w / m ²

Notes:

1. Total L_w takes into account noise source quantity x sub item quantity and % operation.
2. Departing and returning trains have been modelled as two separate line sources. Each line source represents the total sound power level (L_w) of the RST components located at the top and bottom levels of each train set. A speed correction was applied to these line sources to account for the 25 km/h speed limit within the SMF.

5.5 Predicted noise levels

5.5.1 Day 1 predicted noise levels

Table 15 presents the predicted operational noise levels from the SMF for Day 1 scenario at the nearest noise-sensitive receivers at NCA-SMF01, NCA-SMF02 and NCA-SMF03 for standard and noise-enhancing meteorological conditions.

TABLE 15: DAY 1 - PREDICTED NOISE EMISSIONS

NCA			dBL _{Aeq, 15 mins}					
			Standard meteorological conditions			Noise-enhancing meteorological conditions		
			Receiver		Criteria	Concawe		ISO 9613-2:1996
			Predicted noise levels	Exceedance	Predicted noise levels	Exceedance	Predicted noise levels	Exceedance
Scenario A Night 3:30 am-4:00 am								
SMF01	23824-247U-RES-EX-SMF01	37	-	-	33	-	37	-
SMF02	24376-471D-RES-EX-SMF02	37	-	-	35	-	37	-
SMF02	24717-720D-RES-EX-SMF02	37	-	-	28	-	30	-
SMF03	23063-208D-RES-EX-SMF03	37	-	-	24	-	27	-
Scenario B Night 4:00 am-4:15 am								
SMF01	23824-247U-RES-EX-SMF01	37	-	-	33	-	38	1
SMF02	24376-471D-RES-EX-SMF02	37	-	-	34	-	37	-
SMF02	24717-720D-RES-EX-SMF02	37	-	-	28	-	30	-
SMF03	23063-208D-RES-EX-SMF03	37	-	-	24	-	28	-
Scenario C Day 3:15 pm-3:45 pm								
SMF01	23824-247U-RES-EX-SMF01	40	37	-	-	-	-	-
SMF02	24376-471D-RES-EX-SMF02	40	39	-	-	-	-	-
SMF02	24717-720D-RES-EX-SMF02	40	30	-	-	-	-	-
SMF03	23063-208D-RES-EX-SMF03	40	26	-	-	-	-	-
Scenario D Day 3:45 pm-4:00 pm								
SMF01	23824-247U-RES-EX-SMF01	40	33	-	-	-	-	-
SMF02	24376-471D-RES-EX-SMF02	40	38	-	-	-	-	-
SMF02	24717-720D-RES-EX-SMF02	40	29	-	-	-	-	-
SMF03	23063-208D-RES-EX-SMF03	40	23	-	-	-	-	-
Scenario E Evening 7:00 pm-8:00 pm								
SMF01	23824-247U-RES-EX-SMF01	40	-	-	34	-	39	-
SMF02	24376-471D-RES-EX-SMF02	40	-	-	35	-	38	-
SMF02	24717-720D-RES-EX-SMF02	40	-	-	30	-	32	-
SMF03	23063-208D-RES-EX-SMF03	40	-	-	25	-	29	-

Results indicate that the criteria are met for the five worst-case scenarios, except for a minor exceedance of 1 dB at 23824-247U-RES-EX-SMF01 in Scenario B.

Table 16 presents a breakdown of the contributing noise sources at each receiver. Noise sources contributing less than 10 dB to the total cumulative noise at the receivers for all scenarios have been excluded to maintain brevity.

TABLE 16: PREDICTED NOISE SOURCE CONTRIBUTIONS FOR DAY 1

Assessment Period	Night 3:30 am-4:00 am			Night 4:00 am-4:15 am			Day 3:15 pm-3:45 pm			Day 3:45 pm-4:00 pm			Evening 7:00 pm-8:00 pm		
Meteorological conditions	Noise-enhancing			Noise-enhancing			Standard			Standard			Noise-enhancing		
Receiver ID	23824- 247U- RES- EX- SMF01	24376- 471D- RES- EX- SMF02	23063- 208D- RES- EX- SMF03	23824- 247U- RES- EX- SMF01	24376- 471D- RES- EX- SMF02	23063- 208D- RES- EX- SMF03	23824- 247U- RES- EX- SMF01	24376- 471D- RES- EX- SMF02	23063- 208D- RES- EX- SMF03	23824- 247U- RES- EX- SMF01	24376- 471D- RES- EX- SMF02	23063- 208D- RES- EX- SMF03	23824- 247U- RES- EX- SMF01	24376- 471D- RES- EX- SMF02	23063- 208D- RES- EX- SMF03
Criteria	37	37	37	37	37	37	40	40	40	40	40	40	40	40	40
Total Predicted dBL _{Aeq, 15min}	37	37	27	38	37	28	38	39	26	33	38	23	39	38	29
BEL	19	25	12												
Car Park	15	7	8	15	7	8	16	8	10	16	8	10	16	8	10
Graffiti / Bio-wash Building - Doors													5	20	
UFWL Building - Doors							2	17		2	17		5	19	
Maintenance - East Facade	5	27		5	27		3	25		3	25		5	27	
Maintenance - North Facade			10			10			7			7			10
Maintenance - South Facade	9	22		9	22		7	20		7	20		9	22	
Maintenance - West Facade	17	11	22	17	11	22	16	9	19	16	9	19	17	11	22
Maintenance Building - Doors	1	13		1	13		23	35	3	23	35	3	1	13	
Maintenance Building - Vertical Glazing	16	31	10	16	31	10	16	31	9	16	31	9	17	32	11
Misc Buildings MEP	20	26	17	21	26	17	17	24	14	17	24	14	20	26	17
OCC - Cooling Tower	20	8	14	20	8	14	17	6	12	17	6	12	20	8	14
OCC - East Facade	2		11	2		11			8			8	2		11
OCC - Heat Exchanger	17	4	12	17	4	12	15	1	10	15	1	10	17	4	12
OCC - West Facade	23			23			20			20			23		
RST - Departure				29	27	18				27	26	16			
RST - Returning													34	32	24
RST - Stabling Yard	35	32	23	35	31	23	36	32	23				35	31	23
RST - Door Chimes	17	5		17	5		17	5		17	5		17	5	
Substation	31	29	12	31	29	12	28	27	8	28	27	8	31	29	12
Substation - DWE	27	27	7	27	27	7	24	25	4	24	25	4	27	27	7

Table 17 summarises the primary contributors of noise at receivers where the noise criteria is exceeded.

TABLE 17: DAY ONE PRIMARY NOISE CONTRIBUTORS TO EXCEEDANCE

Scenario	Receivers that exceed noise criteria	Top contributors of noise
Scenario B	23824-247U-RES-EX-SMF01	RST – Stabling Yard
Night 0400 am – 0415 am		- RST – Departure - Substation

Further discussion regarding predicted exceedances is included in Section 5.6.1.

5.5.2 Ultimate service predicted noise levels

The primary change in operations for Ultimate service is the increased number of stabled trains i.e. from 12 trains to 18 trains (10 to 16 operational) and increase from 3-car to 4-car train sets. Appendix E.2 presents the noise sources and operations for Ultimate service. The predicted noise emissions for Ultimate service is presented in Table 18, with detailed noise contribution presented in Table 19.

TABLE 18: PREDICTED NOISE EMISSION FOR ULTIMATE SERVICE

NCA	Receiver	Criteria	dBL _{Aeq, 15 mins}					
			Standard meteorological conditions		Noise-enhancing meteorological conditions			
			CONCAWE		ISO 9613-2:1996		CONCAWE	
			Predicted noise levels	Exceedance	Predicted noise levels	Exceedance	Predicted noise levels	Exceedance
Scenario A Night 3:30 am-4:00 am								
SMF01	23824-247U-RES-EX-SMF01	37	-	-	36	-	39	2
SMF02	24376-471D-RES-EX-SMF02	37	-	-	36	-	39	2
SMF02	24717-720D-RES-EX-SMF02	37	-	-	29	-	31	-
SMF03	23063-208D-RES-EX-SMF03	37	-	-	26	-	29	-
Scenario B Night 4:00 am-4:15 am								
SMF01	23824-247U-RES-EX-SMF01	37	-	-	35	-	39	2
SMF02	24376-471D-RES-EX-SMF02	37	-	-	36	-	38	1
SMF02	24717-720D-RES-EX-SMF02	37	-	-	29	-	31	-
SMF03	23063-208D-RES-EX-SMF03	37	-	-	25	-	29	-
Scenario C Day 3:15 pm-3:45 pm								
SMF01	23824-247U-RES-EX-SMF01	40	40	-	-	-	-	-
SMF02	24376-471D-RES-EX-SMF02	40	40	-	-	-	-	-
SMF02	24717-720D-RES-EX-SMF02	40	31	-	-	-	-	-
SMF03	23063-208D-RES-EX-SMF03	40	28	-	-	-	-	-
Scenario D Day 3:45 pm-4:00 pm								

NCA	Receiver	Criteria	dBL _{Aeq, 15 mins}					
			Standard meteorological conditions		Noise-enhancing meteorological conditions			
			CONCAWE		ISO 9613-2:1996		CONCAWE	
			Predicted noise levels	Exceedance	Predicted noise levels	Exceedance	Predicted noise levels	Exceedance
SMF01	23824-247U-RES-EX-SMF01	40	37	-	-	-	-	-
SMF02	24376-471D-RES-EX-SMF02	40	39	-	-	-	-	-
SMF02	24717-720D-RES-EX-SMF02	40	30	-	-	-	-	-
SMF03	23063-208D-RES-EX-SMF03	40	26	-	-	-	-	-
Scenario E Evening 7:00 pm-8:00 pm								
SMF01	23824-247U-RES-EX-SMF01	40	-	-	35	-	40	-
SMF02	24376-471D-RES-EX-SMF02	40	-	-	36	-	39	-
SMF02	24717-720D-RES-EX-SMF02	40	-	-	30	-	33	-
SMF03	23063-208D-RES-EX-SMF03	40	-	-	25	-	30	-

TABLE 19: PREDICTED NOISE SOURCE CONTRIBUTIONS FOR ULTIMATE

Assessment Period	Night 3:30 am-4:00 am			Night 4:00 am-4:15 am			Day 3:15 pm-3:45 pm			Day 3:45 pm-4:00 pm			Evening 7:00 pm-8:00 pm		
Meteorological Conditions	Noise-enhancing			Noise-enhancing			Standard			Standard			Noise-enhancing		
Receiver ID	23824- RES- EX- SMF01	24376- RES- EX- SMF02	23063- RES- EX- SMF03	23824- RES- EX- SMF01	24376- RES- EX- SMF02	23063- RES- EX- SMF03	23824- RES- EX- SMF01	24376- RES- EX- SMF02	23063- RES- EX- SMF03	23824- RES- EX- SMF01	24376- RES- EX- SMF02	23063- RES- EX- SMF03	23824- RES- EX- SMF01	24376- RES- EX- SMF02	23063- RES- EX- SMF03
Criteria	37	37	37	37	37	37	40	40	40	40	40	40	40	40	40
Total Predicted dBL _{Aeq, 15min}	39	39	29	39	38	29	40	40	28	37	39	26	40	39	30
BEL	19	25	12												
Car Park	15	7	8	15	7	8	16	8	10	16	8	10	16	8	10
Graffiti / Bio-wash Building - Doors								3					5	20	
UFWL Building - Doors							2	17		2	17		5	19	
Maintenance - East Facade	5	27		5	27		3	25		3	25		5	27	
Maintenance - North Facade			10			10			7			7			10
Maintenance - South Facade	9	22		9	22		7	20		7	20		9	22	
Maintenance - West Facade	17	11	22	17	11	22	16	9	19	16	9	19	17	11	22
Maintenance Building - Doors	1	13		1	13		23	35	3	23	35	3	1	13	
Maintenance Building - Vertical Glazing	16	31	10	16	31	10	16	31	9	16	31	9	17	32	11
Misc Buildings MEP	20	26	17	20	26	17	17	24	14	17	24	14	20	26	17
OCC - Cooling Tower	20	8	14	20	8	14	17	6	12	17	6	12	20	8	14
OCC - East Facade	2		11	2		11			8			8	2		11
OCC - Heat Exchanger	17	4	12	17	4	12	15	1	10	15	1	10	17	4	12
OCC - West Facade	23			23			20			20			23		
RST - Departure				30	28	19				29	28	17			
RST - Returning													35	33	25
RST - Stabling Yard	38	36	26	36	34	26	39	36	26	35	32	23	36	33	25
RST - Door Chimes	17	5		17	5		17	5		17	5		17	5	
Substation	31	29	12	31	29	12	28	27	8	28	27	8	31	29	12
Substation - DWE	27	27	7	27	27	7	24	25	4	24	25	4	27	27	7
Train wash							8			8			11		2

5.5.3 Modifying factors assessment

The assessment has considered modifying factor corrections in accordance with Table C1 of the NPfI [3]. For the SMF, the potential for intermittent noise, low frequency and tonality noise factors have been considered given the characteristics of the plant equipment and their operations within the site.

5.5.3.1 Intermittent noise

In the SMF site, no sources were identified that would require application of the intermittent modifying factor correction [17]. Consideration was given to the operation of train compressors; however a single unit operation is expected to only occur once in any 15-minute period, and the highest noise level contribution from any one compressor is 22 dBL_{Aeq} during operation, which is 10 dB below the night background level. Therefore, the source would not result in a greater than 5 dB change in the ambient noise level at the receiver location.

5.5.3.2 Low frequency

A low frequency assessment has been undertaken for all noise-sensitive receivers surrounding the SMF for Day 1 and Ultimate as per Table C2 of the NPfI [3]. From the results, it was determined that there are no low-frequency penalties applied to the predicted noise levels and therefore is not expected to be an issue.

5.5.3.3 Tonality assessment

Third-octave band frequency data is not available for all noise sources to enable detailed assessment of tonality. However, the primary noise source with risk of tonal characteristics is the substation equipment, such as transformers. A conservative screening assessment has been carried out based on predicted octave band noise levels for the highest individual noise source and at the worst-case receiver location. Assessment is limited to the low frequency octave bands where tonal components are more likely to occur for substation equipment. This has been compared against the lowest third-octave ISO 389-7:2005 free-field hearing thresholds for each octave band. The predicted level has also been compared against the low-frequency noise thresholds in Table C2 of NPfI, although it is acknowledged that this is not specific to the assessment of tonality.

From Table 20, the predicted noise levels at 63 Hz and 125 Hz are below both the ISO 389-7 hearing threshold and the NPfI low frequency threshold values. Therefore, the risk that the substation equipment will exhibit tonal characteristics is low.

TABLE 20: TONALITY SCREENING ASSESSMENT

NCA	Receiver	Noise source	Broadband dB(A)	Octave band centre frequency, dB	
				63 Hz	125 Hz
SMF02	24376-471D-RES-EX-SMF02	TX1-1AC-SFC-Tx	18	21	17
<i>ISO 389-7:2005 free-field hearing thresholds – lowest third-octave band</i>			-	31.5	17.9
<i>NPfI low frequency noise thresholds – lowest third-octave band</i>			-	48	44

5.5.4 Sleep disturbance assessment

Operational activity and rolling stock noise levels received do not include L_{max} data nor indicate that any short-term high instantaneous events that will occur from the identified sources. In the absence of specific data, the following assessments have been carried out for potential maximum noise events:

- Staff carpark - Car door slam / vehicle engine starting: L_w 100 dB(A).
- Battery Electric Locomotive / IMVs: L_w 102 dB(A).
- Door chime testing: L_w 85 dB(A).

Table 21 indicates compliance at the most affected receivers for the worst-case meteorological conditions.

TABLE 21: SLEEP DISTURBANCE ASSESSMENT TO MOST AFFECTED RECEIVERS – WITH BASELINE MITIGATION MEASURES

NCA	Receiver	Sleep disturbance criteria	Predicted noise level – dBL _{Amax}
		dBL _{Amax}	Noise-enhancing conditions
SMF01	23824-247U-RES-EX-SMF01	52	44
SMF02	24376-471D-RES-EX-SMF02	52	39
SMF03	23063-208D-RES-EX-SMF03	52	36

5.6 SMF assessment summary

5.6.1 Summary of predicted noise levels

The assessment has revealed some exceedances of the NPfI Project Specific Noise Trigger Levels (PSNTLs) for the following scenarios and receiver locations:

- Day 1: Up to 1 dB exceedance has been predicted at the receiver to the northwest of the SMF (23824-247U-RES-EX-SMF01).
- Ultimate service: Up to 2 dB exceedance predicted at the receivers to the north (23824-247U-RES-EX-SMF01) and to the east (24376-471D-RES-EX-SMF02) of the SMF site.
- Exceedances are predicted only under noise-enhancing meteorological conditions.

Notwithstanding the marginal exceedances, consideration of all feasible and reasonable mitigation measures is warranted.

5.6.2 Feasible and reasonable design measures

The assessment of feasible and reasonable mitigation measures is based on the guidance in Section 3.4 and Fact Sheet F of the NPfI. In accordance with the NPfI, feasibility relates to engineering considerations and what can practically be built/implemented, and reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:

- noise impacts to affected land uses – existing and future levels, projected changes in noise levels, and level of exceedances.
- noise mitigation benefits - amount of noise reduction expected, number of people protected.
- cost effectiveness of mitigation - cost of mitigation versus benefit provided.
- community views - aesthetic impacts and community wishes.

A range of noise mitigation measures have been considered as part of the noise mitigation design to protect noise sensitive receivers surrounding the SMF. There are three categories into which these noise mitigation measures can fall, in hierarchical order:

- At-source treatment (at source);
- Path treatment (between source and receiver, e.g noise barriers); and
- At-property treatment (at receiver).

In accordance with the NPfI, following consideration of at-source and path treatments, an evaluation of residual exceedances is to be carried out to inform the reasonableness of at-property treatment.

5.6.2.1 At-source and path treatment options

The noise mitigation and management measures recommended for incorporation in the SMF design include:

- Selection of lowest practicable noise emitting plant and equipment which do not exhibit tonal noise;

- Incorporation of air path mitigation measures including acoustic duct lining and attenuators;
- Specification of sound insulation performance of the building envelope;
- Incorporation of acoustic finishes within plantrooms to reduce reverberant noise buildup;
- Positioning of plant and equipment away from sensitive receivers where possible; and,
- Operational management measures such as installation of noise monitors.

The primary noise sources that contribute to the predicted exceedances are:

- Rolling stock noise emission from the Stabling Yard.
- Maintenance Building emissions via open louvres, predominantly high-level vertical louvres.

Regarding rolling stock operations emissions, the key noise sources are the HVAC and ASU (compressors). The source noise levels modelled are considered representative of best-practice outcomes.

Regarding the opening of maintenance building louvres, thermal modelling analysis determined that the high-level vertical louvres could remain closed without compromising thermal comfort during the cooler winter months. The predicted noise levels presented in this assessment are therefore more representative of conditions during warmer months. The high-level operable windows can therefore be closed during the night in winter months when temperature inversions and noise enhancing winds are predicted to occur.

The use of noise barriers along the Stabling Yards was investigated to mitigate the predicted exceedances. However, it was evaluated that a noise wall would need to be of significant height and length to provide appropriate noise reduction (approximately 7 m high and 420 m long). Such a mitigation would present as not feasible due to the impracticability of construction and implications on operations. Further, a 7 m height wall is considered an unreasonable mitigation measure given the predicted marginal noncompliance.

5.6.2.2 Residual exceedances

Following implementation of all reasonable and feasible mitigation and management measures, the SMF noise assessment has predicted residual exceedances of ≤ 2 dB. The predicted levels with exceedances for Ultimate Service during noise enhancing conditions are however below the Project Amenity Noise Level of 40 dB(A).

Accordingly, based on the NPfl, the residual exceedances are categorised as negligible and the need for at-property treatment is not warranted.

6. Station noise and vibration assessment

6.1 Overview

The following stations have been considered in this ONVR as part of the SSI-10051 Instrument of Approval - St Marys, Orchard Hills, Luddenham and Aerotropolis. The operational noise and vibration assessment considers the following sources which relate to normal operations at these stations:

- Tunnel ventilation and trackway fan services (operations in normal and congested mode).
- Building services equipment including cooling towers, chillers, exhaust and supply fans;
- Regular PA announcement.

Operational scenarios that classify for assessment of noise emissions are detailed in each station's appendix.

Noise sources of each station have been tabulated in Table 22.

TABLE 22: STATION FACILITIES AND ASSOCIATED NOISE AND VIBRATION SOURCES

Stations systems	STM	OHE	LDN	AEC
Environmental Control Systems (ECS) (excluding cooling towers)	✓	✓	✓	✓
Cooling Towers	✓	✓	x	✓
Tunnel Ventilation Systems (TVS)	✓	✓	x	✓
Tunnel Exhaust Systems (TES)	✓	✓	x	✓
Draught Relief Systems (DRS)	✓	✓	x	✓
Water cooled chillers	✓	✓	x	✓
Air cooled chillers (ACC)	x	x	✓	x
Public Address (PA) system	✓	✓	✓	✓

6.2 Noise and vibration objectives

6.2.1 Land use assessment

A Land Use Assessment has been conducted to define Noise Catchment Areas and identify the noise sensitive receivers surrounding the stations.

An overview of the land use specific to each station is provided in their respective sections.

6.2.2 Noise criteria

6.2.2.1 Derivation of the project specific noise levels

Noise emissions are assessed to operational noise criteria for the day, evening and night periods in accordance with the NPfI as per E58 of the SSI 10051 conditions of approval.

For existing receivers approved up to the approval date of the SSI 10051 (23 July 2021), operational noise criteria are derived in accordance with the NPfI. The methodology to deriving the Project Specific Noise Trigger Level (PSNTL) is detailed in Appendix D.

Regarding the derivation of Project Amenity Noise Levels (PANL) for future receivers, these were derived by Sydney Metro having regard to the existing environment, future development and feasibility of complying with established criteria. In the derivation of criteria, the 5 dB reduction in the derivation of the PANL criteria was not adopted at St Marys (STM) NCA-STM03 and Orchard Hills (OHE). For the potential future receiver locations, it is considered that the Station will be the predominant industrial noise source. This has also been adopted for other sensitive receivers relevant to those stations and NCAs.

6.2.2.2 Future receivers

The noise criteria for potential future receivers have been established using the NPfI Project Amenity criteria. These noise limits have been defined at 30 m from station buildings or at the nearest receiver lot boundary (whichever is furthest) with consideration of the potential future receiver type. If the future land zoning is not confirmed, the criteria for 'urban' residential has been adopted as a worst-case. The criteria have been established by Sydney Metro in terms of assessable distance and noise limits based on previous metro projects and has been outlined within the Project requirements. The assessment location is at any height on the vertical plane.

Potential future development within the 30 m buffer will be addressed through the requirements within the *State Environmental Planning Policy (Transport and Infrastructure) 2021* and with consultation with relevant local government councils as outlined in Section 9.2.

6.2.2.3 Draught relief shafts

Train pass-by noise emitted from draught relief shafts (DRS) have been assessed at residential and commercial receivers against criteria of $dBL_{max,95\%}$ of 55 and 65 dB(A) respectively as outlined in Section 5.8.4 of Western Sydney Airport Technical Paper 2 Noise and Vibration [1].

Table 23 presents the PSNTL for existing and future noise sensitive receivers impacted by the noise emissions from the stations.

TABLE 23: STATIONS PROJECT SPECIFIC NOISE AND VIBRATION LEVELS FOR SENSITIVE RECEIVERS

Receivers				NPfl - PSNTLs				Sleep disturbance dBL _{Amax} (night)	DRS dBL _{Amax}
Receivers Type	ID	Station	NCA	Day dBL _{Aeq, 15min}	Evening dBL _{Aeq, 15min}	Night dBL _{Aeq, 15min}	When in use dBL _{Aeq, 15min}		
Existing Receivers									
Residential ¹	RES	STM	STM01	46	46	43	-	53	55
			STM02	44	44	43	-	53	55
			STM03	49	46	39	-	52	55
		OHE	OHE01	46	46	43	-	53	55
		LDN	LDN01	41	41	38	-	52	55
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	HTL	STM	ALL	65	55	50	-	-	-
Commercial premises	COM	STM	ALL	-	-	-	63	-	65
Retail areas	RET	STM	ALL	-	-	-	63 ²	-	-
Industrial premises	IND	STM	ALL	-	-	-	68	-	-
Telstra Exchange	TEL	STM	STM02	-	-	-	63 ²	-	-
Future receivers (30 m from station or nearest lot boundary whichever furthest)									
Residential	RES	STM	STM01, STM02	58	48	43	-	52	55
Residential ¹	RES	STM	STM03	63	53	48	-	52	55
Residential ¹	RES	OHE	-	63	53	48	-	52	55
Residential	RES	LDN	-	58	48	43	-	52	-
Commercial	COM	LDN	-	-	-	-	63	-	-
Residential	RES	AEC	-	58	48	43	-	52	55

Notes:

- Noise emissions amenity criteria for both existing and future residential receivers for STM03, OHE have not adopted the 5dB reduction (to account for other future industrial sources) as per the Sydney Metro Concept Reports.
- The NPfl external commercial criteria have been adopted for this receiver type.

6.2.3 Vibration criteria

Operational vibration emissions criteria for external receivers surrounding the stations have been established in accordance with the 'Assessing vibration: a technical guideline' [4] and is presented in Table 24.

TABLE 24: VIBRATION CRITERIA FOR EXTERNAL RECEIVERS SURROUNDING THE STATIONS

Land Use Receiver Type	ID	Continuous ¹ Z-axis preferred		Impulsive ¹ Z-axis - preferred		Intermittent - preferred	
		Day (m/s ²)	Night (m/s ²)	Day (m/s ²)	Night (m/s ²)	Day (m/s ^{1.75}) ²	Night (m/s ^{1.75}) ²
Residential	RES	0.01	0.007	0.30	0.10	0.20	0.13
Commercial	COM	0.02	0.02	0.64	0.64	0.56	0.56
Retail areas	RET	0.02	0.02	0.64	0.64	-	-
Industrial	IND	0.04	0.04	0.64	0.64	1.1	1.1

Notes:

1. Continuous and impulsive vibration criteria are presented as weighted root mean square (RMS) acceleration levels.
2. Intermittent vibration criteria are shown as vibration dose values.

Plant equipment within the station buildings will be vibration isolated to achieve the internal vibration criteria for sensitive spaces. Given the proximity of these internal spaces to the building services equipment, the internal vibration criteria will govern the design requirements. When factoring additional attenuation provided by the building structure (floors/foundation coupling loss), ground propagation and distance to the nearest residences, vibration impacts to these receivers will be insignificant and will readily meet the vibration criteria at external receivers. Accordingly, no quantitative assessment has been carried out.

6.3 Noise assessment inputs and methodology

Noise emission assessment focuses on the primary plant and tunnel ventilation equipment locations. Station and service buildings noise sources have been added to the digital model to refine predictions and mitigation of operational noise impact to surrounding noise-sensitive receivers.

Table 25 summarises the Fixed facilities/Stations noise emissions modelling methodology.

TABLE 25: SUMMARY OF FIXED FACILITIES NOISE EMISSION MODELLING METHODOLOGY

Item	Detail
Noise modelling software	SoundPLAN Version 8.1
Noise propagation model	ISO 9613-2 (1996) Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation [14].
Station buildings	External noise emissions modelling focuses on the Service buildings and the station noise sources, all cumulatively assessed in the noise model. Building footprints, relative location, and dimensions are based on architectural drawings.
Noise sources	Noise sources combinations and noise levels used in the model are summarised within the station appendices i.e. Equipment Noise Levels and Operation Scenarios. The assessment has included the following key sources: • Tunnel ventilation and trackway exhaust systems, including draught relief systems; • Cooling towers; • ECS systems interfacing with atmosphere; • PA announcements in the concourse and platform areas detailed in Section 6.3.1; and, • Noise sources associated with the FSM (mechanical plant equipment and PA system).

Item	Detail
	Further detail on tunnel train noise levels is provided in Section 6.3.2. Source locations are detailed within figures under each station section.
PA modelled scenarios	A worst case 15 min period was modelled during peak times for the PA system.
ECS/TVS modelled scenarios	The following worst-case scenarios were modelled for the station noise emissions. • Evening Congested • Night Congested
Directivity	• Stack directivity has been applied to plenum/shaft openings to environment for TVS and for CT discharge [18]. These vertically discharging sources have been considered as stacks as this is pattern of directivity factors diffraction of sound beyond 90 degrees, which might represent a non-baffled discharge point located at the edge of a roof. • Louvre directivity [19] has been applied for horizontal sources located in walls (baffled) and considers the geometric effects of these apertures relative to the octave band frequency in vertical and horizontal axis.
External receiver buildings	Building polygons are imported into the noise model referencing GIS data from the land use assessment. These are shown in the Land Use Maps from Appendix B.
Receiver heights	• 1.5 m above floor level of each receiver building for each relevant floor level for existing receivers • Future receivers are placed on a grid with 4 m height per floor.
Ground topography	Design elevation data has been provided by the civil team for the fixed facility site. Elevation data (1 m LIDAR) was sourced from ICSM ELVIS for terrain beyond these extents. SoundPLAN triangulates the data to create a Digital Ground Model (DGM).
Ground absorption	• $G = 0.5$ has been adopted based on the project environment for existing receivers. • $G = 1$ for future receivers at elevation.
Mitigation measures	General mechanical system mitigation measures for TVS, TES, DRS (except Luddenham station), and ECS. • Internal acoustic linings for ducts, bend and plenum, duct laggings, attenuators. • Room noise breakout treatment measures • Acoustic linings in plantrooms/plena with external openings, various R_w rated walls and external doors.
Safety factor/ Contingency	3 dB

6.3.1 PA noise sources

Each station will include a public address system (PA) for the purpose of broadcasting safety and other announcements at platform areas, station entry points, paid / unpaid concourse areas and back of house (staff) areas. Table 27 provides a guidance on announcements frequencies, times of day and locations within station areas where these announcements may occur.

At open platform and concourses (such as LDN), PA loudspeakers have been modelled as individual point sources with loudspeaker directivity applied. For stations with enclosed GF concourses and underground platforms (STM, AEC, OHE), the PA sound power levels for the environmental assessment (at station entrance and concourse openings) are derived from the internal sound pressure level distributions maps provided by the PA designer..

Table 26 summarises the selection of loudspeakers and the sound power output ranges across the stations assessed.

TABLE 26: LOUDSPEAKER INFORMATION AND SOUND POWER SUMMARY

Model	Type	SWL dBL _{Aeq}	SWL L _{Amax} ¹
SPCO-20W-200-EN54 (ASL)	Column speaker	87 - 96	93 - 102

Model	Type	SWL dBL _{Aeq}	SWL L _{Amax} ¹
SPCF-06W-65-EN54 (ASL)	Mounted ceiling speaker	82 - 88	88 - 94
SPCF-20W-80-EN54 (ASL)	Mounted ceiling speaker	80 - 90	86 - 96

Notes:

1. Assumption: $L_{Amax} = dBL_{Aeq} + 6 \text{ dB}$.

Announcement parameters

The PA strategy for the Ultimate Stage is presented in Table 27. Regular announcements may occur for each train arrival/departure and to convey other educational, reminder or promotional and way finding. Table 27 presents the announcement parameters adopted for noise modelling

TABLE 27: PA ANNOUNCEMENT PARAMETERS

Coverage Area	Periods	Time	No. of announcements per 15 min period	Average individual announcement duration
Platform	Peak period	6:00am - 8:30am 4:30pm - 7:30pm	9 ¹	15 sec
	Off peak - day / evening	8:30am - 4:30pm 7:30pm - 10:00pm	6 ¹	15 sec
Concourse	Peak period	6:00am - 8:30am 4:30pm - 7:30pm	4 ²	15 sec
	Off peak - day / evening	8:30am - 4:30pm 7:30pm - 10:00pm	4 ²	15 sec
	Off peak - night	10:00pm - 6:00am	4 ²	15 sec

Notes:

1. Announcement types include notification of train arrival/departure, education, reminder, promotional and wayfinding.
2. Announcement types as above but excludes notification of train arrival/departure.

Speaker volume design inputs

The volume of announcements at receiver positions 1.5 m above platform and concourse areas is modelled as 10 dB higher than the 55 dB(A) normal ECS operations ambient noise levels.

Announcements related to train service delays, crowd control or emergencies will only be made when required and may occur at any time of the day or night. The frequency of such announcements is anticipated to be minimal and therefore does not warrant specific assessment.

The proposed PA system includes ambient noise compensation technology. This allows the volume of announcements to be set on the basis of the current noise environment in different areas of the station. During peak periods when ambient noise levels are high, the volume of announcements is increased so that announcements remain clear. During off-peak periods, when ambient noise levels are low, the volume of announcements is automatically reduced.

6.3.2 Rail noise for draught relief shaft emission

In tunnel noise levels were predicted by the train supplier based on the train design, trackform and infrastructure noise mitigation using ODEON software. Predictions were made for various locations around the train. Locations at the top of the tunnel have been utilised for the draught relief shaft (DRS) emission assessment.

Noise levels will vary based on the train speed, which could vary between 40 km/h and 75 km/h at the various DRS locations. The assessment presented in this report has been conservatively based on the maximum speed of 75 km/h at all locations. A +3 dB correction has also been adopted to account for potential uncertainty in the predicted in-tunnel sound pressure levels. The speed-corrected sound pressure is presented in Table 28.

TABLE 28: IN-TUNNEL TRAIN SOUND PRESSURE LEVEL

Source description	Overall dB(A)	Octave-band centre frequency (Hz), dB(Z)							
		63	125	250	500	1 k	2 k	4 k	8 k
In-tunnel train sound pressure level	98	107	97	97	94	92	91	86	88
Bare tunnel, slab track with Delkor RF167 rail fastener and Pyrotek AS60-8500 rail damper (75 km/h)									

Note: A 3 dB safety factor has been applied to the octave-band spectrum.

6.4 St Marys station

6.4.1 Overview

St Marys station is located to the North of the town centre bounded by the station entries on Station Street to the South and Harris Street to the North. The area North of the station contains an industrial cluster of trade, manufacturing, storage centres and commuter car park. The Southern side serves as a commercial and residential hub, anchored by Queen street's retail district. The station precinct consists of an Eastern Services building containing major tunnel ventilation systems (TVS), draught relief shaft (DRS), and ECS equipment (including cooling towers), a Central services building containing ECS equipment and the bus driver's facility as well as the station concourse to the west. The layout of the station and the noise emission sources are shown in Figure 4.

6.4.2 Footbridge St Marys (FSM)

The FSM will enable commuters transfer between the metro platforms and suburban trains. Noise sources include emissions from the PA system to be installed across the length of the bridge and from the mechanical plant equipment located in the service tower adjacent to the east side of the Northern Staircase of the footbridge (see Figure 4).

6.4.3 Land use assessment

The Land use survey shows STM is bound by a mix of land use types including.

- An industrial cluster to the North adjacent to STM01 which is minimally impacted by station noise emission.
- Residential receivers and retail/commercial receivers bound to the west of Queen Street moderately affected by station emission noises.
- Residential receivers to the south of station service buildings in STM03 being the primary noise affected receivers.

A detailed land use map can be found in Appendix B.

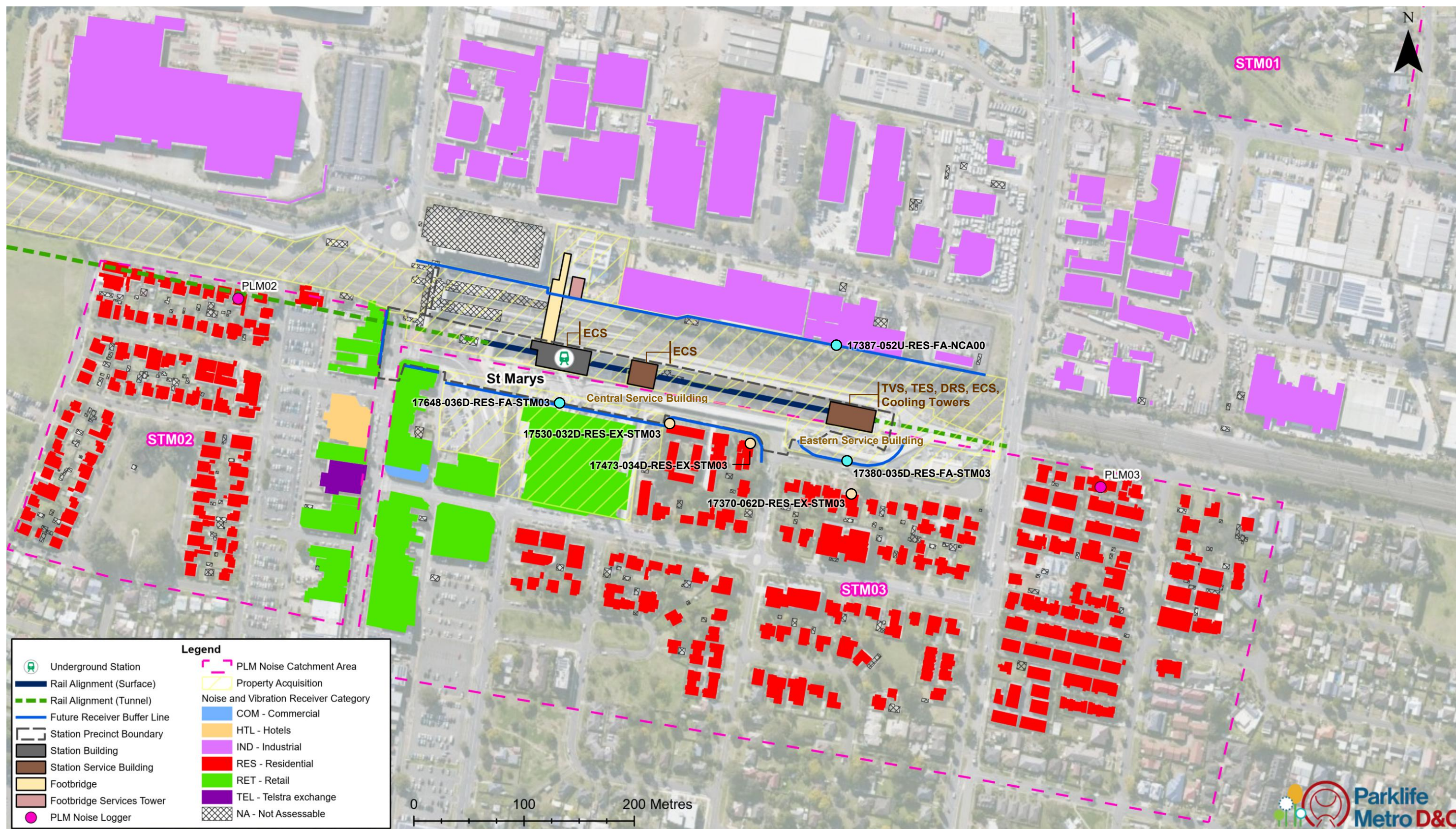


FIGURE 4: STM STATION LOCATION AND NOISE SOURCE MAP

6.4.4 STM noise criteria

Table 29 summarises the STM project specific noise criteria at all relevant receiver categories. The method of establishing the project specific noise criteria is detailed in Appendix D.

TABLE 29: STM NOISE SENSITIVE RECEIVER CRITERIA

NCA¹	Type ID	NPfl receiver category:	Noise monitor ID	Measured RBL (dBL _{AF90})			Assessment RBL (dBL _{AF90})			Recommend Amenity Noise Level (RANL)			Project Intrusiveness Noise Level (dBL _{Aeq,15min})			Project Amenity Noise Level (dBL _{Aeq,15min})			Project Specific Noise Trigger Level (PSNTL)			Sleep disturbance (Residential only)	
				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N - dBL _{Aeq,15min}	N - dBL _{AMax}
Existing receivers																							
STM01	RES	Residence - Urban	NML-PLM01	41	41	38	41	41	38	60	50	45	46	46	43	58	48	43	46	46	43	43	53
STM02	RES	Residence - Urban	NML-PLM02	39	42	38	39	39	38	60	52²	52²	44	44	43	58	50	47	44	44	43	43	53
STM03	RES	Residence - Urban	NML-PLM03	44	41	34	44	41	34	60	50	45	49	46	39	63	53	48	49	46	39	39	52
STM03	HTL	Hotel - Urban	-	-	-	-	-	-	-	65	55	50	-	-	-	68	58	53	68	58	53	-	-
STM01, STM02	HTL	Hotel - Urban	-	-	-	-	-	-	-	65	55	50	-	-	-	63	53	48	63	53	48	-	-
STM01, STM02	COM	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	63	63	63	63	63	63	-	-
STM03	COM	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	68	68	68	68	68	68	-	-
STM01, STM02	RET	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	63	63	63	63	63	63	-	-
STM03	RET	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	68	68	68	68	68	68	-	-
STM01, STM02	IND	Industrial Premises	-	-	-	-	-	-	-	70	70	70	-	-	-	68	68	68	68	68	68	-	-
STM03	IND	Industrial Premises	-	-	-	-	-	-	-	70	70	70	-	-	-	73	73	73	73	73	73	-	-
STM02	TEL	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	63	63	63	63	63	63	-	-
Future receivers																							
STM01,STM02	RES	Residence - Urban	-	-	-	-	35	35	30	60	50	45	-	-	-	58	48	43	58	48	43	40	52
STM03	RES	Residence - Urban	-	-	-	-	35	35	30	60	50	45	-	-	-	63	53	48	63	53	48	40	52
STM01, STM02	COM	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	63	63	63	63	63	63	-	-

Notes:

1. Consistent with the Sydney Metro Concept Report, a 5 dB deduction was not applied to STM PANL at NCA-STM03, however a 5dB deduction has been applied to the PANL of NCA-STM01 and NCA-STM02 as the ongoing redevelopment can become industrial sources in the future.
2. The representative week Evening and Night measurements at STM-02 is 62 dBL_{Aeq}, consequently in accordance to the NPfl the RANL is set at 10dB below the existing industrial noise level as it is unlikely to reduce over time.

The NPfl defines day, evening and night-time period as follows:

- **D** - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- **E** - Evening: the period from 6 pm to 10 pm, Monday to Sunday & Public Holidays.
- **N** - Night: from 10 pm to 7 am, Monday to Saturday, or 10 pm to 8 am on Sunday & Public Holidays.

6.4.5 Noise sources and operational modes

Noise sources contributing to the environmental noise emissions include the TVS, TES, DRS, ECS equipment and PA System.

The operational modes of the sources vary throughout the day, evening and night period, generally with reduced operation and noise output during the night period as a result of station activity and environmental conditions. The modes of operation are summarised in Appendix F.

6.4.6 Summary of predicted noise levels

The predicted noise emissions from STM to the reasonably most affected receivers are presented in Table 30.

The noise predictions include mitigation measures as outlined in Section 6.4.7.

The assessment has considered modifying factor corrections in accordance with Table C1 of the NPfI [3]. The primary concern for the assessed sources was low frequency modifying corrections for the TVF and ECS equipment, however, it was determined however that no corrections were required.

TABLE 30: STM STATION LAEQ,PERIOD NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Assessment period	Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted noise levels dBL _{Aeq,15 mins}				Cumulative criteria dBL _{Aeq,15 mins}	Exceedance
			TVS ³ , ECS	PA noise	FSM ⁴	Cumulative		
Day/Evening	Future	17380-035D-RES-FA-STM03 ⁵	50	30	-	50	53 ⁶	-3
	Existing	17473-034D-RES-EX-STM03	38	33	-	39	46 ⁶	-7
Night	Future	17387-052U-RES-FA-NCA00 ^{1,5}	48	30	-	48	48	0
	Future	17648-036D-RES-FA-STM03 ⁵	40	51	-	51	48	3
	Existing	17473-034D-RES-EX-STM03	38	33	-	39	39	0
	Existing	17530-032D-RES-EX-STM03	36	39	35	42	39	3

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. TVS operating in congested mode.
4. FSM Emissions include PA and mechanical plant equipment.
5. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.
6. The more stringent Evening criteria has been used for the assessment.

6.4.6.1 Sleep disturbance assessment

The night period sleep disturbance assessment is controlled by intermittent noise emission from the station PA system. Table 31 summarises the reasonably most affected existing and potential future receiver.

TABLE 31: STM PA NOISE EMISSION SLEEP DISTURBANCE ASSESSMENT

Future/ Existing Receiver	Receiver ID ¹	Predicted dBL _{AFmax}	Sleep Disturbance criteria dBL _{AFmax}	Exceedance
Future	17648-036D-RES-FA-STM03 ²	69	52	17

Future/ Existing Receiver	Receiver ID ¹	Predicted dBL _A F _{max}	Sleep Disturbance criteria dBL _A F _{max}	Exceedance
Existing	17530-032D-RES-EX-STM03	57	52	5

Notes:

1. Receiver ID nomenclature has been defined in Section 3.2.
2. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

PA management recommendations have been included in Section 6.4.7.2 to address exceedances.

6.4.6.2 Draught relief shaft assessment

Noise predictions for DRS noise emissions post acoustic mitigation are presented in Table 32.

TABLE 32: STM DRAUGHT RELIEF SHAFT NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Future/Existing Receiver	Receiver ID ¹	dBL _A F _{max} , 95%		
		Predicted noise level	Criteria	Exceedance
Future	17380-035D-RES-FA-STM03 ^{1,2}	52	55	-3
Existing	17370-062D-RES-EX-STM03	46	55	-9

Notes:

1. Receiver ID nomenclature has been defined in Section 3.2.
2. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

6.4.7 Noise mitigation measures

6.4.7.1 ECS and TVS noise mitigation measures

Noise impacts from ECS and TVS plant equipment will be mitigated through the following measures:

- Selection of lowest practicable noise emitting plant and equipment which do not exhibit tonal noise.
- Incorporation of air path mitigation measures including acoustic lining and noise attenuators.
- Specification of sound insulation performance of the building envelope.
- Incorporation of acoustic finishes within plantrooms to reduce reverberant noise buildup where required.
- Positioning of plant and equipment away from sensitive receivers where possible.

6.4.7.2 PA noise management

The PA noise emission assessment has predicted exceedances at existing and future potential residential receivers during night-time period. The assessment is based on the PA announcement parameters presented in Table 25. The following operational management measures are to be implemented to address the non-compliances:

- Ambient noise compensation technology – The current assessment is based on conservative background noise levels during the night period. The ambient noise compensation will allow adjustment to the announcement sound level based on the prevailing noise environment in different areas of the station.
- Number of announcements reduction – The number of non-critical announcements including educational, reminder, promotional and wayfinding announcements will be limited to reduce environmental noise impact. During night periods of 10:00 pm to 7:00 am the following day, only train arrival/departure announcements to be exclusively broadcasted within the platform area.

- Announcement zones – Critical announcement coverage zones to be established with varying optimised speaker sound levels to minimise noise spills into environment while ensuring satisfactory levels for speech intelligibility.
- Controlled speaker sound levels – Manual adjustment of speaker volumes to minimise noise spill at the operators' discretion, this procedure will be necessary in lieu of the ambient noise compensation technology.

6.4.8 STM assessment summary

Following the implementation of all reasonable and feasible at-source mitigation measures the predicted noise levels due to the operations at St Marys Station complies at all assessment locations for all time periods with exception of PA noise emission at both existing and future potential residential receivers at night time periods, these exceedances will be minimised or mitigated with the PA management recommendations in Section 6.4.7.2.

6.5 Orchard Hills East station

6.5.1 Overview

Orchard Hills East station (OHE) is an at-grade station located on the eastern side of Kent Road, north of Lansdowne Road, and immediately south of the St Marys tunnel. It is situated between scattered suburban residential areas to the east and west, with denser urban residential at Claremont Meadows further to the north. The station consists of the Northern Services building containing major tunnel ventilation systems, draught relief shafts, and ECS equipment (including cooling towers), the central station concourse building, and the Southern Pod with ECS equipment. The layout of the station and the noise emission sources are shown in Figure 5.

6.5.2 Land use assessment

The Land use survey shows OHE is surrounded by residential receivers to the north, east, and west. The nearest existing residential receiver is approximately 100 m west of the Northern Service Station Building, which is minimally impacted by station noise emissions along with the remaining existing receivers.

A detailed land use map can be found in Appendix B.

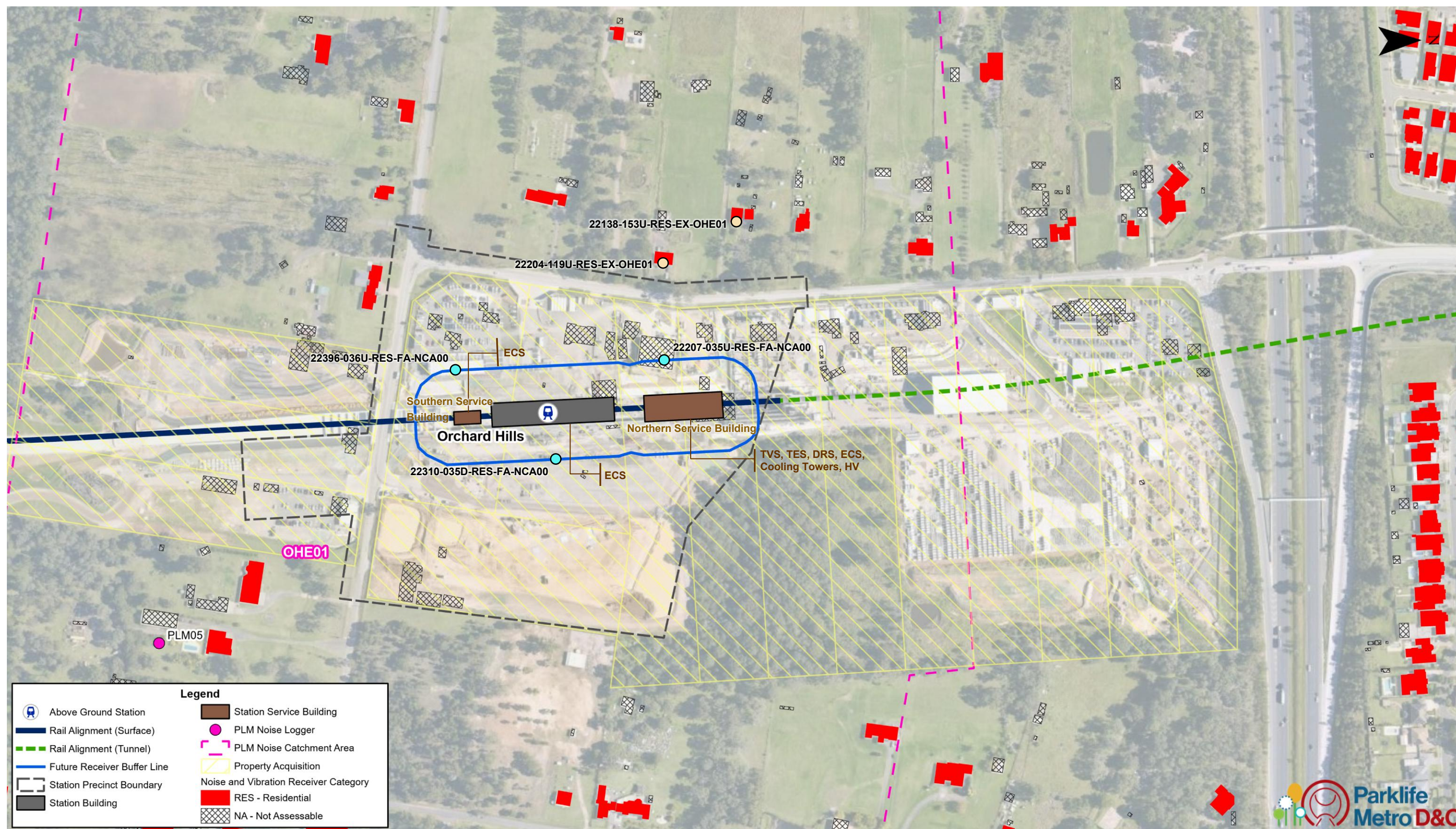


FIGURE 5: OHE STATION LOCATION AND NOISE SOURCE MAP

6.5.3 OHE noise criteria

Table 33 summarises the OHE project specific noise criteria at all relevant receiver categories. The method of establishing the project specific noise criteria is detailed in Appendix D.

TABLE 33: OHE NOISE SENSITIVE RECEIVER CRITERIA

NCA ¹	Type ID	NPfl receiver category:	Noise monitor ID	Measured RBL (dBL _{AF90})			Assessment RBL (dBL _{AF90})			Recommend Amenity Noise Level (RANL)			Project Intrusiveness Noise Level (dBL _{Aeq, 15min})			Project Amenity Noise Level (dBL _{Aeq, 15min})			PSNTL			Sleep Disturbance (Resi Only)	
				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N - dBL _{Aeq,15min}	N - dBL _{AMax}
				Existing Receivers																			
OHE01	RES	Residence – Suburban ²	NML-PLM05	41	41	38	41	41	38	55	45	40	46	46	43	58	48	43	46	46	43	43	53
Future Receivers																							
OHE	RES	Residence - Urban	-	-	-	-	-	-	-	60	50	45	-	-	-	63	53	48	63	53	48	48	52

- Notes:
- 1. Consistent with the Sydney Metro Concept Report, a 5 dB deduction was not applied to OHE PANLs, as they were assumed to be the predominant industrial source at the nearest receivers.
 - 2. Background noise levels are influenced significantly by the M4, consequently in accordance with the NPfl a suburban classification has been adopted.
- The NPfl defines day, evening and night-time period as follows:
- **D** - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays. 6 pm to 10 pm, Monday to Sunday & Public Holidays.
 - **E** - Evening: the period from 6 pm to 10 pm, Monday to Sunday & Public Holidays.
 - **N** - Night: from 10 pm to 7 am, Monday to Saturday, or 10 pm to 8 am on Sunday & Public Holidays.

6.5.4 Noise sources and operational modes

Noise sources contributing to the predicted environmental noise levels include the TVS, DRS, ECS and HV equipment.

The operational modes of the sources vary throughout the day, evening and night period, generally with reduced operation and noise output during the night period as a result of station activity and environmental conditions. The modes of operation are summarised in Appendix G.

6.5.5 Summary of predicted noise levels

The predicted noise emissions from OHE with to the reasonably most affected receivers are presented in Table 34.

The noise predictions include mitigation measures as outlined Section 6.5.6.

The assessment has considered modifying factor corrections in accordance with Table C1 of the NPfl [3]. The primary concern for the assessed sources was low frequency modifying corrections for the TVF and ECS equipment, however, it was determined however that no corrections were required.

TABLE 34: OHE STATION LAEQ,PERIOD NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Assessment Period	Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted noise levels dBL _{Aeq, 15 mins}			Criteria	Exceedance
			TVS ³ , ECS	PA noise	Cumulative		
Day/Evening	Future	22207-035U-RES-FA-NCA00 ⁴	48	42	49	53 ⁵	-4
	Future	22310-035D-RES-FA-NCA00 ⁴	38	48	49	53 ⁵	-4
	Future	22396-036U-RES-FA-NCA00 ⁴	38	44	45	53 ⁵	-8
	Existing	22204-119U-RES-EX-OHE01	37	36	40	46 ⁵	-6
Night	Future	22207-035U-RES-FA-NCA00 ⁴	48	42	49	48	1
	Future	22310-035D-RES-FA-NCA00 ⁴	38	48	49	48	1
	Future	22396-036U-RES-FA-NCA00 ⁴	38	44	45	48	-3
	Existing	22204-119U-RES-EX-OHE01	37	36	39	43	-4

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. TVS operating in congested mode.
4. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.
5. The more stringent Evening criteria has been used for the assessment.

6.5.5.1 Sleep disturbance assessment

The night period sleep disturbance assessment is controlled by intermittent noise emission from the station PA system. Table 35 summarises the reasonably most affected existing and potential future receiver.

TABLE 35 OHE PA NOISE EMISSION SLEEP DISTURBANCE ASSESSMENT

Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted dBL _{AFmax}	Sleep Disturbance criteria dBL _{AFmax}	Exceedance
Future	22310-035D-RES-FA-NCA00 ^{1,3}	66	52	14
Existing	22204-119U-RES-EX-OHE01	53	53	0

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2
3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

PA management recommendations have been included in Section 6.5.6.2 to address exceedances.

6.5.5.2 Draught relief shaft assessment

Noise predictions for DRS noise emissions post mitigation treatments are presented in Table 36.

TABLE 36: OHE DRAUGHT RELIEF SHAFT NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Future/Existing Receiver	Receiver ID ^{1,2}	dBL _{AFmax} , 95%		
		Predicted noise levels	Criteria (All time periods)	Exceedance
Future	22207-035U-RES-FA-NCA00 ^{1,3}	53	55	-2
Existing	22138-153U-RES-EX-OHE01	35	55	-20

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

6.5.6 Noise mitigation measures

6.5.6.1 ECS and TVS noise mitigation measures

Noise impacts from ECS and TVS plant equipment will be mitigated through the following measures:

- Selection of lowest practicable noise emitting plant and equipment which do not exhibit tonal noise.
- Incorporation of air path mitigation measures including acoustic lining and noise attenuators.
- Specification of sound insulation performance of the building envelope.
- Incorporation of acoustic finishes within plantrooms to reduce reverberant noise buildup where required.
- Positioning of plant and equipment away from sensitive receivers where possible.

6.5.6.2 PA noise management

The PA noise emission assessment has predicted exceedances at future potential residential receivers during night-time period. The assessment is based on the PA announcement parameters presented in Table 25. The following operational management measures are to be implemented to address the non-compliances:

- Ambient noise compensation technology – The current assessment is based on conservative background noise levels during the night period. The ambient noise compensation will allow adjustment to the announcement sound level based on the prevailing noise environment in different areas of the station.

- Number of announcements reduction – The number of non-critical announcements including educational, reminder, promotional and wayfinding announcements will be limited to reduce environmental noise impact. During night periods of 10:00 pm to 7:00 am the following day, only train arrival/departure announcements to be exclusively broadcasted within the platform area.
- Announcement zones – Critical announcement coverage zones to be established with varying optimised speaker sound levels to minimise noise spills into environment while ensuring satisfactory levels for speech intelligibility.
- Controlled speaker sound levels – Manual adjustment of speaker volumes to minimise noise spill at the operators' discretion, this procedure will be necessary in lieu of the ambient noise compensation technology.

6.5.7 OHE assessment summary

Following the implementation of all reasonable and feasible at-source mitigation measures the predicted noise levels due to the operations at OHE Station complies at all existing sensitive receivers for all time periods with exception of PA noise emission at future potential residential receivers during the night time period, these exceedances will be minimised or mitigated with the PA management recommendations in Section 6.5.6.2.

6.6 Luddenham Station

6.6.1 Overview

Luddenham Station (LDN) is an elevated station located north of Luddenham Road. It is set in a greenfield site, with residential areas to the west. This station will be part of a new precinct featuring mixed-use developments and commercial spaces. The station consists of two main structures: the main Station Building and a Station Services Building that contains ECS equipment and other supporting facilities. The layout of the station and the noise emissions sources are shown in Figure 6.

6.6.2 Land use assessment

For LDN, no NCAs have been identified in the vicinity of the station as there are no existing noise sensitive receivers within 200 m of the Station facilities. An existing residential noise sensitive receiver has been identified ~800 m from the station facilities.

A detailed land use map can be found in Appendix B.

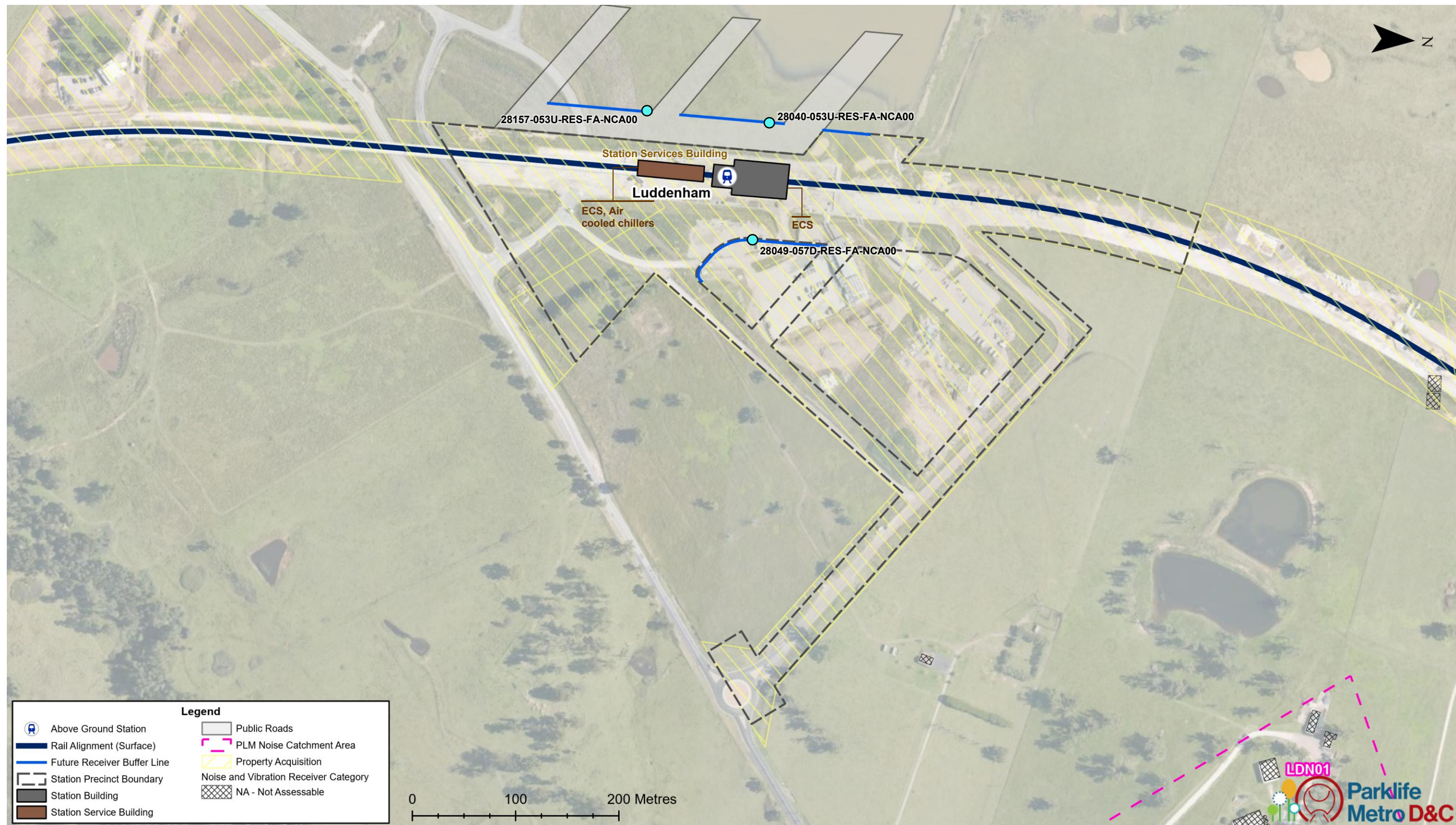


FIGURE 6: LDN STATION LOCATION AND NOISE SOURCE MAP

6.6.3 LDN noise criteria

Table 37 summarises the LDN project specific noise criteria at all relevant receiver categories. The method of establishing the project specific noise criteria is detailed in Appendix D.

TABLE 37: LDN NOISE SENSITIVE RECEIVER CRITERIA

NCA	Type ID	NPfl receiver category:	Noise monitor ID	Measured RBL (dBL _{AF90})			Assessment RBL (dBL _{AF90})			Recommend Amenity Noise Level (RANL)			Project Intrusiveness Noise Level (dBL _{Aeq, 15min})			Project Amenity Noise Level (dBL _{Aeq, 15min})			PSNTL			Sleep Disturbance (Resi Only)	
Existing Receivers				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N - dBL _{Aeq, (15min)}	N - dBL _{Max}
LDN01	RES	Residence - Suburban	NML-PLM09	36	38	36	36	36	36	55	45	40	41	41	41	53	43	38	41	41	38	38	52
Future Receivers				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N - dBL _{Aeq, (15min)}	N - dBL _{Max}
LDN	RES	Residence - Urban	-	-	-	-	-	-	-	60	50	45	-	-	-	58	48	43	58	48	43	43	52
LDN	COM	Commercial Premises	-	-	-	-	-	-	-	65	65	65	-	-	-	63	63	63	63	63	63	-	-

- Notes:
- The NPfl defines day, evening and night-time period as follows:
- **D** - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
 - **E** - Evening: the period from 6 pm to 10 pm, Monday to Sunday & Public Holidays.
 - **N** - Night: from 10 pm to 7 am, Monday to Saturday, or 10 pm to 8 am on Sunday & Public Holidays.

6.6.4 Noise sources and operational modes

Noise sources contributing to the predicted environmental noise levels include ECS equipment.

The operational modes of the sources vary throughout the day, evening and night period, generally with reduced operation and noise output during the night period as a result of station activity and environmental conditions. The modes of operation are summarised in Appendix H.

6.6.5 Summary of predicted noise levels

The predicted noise emissions from LDN to the reasonably most affected receivers are presented in Table 38.

The noise predictions include mitigation measures as outlined in Section 6.6.6.

The assessment has considered modifying factor corrections in accordance with Table C1 of the NPfI [3]. The primary concern for the assessed sources was low frequency modifying corrections for the TVF and ECS equipment, however, it was determined however that no corrections were required.

TABLE 38: LDN STATION LAEQ,PERIOD NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Assessment Period	Future/existing Receiver	Receiver ID ^{1,2}	Predicted noise levels (dBL _{Aeq,15 mins})			Criteria (dBL _{Aeq,15mins})	Exceedance
			ECS	PA noise emissions	Cumulative		
Night	Future	28157-053U-RES-FA-NCA00 ^{1,3}	42	45	47	43	4
	Future	28049-057D-RES-FA-NCA00 ^{1,3}	42	55	56	43	13
	Future	28040-053U-RES-FA-NCA00 ^{1,3}	37	55	56	43	13
	Existing	27272-048D-RES-EX-LDN01 ⁴	13	25	25	38	-13

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.
4. This receiver ID is not located in Figure 6 due to its extensive distance from the noise source.

6.6.5.1 Sleep disturbance assessment

The night period sleep disturbance assessment is controlled by intermittent noise emission from the open platform and concourse station PA system.

Table 39 summarises the reasonably most affected existing and potential future receiver.

TABLE 39: LDN PA NOISE EMISSION SLEEP DISTURBANCE ASSESSMENT

Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted dBL _{AFmax}	Sleep Disturbance criteria dBL _{AFmax}	Exceedance
Future	28049-057D-RES-FA-NCA00 ^{1,3}	70	52	18
Existing	27272-048D-RES-EX-LDN01	39	52	-13

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.

Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted dBL _{AFmax}	Sleep Disturbance criteria dBL _{AFmax}	Exceedance
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3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

PA management recommendations have been included in Section 6.6.6.2 to address exceedances.

6.6.6 Noise mitigation measures

6.6.6.1 ECS noise mitigation measures

Noise impacts from ECS plant equipment will be mitigated through the following measures:

- Selection of lowest practicable noise emitting plant and equipment which do not exhibit tonal noise.
- Incorporation of air path mitigation measures including acoustic lining and noise attenuators.
- Specification of sound insulation performance of the building envelope.
- Incorporation of acoustic finishes within plantrooms to reduce reverberant noise buildup where required.
- Positioning of plant and equipment away from sensitive receivers where possible.

6.6.6.2 PA noise management

The PA noise emission assessment has predicted exceedances at future potential residential receivers during night-time period. The assessment is based on the PA announcement parameters presented in Table 25. The following operational management measures are to be implemented to address the non-compliances:

- Ambient noise compensation technology – The current assessment is based on conservative background noise levels during the night period. The ambient noise compensation will allow adjustment to the announcement sound level based on the prevailing noise environment in different areas of the station.
- Number of announcements reduction – During the evening period of 6:00 pm to 10:00 pm the number of non-critical announcements including educational, reminder, promotional and wayfinding announcements will be limited to reduce environmental noise impact. Due to the open cut station configuration, during the night periods of 10:00 pm to 7:00 am the following day, only emergency/crowd control announcements will broadcasted when necessary.
- Announcement zones – Critical announcement coverage zones to be established with varying optimised speaker sound levels to minimise noise spills into environment while ensuring satisfactory levels for speech intelligibility.
- Controlled speaker sound levels – Manual adjustment of speaker volumes to minimise noise spill at the operators' discretion, this procedure will be necessary in lieu of the ambient noise compensation technology.

6.6.7 LDN assessment summary

Following the implementation of all reasonable and feasible at-source mitigation measures the predicted noise levels due to the operations at Luddenham Station complies at all assessment locations for all time periods with exception of PA noise emission at future potential residential receivers during the night time period, these exceedances will be minimised or mitigated with the PA management recommendations in Section 6.6.6.2.

6.7 Aerotropolis Station

6.7.1 Overview

The Aerotropolis station is located in Bradfield to the Eastern side of Badgerys Creeks Road. The station consists of the Northern services building containing the major TVS and TES equipment, draught relief shaft, and ECS equipment (including cooling towers), the Southern services building containing ECS equipment and the station concourse building in between with an over station development. The layout of the station and the noise emission sources are shown in Figure 7. The station precinct is surrounded by sparse suburban residential receivers to the east and west side. The station is the major transport hub to the city centre which will consist of residential, business precincts, education and advanced industries.

6.7.2 Land use assessment

Land use survey shows no existing sensitive receivers within 200 m of the station facilities; the nearest existing sensitive receiver is approximately 300 m to the West of the Northern Service Building. A detailed land use map can be found in Appendix B.

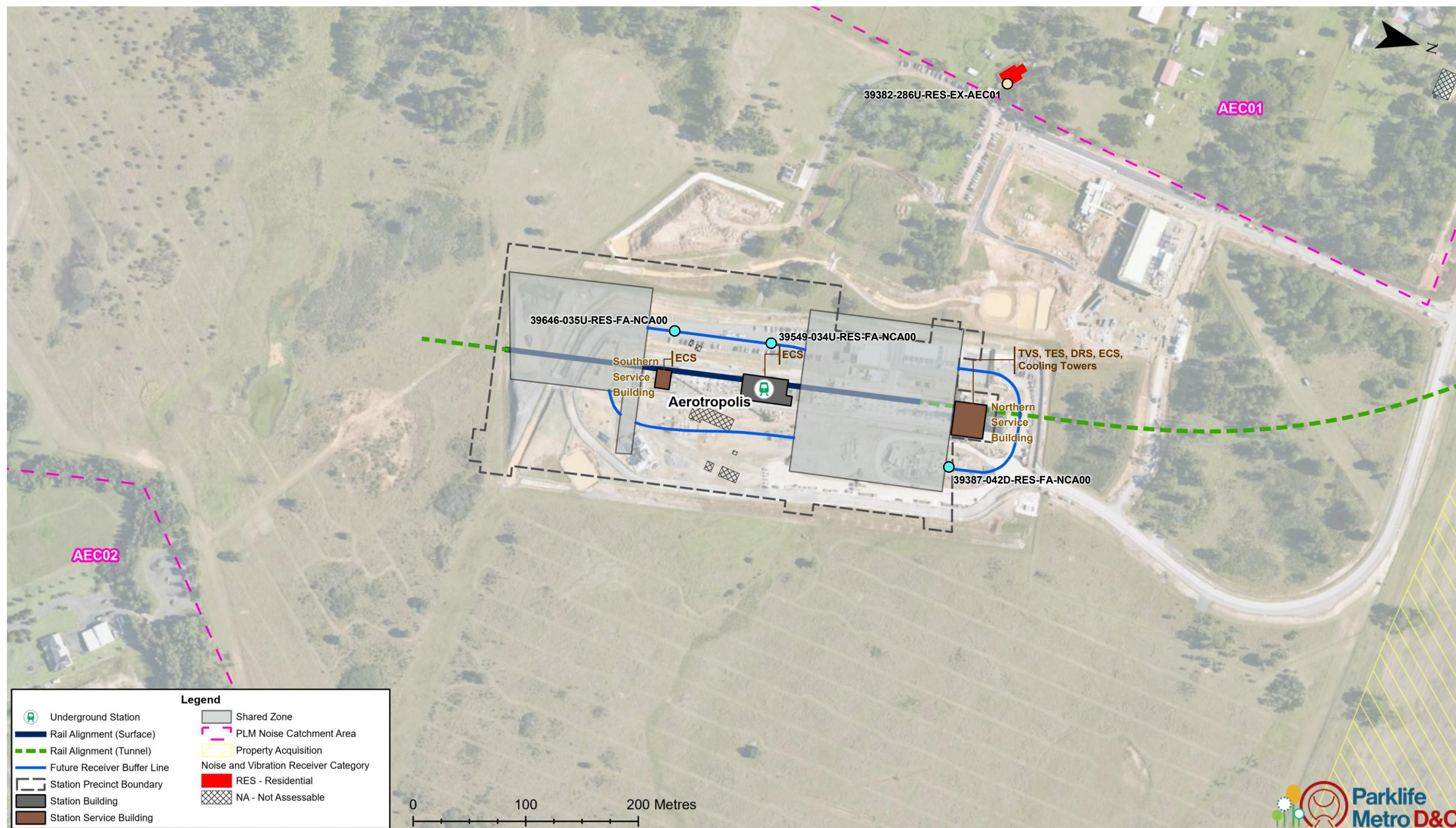


FIGURE 7: AEC STATION LOCATION AND NOISE SOURCE MAP

6.7.3 AEC noise criteria

Table 40 summarises the AEC project specific noise criteria at all relevant receiver categories. The method of establishing the project specific noise criteria is detailed in Appendix D.

TABLE 40: AEC NOISE SENSITIVE RECEIVER CRITERIA

NCA	Type ID	NPfl receiver category:	Noise monitor ID	Measured RBL (dBL _{AF90})			Assessment RBL (dBL _{AF90})			Recommend Amenity Noise Level (RANL)			Project Intrusiveness Noise Level (dBL _{Aeq, 15min})			Project Amenity Noise Level (dBL _{Aeq, 15min})			PSNTL			Sleep Disturbance (Resi Only)	
				D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	N - dBL _{Aeq, (15min)}	N - dBLMax
Existing Receivers																							
AEC01	RES	Residence - Suburban	NML-PLM10	42	45	38	42	42	38	60	54	56	47	47	43	58	52	54	47	47	43	43	53
Future Receivers																							
AEC01	RES	Residence - Urban	-	-	-	-	-	-	-	60	50	45	-	-	-	58	48	43	58	48	43	43	53

- Notes:
- The NPfl defines day, evening and night-time period as follows:
- **D** - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
 - **E** - Evening: the period from 6 pm to 10 pm, Monday to Sunday & Public Holidays.
 - **N** - Night: from 10 pm to 7 am, Monday to Saturday, or 10 pm to 8 am on Sunday & Public Holidays.

6.7.4 Noise sources and operational modes

Noise sources contributing to the environmental noise emissions include the TVS, TES, DRS, and ECS equipment.

The operational modes of the sources vary throughout the day, evening and night period, generally with reduced operation and noise output during the night period as a result of station activity and environmental conditions. The modes of operation are summarised in Appendix I.

6.7.5 Summary of predicted noise levels

The predicted noise emissions from AEC to the reasonably most affected receivers are presented in Table 41.

The noise predictions include mitigation measures as outlined in Section 6.7.6.

The assessment has considered modifying factor corrections in accordance with Table C1 of the NPfl [3]. The primary concern for the assessed sources was low frequency modifying corrections for the TVF and ECS equipment, however, it was determined however that no corrections were required.

TABLE 41 AEC STATION LAEQ,PERIOD NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Operational mode	Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted noise levels (dBL _{Aeq 15 mins})			Criteria	Exceedance
			TVS ³ , ECS	PA noise emissions	Cumulative		
Day/Evening	Future	39387-042D-RES-FA-NCA00 ^{1,4}	44	19	44	48 ⁵	-4
	Future	39549-034U-RES-FA-NCA00 ^{1,4}	38	47	48	48 ⁵	0
	Future	39646-035U-RES-FA-NCA00 ^{1,4}	31	37	38	48 ⁵	-10
	Existing	39382-286U-RES-EX-AEC01	20	25	26	47 ⁵	-21
Night	Future	39387-042D-RES-FA-NCA00 ^{1,4}	42	19	42	43	-1
	Future	39549-034U-RES-FA-NCA00 ^{1,4}	38	47	48	43	5
	Future	39646-035U-RES-FA-NCA00 ^{1,4}	31	37	38	43	-5
	Existing	39382-286U-RES-EX-AEC01	19	25	26	43	-17

Notes:

1. No NCA defined for future receivers external to NCA Boundaries
2. Receiver ID nomenclature has been defined in Section 3.2.
3. TVS operating in congested mode.
4. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.
5. The more stringent Evening criteria has been used for the assessment.

6.7.5.1 Sleep disturbance assessment

The night period sleep disturbance assessment is controlled by intermittent noise emission from the station PA system. Table 42 summarises the reasonably most affected existing and potential future receiver.

TABLE 42: AEC PA NOISE EMISSION SLEEP DISTURBANCE ASSESSMENT

Future/ Existing Receiver	Receiver ID ^{1,2}	Predicted dBL _{Afmax}	Sleep Disturbance criteria dBL _{Afmax}	Exceedance
Future	39549-034U-RES-FA-NCA00 ^{1,3}	66	53	13
Existing	39382-286U-RES-EX-AEC01	43	53	-10

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.

PA management recommendations have been included in Section 6.7.6.2 to address exceedances.

6.7.5.2 Draught relief shaft assessment

Noise predictions for DRS noise emissions post acoustic mitigation are presented in Table 43.

TABLE 43: AEC DRAUGHT RELIEF SHAFT NOISE ASSESSMENT AT REASONABLY MOST AFFECTED RECEIVERS

Future/Existing Receiver	Receiver ID ^{1,2}	dBL _{Afmax} , 95%		Exceedance
		Predicted noise levels	Criteria (All time periods)	
Future	39387-042D-RES-FA-NCA00 ^{1,3}	55	55	0
Existing	39382-286U-RES-EX-AEC01	31	55	-24
	39368-600D-RES-EX-AEC02 ⁴	14	55	-41

Notes:

1. No NCA defined for future receivers external to NCA Boundaries.
2. Receiver ID nomenclature has been defined in Section 3.2.
3. The future buffer receivers are assessed at 30 m or at the nearest receiver lot boundary (whichever is further) from the boundary of stations, facilities, and electrical substation.
4. This receiver ID is not located in Figure 7 due to its extensive distance from the noise source.

6.7.6 Noise mitigation measures

6.7.6.1 ECS and TVS noise mitigation measures

Noise impacts from ECS and TVS plant equipment will be mitigated through the following measures:

- Selection of lowest practicable noise emitting plant and equipment which do not exhibit tonal noise.
- Incorporation of air path mitigation measures including acoustic lining and noise attenuators.
- Specification of sound insulation performance of the building envelope.
- Incorporation of acoustic finishes within plantrooms to reduce reverberant noise buildup where required.
- Positioning of plant and equipment away from sensitive receivers where possible.

6.7.6.2 PA noise management

The PA noise emission assessment has predicted exceedances at future potential residential receivers during night-time period. The assessment is based on the PA announcement parameters presented in Table 25. The following operational management measures are to be implemented to address the non-compliances:

- Ambient noise compensation technology – The current assessment is based on conservative background noise levels during the night period. The ambient noise compensation will allow adjustment to the announcement sound level based on the prevailing noise environment in different areas of the station.
- Number of announcements reduction – The number of non-critical announcements including educational, reminder, promotional and wayfinding announcements will be limited to reduce environmental noise impact. During night periods of 10:00 pm to 7:00 am the following day, only train arrival/departure announcements to be exclusively broadcasted within the platform area.
- Announcement zones – Critical announcement coverage zones to be established with varying optimised speaker sound levels to minimise noise spills into environment while ensuring satisfactory levels for speech intelligibility.
- Controlled speaker sound levels – Manual adjustment of speaker volumes to minimise noise spill at the operators' discretion, this procedure will be necessary in lieu of the ambient noise compensation technology.

6.7.7 AEC assessment summary

Following the implementation of all reasonable and feasible at-source mitigation measures the predicted noise levels due to the operations at Aerotropolis Station complies at all assessment locations for all time periods with exception of PA noise emission at future potential residential receivers during the night time period, these exceedances will be minimised or mitigated with the PA management recommendations in Section 6.7.6.2.

7. Rail operations noise and vibration

7.1 Noise and vibration objectives

The following criteria are established in accordance with the ONVR requirements in section 1.2 which includes the NSW *Rail Infrastructure Noise Guideline* (RING) [5] and NSW *Assessing Vibration – A technical guideline* (AVTG) [4]. Other project requirements have also been relied upon in establishing criteria for receiver types not included in the Conditions of Approval.

7.1.1 Land use assessment

A Land Use Assessment has been conducted as per Section 3 and a detailed land use map can be found in Appendix B.

7.1.2 Criteria

Rail operations noise and vibration criteria are established in accordance with the RING. Based on the guideline, SMWSA has been classified as a new rail line. While the project interfaces with the existing heavy rail network at St Marys Station, the operational line exists within a new tunnel and thus it was not deemed neither a redevelopment nor shared corridor with the T1 Western line. Notwithstanding, SMWSA will not contribute to any cumulative airborne noise impact and ground-borne noise is not assessed based on a cumulative criterion. Vibration could be assessed cumulatively however the assessment demonstrates that the contribution from SM-WSA is well below the 'preferred' criteria.

The noise and vibration criteria in tunnel and above ground summarised in Table 44.

TABLE 44: RAIL OPERATIONS – GROUND-BORNE NOISE, VIBRATION AND AIRBORNE NOISE CRITERIA SUMMARY

Land use receiver type	Source type:		Ground-borne Noise (GBN)	Ground-borne vibration (GBV)	Airborne noise	
	Project area:		In-Tunnel / Above Ground ¹	In-Tunnel and Above Ground	Above Ground	
	Requirement reference:		RING/ Project requirements	AVTG	RING ³	
	Receiver ID	Assessment period	dBL _A max, 95%	Intermittent preferred (m/s ^{1.75}) ²	dBL _{Aeq,period}	dBL _A max,95%
Residential	RES	Day (7 am-10 pm)	40	0.2	dBL _{Aeq,15hr} 60 external	80
		Night (10 pm-7 am)	35	0.13	dBL _{Aeq,9hr} 55 external	80
Hotels (accommodation areas)	HTL	Day (7 am-10 pm)	40	0.2	N/A	N/A
		Night (10 pm-7 am)	35	0.13	N/A	N/A
Commercial (Private offices and conference rooms) ⁴	COM	When in use	40 ⁵	0.4	N/A	N/A
Retail areas	RET	When in use	50 ⁵	N/A	N/A	N/A
Industrial (Workshops)	IND	When in use	N/A	0.8	N/A	N/A
Cinemas	CIN	When in use	35 ⁵	N/A	N/A	N/A
Public halls	PBH	When in use	35 ⁵	N/A	N/A	N/A
Places of Worship	PLA	When in use	40-45	0.4	dBL _{Aeq,1hr} 40 internal	N/A
Educational institutions (schools)	EDU	When in use	40-45	0.4	dBL _{Aeq,1hr} 40 internal	N/A
Childcare centres ⁶	CCC	When in use	40-45 ⁵	0.4	dBL _{Aeq,1hr} 40 internal	N/A
Lecture theatres ⁶	LCT	When in use	35 ⁵	0.4	dBL _{Aeq,1hr} 40 internal	N/A

Land use receiver type	Source type:		Ground-borne Noise (GBN)	Ground-borne vibration (GBV)	Airborne noise	
	Project area:		In-Tunnel / Above Ground ¹	In-Tunnel and Above Ground	Above Ground	
	Requirement reference:		RING/ Project requirements	AVTG	RING ³	
	Receiver ID	Assessment period	dBL _{ASmax, 95%}	Intermittent preferred (m/s ^{1.75}) ²	dBL _{Aeq,period}	dBL _{Amax,95%}
Film/TV/Sound recording studios	STU	When in use	NR15 ⁵	N/A	N/A	N/A
Hospitals - critical spaces ⁷	HPC	When in use	40 ⁵	0.1	N/A	N/A
Hospitals – wards ⁷	HPW	When in use	40 ⁵	N/A	dBL _{Aeq,1hr} 35 internal	N/A
Hospitals - other uses ⁷	HPO	When in use	40 ⁵	N/A	dBL _{Aeq,1hr} 60 external	N/A
Drama theatres	DRT	When in use	NR25 ⁵	N/A	N/A	N/A
Open space - passive use	OSP	When in use	N/A	N/A	dBL _{Aeq,15hr} 60 external	N/A
Open space - active use	OSA	When in use	N/A	N/A	dBL _{Aeq,15hr} 65 external	N/A
TransGrid 5A1/5A2 Structure 266 Footing	TGT	All	N/A	125 mm/s (interface requirement)	N/A	N/A
Telephone exchange	TEL	All	50	0.1	N/A	N/A

Notes:

1. GBN criteria assessed only when greater than airborne noise.
2. Vibration levels are presented as vibration dosage values.
3. RING New Rail Line trigger levels are external at 1 m from façade unless otherwise stated.
4. Private office used as conservative assessment for all Commercial. General offices criterion is GBN 45 dB(A).
5. Criteria established based on other project specific requirements.
6. GBN and GBV based on education institutions.
7. Medical institution GBN criteria adopted.

7.2 Ground-borne noise and vibration assessment

Ground-borne noise and vibration from the railway is due to rolling vibration from the wheel-rail interface being transmitted via the track system into the surrounding tunnel and ground and propagating into nearby building structures. Potential impacts are primarily controlled by the selection of vibration isolating resilient track fixings, including resilient baseplates and isolated-slab tracks (IST). The following sections outline the assessment methodology.

7.2.1 Methodology

The tunnel ground-borne noise model used for this assessment is based on the model developed for the Channel Tunnel Rail Link (CTRL) in the UK. It has been highly validated both in the UK, and on projects in Sydney, Melbourne, and Singapore. The model allows the consideration of a wide range of system input parameters and allows the detailed prediction of spectral ground-borne noise and vibration levels allowing the resulting noise spectrum to be considered in the design process.

The model accounts for the rolling stock and system parameters, such as unsprung mass, overall average mass, axle and sleeper spacing, and the trackform Insertion Gain (IG). The source vibration level is based on vibration velocity measurements of representative trains on known track and ground lithology (known as the Reference Source Spectrum or Vibration Reference Spectrum). The vibration attenuation through the ground is considered independently in the horizontal and vertical directions, more accurately representing the different modes of wave propagation (i.e. surface waves (Rayleigh waves) dominate vibration from shallow tunnels, while compression waves dominate vibration from deep tunnels).

Receiver building response is represented, including: the coupling loss of the foundations, amplification associated with suspended floors and transmission of structure-borne vibration into airborne noise.

Calculation procedures for the method are consistent with ISO 14837-1 and take account of all key parameters, including train design, train speed, track design, tunnel design, tunnel depth, ground conditions, receiving building foundations, and receiving building type.

The calculation procedures generally consist of:

- source terms;
- propagation; and
- building response.

The above ground model used for this assessment is based on the Federal Transit Administration (FTA) Vibration Impact Assessment Manual and BS ISO 14837-1:2005 *Mechanical Vibration – Ground-borne noise and vibration arising from rail systems – part 1: General guidance*.

Ground-borne noise and vibration levels from at-grade track has also been predicted to identify any potential mitigation. It is however noted that mitigation of ground borne noise is only required where noise levels are predicted to be above both the criteria and the airborne noise level. Detailed assessment of ground-borne noise and vibration has not been assessed for the viaduct sections, as sensitive receivers are significantly removed from the structures (closest residential development is approximately 200 m) and therefore deemed not to be at risk of impact.

The same source terms, insertion gains, and building response(s) are used for both the in-tunnel and above ground modelling.

7.2.1.1 Source terms

The source terms have been derived from measurements of vibration undertaken at locations around Sydney for a range of existing metropolitan rolling stock (i.e. Tangara and Waratah rolling stock). The source terms have been adjusted in the model to take account of the loading and unsprung mass differences between the reference source rolling stock and the proposed Siemens rolling stock.

Trackform corrections have been undertaken by adjusting for the Insertion Gain (IG) of the various alternative trackforms which have been calculated using CIVET (Change in Vibration Emission from Trackforms) developed by BRR in the UK and IGITUR (Insertion Gains In Tracks of Underground Railways) developed by the Institute of Sound and Vibration Research. The insertion gains are expressed in decibels with reference to a hypothetical 'highly stiff' reference trackform (representative of paved concrete track, PACT) in Figure 12 and Figure 13.

The speed correction has been undertaken using the CTRL/HS1 calculation procedure which accounts for differences in the following parameters between the source term train/track system and the proposed system:

- the spacing between sleepers or rail fastening;
- the spacing between axles on a train (axle pitch); and
- the change in the dynamic forces generated by the combined surface roughness of the rails and train wheels when the speed is changed.

7.2.1.2 Propagation model

The propagation model for ground-borne sound and vibration bored from tunnelled sections of railway has been derived from a statistical analysis of the results of measurements of ground-borne sound and vibration from a variety of train types in tunnels both in the UK and France. Separate aspects of the transmission path are addressed by three specific terms to account for:

- absorption and geometric dispersion of the bulk waves from tunnel to surface (a function of depth from railhead to surface);
- absorption and dispersion of the surface wave (a function of horizontal distance from tunnel centre); and
- the effect of tunnel width.

Analysis of the available data for ground-borne sound from trains in bored tunnels indicated that differences in lithology do not have a major influence upon the propagation characteristics.

The calculation of propagation is as follows:

- Tunnel to surface correction: see Table 45 below
- Horizontal propagation: $A \times \log((\text{distance} + 10)/10)$
- Vertical propagation: $B \times \log(\text{depth}/10)$
- Tunnel factor: $C \times \log(\text{diameter}/10)$

TABLE 45: PROPAGATION FACTORS

Third octave band centre frequency, Hz	Adjustment / co-efficient			
	Tunnel to surface	A	B	C
5.0 and below	-15	-9	-20	-50
6.3	-18	-9	-22	-53
8.0	-13	-13	-24	-37
10	-16	-14	-16	-46
12.5	-20	-13	-7	-50
16	-19	-12	-12	-47
20	-29	-12	-9	-78
25	-27	-6	-12	-76
31.5	-15	-16	-14	-63
40	-6	-21	-26	-28

Third octave band centre frequency, Hz	Adjustment / co-efficient			
	Tunnel to surface	A	B	C
50	-3	-19	-17	-27
63	2	-20	-15	-11
80	6	-22	-19	21
100	7	-21	-23	13
125	3	-18	-17	-7
160	-3	-14	-6	-48
200	-9	-6	-1	-73
250	-7	-3	-10	-88

7.2.1.3 Building response

Ground-borne sound levels ($\text{dBL}_{\text{pASmax}}$) near the centre of ground floor and basement rooms are calculated from RMS one-third octave band vertical particle velocities (evaluated for the period while a train is passing) outside the building of interest. The conversion to internal ground-borne sound levels is based on corrections measured by Bolt Beranek and Newman (BBN) / Kurzweil, validated and adjusted through an analysis of measurements carried out during a collaborative study between British Rail and London Underground Limited (LUL).

The vibration attenuation per building level has been based on the levels identified from recent research completed in NSW [20].

The building response factors used in the calculation model are shown in Table 46 below. No coupling loss has been used for buildings, which is a conservative approach for some building types.

TABLE 46: BUILDING RESPONSE FACTORS

Third octave band centre frequency, Hz	Adjustment, dB			
	Structure-borne vibration to indoor noise	Attenuation per floor	Vibration amplification – ground floor	Vibration amplification – upper floors
5.0 and below	-26	0.0	0	1
6.3	-26	0.0	1	3
8.0	-26	0.0	1	4
10	-26	0.0	0	5
12.5	-26	0.0	2	8
16	-26	0.0	4	14
20	-26	-0.2	8	14
25	-26	0.0	11	10
31.5	-26	0.0	10	8
40	-26	-0.1	8	6
50	-26	-0.2	6	4
63	-26	-0.2	4	6
80	-26	0.0	1	-2
100	-26	0.2	1	-4
125	-26	0.0	2	-3

Third octave band centre frequency, Hz	Adjustment, dB		Vibration amplification – ground floor	Vibration amplification – upper floors
	Structure-borne vibration to indoor noise	Attenuation per floor		
160	-26	0.0	-2	0
200	-26	0.2	0	0
250	-26	0.0	0	0

7.2.1.4 Vibration dosage values

Vibration dosage values (VDVs) have been predicted based on the predicted ground-borne vibration level at the receiver in accordance with the CTRL model. In accordance with *Assessing Vibration a Technical Guideline* [4] the Wg weighting has been applied to the predicted 1/3 Octave Band Vibration levels to determine an eVDV. eVDVs were calculated with Ultimate service train movement volumes for the day and night periods presented in Table 54 with separate calculation for the 'up' and 'down' alignment. The eVDVs from each track were then combined to calculate the total eVDV at the receiver, which was then compared to the relevant criteria.

7.2.2 Inputs

The input data in Table 47 below has been used for the ground-borne noise and vibration modelling.

TABLE 47: GROUND-BORNE NOISE AND VIBRATION INPUTS

Component	Item	Reference
Track details	Horizontal and vertical alignment	Track alignments dated 14/02/2023.
Rolling stock information	Vibration reference source levels	Per Section 7.2.2.1.
	Unsprung mass	New WSA SSTOM rolling stock has the following unsprung wheelset mass per axle: - Motor Car (MC): 1,807 kg - Trailer Car (TC): 1,458 kg The range of unsprung wheelset mass has been accounted for in the uncertainty analysis.
	Rolling stock details	- Axle load (max load): 16,982 kg Axle pitches (refer Figure 8) - Axle 1 pitch: 2.3 m - Axle 2 pitch: 5.1 m - Axle 3 pitch: 7.4 m
Ground and receiver details	Ground elevation	1 m elevation LiDAR contours from design team dated 10/07/2023 1 m elevation track contours from design team dated 22/02/2023
	Lithology	Shale Class I/II and Shale Class III as per Geotechnical Interpretative Report

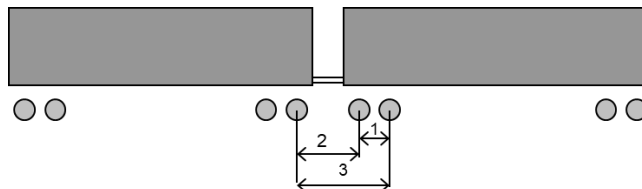


FIGURE 8: DIAGRAM OF AXLE PITCH

Component	Item	Reference
Operational Parameters	Receiver locations, elevation, classification, no. of storeys.	As per land use survey in Appendix B.
	Assessment locations	At the nearest point of the building envelope to the track alignment.
	Operating speed	The speed profile used in this assessment is based on the Headway Simulation Report which is summarised in Section 7.3.2.2.
	Train movements	Train movements are based on the Ultimate service (Timeframe 2) timetable, summarised in Table 54.

7.2.2.1 Vibration reference source levels

For the CTRL/HS1 method, ground-borne source vibration measurements have been undertaken adjacent to several Sydney at-grade ballasted suburban lines to characterise the reference vibration source levels for current rolling stock based on the typical network wheel and rail conditions. Note that adjustments to these source levels are made within the model to account for physical differences between the measured rolling stock and the Siemens rolling stock.

TABLE 48: MASS CORRECTIONS APPLIED TO ROLLING STOCK

Correction for max overall mass, Λ per axle $f < 25$ Hz	Correction for max unsprung mass, Ω per axle $f > 31.5$ Hz
$\Delta L(f) = 20 \times \log \frac{\Lambda}{\Lambda_{ref}}$	$\Delta L(f) = 20 \times \log \frac{\Omega}{\Omega_{ref}}$

The CTRL/HS1 reference source vibration level is a ground surface vibration level ($dBLeq, T_{passby}$) measured at 10 m from ballasted surface track for a vehicle travelling at 80 km/h. All on-site vibration source measurements were normalised from the actual measurement distance and vehicle speed to the reference distance and speed. The CTRL/HS1 methodology is based on an $dBLeq$ reference source level, which is used to predict the resultant $dBLa_{max,95\%}$ ground-borne noise level. The CTRL/HS1 model was validated on the basis of $dBLeq$ source levels and $dBLa_{max}$ results at receivers.

Figure 9 and Figure 10 illustrate the range of normalised vehicle passby source vibration measurements (as a $dBLeq, T_{passby}$) undertaken near Loftus Crescent and Lewisham Station respectively. The adopted reference source level is overlaid.

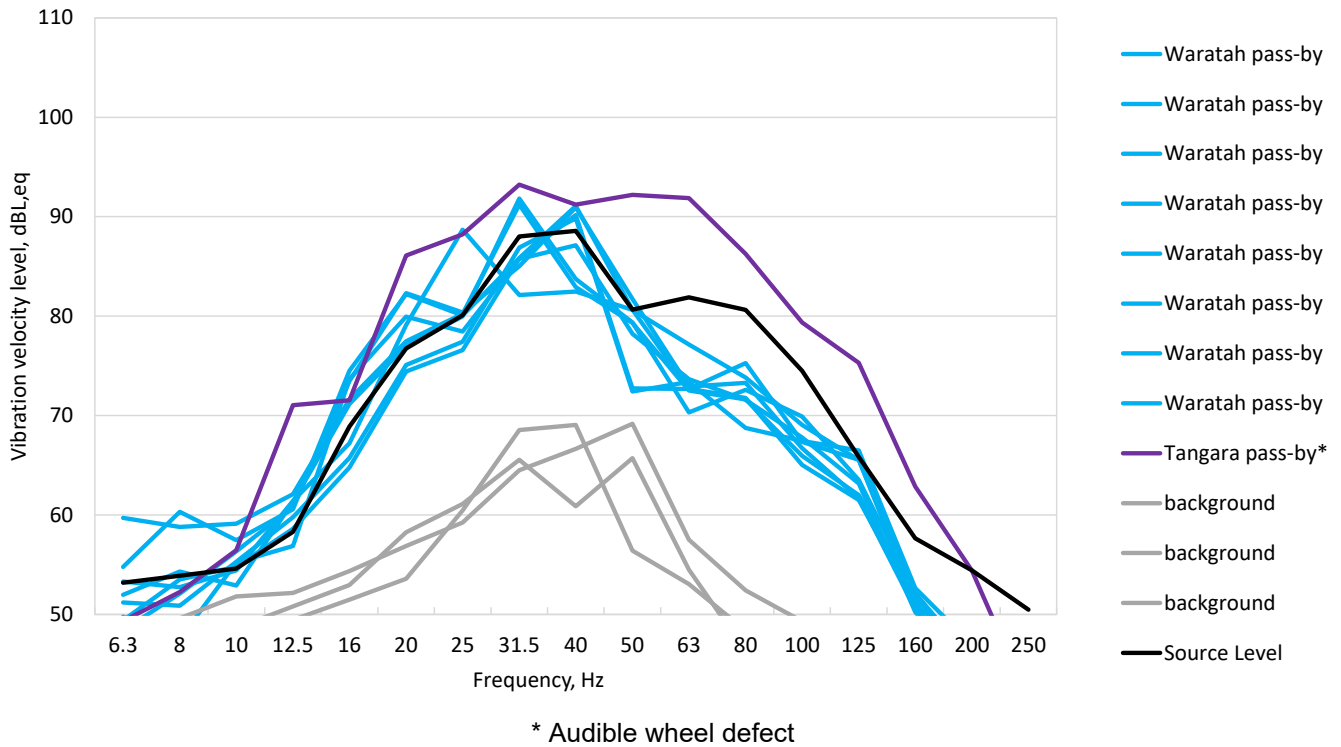


FIGURE 9: TRAIN PASS-BY MEASUREMENTS AT LOFTUS CRES, HOMEBUSH

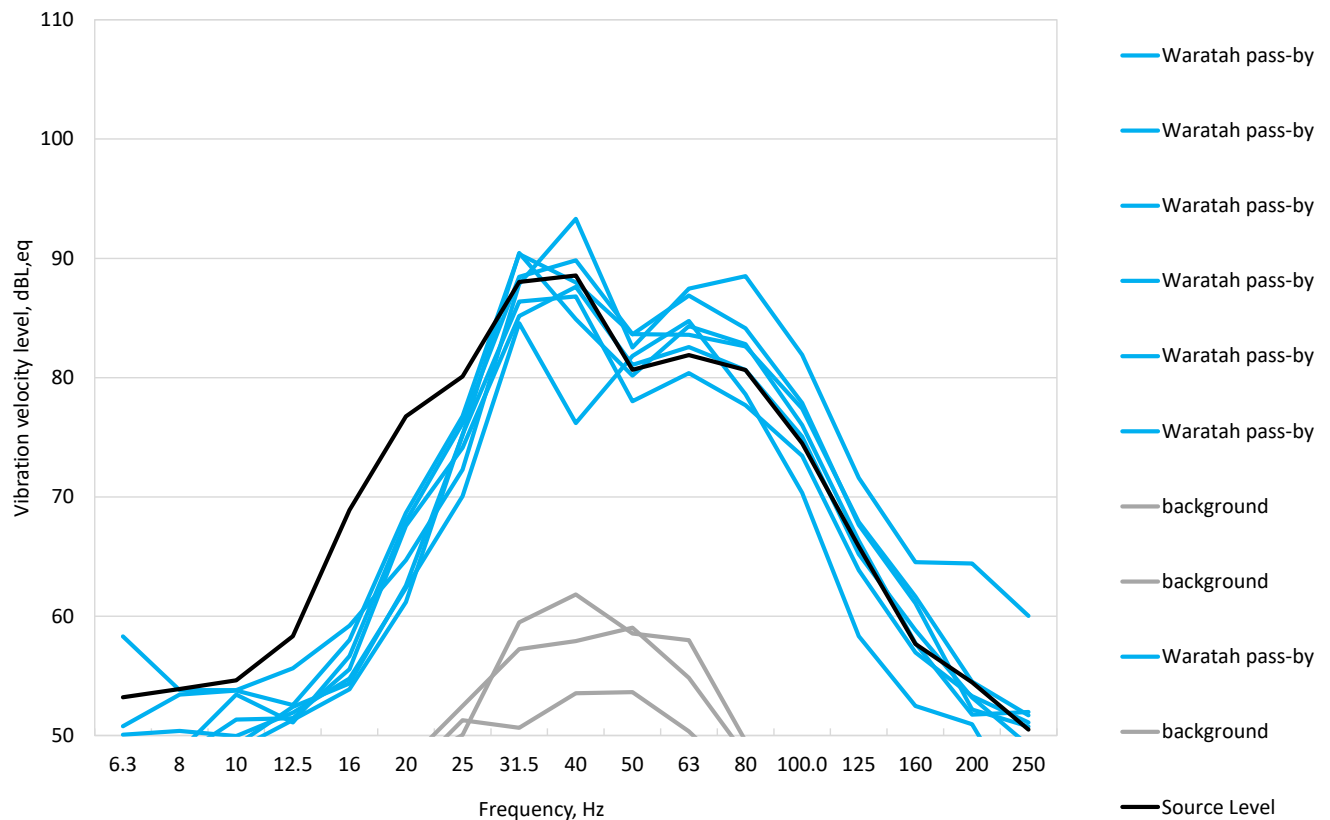


FIGURE 10: TRAIN PASS-BY MEASUREMENTS AT LEWISHAM STATION

The adopted reference source vibration level is shown in Figure 11 alongside reference source vibration levels adopted for other recent similar projects in Australia and overseas.

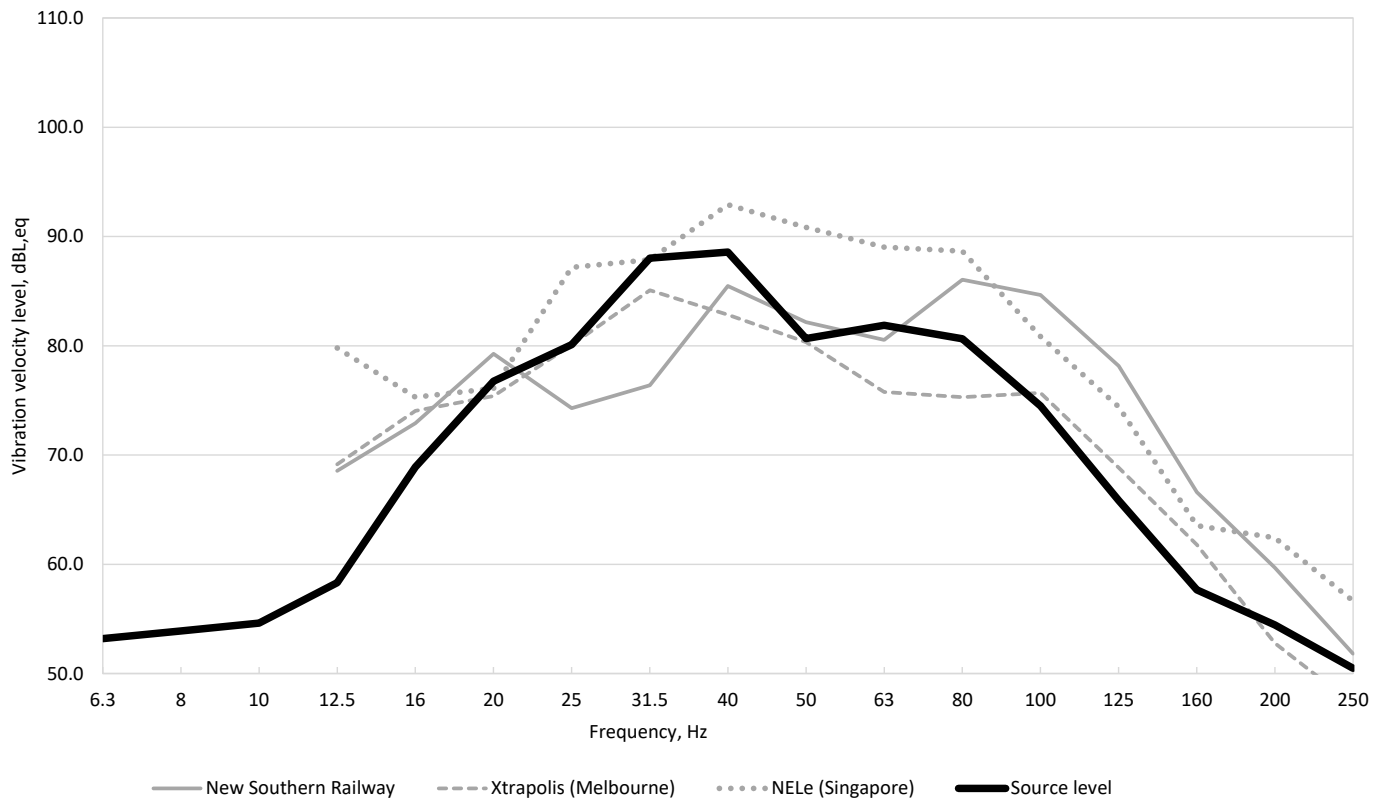


FIGURE 11: COMPARISON OF ADOPTED REFERENCE SOURCE LEVEL WITH VARIOUS MEASUREMENT LOCATIONS

It is acknowledged that the prediction uncertainty assessment should consider the mean of the train source vibration spectra and include the variation in measured levels to determine the appropriate expanded uncertainty.

7.2.2.2 Trackforms and insertion gains

An iterative assessment was undertaken to establish the trackform in terms of vibration isolation performance (insertion gain). The trackform and fastening systems specified for SM-WSA are presented in Table 49.

TABLE 49: TRACKFORM AND RAIL FASTENER SPECIFICATION

Location	Track type NV ID	Description
Tunnel	Type 2 – NV-B	Standard performance non-crossover track - Baseplate dynamic stiffness: 20 kN/mm - Maximum rail pad stiffness: 1000 kN/mm - Rail fasteners spaced at 700 mm centres¹ - Fibre-reinforced concrete slab with sleeper gauge holding device
	Type 4 – NV-C	Standard performance crossover - Tunnel crossover - Baseplate dynamic stiffness: 20 kN/mm. - Maximum rail pad stiffness: 1000 kN/mm - Rail fasteners spaced at 600 mm centres¹ - Fibre-reinforced concrete slab with temporary gauge holding device

Location	Track type NV ID	Description
	Type 2 – NV-D	High attenuation - Standard (non-crossover) track with softer trackform for improved GBNV performance - Baseplate dynamic stiffness: 8 kN/mm. - Maximum rail pad stiffness: 1000 kN/mm. - Rail fasteners spaced at 700 mm centres¹ - Fibre-reinforced concrete slab with sleeper gauge holding device
	Type 4 – NV-E	High attenuation crossover - Crossover track with softer trackform for improved GBNV performance - Baseplate dynamic stiffness: 10 kN/mm - Maximum rail pad stiffness: 1000 kN/mm - Rail fasteners spaced at 600 mm centres¹ - Fibre-reinforced concrete slab with temporary gauge holding device
	Type 3 – NV-F	Very High Attenuation IST - St Marys to Orchard Hills near Camira Street for increased GBNV performance. - Isolated Track Slab (IST) 300 mm, 2239 kg/m concrete slab 35 mm isolation mat with dynamic stiffness: 0.012 N/mm³ - Baseplate dynamic stiffness: 20 kN/mm at 700 mm spacing - Maximum rail pad stiffness: 1000 kN/mm - Fibre-reinforced concrete slab with standard sleeper gauge holding device
At-grade	Type 1 – NV-H	Standard track - Standard (non-crossover) track with maximum stiffness - Baseplate dynamic stiffness: 50 kN/mm dynamic stiffness - Maximum rail pad stiffness: 800 kN/mm - Rail fasteners spaced at 700 mm centres¹ - Reinforced concrete slab with bi-block gauge holding device
	Type 5 – NV-I	Crossover/Turnout - Crossover track with maximum stiffness. - Baseplate dynamic stiffness: 50 kN/mm dynamic stiffness - Maximum rail pad stiffness: 800 kN/mm. - Rail fasteners spaced at 600 mm centres¹ - Reinforced concrete slab with temporary gauge holding device
Viaduct	Type 1 – NV-J	Viaduct standard track - Standard (non-crossover) track with stiffness correlated to SCAW (Surface and Civil Alignment Works) interface parameters - Invert with direct fix rail fasteners - Baseplate type: fixed to viaduct block - Baseplate dynamic stiffness: 50 kN/mm - Maximum rail pad stiffness: 800 kN/mm - Rail fasteners spaced at 700 mm centres¹ - Reinforced concrete slab with bi-block gauge holding device

Note:

1. The noise and vibration assessment is based on a fixed spacing. It is noted that spacing may be locally adjusted to suit local obstructions.

For the standard fixed-nose crossover, amplification factors for the ground-borne vibration assessment have been based on Krüger, 2001 cited in the RIVAS Deliverable 3.6 [21], as presented in Table 50. Amplification relates to the predominant source, being the switch nose. However, as the report identifies that the nose is not the only source of potential amplification, the amplification has been assessed for the full length of the crossover for a conservative assessment.

The insertion gains of the tunnel and at-grade/viaduct track forms are shown below in Figure 12 and Figure 13, respectively.

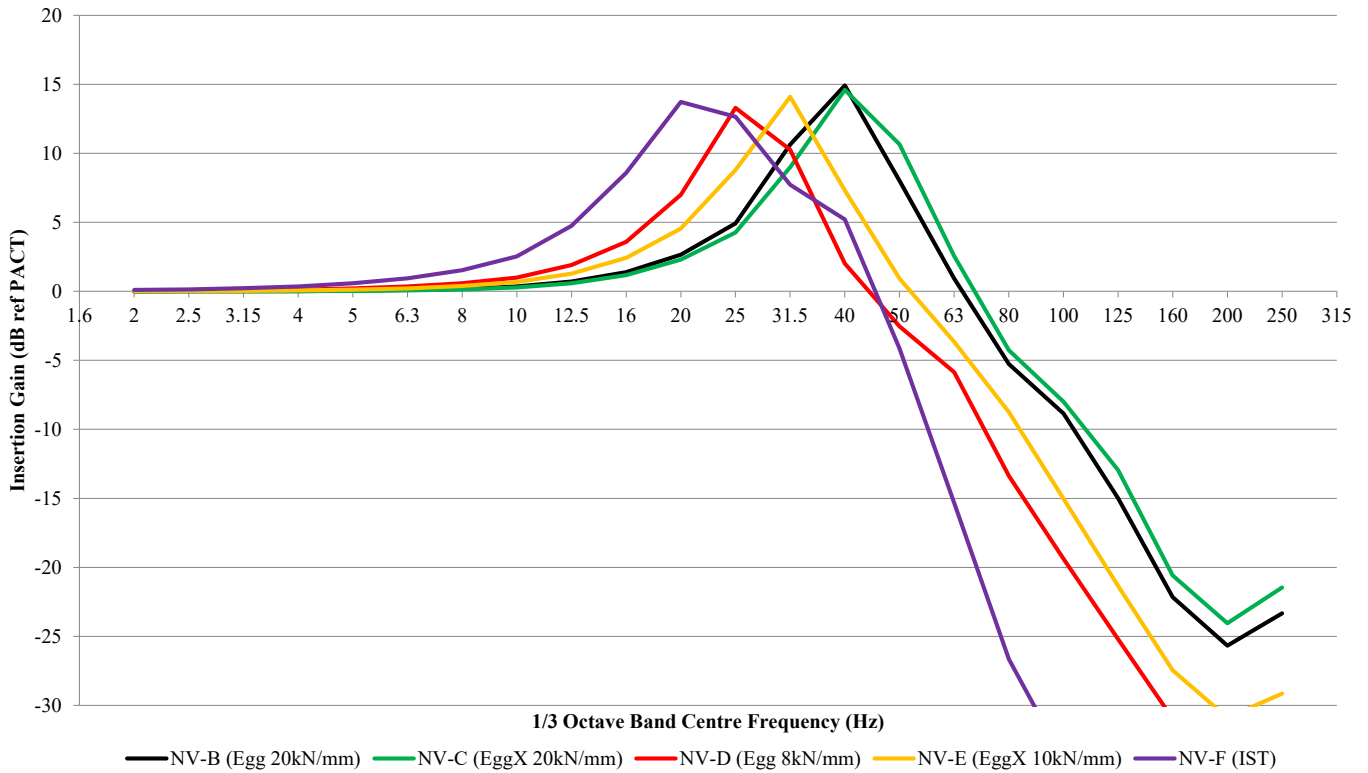


FIGURE 12: INSERTION GAIN FOR IN-TUNNEL TRACK FIXINGS, REFERENCE TO PACT

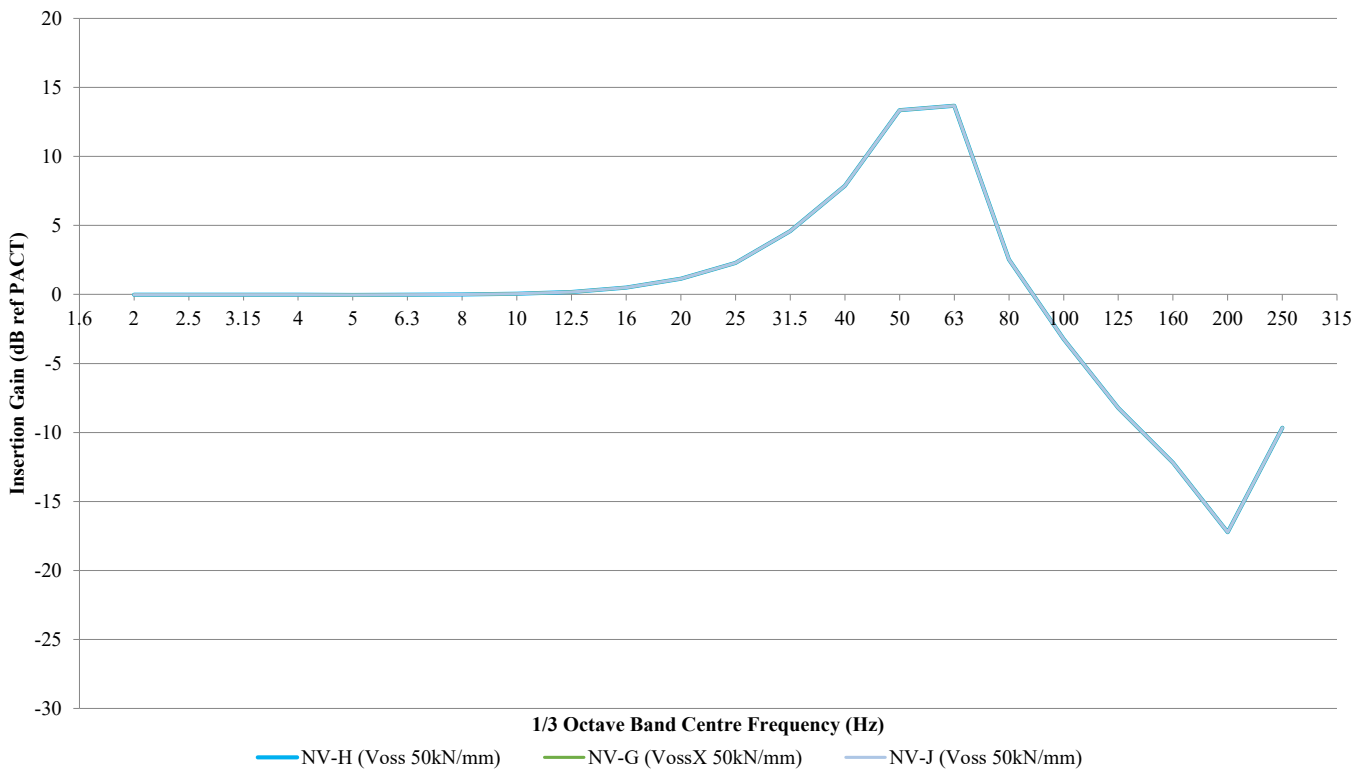


FIGURE 13: INSERTION GAIN FOR AT-GRADE AND VIADUCT TRACK FIXINGS, REFERENCE TO PACT

TABLE 50: ESTIMATION VALUES FOR TURN-OUT AMPLIFICATION AT 8 M FROM CENTRE LINE (KRÜGER, 2001 IN [21])

	Octave band centre frequency, Hz					
	8	16	31.5	63	125	250
dB	5	5	10	15	10	5
Factor	1.8	1.8	3.16	5.6	3.16	1.8

As the source of the turnout is point source, compared with the line source characteristics of the rolling stock, the influence of the turnout reduces at a greater rate by distance.

As the CTRL model is fundamentally a line source model, the correction based on perpendicular distance to the switch nose has followed the formula in Section 2.6.2 of the RIVAS report [21], being:

- $V_{\text{turnout}} = V_{\text{without turnout}} (1 + F \cdot (\text{TATurnout-amplification at 8 m} - 1))$
- Where: $F = 1 - d/50$, where d = perpendicular distance in metres.

Calculation of the distance correction has been based on the perpendicular distance to the track, rather than focus only on the switch nose.

7.2.3 Prediction uncertainties

An uncertainty analysis has been incorporated into the assessment to demonstrate compliance to 95% confidence level of probability of statistical uncertainty determined in accordance with ISO Guide 98-3 Uncertainty in Measurement: Guide to the Expression of Uncertainty in Measurement [22]. It will consider the following parameters listed in Table 51. The 5% (single-sided) exceedance has been calculated in general accordance with Karantonis & Weber 2016 [23].

TABLE 51: GROUND-BORNE NOISE AND VIBRATION UNCERTAINTY ANALYSIS

Parameter with associated uncertainty	Range of parameter		Half Range/ St.dev dB(A)	Distribution	Divisor	Uncertainty contribution	Uncertainty squared	Note
Min	Max							
Source parameters								
Vibration source level variation	Min	Max	5.3	Rectangular	1.73	3.1	9.4	Variation in source level.
Equipment resolution	-0.05 dB	0.05 dB	0.1	Rectangular	1.73	0.0	0.0	Resolution of equipment to 0.1 dB.
Measurement equipment uncertainty	-0.4 dB	0.4 dB	0.4	Normal	1	0.4	0.2	Accuracy of equipment.
Measured speed	-5 %	5 %	0.4	Rectangular	1.73	0.2	0.1	Accuracy of speed measurement for measured source vibration.
Rail roughness	Assumed		2.0	Rectangular	1.73	1.2	1.3	Assumed roughness variation of source term. Note PLM roughness is per ISO 3381.
Log.sum correction	-1 dB	0	0.5	Triangular	2.45	0.2	0	Logarithmic addition errors.
Combined source uncertainty						3.4 dB(A)		
Path parameters								
Train speed corrections	25 Log	35 Log	0.5	Rectangular	1.73	0.3	0.1	Variation in speed correction
Train speed variation	-5 %	0 %	0.3	Rectangular	1.73	0.2	0.0	Assumed variation in train speed on SSTOM.
Fastener correction	-2 dB	2 dB	2.0	Rectangular	1.73	1.2	1.3	Uncertainty in calculation of insertion gain (IG).
Stiffness variation	-15 %	15 %	1.4	Normal	1	1.4	2.0	Variation in actual stiffness of fastener from manufacturer
Frequency dependent dynamic stiffness	Frequency shift		2.0	Rectangular	1.73	1.2	1.3	Captures the dynamic stiffening of fastener at higher frequency (200 Hz).
Unsprung mass	1458	1807	1.0	Rectangular	1.73	0.5	0.3	Variation in unsprung mass between motor car and trailer car

Parameter with associated uncertainty	Range of parameter		Half Range/ St.dev dB(A)	Distribution	Divisor	Uncertainty contribution	Uncertainty squared	Note
	Min	Max						
Ground conditions	2 dB/10 m	1 dB/10 m	1.3	Rectangular	1.73	0.8	0.6	Variation in ground conditions
Attenuation	Method 1	Method 2	0.9	Rectangular	1.73	0.5	0.3	Variation in vibration attenuation.
Combined path uncertainty						2.4 dB(A)	-	-
Receiver parameters								
Distance calculation	-1 m	1 m	0.4	Rectangular	1.73	0.2	0.1	Uncertainty in receiver distance from alignment
Building coupling loss/amplification	-1.8 dB	1.8 dB	1.8	Normal	1	1.8	3.2	Uncertainty of building amplification
Conversion from Lv to Lp	-31 dB	-26 dB	2.5	Rectangular	1.73	1.4	2.1	Variation in Kurzweil correction
Resolution (nearest decimal place)	-0.5 dB	0.5 dB	0.5	Rectangular	1.73	0.3	0.1	Rounding of final result.
Combined receiver uncertainty						2.3 dB(A)		-
Total combined uncertainty						4.8 dB(A)		-
Total expanded uncertainty U95 k=1.64						7.9 dB(A)		-

7.2.4 Validation of model

Vibration prediction using the above methodology have been compared and validated against vibration measurements of existing Sydney Metro (SMNW and ECRL) lines carried out by Acoustic Studio [24].

Vibration measurements were carried out at various external ground surface locations (for both the up and down tracks) on 16 December 2022 as detailed in Table 52.

TABLE 52: LOCATION AND PARAMETERS OF VIBRATION MEASUREMENTS USED FOR VALIDATION OF SSTOM METHODOLOGY

Location	Approximate WGS84 coordinates	Track type (Dynamic stiffness kN/mm)	Depth of tunnel (m)	Rolling stock speed (km/h) ¹	No. of passbys
Castle Howard Road, Cheltenham	-33.761124 S, 151.071184 E	Delkor Eggs (7.8)	20	85	20 Up 20 Down
Fearnley Park, Beecroft	-33.750090 S, 151.055201 E	Delkor Eggs (7.8)	18	85	20 Up 20 Down
Lane Cove Valley Walk, Lane Cove	-33.792260 S, 151.156535 E	Delkor Eggs (12.5)	20	85	20 Up 20 Down
Barombah Road, Epping	-33.763332 S, 151.075141 E	Delkor Eggs (7.8)	25	85	19 Up 21 Down

Notes:

1. During the period of measurements, the line was operating at a restricted speed. It was understood that trains were operating at the maximum speed at all locations.

The CTRL methodology has been used to calculate the external vibration levels, based on the parameters above, for comparison with the measured vibration levels.

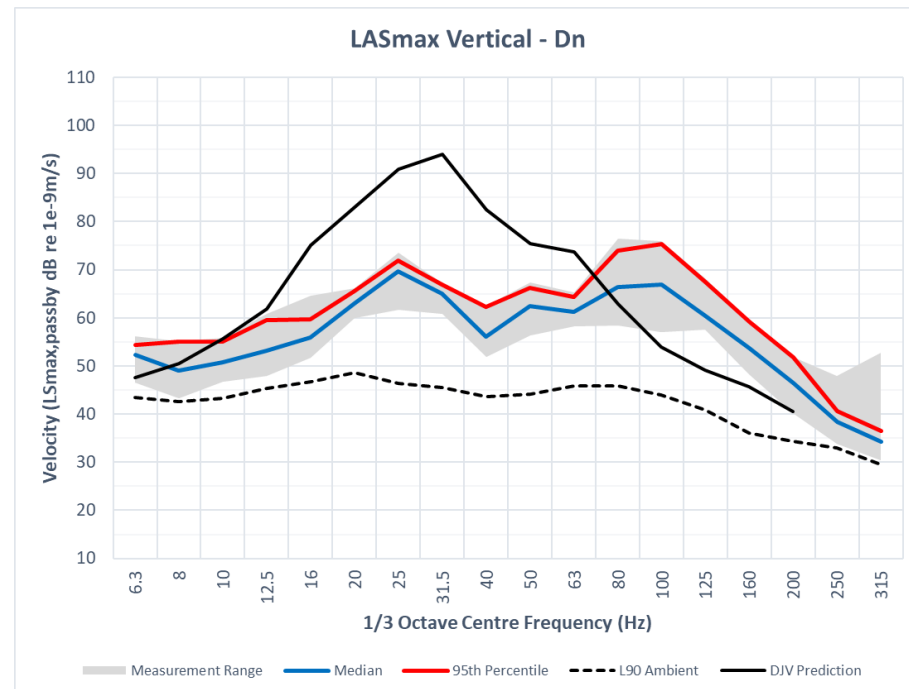
Additionally, an in-dwelling ground-borne noise level has been calculated for the measured vibration levels (following the procedures outlined above i.e. applying the building amplification and the vibration to ground-borne noise correction) for comparison against the CTRL method. The CTRL predictions include the 95% uncertainty factor as described in Section 7.2.3.

A comparison of the predicted $dB_{LASmax(95\% \text{ percentile})}$ vibration velocity and ground-borne noise level and the measured 95% vibration velocity and calculated ground-borne noise level from the measured data is presented below for each site.

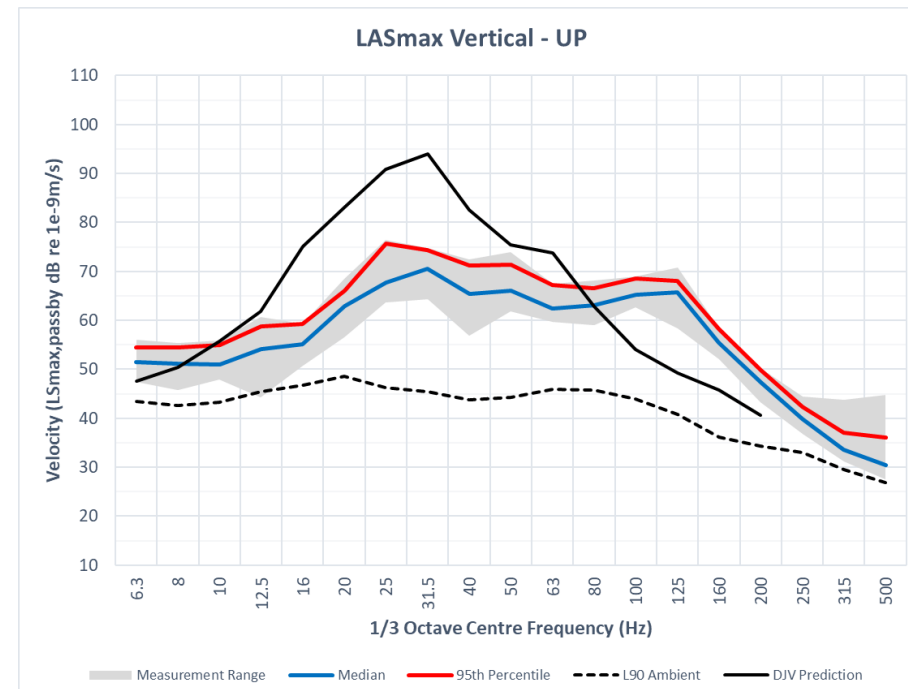
7.2.4.1 Castle Howard Road

Down

Vibration
level



Up



GBN

CTRL prediction

Predicted from measured data

41 dBLASMax

35 dBLASMax

CTRL prediction

Predicted from measured data

41 dBLASMax

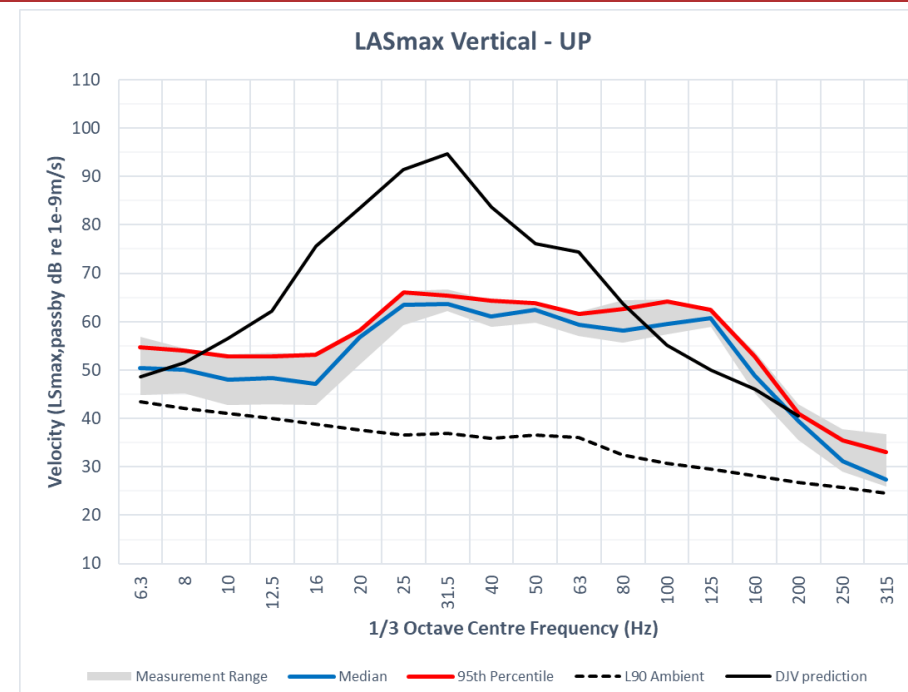
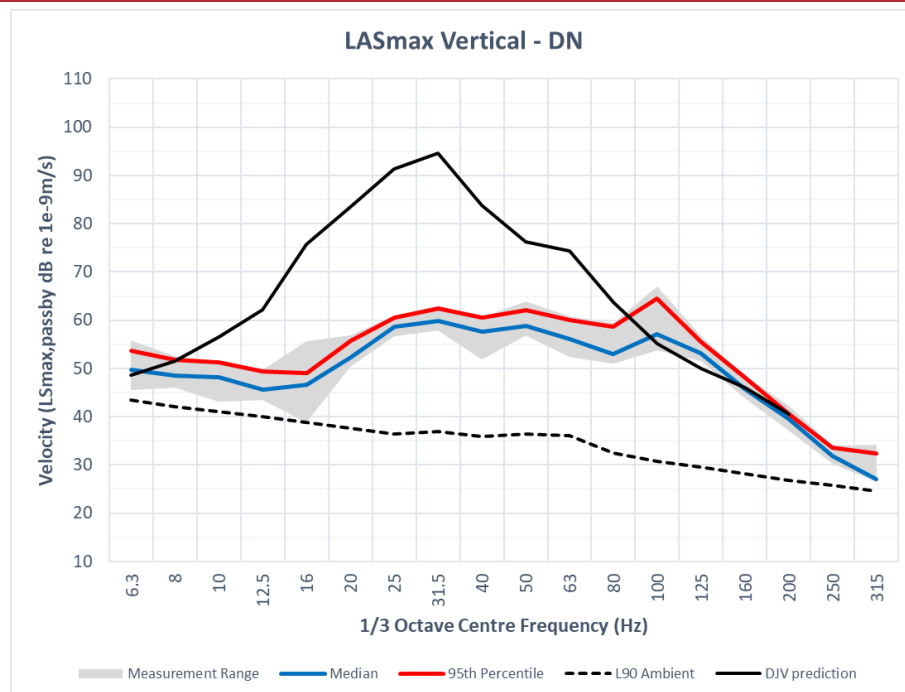
32 dBLASMax

7.2.4.2 Fearnley Park

Down

Up

Vibration



GBN

CTRL prediction

Predicted from measured data

41 dBLASMax

24 dBLASMax

CTRL prediction

Predicted from measured data

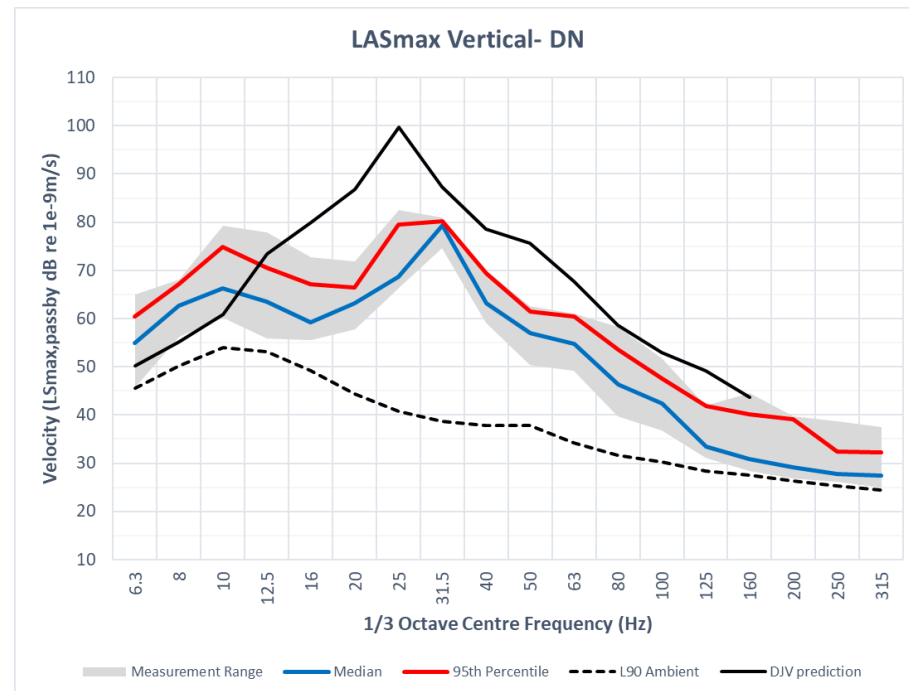
41 dBLASMax

26 dBLASMax

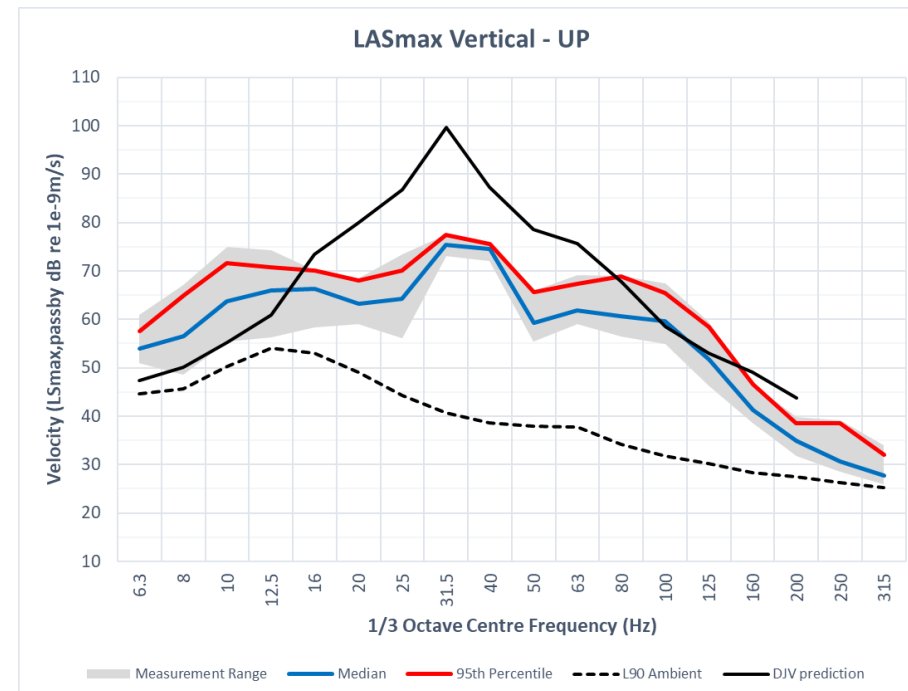
7.2.4.3 Lane Cove Valley

Down

Vibration



Up



GBN

CTRL prediction

Predicted from measured data

46 dBL_{ASMax}

31 dBL_{ASMax}

CTRL prediction

Predicted from measured data

46 dBL_{ASMax}

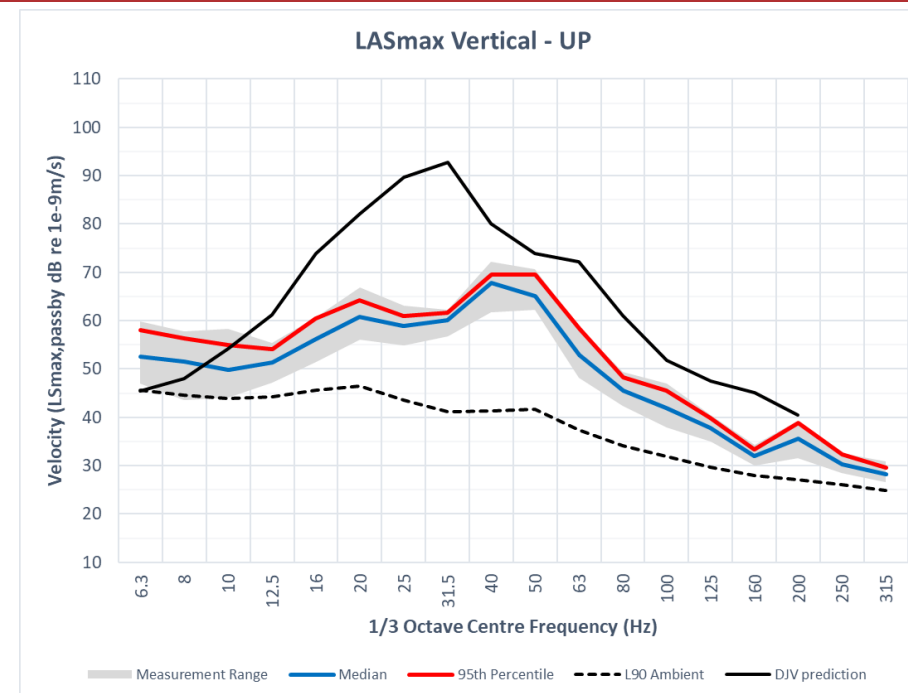
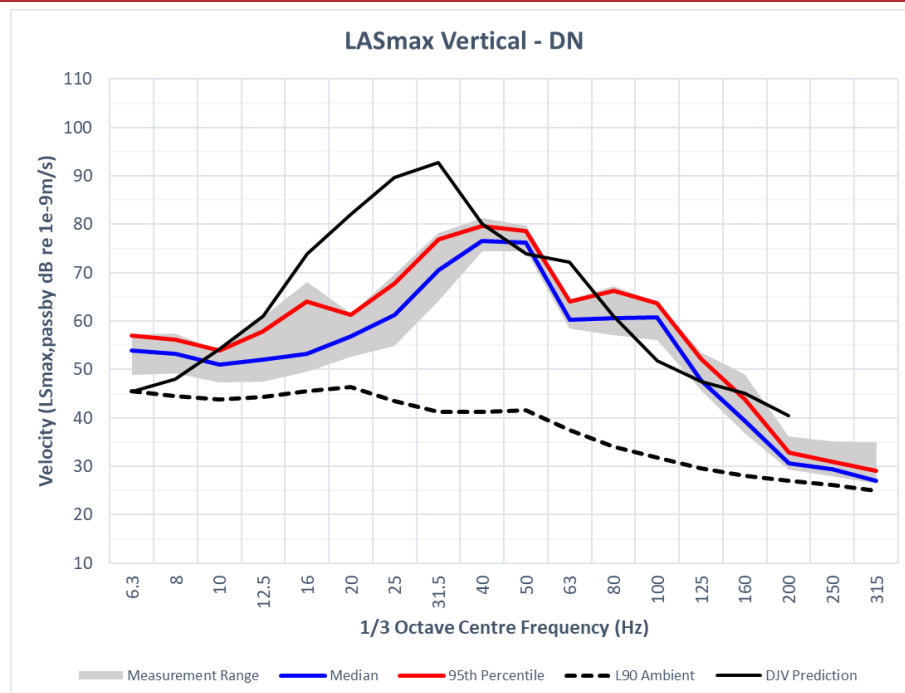
31 dBL_{ASMax}

7.2.4.4 Barombah Road

Down

Up

Vibration



GBN

CTRL prediction

Predicted from measured data

39 dBL_{ASMax}

25 dBL_{ASMax}

CTRL prediction

Predicted from measured data

39 dBL_{ASMax}

24 dBL_{ASMax}

7.2.4.5 Summary of validation

Based on the validation exercise completed, the modelling using the CTRL method overpredicts the ground-borne noise level, this is to be expected as it accounts for uncertainties in the modelling parameters. Removing the approximately 8 dB(A) uncertainty factor results in a slight overprediction of ground-borne noise levels for all but the Castle Howard Road Down direction measurements, for which a minor underprediction would occur.

The measured spectral shape differs at each of the measurements' locations. Some measurement locations show closer agreement between the predicted and measured vibration values. However, the modelling tends to overpredict vibration levels and as such the validation of the model is considered valid.

It is noted that the ground-borne noise drives the assessment and the selection of trackform. As such, priority has been given to the validation of the ground-borne noise component of the model.

7.2.5 Results

The CTRL ground-borne noise and vibration model, together with the predicted track insertion gains have been used to predict the ground-borne noise and vibration levels at all identified sensitive receivers. Figure 14 and Figure 15 present the worst-case exceedance level (predicted level minus criteria) for each receiver over the tunnels. The highest predicted level from the two tunnels has been used. The figures also indicate the trackform and key track features such as turnouts/crossovers. Detailed tabulated results of the predicted ground-borne noise and vibration levels are presented in Appendix J.1.



FIGURE 14: GROUND-BORNE NOISE ASSESSMENT EXCEEDANCE SUMMARY (DAY OR NIGHT) – TUNNEL STM TO OHE

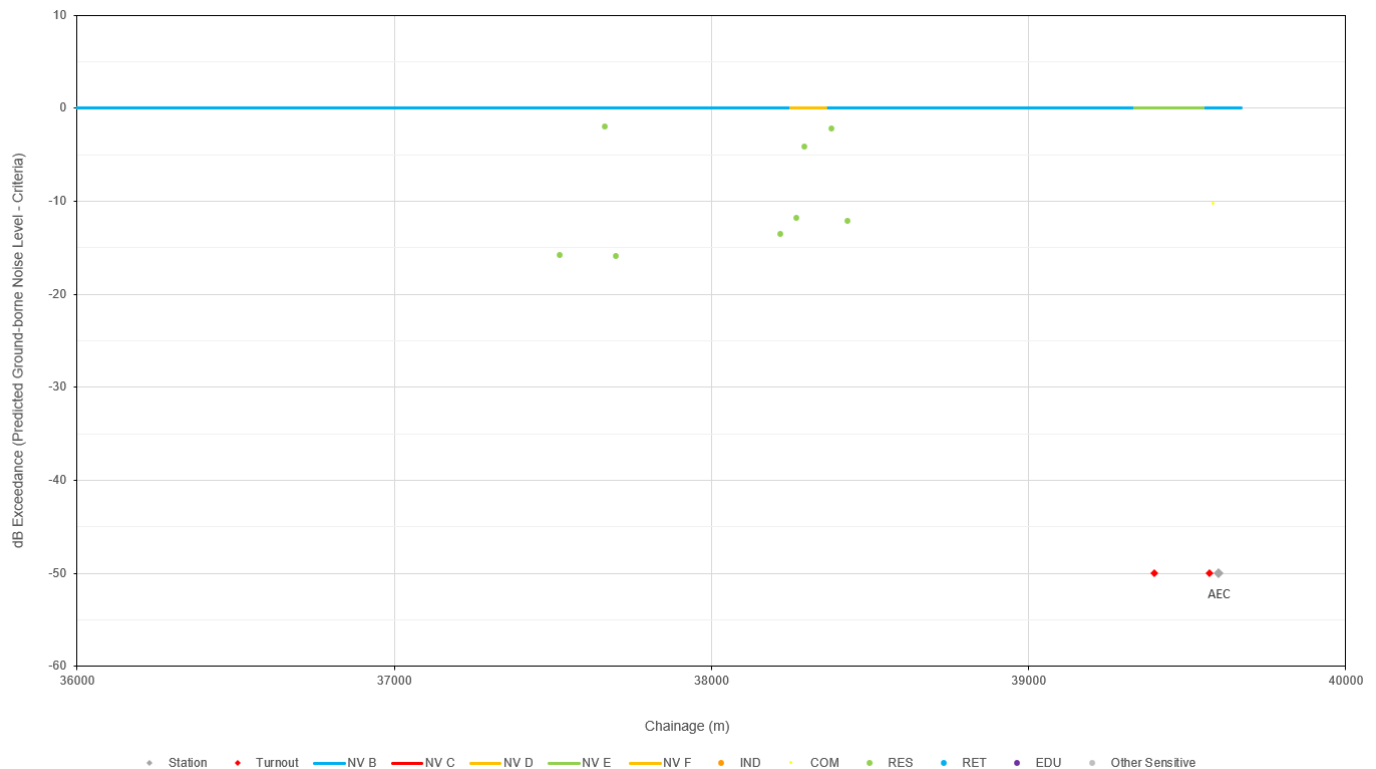


FIGURE 15: GROUND-BORNE NOISE ASSESSMENT EXCEEDANCE SUMMARY (DAY OR NIGHT) – TUNNEL AIRPORT BOUNDARY TO AEC

7.3 Airborne noise (above-ground corridor)

7.3.1 Methodology

Table 10 summarises the rail operational noise modelling methodology.

TABLE 53: SUMMARY OF OPERATIONAL RAIL NOISE MODELLING METHODOLOGY

Item	Detail
Noise modelling software	SoundPLAN 'Rail Noise Module' Version 8.1.
Noise model standard	Nord2000 [25]. Nord2000 was utilised to address other project requirements for 1/1 octave band predictions. Although not documented in this report, assessment was also carried using Kilde84 (Report 130) [26], being the more commonly adopted and validated model for rail projects in NSW. This revealed comparable results between the two methods. For the dBL_{Max} assessment the 'sophisticated calculation method' was utilised as the simplified method resulted in erroneous results as some receiver locations beyond the end of the alignment or partially shielded locations. It is noted that this method does not output octave band results.
Track alignment	The centre line of each track is used as the source object in the noise model.
Train source height	The source object in SoundPLAN is equal to the top-of-rail height. The default source heights in NORD2000 were used for the rail/rolling stock noise component with source noise distributed at 0.01 m, 0.35 m and 0.7 m. The viaduct/bridge structureborne noise was modelled from a height of 0.01 m from the rail centre line string.
Train source levels	The source levels adopted in the noise modelling are shown in Table 55.
Train movements	Train movements are based on the timetable summarised in Table 54.

Item	Detail																				
Train speeds	The speed profile used in this assessment is based on the Headway Simulation Report which is summarised in Section 7.3.2.2.																				
Rail surface discontinuities	No correction applied. Assumed that insulated joints and welded joints are well maintained.																				
Rail roughness	Rail roughness levels based on the levels presented in ISO 3095 and ISO 3381 in accordance with the project design requirements.																				
Turnouts and crossovers	At track locations with turnouts, 6 dB is added to the dB_{LAmax} and L_{AE} reference noise levels over a track length of 20 m: 10 m before to 10 m after the point. The turnout locations are identified on the track diagrams and summarised below: <table> <tr> <th>Up</th><th>Down</th></tr> <tr> <td>23690</td><td>23822</td></tr> <tr> <td>-</td><td>23855</td></tr> <tr> <td>-</td><td>23930</td></tr> <tr> <td>-</td><td>24912</td></tr> <tr> <td>-</td><td>24992</td></tr> <tr> <td>25158</td><td>25024</td></tr> <tr> <td>26200</td><td>26332</td></tr> <tr> <td>33277</td><td>33284</td></tr> <tr> <td>33453</td><td>33460</td></tr> </table>	Up	Down	23690	23822	-	23855	-	23930	-	24912	-	24992	25158	25024	26200	26332	33277	33284	33453	33460
Up	Down																				
23690	23822																				
-	23855																				
-	23930																				
-	24912																				
-	24992																				
25158	25024																				
26200	26332																				
33277	33284																				
33453	33460																				
Curves	Standard corrections for curves are outlined below: - Curves < 300 m radius: + 8 dB (dB_{LAe} and dB_{LAmax}) - Curves $\geq$ 300 m and < 500 m radius: + 3 dB (dB_{LAe} and dB_{LAmax}) There are no curves along the alignment requiring correction.																				
Viaducts and bridges	For the airborne noise model, a bridge profile is applied to the line source object consistent with the SCAW design. A separate noise model scenario has been run for the structureborne noise component, with the source emanating from the rail centre line for each direction. The bridge profile is removed from this model. The airborne and structure-radiated noise levels were calculated separately and added logarithmically to obtain the overall $dB_{LAeq(Period)}$ and $dB_{LAFmax,95\%}$ noise levels. Refer to Section 7.3.2.4 for more information.																				
Portal dive structures	The portal dive structures at OHE and ABP are included as ground topography with dimensions based on the FIW SBT models dated 2023 January. The top of the dive structures is modelled with floating screen.																				
Noise barriers	None included.																				
Buildings	In accordance with design files dated 04/08/2023. Refer to Section 3 Land Use Assessment Station buildings are excluded from the noise model. This results in conservative predictions near stations.																				
Receiver locations	1 m from the façade and 1.5 m above floor level of each receiver building for each relevant floor level. For receivers assessed against the RING, the façade reflection is calculated by NORD2000, based on a building reflection loss of 1 dB.																				
Ground topography	Topographic data provided by the project's design team have been used for in-corridor at grade section of track. 1 m contours have been used for receptor areas up to 600 m on either side of the																				

Item	Detail
	corridor and below viaduct structures. SoundPLAN triangulates the data to create a Digital Ground Model (DGM).
Ground absorption	The validation model for wayside (7.5 m from rail line) and viaduct/bridges structure borne noise was based on an effective flow resistivity category G (hard surface (mostly normal asphalt, concrete), 20,000 kNs/m⁴) and roughness class small (+/- 0.5 m). The SCAW modelling report specifically notes that the modelling includes a reflection from the ground. The assessment model has adopted an effective flow resistivity category a E (compacted field and gravel (compacted lawns, park area), 500 kNs/m⁴) and roughness medium (+/- 1 m).
Weather	In accordance with the RING [5], weather was set to no wind, 15°C, 70% relative humidity.
Reflections from existing barriers, structures & cuttings on opposite side	Includes evaluation of bridge parapets and retaining walls. Parapet walls are modelled as reflective with a 0.1 absorption coefficient.
Allowances for modelling uncertainties	Airborne noise modelling: + 2 dB for source noise levels based on RST parameters. An additional + 3 dB has been added to the airborne noise modelling results to account for potential uncertainties with the prediction model. Structure borne noise: + 3 dB has been added to the SCAW predictions. This results in a noise contribution equal to the specification for the highest emitting structure.

7.3.2 Inputs

7.3.2.1 Train movements

Train movements for Day 1 operations are adopted as Timeframe 1 in accordance with the RING [5]. For Timeframe 2, the RING states that a scenario sometime in the future is to be adopted, e.g. 10 years after operating. Timeframe 2 has been based on Ultimate Service in accordance with SSI-10051. The scenarios are summarised in Table 54.

Comparison of the day and night movements and by reference to the relevant RING $dB_{L_{Aeq,period}}$ trigger levels, the night period will determine noise mitigation requirements for residential receivers, while the day period will determine other receivers where day/night criteria do not apply.

TABLE 54: TRAIN MOVEMENTS

Item	Scenario	
	Day 1 (Timeframe 1)	Ultimate service (Timeframe 2)
No. of carriages	3-car	4-car
Peak headway	5 mins	3 mins
Off-peak headway	10 mins	6 mins
Day volume (7 am to 10 pm) – one way	120	200
Day volume (peak hour) – one way	12	20
Night volume (10 pm to 7 am) – one way	33	55

7.3.2.2 Train speed profile

Train speeds across the alignment are summarised in the train speed plot in Figure 16. The speed profile, has been established based on the following:

- Maximum speed of 100 km/h;
- Acceleration of 1.2 m/s² when leaving platforms, and;
- Deceleration of 0.85 m/s² when entering platforms.

- Station entry and exit speeds not to exceed 40 km/h. A constant speed of 40 km/h has been used.

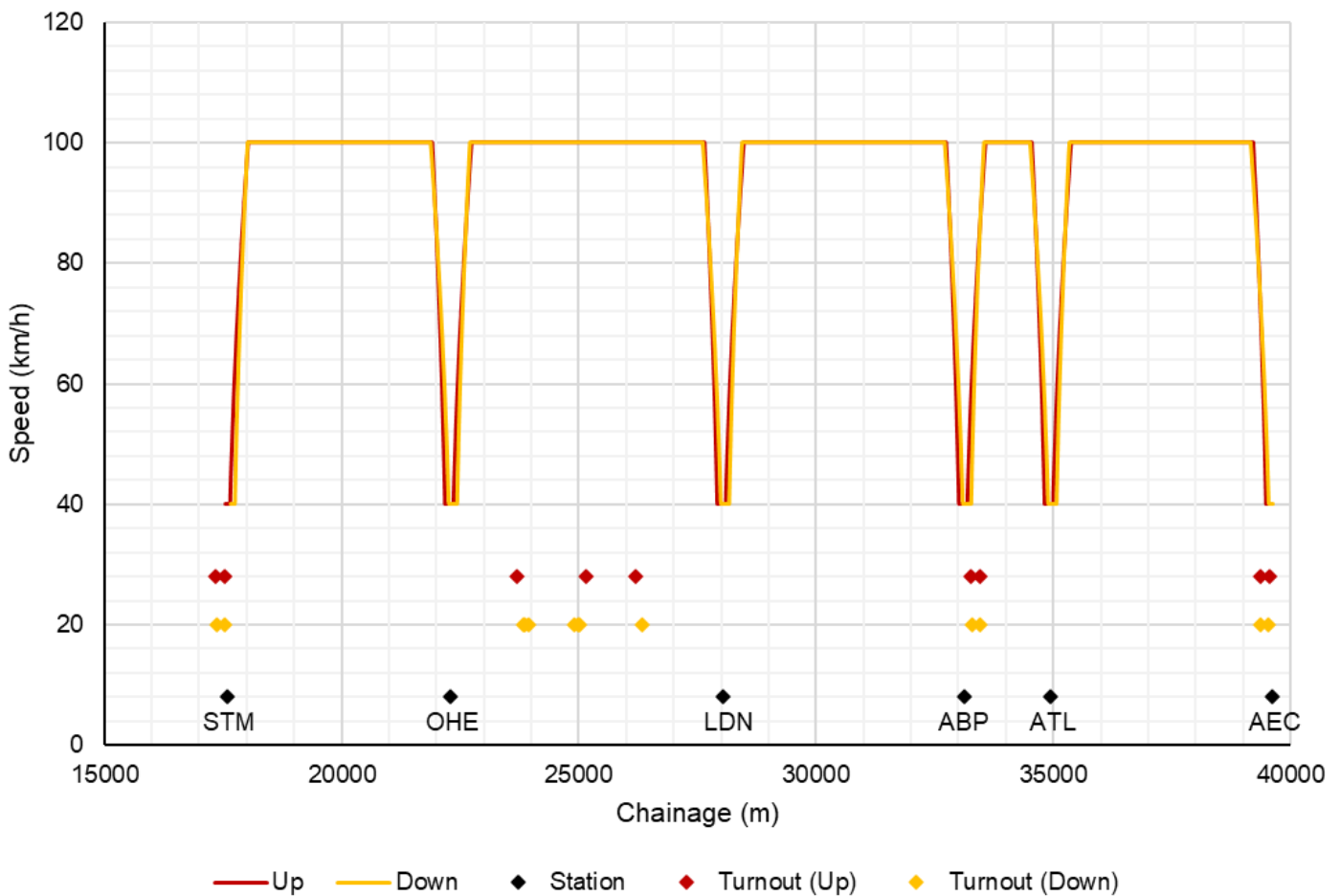


FIGURE 16: TRAIN SPEED PLOT FOR ALIGNMENT

7.3.2.3 Train and trackform noise levels

Broadband and octave band $dBL_{Aeq,tp}$ passby noise levels for the Siemens train have been provided. The $dBL_{Amax,95\%}$ and dBL_{AE} parameters have been estimated to allow assessment against the project requirements. The $dBL_{Amax,95\%}$ noise levels are taken to be 3.5 dB higher than the $dBL_{Aeq,tp}$ noise levels, consistent with the difference observed from reference measurements undertaken for the SSTOM concept design. The dBL_{AE} has been estimated based on the 3-car set passby time including an addition 0.5 seconds to account for the 10 dB down points. The dBL_{AE} for the 4-car set has been estimated from the 3-car set $dBL_{AE} + 10 \cdot \log(4/3)$. A summary of the source noise levels used in the noise modelling is provided in Table 55.

TABLE 55: REFERENCE ROLLING STOCK NOISE LEVELS AT 7.5 M FROM TRACK CENTRE, 100 KM/H

Track characteristics	$dBL_{Aeq,tp}$	$dBL_{Amax,95\%}$	dBL_{AE} (3-car)	dBL_{AE} (4-car)
Slab track	84.7	88.2	89.3	90.6
Rail roughness at ISO 3095 / ISO 3381 limits.				
TDR: Vossloh 300 45 MN/mm dynamic stiffness without rail dampers.				
+ 2 dB contingency.				
As above with rail dampers.	82.7	86.2	87.3	88.6

7.3.2.4 Structure radiated noise

Table 56 sets out the reference structure-borne noise levels for viaduct and bridge structures which were calculated using the NORBERT (Noise of Railway Bridges and Elevated Structures) model, produced by the Institute of Sound and Vibration Research (ISVR) at University of Southampton, UK. A 3 dB contingency has been added to the structure-borne noise predictions (see Table 57).

TABLE 56: STRUCTURE RADIATED NOISE AT 15 M FROM TRACK CENTRE, 100 KM/H

Bridge	Source / track characteristics	dBL _{Amax,95%}
Viaduct	80 m source length, 2 m above the ground Fasteners: 50 kN/mm @ 700 mm spacing Rail roughness: ISO 3381/3095 15 m from source centre line, 1.5 m above the ground. Hard ground	68.2
M12 Bridge	As above but with source 3 m above the ground.	71.2
WSI Bridge	As above but with 21.6 m source length.	68.4
Project specification	SSTOM Viaduct structure-borne noise level	74

7.3.3 Validation

The source data outlined in Section 7.3.2.3 and 7.3.2.4 above has been validated in SoundPLAN in one-third octaves as presented in Table 57 below.

For the validation of bridge and viaduct sources, the 3 dB contingency has been added. The NORD2000 'a' constant was set to 20 as is typical for the noise vs speed relationship for structure radiated noise. It is noted however that the operational speed for all viaduct/bridges is 100 km/h except for Luddenham station. The 'b' constants were established so that the model equated to the lowest noise level of either the dBL_{eq} or dBL_{Max}. As NORD2000 utilises the same constants for the dBL_{eq} and dBL_{Max} calculations, the established model is slightly conservative the other parameter. The 1/3 octave frequency range was limited to 50 Hz to 2.5 kHz as other frequency did not contribute and were not calculated consistently within the model.

For the validation of the rolling stock airborne noise, the NORD2000 'a' constant was set to 30, based on advice from Siemens and being the typical noise vs speed relationship for wheel/rail noise. The 'b' constants were established for the dBL_{eq} noise levels. The resultant dBL_{Max} noise levels are 2.1-2.2 dB below the reference noise levels. This difference has been added to the predicted noise levels at receivers. 1/3 octave data for input to NORD2000 was interpolated based on the 1/1 octave data.

TABLE 57: SOUNDPLAN TRAIN NOISE SOURCE VALIDATION

Item / description	Broadband dB(A)	1/3 Octave band centre frequency, Hz, dB																				
		50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k
Viaduct																						
dB _{L_w}	84.7	92.1	90.8	84.3	79.2	76.1	82.0	85.8	84.4	83.4	82.2	81.2	76.8	72.1	64.6	56.5	47.8	39.3	31.2	-	-	-
Predicted dB _{L_p} @ 15 m dB _{L_{max}} = dB _{L_{Aeq}} , tp	68.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scaled spectra dB _{L_p} @ 15 m, with + 3 dB contingency	71.2	78.6	77.3	70.8	65.7	62.6	68.5	72.3	70.9	69.9	68.7	67.7	63.3	58.6	51.1	43.0	34.3	25.8	17.7	-	-	-
dB _{L_{AE}} @ 15m (80 m length)	76.7	84.0	82.7	76.2	71.1	68.0	73.9	77.7	76.3	75.3	74.1	73.1	68.7	64.0	56.5	48.4	39.7	31.2	23.1	-	-	-
dB _{L_{eq}} , 1hr (1 train per hour) @15 m	41.1	48.4	47.1	40.6	35.5	32.4	38.3	42.1	40.7	39.7	38.5	37.5	33.1	28.4	20.9	12.8	4.1	-4.4	-12.5	-	-	-
Nord2000 constant a		20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	-	-	-
Nord2000 constant b		92.0	90.9	84.8	80.2	77.9	85.0	90.6	90.5	88.6	85.3	83.3	79.4	75.1	67.4	59.4	50.7	42.3	34.3	-	-	-
SoundPLAN – dB _{L_{eq}}	41.0	48.4	47.1	40.6	35.5	32.4	38.3	42.1	40.7	39.7	38.5	37.5	33.1	28.4	20.9	12.8	4.1	-4.4	-12.5	-	-	-
SoundPLAN – dB _{L_{max}}	71.8	79.4	78.0	71.6	66.4	63.2	68.8	72.2	70.4	70.1	69.5	68.7	64.3	59.5	52.0	44.0	35.3	26.7	18.7	-	-	-
dB _{L_{eq}} difference	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
dB _{L_{max}} difference	0.6	0.8	0.7	0.8	0.7	0.6	0.3	-0.1	-0.5	0.2	0.8	1.0	1.0	0.9	0.9	1.0	1.0	0.9	1.0	-	-	-
M12 Bridge																						
dB _{L_w}	84.8 (A)	98.4	98.6	91.2	86.3	82.3	79.6	84.3	85.0	83.4	81.7	80.5	75.8	71.4	63.7	55.3	46.8	38.7	30.4	-	-	-
Predicted dB _{L_p} @ 15 m dB _{L_{max}} = dB _{L_{Aeq}} , tp	71.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scaled spectra dB _{L_p} @ 15 m, with + 3 dB contingency	74.2	87.8	88.0	80.6	75.7	71.7	69.0	73.7	74.4	72.8	71.1	69.9	65.2	60.8	53.1	44.7	36.2	28.1	19.8	-	-	-
dB _{L_{AE}} @ 15m (80 m length)	79.6	93.2	93.4	86.0	81.1	77.1	74.4	79.1	79.8	78.2	76.5	75.3	70.6	66.2	58.5	50.1	41.6	33.5	25.2	-	-	-
dB _{L_{eq}} , 1hr (1 train per hour) @15 m	44.0	57.6	57.8	50.4	45.5	41.5	38.8	43.5	44.2	42.6	40.9	39.7	35.0	30.6	22.9	14.5	6.0	-2.1	-10.4	-	-	-
Nord2000 constant a	-	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	-	-	-
Nord2000 constant b	-	101.6	102.2	95.4	91.4	88.9	88.1	93.8	92.6	88.9	86.7	86.4	81.7	77.1	69.5	61.2	52.7	44.6	36.4	-	-	-
SoundPLAN – dB _{L_{eq}}	44.0	57.6	57.8	50.4	45.5	41.5	38.8	43.5	44.2	42.6	40.9	39.7	35.0	30.6	22.9	14.5	6.0	-2.1	-10.4	-	-	-
SoundPLAN – dB _{L_{max}}	74.9	88.5	88.7	81.2	76.1	71.8	68.5	73.2	74.8	73.8	72.2	70.9	66.1	61.7	54.0	45.7	37.1	29.0	20.7	-	-	-
dB _{L_{eq}} difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
dB _{L_{max}} difference	0.7	0.7	0.7	0.6	0.4	0.1	-0.5	-0.5	0.4	1.0	1.1	1.0	0.9	0.9	0.9	1.0	0.9	0.9	0.9	-	-	-
WSI Bridge																						
dB _{L_w}	84.8	97.8	98.4	89.8	86.5	82.4	79.3	84.4	85.2	83.5	81.9	80.4	76.3	71.1	64.0	55.5	47.2	38.8	31.1	-	-	-
Predicted L _p @ 15 m dB _{L_{max}} = dB _{L_{Aeq}} , tp	68.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scaled spectra dB _{L_p} @ 15 m, with + 3 dB contingency	71.4	84.4	85.0	76.4	73.1	69.0	65.9	71.0	71.8	70.1	68.5	67.0	62.9	57.7	50.6	42.1	33.8	25.4	17.7	-	-	-
dB _{L_{AE}} @ 15m (21.6 m length)	71.2	84.1	84.7	76.1	72.8	68.7	65.6	70.7	71.5	69.8	68.2	66.7	62.6	57.4	50.3	41.8	33.5	25.1	17.4	-	-	-
dB _{L_{eq}} , 1hr (1 train per hour) @15 m	35.6	48.6	49.2	40.6	37.3	33.2	30.1	35.2	36.0	34.3	32.7	31.2	27.1	21.9	14.8	6.3	-2.0	-10.4	-18.1	-	-	-
Nord2000 constant a	-	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	-	-	-
Nord2000 constant b	-	99.8	100.9	93.2	91.3	89.5	89.8	94.5	90.9	86.6	85.0	85.2	80.7	75.3	68.3	59.9	51.6	43.2	35.6	-	-	-
SoundPLAN – dB _{L_{eq}}	37.0	50.1	50.8	42.5	39.7	36.4	34.8	38.6	36.8	34.7	33.5	32.8	28.3	23.1	16.0	7.6	-0.8	-9.2	-16.9	-	-	-
SoundPLAN – dB _{L_{max}}	71.4	84.4	85.0	76.4	73.1	69.0	65.9	71.0	71.8	70.1	68.5	67.0	62.9	57.7	50.6	42.1	33.8	25.4	17.7	-	-	-
dB _{L_{eq}} difference	1.4	1.5	1.6	1.9	2.4	3.2	4.7	3.4	0.8	0.4	0.8	1.6	1.2	1.2	1.2	1.3	1.2	1.2	1.2	-	-	-
dB _{L_{max}} difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Wayside - with dampers																						
1/1 dB _{L_{p(z)}} @ 7.5 m with 2 dB contingency	82.7	-	-	-	-	78.8	-	-	80.6	-	-	77.9	-	-	76.8	-	-	76.5	-	-	73.8	-
1/3 dB _{L_{p(z)}} @ 7.5 m – Interpolated from 1/1	82.7	-	-	-	73.4	74.0	74.6	75.7	76.3	75.4	73.8	72.9	72.6	72.3	71.9	71.8	72.1	72.0	71.1	69.9	69.0	68.1
dB _{L_{Max}}	86.2	-	-	-	77.0	77.6	78.2	79.3	79.9	79.0	77.4	76.5	76.2	75.9	75.5	75.4	75.7	75.6	74.7	73.5	72.6	71.7

Item / description	Broadband dB(A)	1/3 Octave band centre frequency, Hz, dB																				
		50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k
dB_{LAE} @ 7.5 m – 3-car set	87.4	-	-	-	78.1	78.7	79.3	80.5	81.1	80.2	78.6	77.7	77.3	77.0	76.7	76.6	76.8	76.7	75.8	74.6	73.7	72.8
dB_{Leq, 1hr} (1 train per hour)	51.8	-	-	-	42.6	43.2	43.8	44.9	45.5	44.6	43.0	42.1	41.7	41.5	41.1	41.0	41.3	41.2	40.3	39.0	38.1	37.2
Nord2000 constant a	-	-	-	-	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Nord2000 constant b	-	-	-	-	85.7	87.3	89.1	91.3	91.7	89.7	87.3	86.4	86.1	85.9	85.6	85.5	85.8	85.7	84.9	83.7	83.0	82.2
SoundPLAN – dB_L_{eq}	51.8	-	-	-	42.6	43.2	43.8	44.9	45.5	44.6	43.0	42.1	41.7	41.5	41.2	41.1	41.3	41.2	40.3	39.1	38.2	37.3
SoundPLAN – dB_L_{max}	84.1	-	-	-	74.6	75.1	75.5	76.7	77.5	76.7	75.1	74.3	74.0	73.7	73.5	73.3	73.6	73.5	72.6	71.3	70.5	69.6
dB_L_{eq} difference	0.0	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
dB_L_{max} difference	-2.1	-	-	-	-2.4	-2.5	-2.7	-2.6	-2.4	-2.3	-2.3	-2.2	-2.2	-2.2	-2.0	-2.1	-2.1	-2.1	-2.1	-2.2	-2.1	-2.1
Wayside - no dampers																						
1/1 dB_L_{p(z)} @ 7.5 m with 2 dB contingency	84.7	-	-	-	-	79.1	-	-	81.7	-	-	83.0	-	-	78.9	-	-	77.2	-	-	73.9	-
1/3 L_{p(z)} @ 7.5 m – Interpolated from 1/1	84.7	-	-	-	73.4	74.3	75.1	76.2	77.0	77.5	78.4	78.8	77.4	75.2	73.8	73.2	73.1	72.6	71.5	70.1	69.0	67.9
dB_L_{Max}	88.2	-	-	-	76.9	77.8	78.7	79.7	80.6	81.0	81.9	82.3	80.9	78.7	77.3	76.7	76.6	76.1	75.0	73.7	72.6	71.5
dB_{LAE} @ 7.5 m – 3-car set	89.3	-	-	-	78.0	78.9	79.8	80.8	81.7	82.1	83.0	83.4	82.1	79.8	78.4	77.9	77.8	77.2	76.1	74.8	73.7	72.6
dB_{Leq, 1hr} (1 train per hour)	53.8	-	-	-	42.5	43.4	44.2	45.3	46.1	46.6	47.4	47.9	46.5	44.2	42.9	42.3	42.2	41.6	40.5	39.2	38.1	37.0
Nord2000 constant a	-	-	-	-	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Nord2000 constant b	-	-	-	-	85.6	87.5	89.5	91.7	92.3	91.7	91.7	92.1	90.9	88.6	87.3	86.7	86.7	86.1	85.1	83.8	82.9	81.9
SoundPLAN – dB_L_{eq}	53.7	-	-	-	42.5	43.4	44.2	45.3	46.1	46.6	47.4	47.8	46.5	44.2	42.9	42.3	42.2	41.6	40.5	39.2	38.1	37.0
SoundPLAN – dB_L_{max}	86.0	-	-	-	74.5	75.3	75.9	77.1	78.1	78.7	79.5	80.0	78.8	76.4	75.2	74.5	74.5	73.9	72.8	71.4	70.4	69.3
dB_L_{eq} difference	-0.1	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dB_L_{max} difference	-2.2	-	-	-	-2.4	-2.5	-2.8	-2.6	-2.5	-2.3	-2.4	-2.3	-2.1	-2.3	-2.1	-2.2	-2.1	-2.2	-2.2	-2.3	-2.2	-2.2

7.3.4 Results

Noise predictions were undertaken for all receivers identified along the alignment within the Land Use Survey. Only residential type receivers were identified.

Figure 17 and Figure 18 presents the predicted noise levels for the $L_{Aeq,9hour}$ night period for Day 1 (Timeframe 1) and Ultimate Service respectively. Figure 19 presents the $L_{Amax,95percentile}$ assessment, which is same for both the Day 1 (Timeframe 1) and Ultimate Service scenarios. The assessment reveals no exceedances for Day 1 (Timeframe 1) or Ultimate Service.

Detailed tabulated results are provided in Appendix J.2 for all receivers within 100 m of the alignment or within 10 dB of the criteria for Day 1 and Ultimate Service.

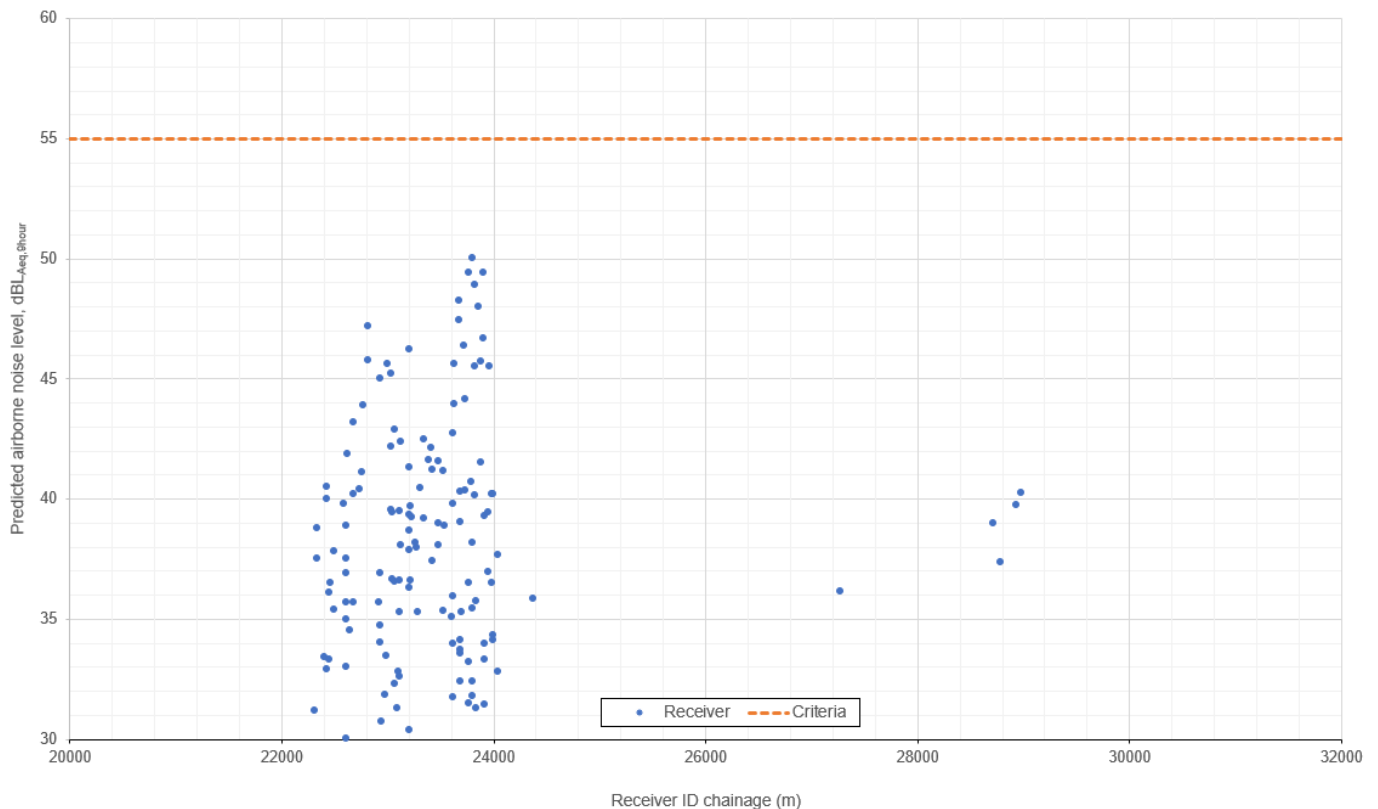


FIGURE 17: AIRBORNE NOISE ASSESSMENT – DAY 1 - LAEQ NIGHT PERIOD

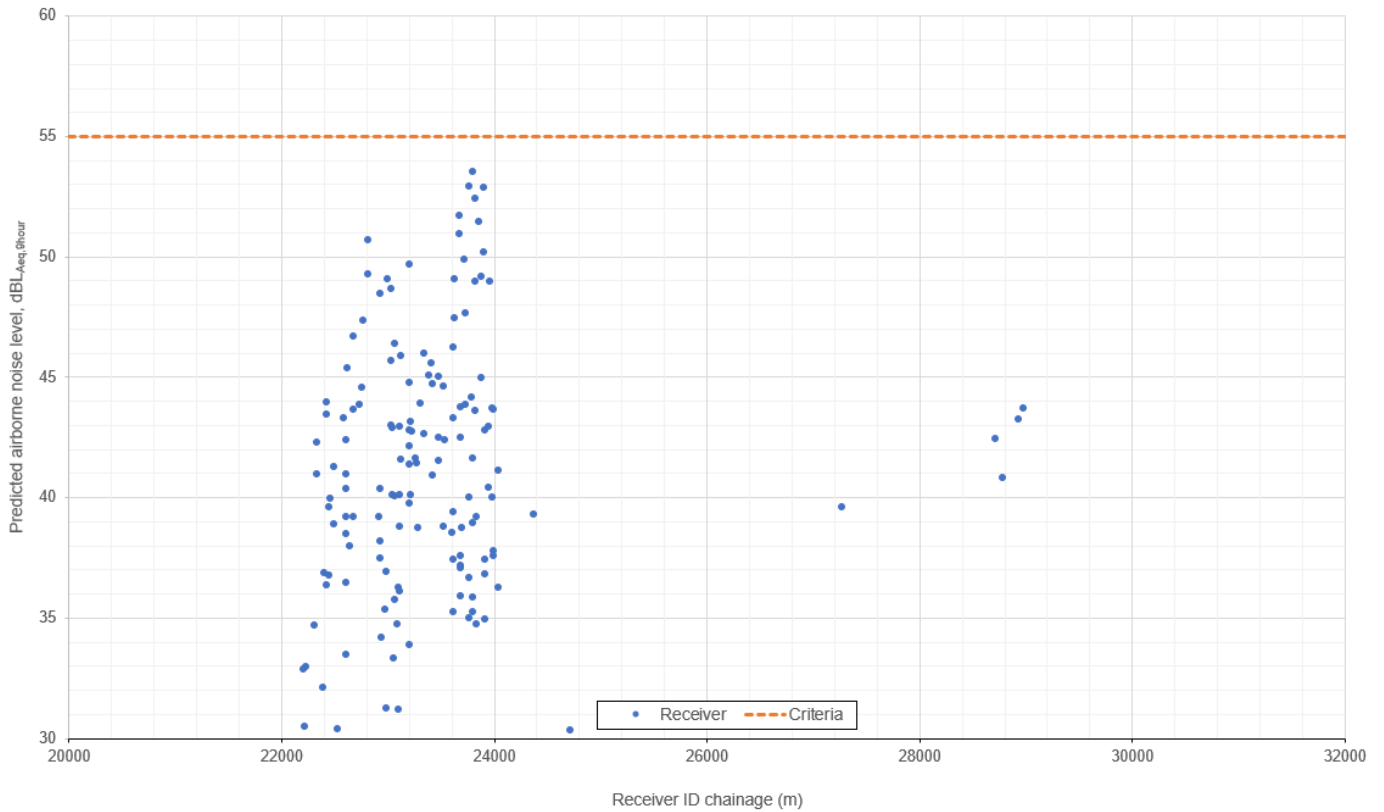


FIGURE 18: AIRBORNE NOISE ASSESSMENT – ULTIMATE SERVICE - LAEQ NIGHT PERIOD

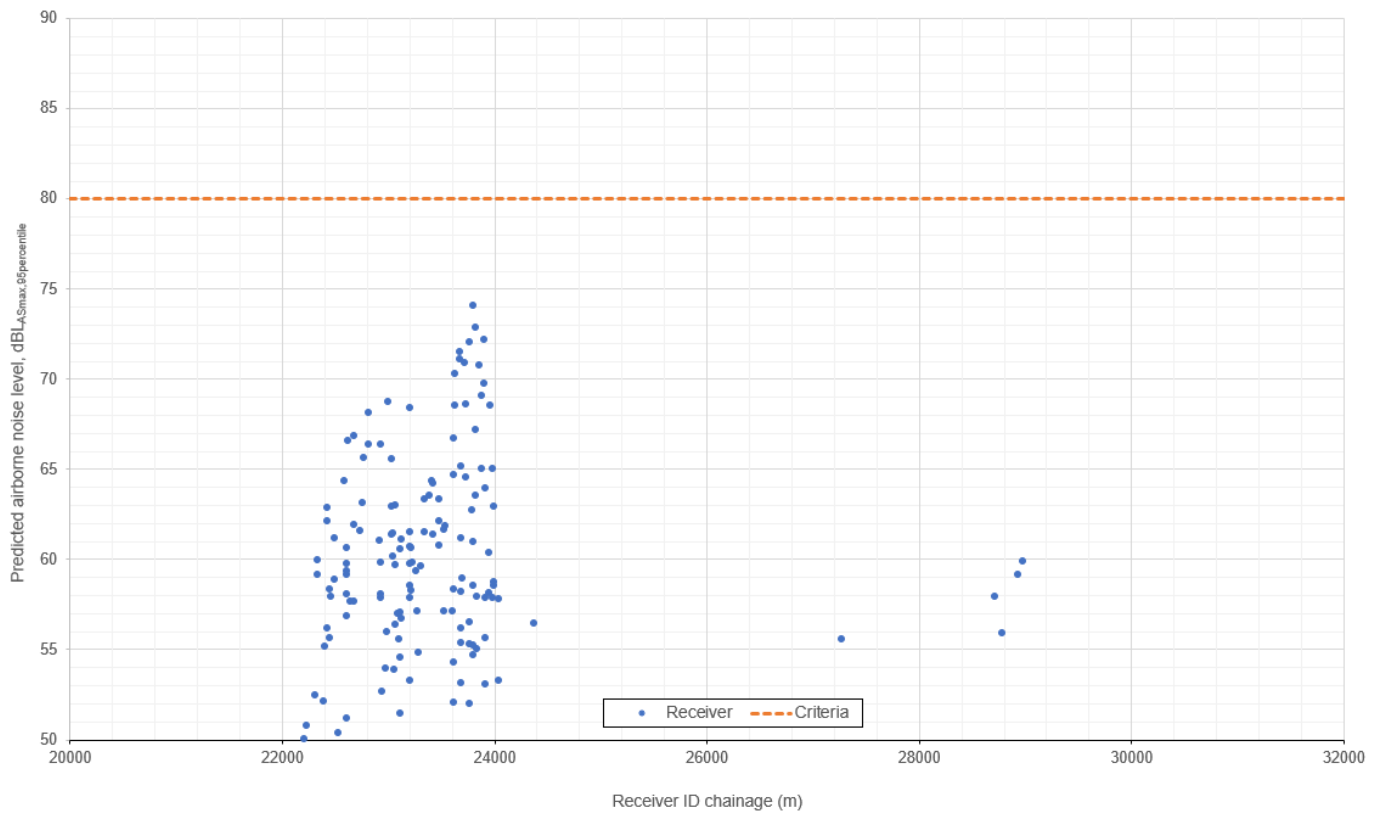


FIGURE 19: AIRBORNE NOISE ASSESSMENT – DAY 1 AND ULTIMATE SERVICE – LAMAX

7.4 Mitigation and management measures

This section outlines the mitigation and management measures related to operational rail noise and vibration.

7.4.1 Rail fasteners and trackform

Table 58 presents a summary of the trackform types which are the basis of the assessment.

TABLE 58: TRACKFORM AND FASTENER SUMMARY

Location	Noise and vibration Track type ID	Comment
Tunnel	STM to OHE	Type 2 – NV-B Type 4 – NV-C Tunnel trackform stiffness to varies as required to meet GBNV criteria and transition requirements.
	Camira Street (UP: 17+820 to 18+105 DOWN: 17+845 to 18+130).	IST determined to be required to achieve GBNV criteria based on inputs and uncertainty analysis. It is noted that only marginal potential exceedance would be predicted with the lowest stiffness NV-B fastener. The IST solution near Camira Street has been determined via analysis. Softer resilient baseplates do not provide the required insertion gain to meet the ground-borne noise criteria in this area. Additionally, there is not space for a full FST-style solution and there are difficulties with achieving the required mass of the FST and whilst allowing space for the resilient FST bearings.
	ABP to AEC	Type 2 – NV-B Type 2 – NV-D Type 4 – NV-C Type 4 – NV-E Tunnel trackform stiffness generally 20 kN/mm dynamic stiffness based on maximum stiffness of basis of design fastener type (Delkor Egg RF167). Areas of lower stiffness for cross-over and GBNV specified.
At-grade	All locations	Type 1 – NV-H Type 4 – NV-I Rail fastener stiffness informed by trackform requirements, ground-borne vibration and track decay rate.
Viaduct	All locations	Type 1 – NV-J Rail fastener stiffness balanced between structure-borne noise control and track decay rate. No crossovers on viaduct.

The track fastenings are presented in Figure 20, Figure 21, and Figure 22.

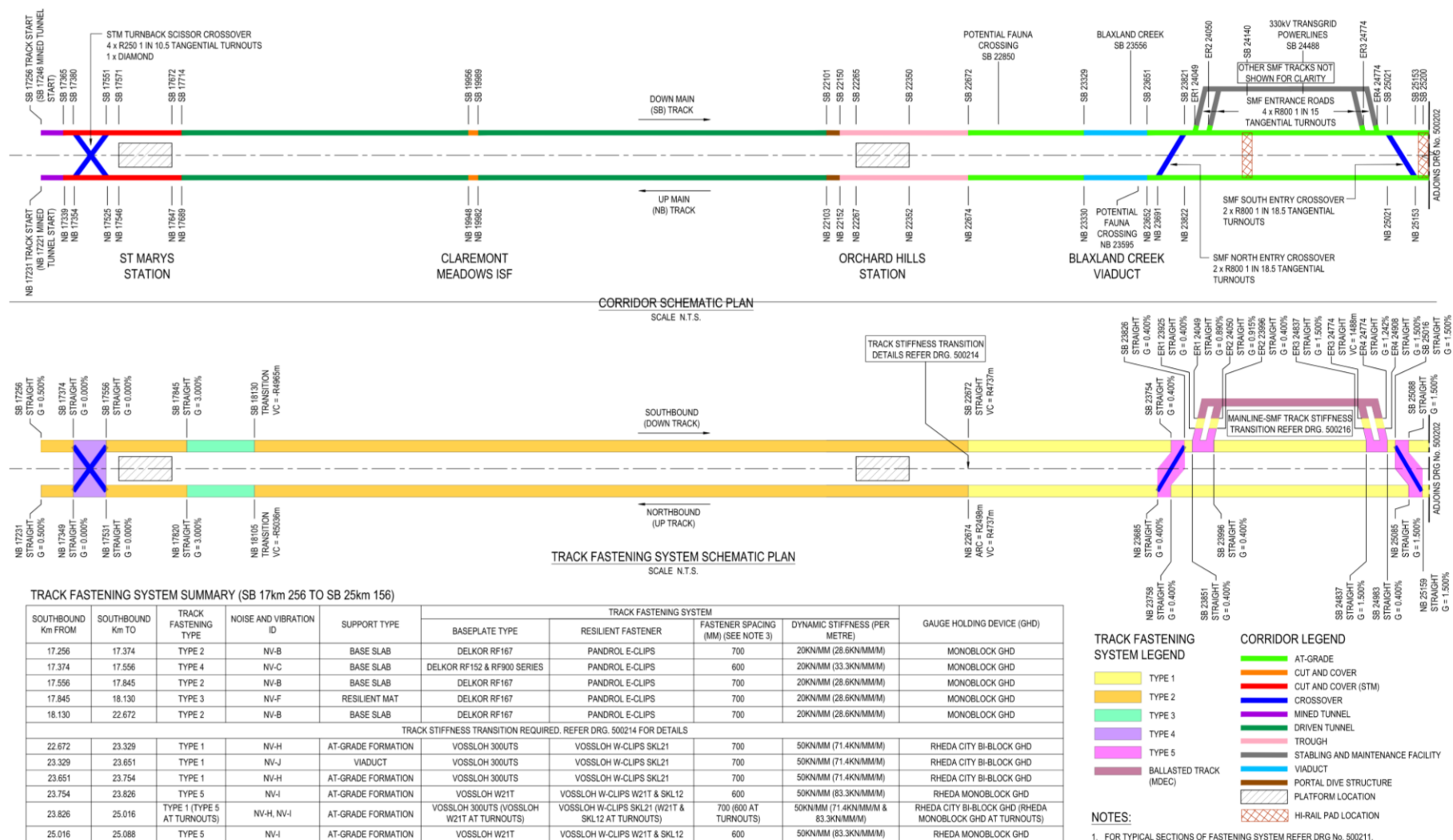
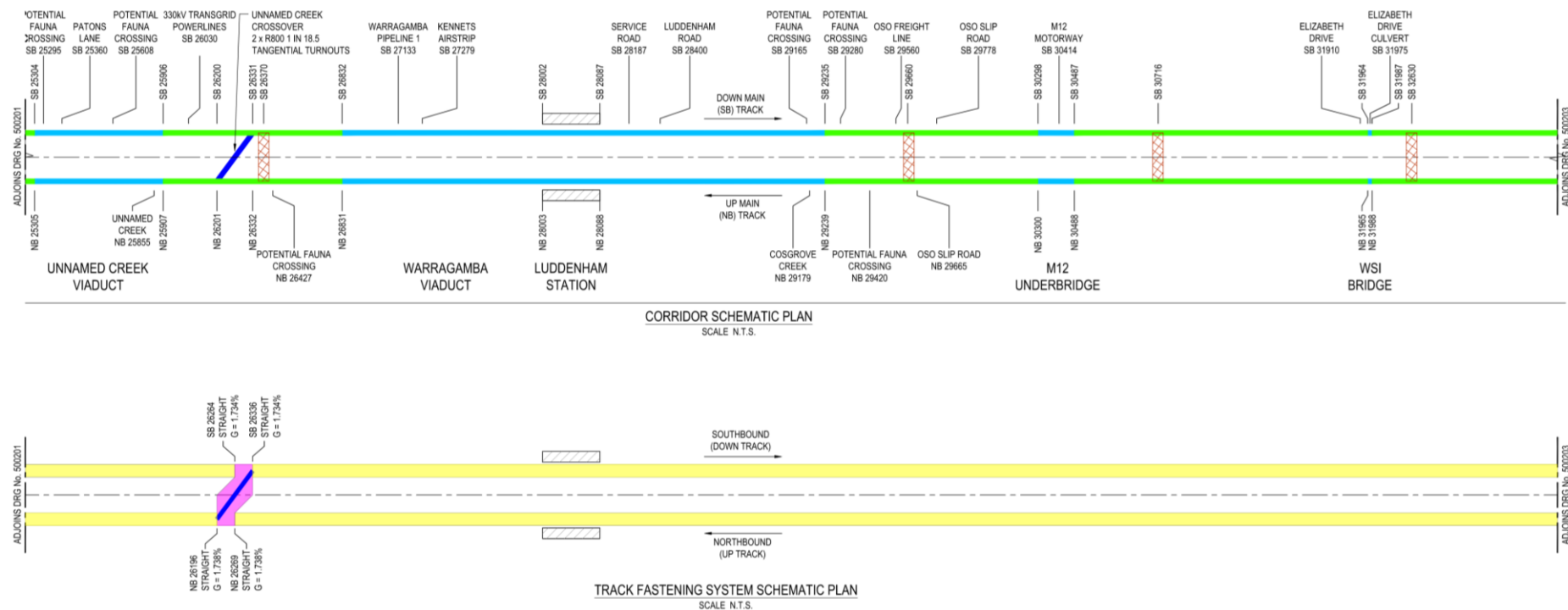


FIGURE 20: TRACK FASTENING TYPES STM TO SMF



TRACK FASTENING SYSTEM SUMMARY (SB 25km 156 TO SB 33km 276)

SOUTHBOUND Km FROM	SOUTHBOUND Km TO	TRACK FASTENING TYPE	NOISE AND VIBRATION ID	SUPPORT TYPE	TRACK FASTENING SYSTEM			DYNAMIC STIFFNESS (PER METRE)	GAUGE HOLDING DEVICE (GHD)
					BASEPLATE TYPE	RESILIENT FASTENER	FASTENER SPACING (MM) (SEE NOTE 3)		
25.088	25.304	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
25.304	25.906	TYPE 1	NV-J	VIADUCT	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
25.906	26.264	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
26.264	26.336	TYPE 5	NV-I	AT-GRADE FORMATION	VOSSLOH W21T	VOSSLOH W-CLIPS W21T & SKL12	600	50KN/MM (83.3KN/MM/M)	RHEDA MONOBLOCK GHD
26.336	26.832	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
26.832	29.235	TYPE 1	NV-J	VIADUCT	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
29.235	30.298	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
30.298	30.487	TYPE 1	NV-J	VIADUCT	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
30.487	31.964	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
31.964	31.987	TYPE 1	NV-J	VIADUCT	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD
31.987	33.276	TYPE 1	NV-H	AT-GRADE FORMATION	VOSSLOH 300UTS	VOSSLOH W-CLIPS SKL21	700	50KN/MM (71.4KN/MM/M)	RHEDA CITY BI-BLOCK GHD

**TRACK FASTENING
SYSTEM LEGEND**



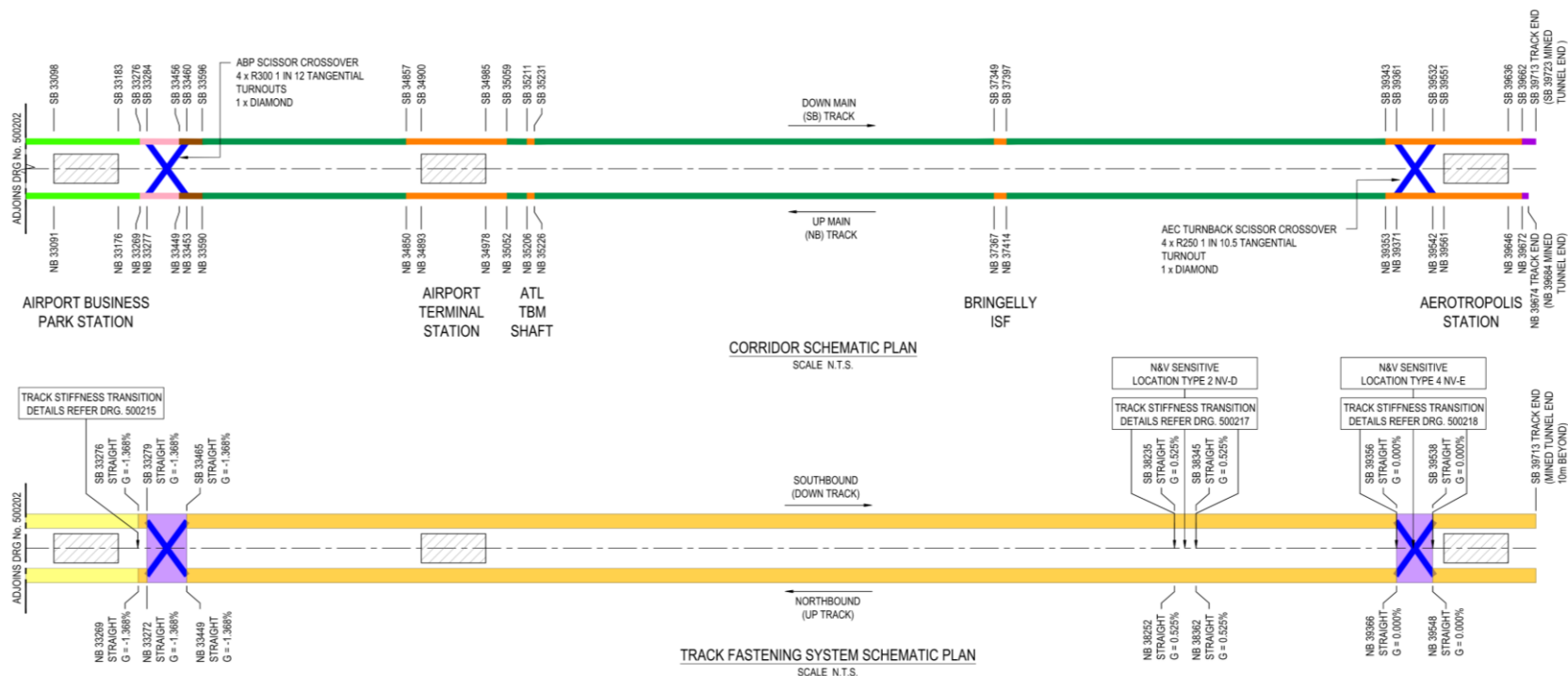
CORRIDOR LEGEND



NOTES:

- FOR TYPICAL SECTIONS OF FASTENING SYSTEM REFER DRG No. 500211.
- TRACK STIFFNESS TRANSITION REFER DRG Nos. 500214 TO 500218.
- FASTENER SPACING SHOULD BE AS SHOWN IN THE TABLE WITH ALLOWANCE FOR 50mm SPACING REDUCTION FOR LOCALISED AREAS TO AVOID CONSTRUCTION JOINTS, OR AS SHOWN OTHERWISE IN TURNOUT GENERAL ARRANGEMENT DRG No 500101 TO 500181.

FIGURE 21: TRACK FASTENING TYPES SMF TO ABP



TRACK FASTENING SYSTEM LEGEND



CORRIDOR LEGEND



NOTES:

- FOR TYPICAL SECTIONS OF FASTENING SYSTEM REFER DRG No. 500211.
- TRACK STIFFNESS TRANSITION REFER DRG Nos. 500214 TO 500216.
- FASTENER SPACING SHOULD BE AS SHOWN IN THE TABLE WITH ALLOWANCE FOR 50mm SPACING REDUCTION FOR LOCALISED AREAS TO AVOID CONSTRUCTION JOINTS, OR AS SHOWN OTHERWISE IN TURNOUT GENERAL ARRANGEMENT DRG No 500101 TO 500181.

FIGURE 22: TRACK FASTENING TYPES ABP TO AEC

7.4.1.1 Equivalent systems

Example projects where equivalent systems have been used on comparable projects are listed in Table 59.

TABLE 59: RAIL SYSTEMS – EQUIVALENT SYSTEMS

System	Other projects where it's been used
Delkor Egg resilient fastener	Sydney Metro Northwest (NSW), Epping to Chatswood Rail Line (NSW), Sydney Metro City and Southwest (NSW)
Vossloh 300 resilient fastener	Caulfield to Dandenong (VIC), Melbourne Metro (VIC)
Isolated Slab Track (IST)	Sydney Metro Northwest (NSW), Metro de Madrid (Spain), Tseung Kwan O Extension (Hong Kong)

7.4.2 Wheel / rail interface

A detailed wheel-rail interface strategy and study have been prepared for the project. The noise and vibration assessment is based on rail roughness being maintained in accordance with ISO 3095 standard roughness levels. A grinding and maintenance strategy has been prepared for this purpose, which includes rail grinding and wheel profiling. It is however noted that the noise assessment includes contingency for potential variation in the wheel-rail contact condition. Furthermore, the extent and proximity of sensitive receiver locations to the above ground alignment are limited and therefore could reduce the extent to which stringent maintenance regimes are required. This will be reviewed during operations.

7.4.3 Trackway noise mitigation measures

Trackway infrastructure noise mitigation measures (such as rail dampers and sound absorptive panels) are not required for airborne noise from the above ground sections. Rail dampers are however included at locations within the tunnel near the draught relief shafts.

7.4.4 Noise barriers

No noise barriers have been identified as a mitigation measure along the alignment.

7.4.5 Future receivers

Notwithstanding the application of mitigation recommendations, future development in proximity to the rail corridor will require assessment in accordance with the *SEPP (Transport and Infrastructure) 2021* [6] and Sydney Metro Corridor Protection Guidelines [27]. Sydney Metro will consult with relevant consent authorities and will review assessments for relevant development applications. Sydney Metro will liaise with consent authorities and applicants to provide relevant information regarding the SM-WSA to enable impacts assessments to be carried out.

Operational noise and vibration levels at future potential receivers has been reduced through the implementation of:

- A maximum allowable rail fastener stiffness in the tunnel to control ground-borne noise and vibration.
- Optimised rail fastener stiffness at-grade and on viaduct to balance structure-radiated noise, airborne noise, and ground-borne noise and vibration.
- Parapets on viaduct to reduce airborne noise.

8. Implementation of mitigation measures (E59)

SSI Condition E59 relates to the implementation of mitigation measures early in the construction phase that may potentially reduce construction noise impacts, e.g. noise barriers, at-property treatment.

No mitigation measures for the Project have been identified as relevant to the requirements of E59.

9. Consultation with stakeholders

9.1 EPA, DPHI, Councils, WPCA

In accordance with SSI Condition E58, consultation meetings were conducted with various stakeholders throughout the project. A summary of the stakeholder consultation is provided in Table 60.

TABLE 60: SUMMARY OF CONSULTATION WITH EXTERNAL STAKEHOLDERS

Date	Organisation	Description
23 Aug 2023	Penrith City Council (PCC)	Presentation of an update to the noise and vibration assessment which focused on criteria establishment for existing and future development surrounding LGA.
28 Mar 2024	Department of Planning, Housing and Infrastructure (DPHI)	Preliminary discussion on SSI E58 requirements including baseline monitoring, approach to assessing future development, expectations on stakeholder consultation.
10 Apr 2024	Department of Planning, Housing and Infrastructure (DPHI)	Follow up discussion on SSI E58 requirements including baseline monitoring, approach to assessing future development, stakeholder consultation requirements.
4 July 2024	Environment Protection Agency (EPA)	Discussion on SSI E58 requirements including baseline monitoring, approach to assessing future development, stakeholder consultation requirements.

9.2 Approach for future receiver assessment

Future development near to the rail corridor, stations and SMF will require assessment in accordance with the requirements of State Environmental Planning Policy (Transport and Infrastructure) 2021. Clause 2.100 in Division 15 Subdivision 2 'Development in or adjacent to rail corridors and interim rail corridors' – notification and other requirements, states:

2.100 Impact of rail noise or vibration on non-rail development

(1) *This section applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration—*

- (a) *residential accommodation,*
- (b) *a place of public worship,*
- (c) *a hospital,*
- (d) *an educational establishment or centre-based child care facility.*

(2) *Before determining a development application for development to which this section applies, the consent authority must take into consideration any guidelines that are issued by the Planning Secretary for the purposes of this section and published in the Gazette.*

(3) *If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded—*

- (a) *in any bedroom in the residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,*
- (b) *anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.*

The following guidelines are to be referred to by future development:

- *Development Near Rail Corridors and Busy Roads – Interim Guideline* [28]
- *Sydney Metro At Grade and Elevated Sections Corridor Protection Guidelines* [27]
- *Sydney Metro Underground Corridor Protection Technical Guidelines* [29]

It is noted that the TISEPP does not include specific criteria or guidance for the assessment of intermittent sources that can cause annoyance or sleep disturbance that is typically assessed using the L_{max} descriptor. It is however recommended that this aspect be considered in the assessment of future development near stations and the SMF.

The process of assessing of future development applications is to be managed by Sydney Metro in consultation with relevant consent authorities.

9.3 Affected property owners

Affected property owners relates to properties where at-property acoustic treatment is required, such as noise barriers on residential boundaries, sound insulating glazing and ventilation systems. Based on the assessment, at-property treatment has not been recommended and therefore there are no affected property owners required to be consulted with.

10. Noise monitoring and complaints management

10.1 Post-operation compliance

In accordance with SSI Condition E60, operational noise levels shall be reviewed within 12 months of commencement of operations of the CSSI. The review shall have regard to the status of land use planning, any land use changes and the background noise environment within areas adjacent to the Project at the time of the relevant review. The Operator shall submit the results of the review to the Director General. Any proposed changes to the operational noise levels as a result of the review shall be included in a revised ONVR.

In addition, the Operator shall detail the testing requirements for maintenance activities and emergency plant equipment in an Operational Management Plan.

10.2 Complaints management

In accordance with SSI Condition E58 (g), the Operator is committed to a program of customer engagement to encourage ongoing feedback that will be used in the continual improvement of the Sydney Metro Western Sydney Airport services. The procedures for managing complaints should follow the Overarching Community Communication Strategy approved by DPHI in July 2021 [7], this document can be found online at the DPHI major projects website.

- Public channels for enquiries and complaints:
 - Phone lines managed by SM on behalf of the NSW Government.
 - Website managed by SM on behalf of the NSW Government.
 - Operators' email provided.
 - Enquiries and complaints received related to SM operations will be reviewed and if required, actioned.
- Complaint handling
 - All complaints will be recorded, and follow-up actions will be documented.
 - Each complaint will be investigated to determine the nature of the noise and/or vibration disturbance and their likely cause.
 - The operator may contact the complainant at their discretion.
- Post-investigation actions - Appropriate course of action(s) will be determined and communicated with the complainant.
 - For complaints relating to high noise or vibration levels, additional monitoring by qualified acoustic consultant would be considered to determine operational noise and/or vibration levels at the complainant's property
 - The measured levels will be reviewed against the station and rail operations noise criteria and the predicted levels in this ONVR to determine whether the implemented mitigation measure is sufficient.
 - If the source of noise or vibration is found to be non-compliant with project requirements, direct and prompt rectification will be undertaken including application of feasible and reasonable mitigation measures.
 - If noise and/or vibration measures are necessary, a rectification program will be established, and the complainant will be informed.

11. Independent verification of noise and vibration study

This section outlines the independent verification of the ONVR undertaken by a noise and vibration expert as required by Condition of consent E58 of CSSI-10051.

Renzo Tonin and Associates were engaged to undertake this independent verification role. The independent verification team consists of:

- Peter Karantonis - Director
- Neil Gross – Principal Acoustic Engineer

The verification scope includes:

- Review of background noise monitoring results and fixed facilities targets.
- Review of adopted noise and vibration criteria for fixed facilities and rail operations.
- Review of the adequacy of the methodology utilised.
- Review of modelling inputs and outputs.
- Review of noise and vibration prediction results in relation to criteria.
- Review of the adequacy of the conclusions in relation to the potential extent of noise and vibration impact and the required mitigation.

A statement of verification has been prepared by Renzo Tonin and Associates and is attached in Appendix K.

It is noted that the independent verification was undertaken on a previous version of this report, which included additional project requirements not outlined in CSSI-10051. This version has been updated to address only the requirements of CSSI-10051.

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Appendix A Terminology and definitions

Appendix A.1 Terminology

Term	Description
ABP	Airport Business Park
AEC	Aerotropolis Station
APS	Aux Power Supply
ARL	Acoustic Research Lab
AS	Australian Standard
ASU	Air Separation Units
AVTG	Assessing Vibration: A Technical Guideline 2006
AWS	Automatic Weather Station
BEL	Battery Electric Locomotive
BOM	Bureau of Meteorology
CCC	Child Care Centres
CH	Chainage
CIN	Cinemas
CIVET	Change in Vibration Emission from Trackforms
COM	Commercial (private offices and conference rooms)
CSSI	Critical State Significant Infrastructure
CT	Cooling Tower
CTRL	Channel Tunnel Rail Link
DEC (Former)	Department of Environment and Conservation
DGM	Digital Ground Model
DPHI	Department of Planning Housing and Infrastructure
DPPS	Depot Personnel Protection System
DRS	Draught Relief Shaft
DRT	Drama Theatres
DWE	Dynamic Wheelset Evaluation

Term	Description
ECRL	Epping to Chatswood Rail Link
ECS	Environmental Control System
EDU	Educational Institutions
EIS	Environmental Impact Statement
ELVIS	Elevation and Depth Information System
EPA	Environment Protection Authority
eVDV	Estimated Vibration Dosage Values
EX	Existing
FIW	Foundation Infrastructure Works
FSM	Footbridge St Mary
FST	Fire, Smoke, Toxicity
FTA	Federal Transit Administration
GBN	Ground Borne Noise
GBV	Ground Borne Vibration
GBVN	Ground Borne Vibration and Noise
GIS	Geographic Information System
HPC	Hospitals - Critical Spaces
HPO	Hospitals - Other Uses
HPW	Hospitals - Wards
HVAC	Heat Ventilation Air Conditioning
ICSM	Intergovernmental Committee on Surveying and Mapping
IG	Insertion Gain
IND	Industrial (Workshops)
ISO	International Organization for Standardization
IST	Isolated-Slab Tracks
LCT	Lecture Theatres

Term	Description
LDN	Luddenham Station
LGA	Local Government Area
LIDAR	Light Detection and Ranging
MEP	Mechanical, Electrical, Plumbing
MOS	Mobile Operations Supervisor
MT	Main Transformer
NCA	Noise Catchment Area
NEWA	Noise Enhancement Wind Analysis
NML	Noise Monitoring Location
NPfi	Noise Policy for Industry
OCC	Operations Control Centre
OHE	Orchard Hill East Station
ONVR	Operational Noise Vibration Review
OpCo	Operating Company
OSA	Open Space - Active Use
OSP	Open Space - Passive Use
PA	Public Address
PANL	Project Amenity Noise Level
PBH	Public Halls
PCC	Penrith City Council
PLA	Places of Worship
PLM	Park Life Metro
PLRRC	Patons Lane Resource Recovery Centre
PPP	Public Private Partnership
PSNTL	Project Specific Noise Trigger Level
RANL	Recommended Amenity Noise Level

Term	Description
RBL	Rating Background Level
RES	Residential
RET	Retail Areas
RF	Radio Frequency
RING	Rail Infrastructure Noise Guideline
RIVAS	Railway Induced Vibration Abatement Solutions
RMS	Root Mean Square
RST	Rolling stock (reference to train manufacturer)
SBN	Structure Borne Noise
SCAW	Surface and Civil Alignment Works
SEPP	State Environmental Planning Policies
SMF	Stabling and Maintenance Facility
SMNW	Sydney Metro North West
SMWSA	Sydney Metro Western Sydney Airport
SSI	State Significant Infrastructure
SSTOM	Stations, Systems, Trains, Operations and Maintenance
STM	St Marys Station
STU	Film/TV/Sound recording studios
TDR	Track Decay Rate
TEL	Telstra Exchange
TES	Tunnel Exhaust System
TGT	Transgrid Tower
THWS	Train Hazard Warning System
TIC	Traction Inverter Container
TISEPP	Transport and Infrastructure State Environmental Planning Policy
TM	Traction Motor

Term	Description
TVF	Tunnel Ventilation Fan
TVS	Tunnel Ventilation System, inclusive of tunnel ventilation fan and over-trackway exhausts
UFWL	Under Floor Wheel Lathe
VDV	Vibration Dosage Values
WPCA	Western Parkland City Authority
WSA	Western Sydney Airport
WSI	Western Sydney International

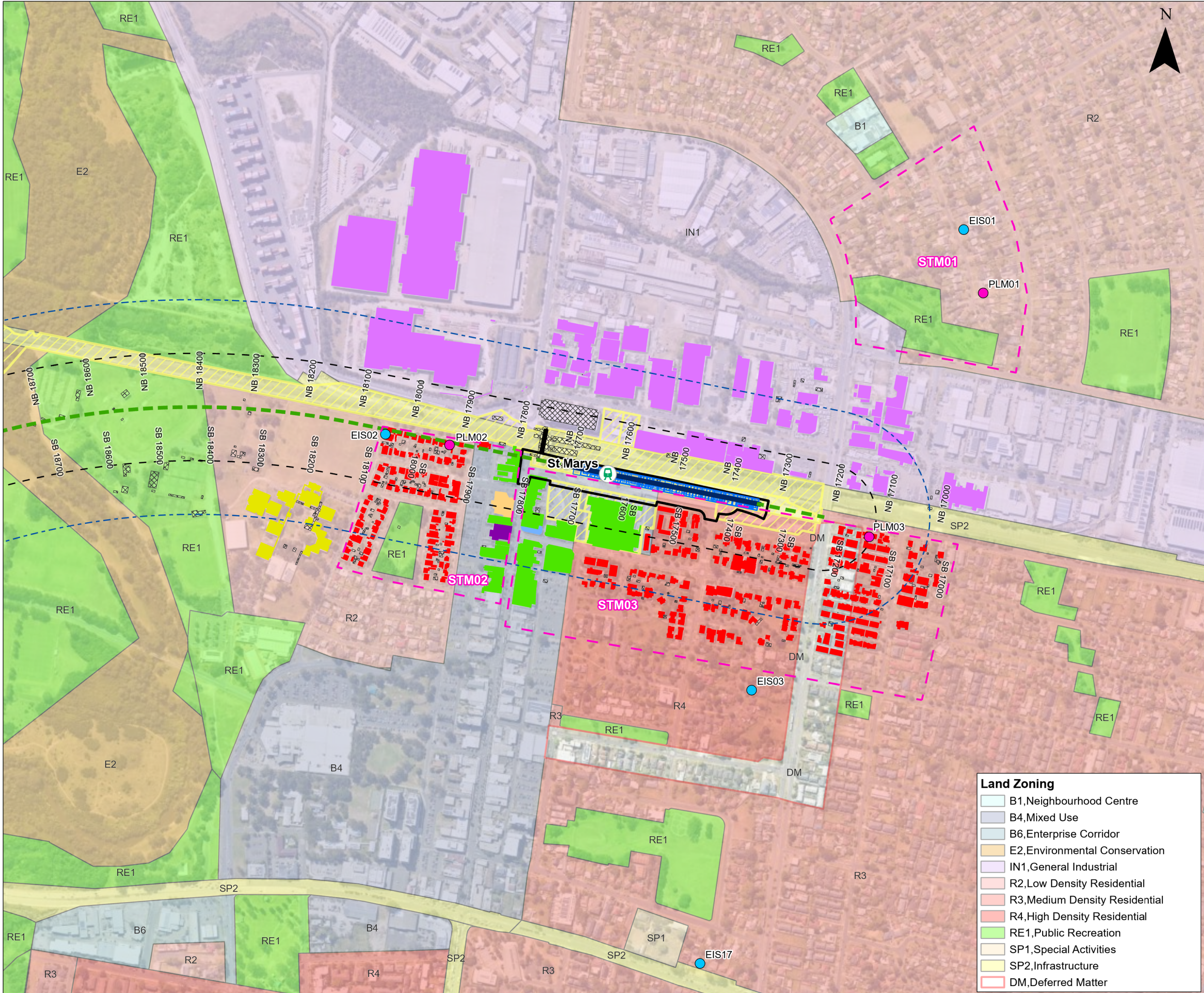
Appendix A.2 Definitions

Technical term	Description
Attenuation	A reduction in amplitude of noise or vibration due to increasing distance or other means such as noise barriers, materials or mitigation measures. Vibration attenuation may occur due to damping of a vibration system, the inclusion of attenuating devices or, in the case of ground vibration, during propagation through the ground. Ground attenuation is determined by the dynamic properties of the site's soil and rock.
Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Airborne noise	Noise that propagates through the air between source and receiver. Most relevant for noise from surface railway tracks or stationary facilities.
Alignment	The position of the railway tracks in three dimensions along their length.
Ambient noise/vibration	The all-encompassing noise/vibration within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made. Assessment periods may be daytime, evening, Night-operation, 24-hour or busiest 1-hour period (when in use). Time periods associated with each assessment period are defined in the relevant section of this report and differ for rail operations and stationary facilities.
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, when extraneous noise is removed. 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 ₉₀ noise level (see below).
Chainage	Refers to the distance, along the railway tracks, usually given in kilometres or metres.
CSSI	Critical State Significant Infrastructure.
Decibel (dB)	A unit of measure commonly used to express noise and vibration. For sound, a reference level of 20 µPa is used. For vibration, a variety of reference levels are used. Vibration levels in this report use a reference level of 1 nm/s for vibration velocity and 1 mm/s ² for vibration acceleration.
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is 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 switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB_{L1}	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
dB_{L10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
dB_{L90}	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).

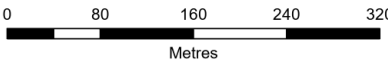
Technical term	Description
dBL_{eq}	The 'equivalent noise level' is the summation of noise events and integrated over a selected period of time.
dBL_{AE}	The 'equivalent noise level' is the summation of train car passby events integrated over a selected period.
dBL_{Aeq,15min}	The 'equivalent noise level' is the summation of noise events and integrated over a 15-minute period.
dBL_{Aeq,1hr}	The 'equivalent noise level' is the summation of noise events and integrated over a 1 hour period.
dBL_{Aeq,tp}	The 'equivalent noise level' is the summation of train passby events integrated over a selected period.
dBL_{AFMax}	The A weighted maximum sound pressure level measured over a given period, with a 'fast' response time weighting (typically used for airborne noise measurements).
dBL_{ASMax,95%}	The A weighted maximum noise level not exceeded by 95 per cent of individual pass-by events with a 'slow' response time weighting (typically used for ground-borne noise measurements).
dBL_p	The sound pressure level.
dBL_{p(Z)}	The Z weighted sound pressure level.
dBL_w	Notation of sound power level.
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.
Ground-borne noise (GBN)	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Impulsive noise or vibration	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 or vibration.
Intermittent noise or vibration	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise or vibration remains at levels different from that of the ambient is one second or more.
Natural frequency	The frequency at which a system tends to oscillate in the absence of any driving or damping force.
Octave	An octave represents a doubling or halving in frequency. Noise or vibration levels across a frequency spectrum are commonly given in octave or one-third octave frequency bands.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.

Technical term	Description
Receiver	A location or dwelling that is exposed to noise and/or vibration. A sensitive receiver refers to a building that has noise and/or vibration criteria that is required to be met.
SI Unit	Units adopted as a standard for International use, for example, metres for distance, seconds for time, kilogram for mass, etc.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into 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 pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
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.
Source	Point from which noise and/or vibration is emitted.
Spectrum	The result of transforming a signal from the time domain to the frequency domain.
Structure-borne noise	Another term for ground-borne, regenerated, or re-radiated noise.
Tactile vibration	Vibration of a level that can be felt by humans, dependant on the amplitude and frequency of the source.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.
Turnout	Points which allow the rail vehicle to diverge from one rail line to another. A crossover is a pair of points that connects two tracks in both directions. Rail vehicles passing over turnouts is a source of impulsive noise.
VC curves	Vibration Criterion curves are frequency dependant criteria for sensitive equipment.
Vibration dose value	Vibration dose value – a measure of tactile vibration levels relating to intermittent vibration levels, eVDV is estimated vibration dose value.
Velocity	The rate of change of vibration displacement, usually measured in mm/s.
Vibration	A mechanical phenomenon whereby oscillations occur about an equilibrium point; a periodic back-and-forth motion of an elastic body or medium, commonly resulting when almost any physical system is displaced from its equilibrium condition.

Appendix B Land use maps



PARKLIFE METRO PTY LTD
ABN 98 657 249 682

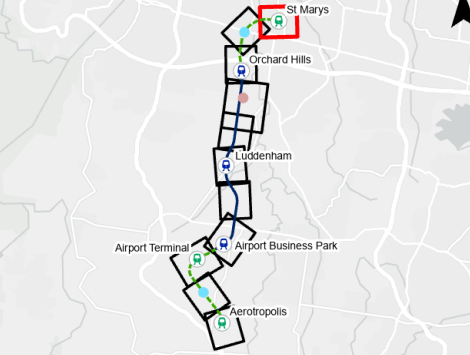


Scale: 1:6,500 @ A3
GDA2020 MGA Zone 56

LEGEND

- Underground Station
- Rail Alignment (Surface)
- Rail Alignment (Tunnel)
- Station or Facility Building Structures
- Alignment 100m Buffer
- Alignment 200m Buffer
- Project Site Boundary
- Property Acquisition
- Noise Measurement Locations**
- PLM Noise Logger
- EIS Noise Logger
- PLM Noise Catchment Area
- Noise and Vibration Receiver Category**
- COM - Commercial
- EDU - Education institutions
- HTL - Hotels
- IND - Industrial
- RES - Residential
- RET - Retail
- TEL - Telstra exchange
- NA - Not Assessable

KEY MAP



SOURCES:
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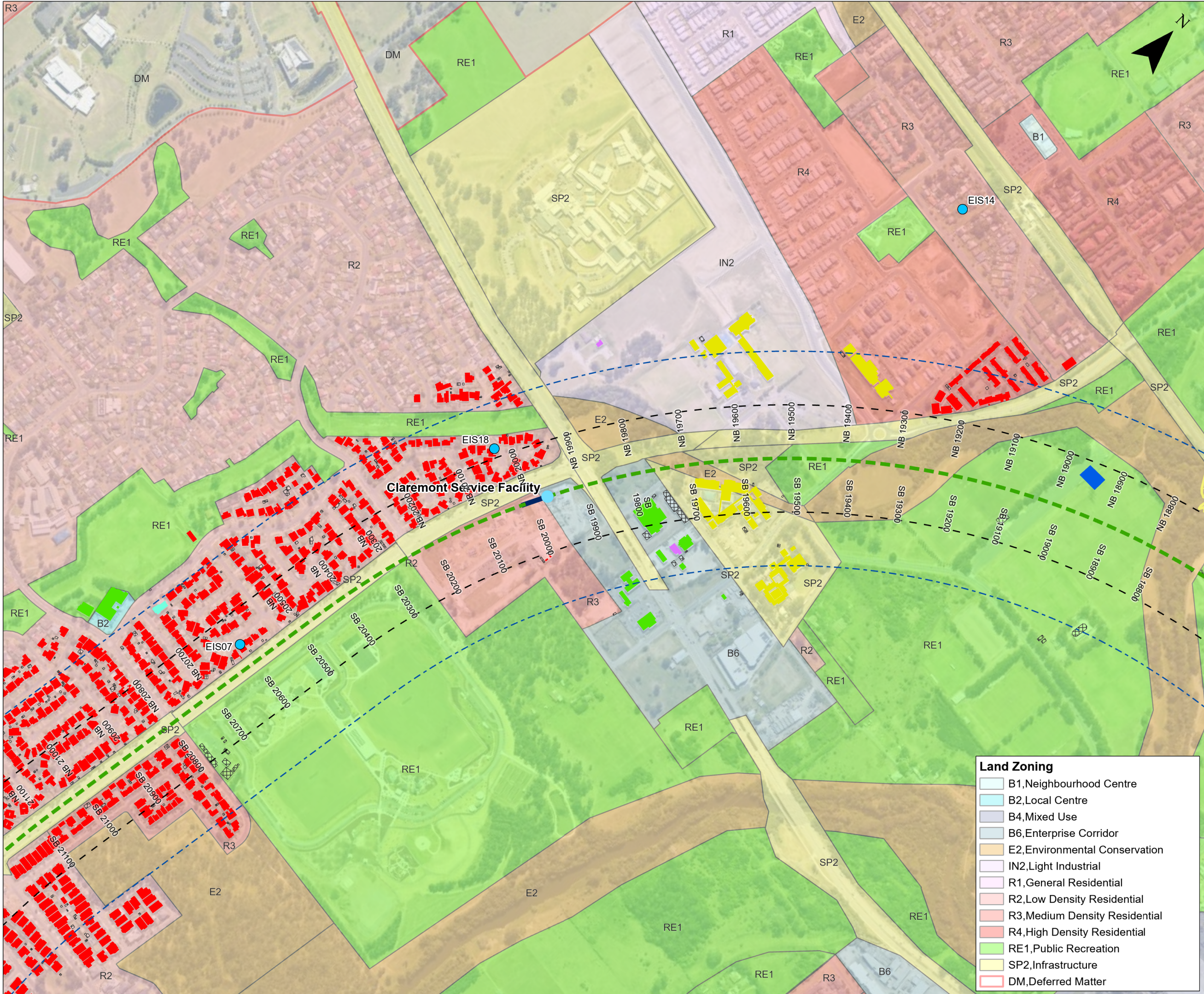
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Land Zoning

- B1,Neighbourhood Centre
- B4,Mixed Use
- B6,Enterprise Corridor
- E2,Environmental Conservation
- IN1,General Industrial
- R2,Low Density Residential
- R3,Medium Density Residential
- R4,High Density Residential
- RE1,Public Recreation
- SP1,Special Activities
- SP2,Infrastructure
- DM,Deferred Matter

PROJECT: Sydney Metro - WSA
LOCATION: STM
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 1
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002





PARKLIFE METRO PTY LTD
ABN 98 657 249 682

080160240320

Metres

Scale:1:6,500 @ A3
GDA2020 MGA Zone 56

LEGEND

Service Facility (Inactive Site)

Rail Alignment (Surface)

Rail Alignment (Tunnel)

Alignment 100m Buffer

Alignment 200m Buffer

Property Acquisition

Noise Measurement Locations

EIS Noise Logger

Noise and Vibration Receiver Category

CCC - Childcare centres

EDU - Education institutions

IND - Industrial

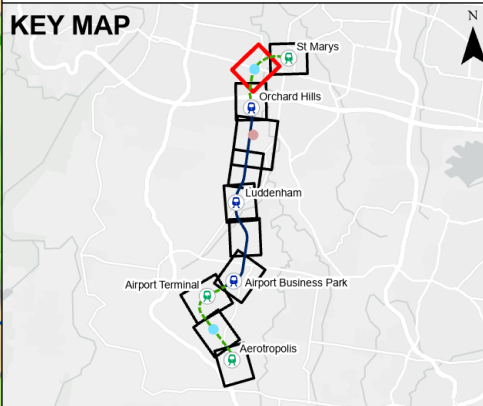
RES - Residential

RET - Retail

TGT - Transgrid tower

NA - Not Assessable

KEY MAP



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PROJECT: Sydney Metro - WSA

LOCATION: CSF

FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 2

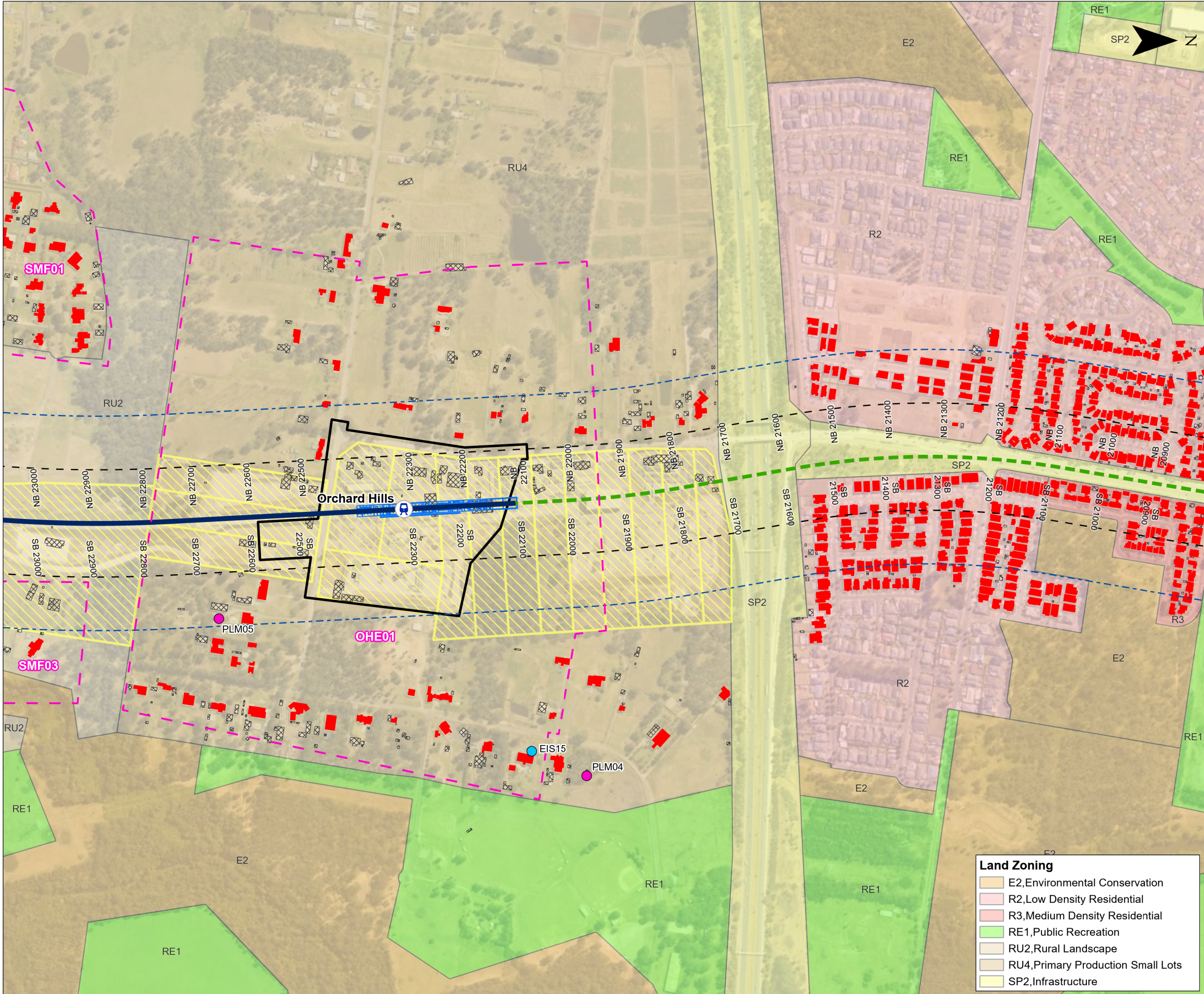
CREATED BY: NC17428

DATE: 17/10/2024

VERSION: 8

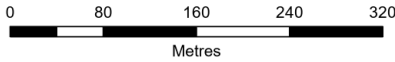
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PARKLIFE METRO PTY LTD
ABN 98 657 249 682



0 80 160 240 320
Metres

Scale:1:6,500 @ A3
GDA2020 MGA Zone 56

LEGEND

-  Above Ground Station
-  Rail Alignment (Surface)
-  Rail Alignment (Tunnel)
-  Station or Facility Building Structures
-  Alignment 100m Buffer
-  Alignment 200m Buffer
-  Project Site Boundary
-  Property Acquisition

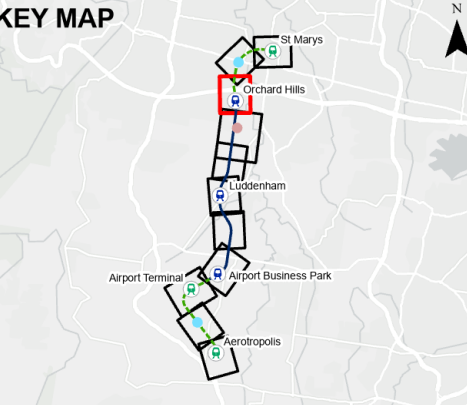
Noise Measurement Locations

-  PLM Noise Logger
-  EIS Noise Logger
-  PLM Noise Catchment Area

Noise and Vibration Receiver Category

-  RES - Residential
-  NA - Not Assessable

KEY MAP



SOURCES:
1. Basemap @ Australian capital cities latest:
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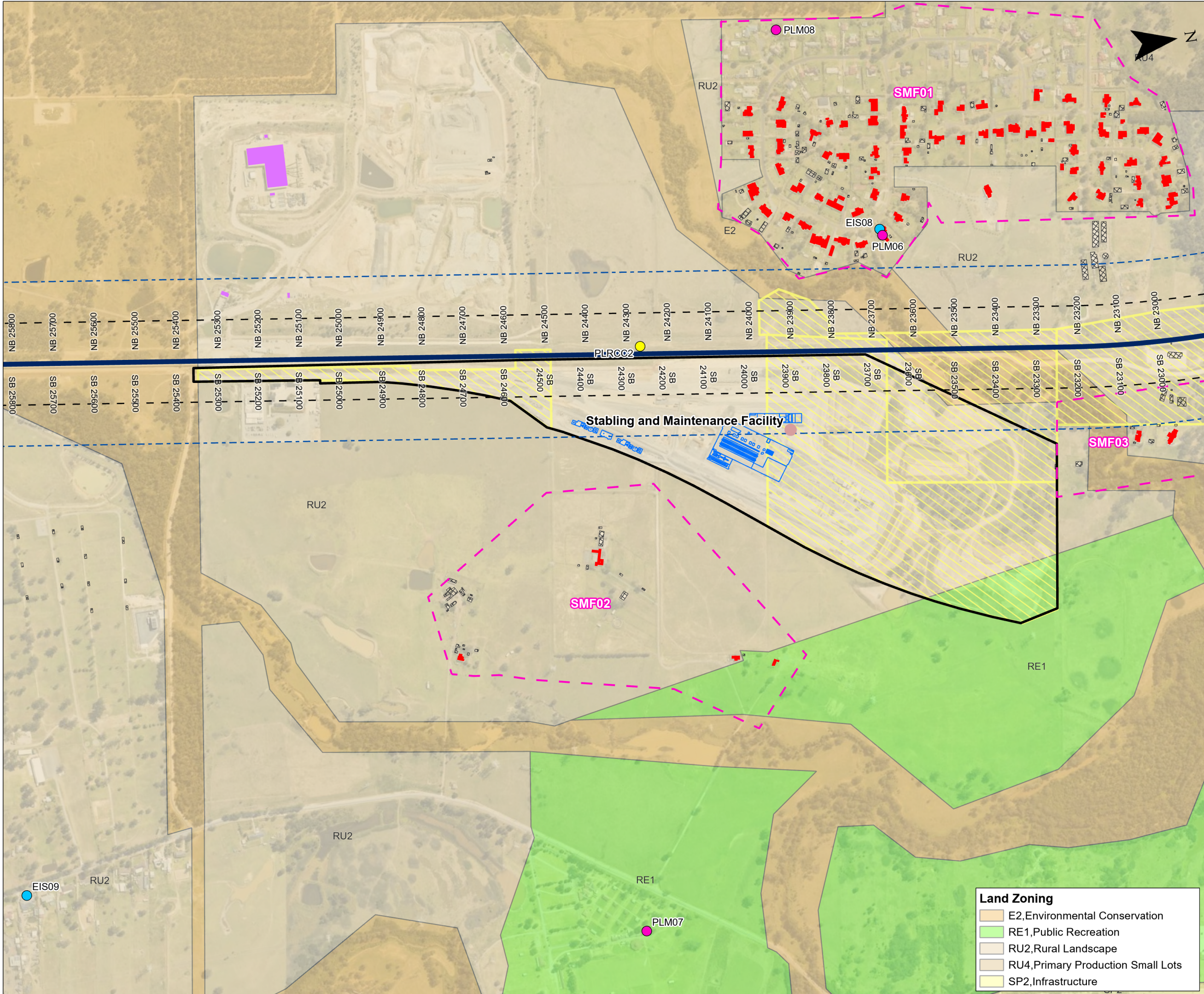
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PROJECT: Sydney Metro - WSA
LOCATION: OHE
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 3
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

-  E2, Environmental Conservation
-  R2, Low Density Residential
-  R3, Medium Density Residential
-  RE1, Public Recreation
-  RU2, Rural Landscape
-  RU4, Primary Production Small Lots
-  SP2, Infrastructure





PARKLIFE METRO PTY LTD
ABN 98 657 249 682

0 100 200 300 400
Metres

Scale:1:8,500 @ A3
GDA2020 MGA Zone 56

LEGEND

- Stabling and Maintenance Facility
- Rail Alignment (Surface)
- Station or Facility Building Structures
- Alignment 100m Buffer
- Alignment 200m Buffer
- Project Site Boundary
- Property Acquisition

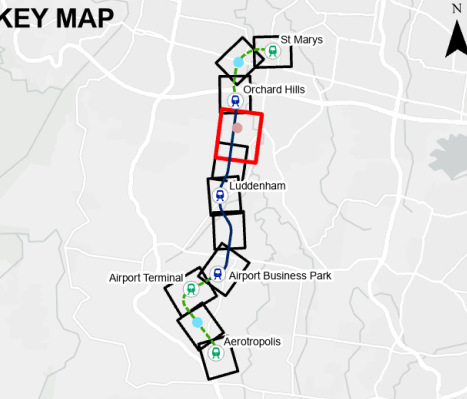
Noise Measurement Locations

- PLM Noise Logger
- EIS Noise Logger
- PLRRC Noise Logger
- PLM Noise Catchment Area

Noise and Vibration Receiver Category

- IND - Industrial
- RES - Residential
- NA - Not Assessable

KEY MAP



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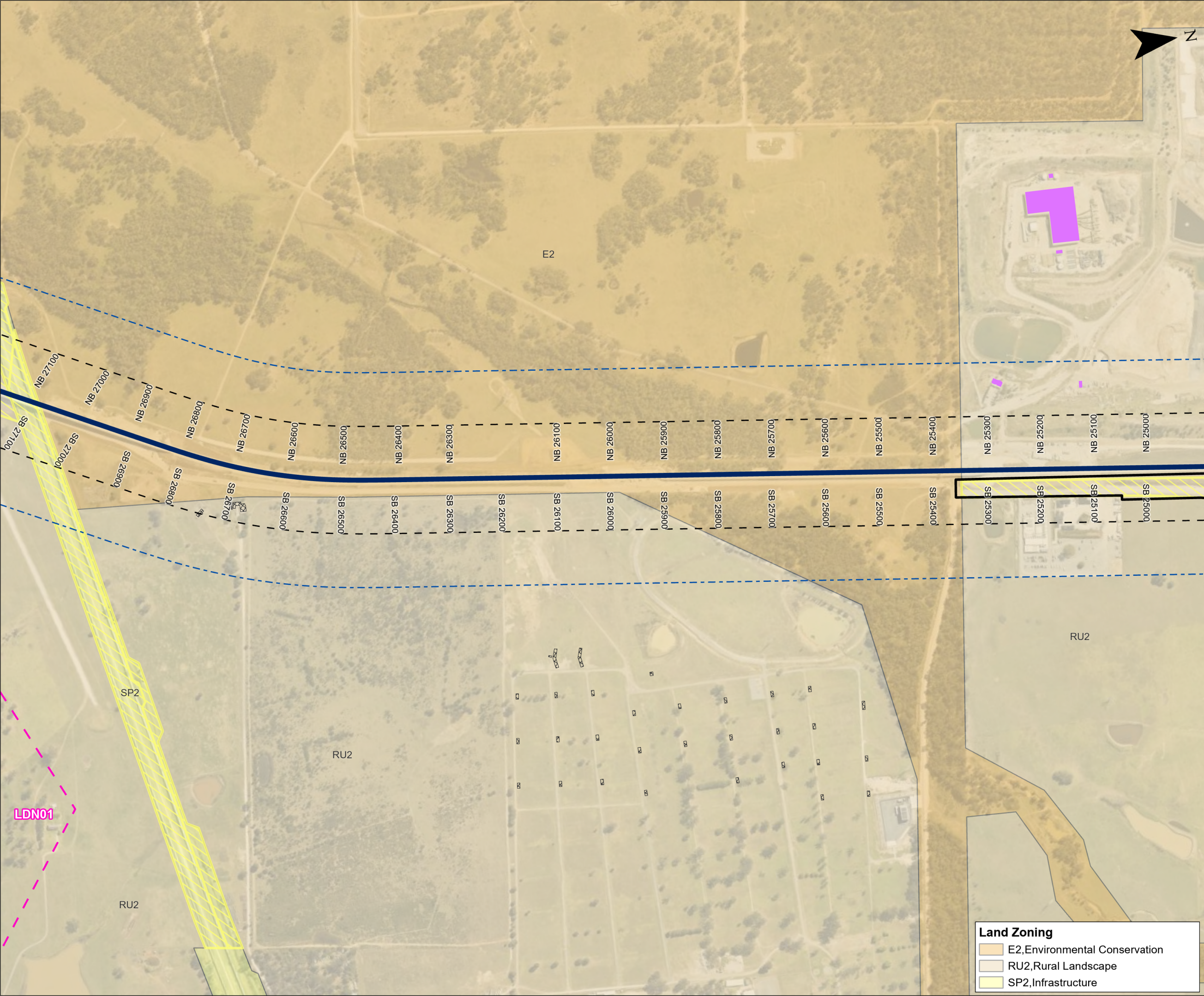
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PROJECT: Sydney Metro - WSA
LOCATION: SMF
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 4
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

- E2,Environmental Conservation
- RE1,Public Recreation
- RU2,Rural Landscape
- RU4,Primary Production Small Lots
- SP2,Infrastructure





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ABN 98 657 249 682

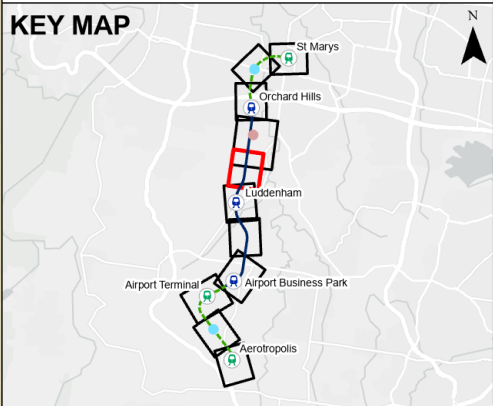
0 80 160 240 320
Metres

Scale: 1:6,500 @ A3
GDA2020 MGA Zone 56

LEGEND

- Rail Alignment (Surface)
- Alignment 100m Buffer
- Alignment 200m Buffer
- Project Site Boundary
- Property Acquisition
- PLM Noise Catchment Area
- Noise and Vibration Receiver Category**
- IND - Industrial
- NA - Not Assessable

KEY MAP



SOURCES:
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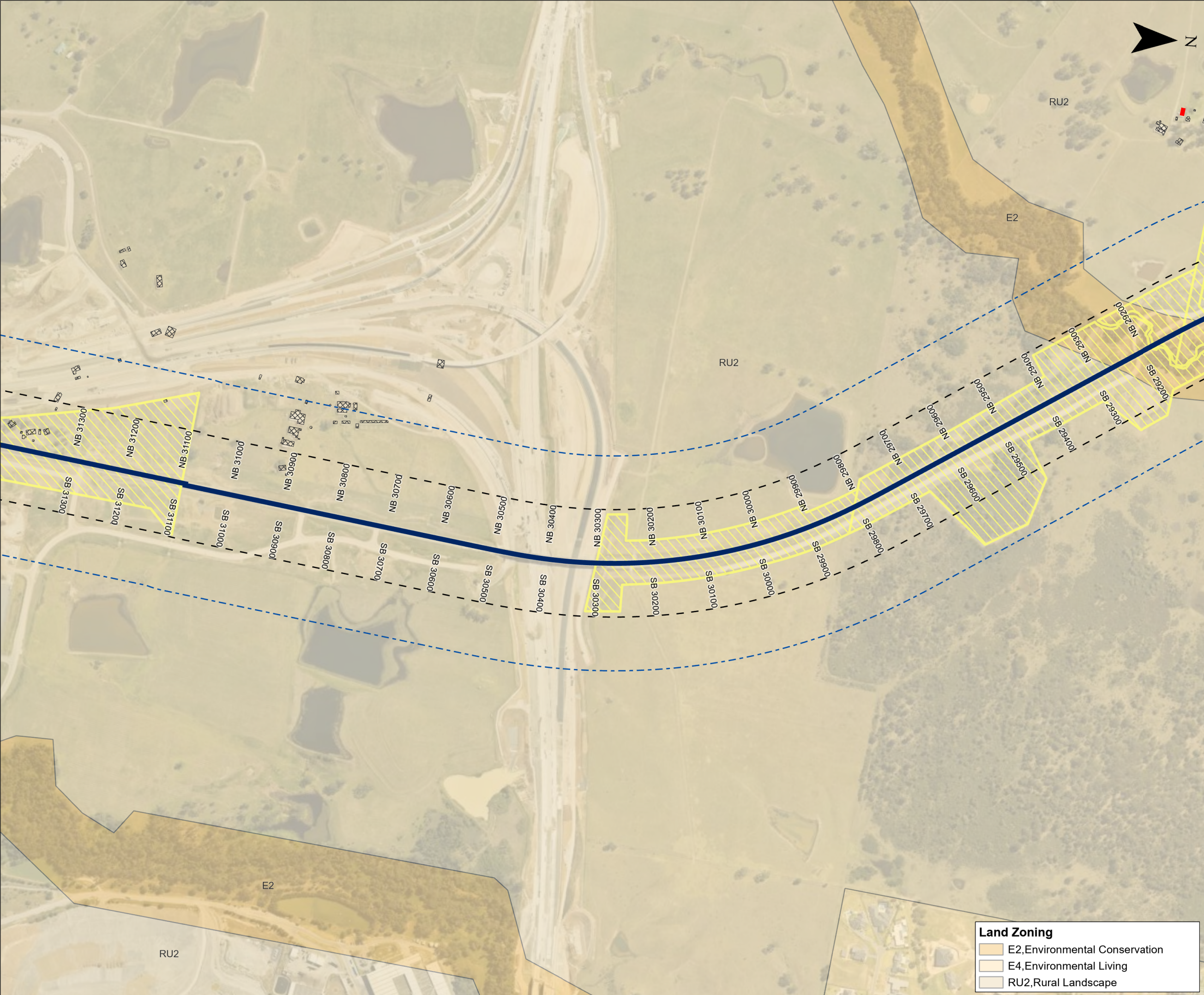
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PROJECT: Sydney Metro - WSA
LOCATION: SMF
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 5
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

- E2, Environmental Conservation
- RU2, Rural Landscape
- SP2, Infrastructure





PARKLIFE METRO PTY LTD

ABN 98 657 249 682

080160240320

Metres

Scale:1:6,500 @ A3

GDA2020 MGA Zone 56

LEGEND

Rail Alignment (Surface)

Alignment 100m Buffer

Alignment 200m Buffer

Property Acquisition

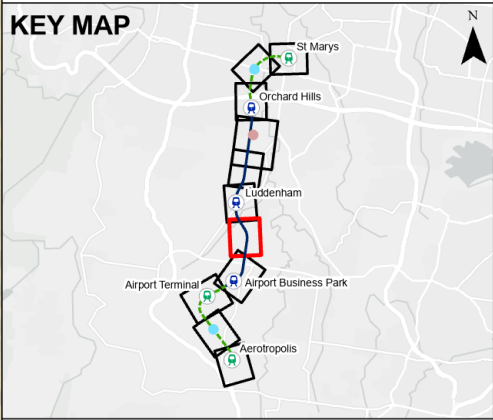
Noise Measurement Locations

EIS Noise Logger

Noise and Vibration Receiver Category

RES - Residential

NA - Not Assessable



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PROJECT:

LOCATION:

FIGURE TITLE:

PAGE NO:

CREATED BY:

DATE:

VERSION:

FIGURE NO:

Sydney Metro - WSA

SWD

Operational Noise and Vibration Review - Land Use Survey

7

NC17428

17/10/2024

8

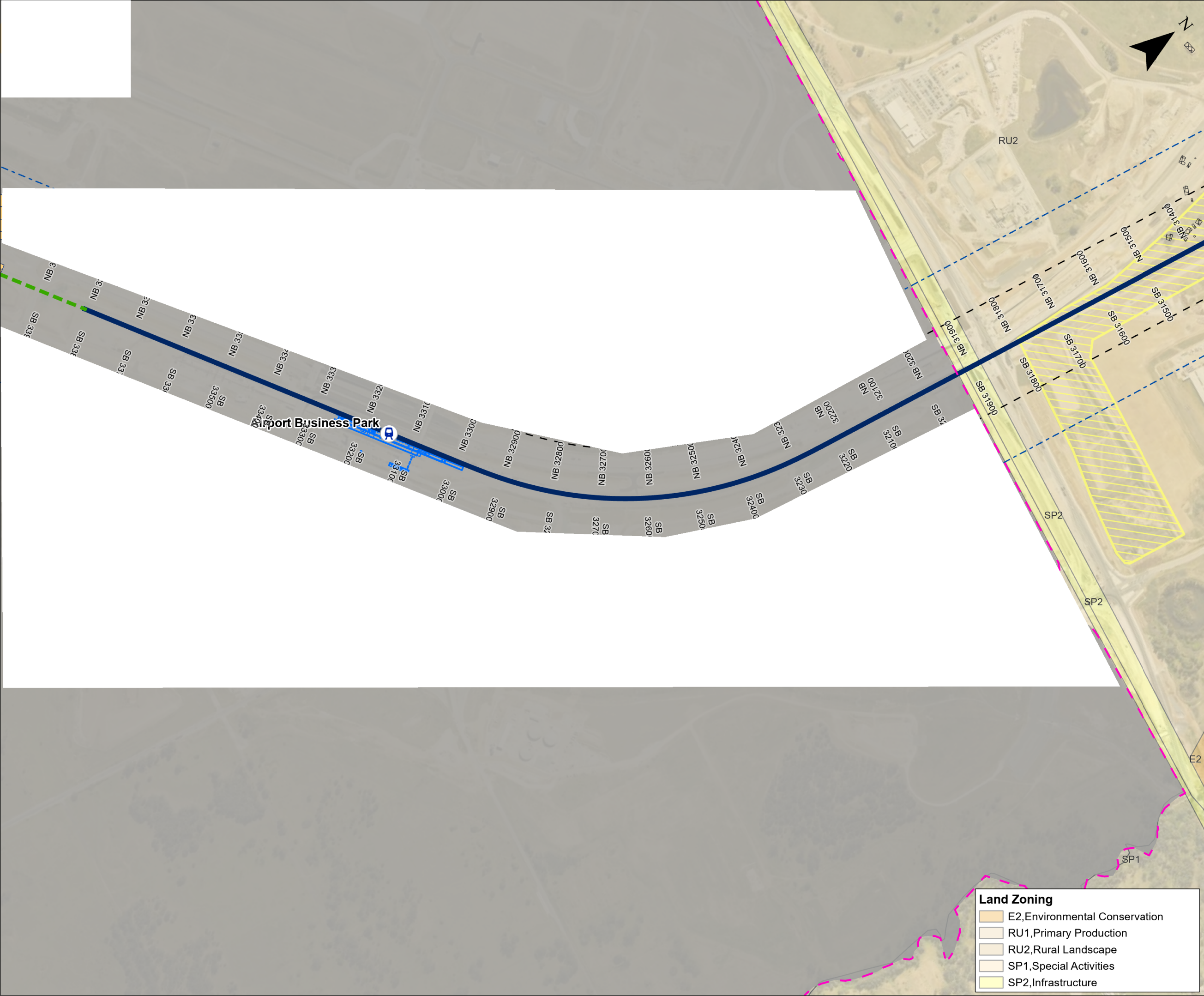
SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

E2,Environmental Conservation

E4,Environmental Living

RU2,Rural Landscape



PARKLIFE METRO PTY LTD
ABN 98 657 249 682

0 80 160 240 320
Metres

Scale: 1:7,000 @ A3
GDA2020 MGA Zone 56

LEGEND

- Above Ground Station
- Rail Alignment (Surface)
- Rail Alignment (Tunnel)
- Station or Facility Building Structures
- Alignment 100m Buffer
- Alignment 200m Buffer
- Western Sydney Airport
- Property Acquisition
- Noise Measurement Locations**
 - EIS Noise Logger
 - PLM Noise Catchment Area
- Noise and Vibration Receiver Category**
 - APT - Airport terminal
 - COM - Commercial
 - HTL - Hotels
 - NA - Not Assessable
 - Future Assessable Receiver

KEY MAP

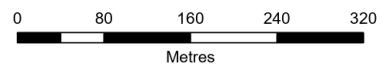
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PROJECT: Sydney Metro - WSA
LOCATION: ABP
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey
PAGE NO: 8
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

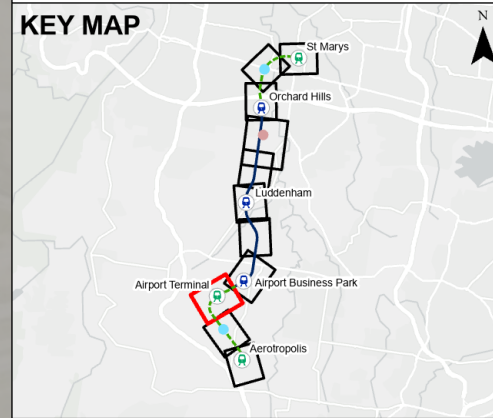
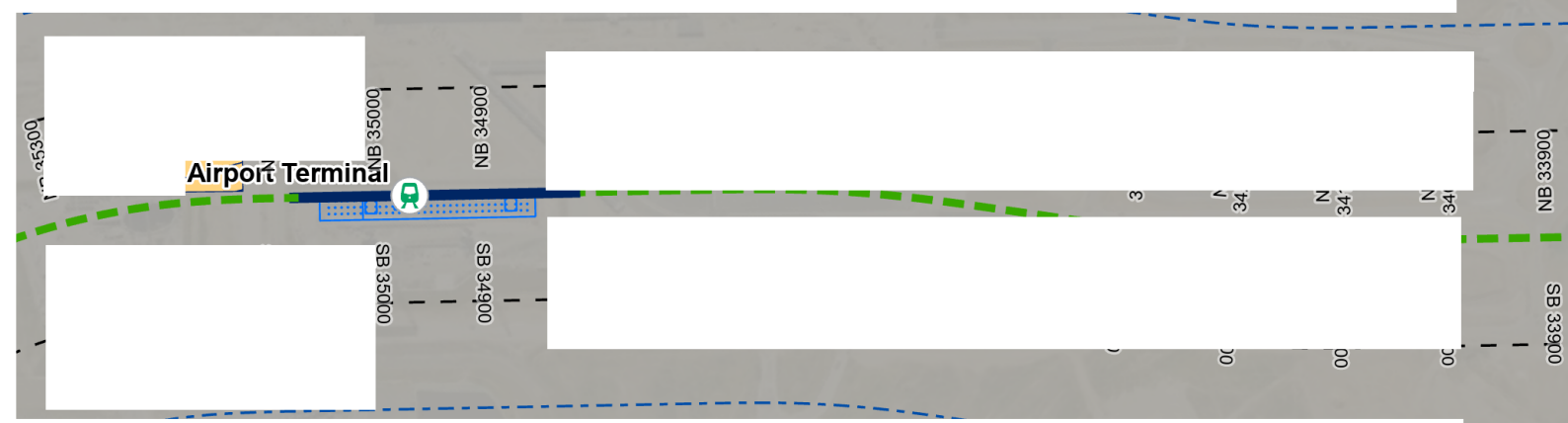


PARKLIFE METRO PTY LTD
ABN 98 657 249 682



Scale:1:7,000 @ A3
GDA2020 MGA Zone 56

- LEGEND**
- Underground Station
 - Rail Alignment (Surface)
 - Rail Alignment (Tunnel)
 - Station or Facility Building Structures
 - Alignment 100m Buffer
 - Alignment 200m Buffer
 - Western Sydney Airport
 - PLM Noise Catchment Area
- Noise and Vibration Receiver Category**
- APT - Airport terminal
 - ATC - Airport tower control
 - COM - Commercial
 - HTL - Hotels
 - Future Assessable Receiver



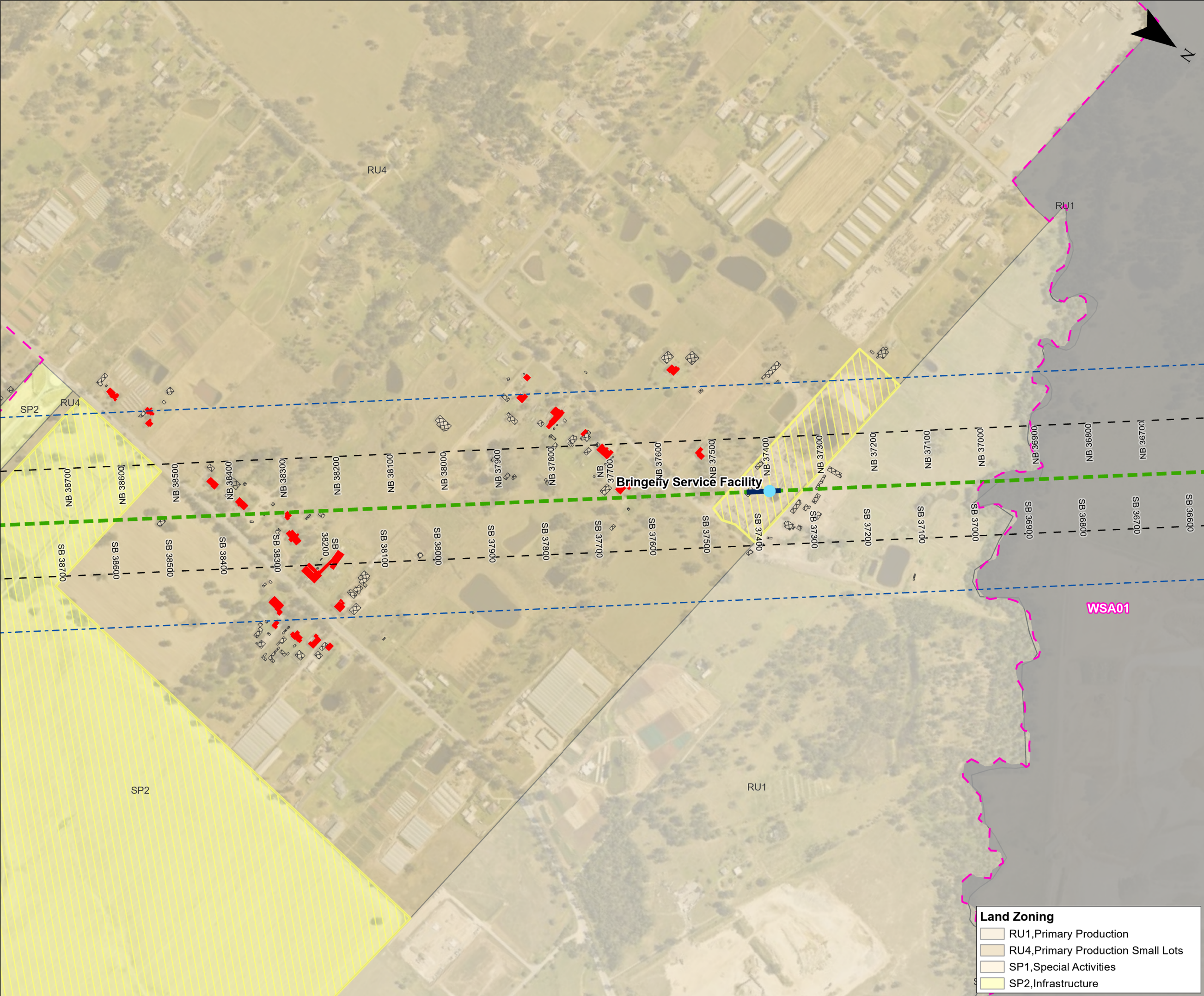
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PROJECT: Sydney Metro - WSA
LOCATION: ATL
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 9
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning
 SP1, Special Activities





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0 80 160 240 320
Metres

Scale:1:6,500 @ A3
GDA2020 MGA Zone 56

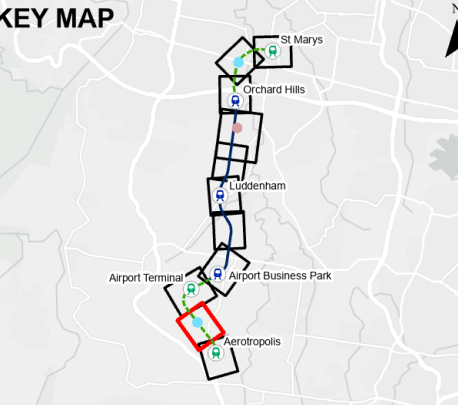
LEGEND

- Service Facility (Inactive Site)
- Rail Alignment (Surface)
- Rail Alignment (Tunnel)
- Alignment 100m Buffer
- Alignment 200m Buffer
- Western Sydney Airport
- Property Acquisition
- PLM Noise Catchment Area

Noise and Vibration Receiver Category

- RES - Residential
- NA - Not Assessable

KEY MAP



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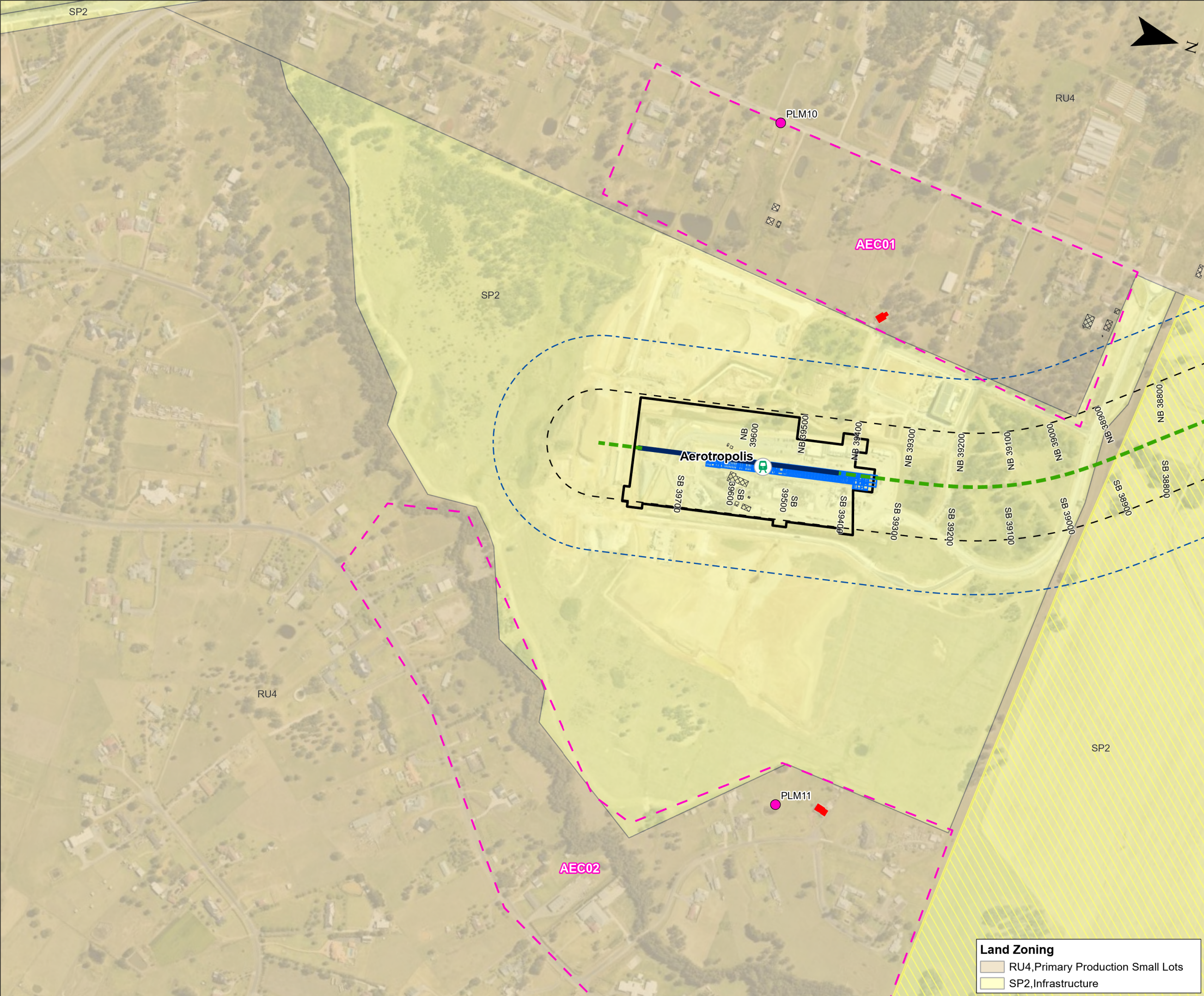
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PROJECT: Sydney Metro - WSA
LOCATION: BSF
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 10
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

- RU1,Primary Production
- RU4,Primary Production Small Lots
- SP1,Special Activities
- SP2,Infrastructure



PARKLIFE METRO PTY LTD
ABN 98 657 249 682

0 80 160 240 320
Metres

Scale:1:6,500 @ A3
GDA2020 MGA Zone 56

LEGEND

- Underground Station
- Rail Alignment (Surface)
- Rail Alignment (Tunnel)
- Station or Facility Building Structures
- Alignment 100m Buffer
- Alignment 200m Buffer
- Project Site Boundary
- Property Acquisition

Noise Measurement Locations

- PLM Noise Logger
- PLM Noise Catchment Area

Noise and Vibration Receiver Category

- RES - Residential
- NA - Not Assessable

KEY MAP

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PROJECT: Sydney Metro - WSA
LOCATION: AEC
FIGURE TITLE: Operational Noise and Vibration Review - Land Use Survey

PAGE NO: 11
CREATED BY: NC17428
DATE: 17/10/2024
VERSION: 8
FIGURE NO: SMWSASSM-PLD-SWD-SW000-EN-GIS-0002

Land Zoning

- RU4, Primary Production Small Lots
- SP2, Infrastructure

Appendix C Long term noise monitoring methodology

Overview

Noise monitoring has been undertaken in accordance with the EPA Approved Methods for the measurement and analysis of environmental noise in NSW [30].

Long-term unattended noise loggers were installed at the locations outlined in Table 61. All loggers were positioned in the 'free-field', at a height of 1.5 m above the local ground. The sample time interval was set to 15 minutes and the meter time constant set to 'Fast'.

The loggers continuously record ambient noise levels for a period of up to 14 consecutive days between 24 March 2023 to 6 April 2023, allowing for adverse weather conditions, with the aim to collecting a minimum of 7 days of valid data at each location. It is noted that the monitoring period did not include school holidays and was deemed typical.

Measurement Locations

Table 61 presents the monitoring locations against each the station or facility. The noise monitoring locations are shown in the land use maps in Appendix B.

The locations were selected to establish existing baseline noise levels and Rating Background Levels (RBLs) at the nearest most potentially affected residential locations to each facility for which the NPfl applies. Monitoring was only carried out at fixed facilities with existing residential receivers.

TABLE 61 LONG-TERM BASELINE NOISE MONITORING LOCATIONS

Nearest Station / Facility	Proposed Noise Monitoring Locations		
	NCA	ID	Address
St Marys (STM)	NCA-STM01	NML-PLM01	32 Cedar Crescent, St Marys
	NCA-STM02	NML-PLM02	1 Camira St, St Marys
	NCA-STM03	NML-PLM03	82 Hobart Street, St Marys
Orchard Hills (OHE)	NCA-OHE01	NML-PLM04	44 Samuel Marsden Road, Orchard Hills
		NML-PLM05	8 Lansdowne Street Orchard Hills
Stabling and Maintenance Facility (SMF)	NCA-SMF01	NML-PLM06	7 Bordeaux Place, Orchard Hills
	NCA-SMF02	NML-PLM07	44 Luddenham Road, Orchard hills NSW
	NCA-SMF01	NML-PLM08	4 Chablis Place, Orchard Hills
Luddenham Road (LDN)	NCA-LDN01	NML-PLM09	48 Portrush Crescent, Luddenham
Aerotropolis Core (AEC)	NCA-AEC01	NML-PLM10	105 Badgerys Creek Road, Badgerys Creek
	NCA-AEC02	NML-PLM11	25 The Retreat, Bringelly

Equipment

Table 62 details the noise monitoring equipment used. All loggers carry current calibration certificates. Calibration of the noise monitoring equipment was checked prior to and following all measurements with no significant drift in calibration being recorded.

TABLE 62: NOISE MONITORING INSTRUMENTATION

Location ID	Equipment/model	Serial No.	Class per IEC 61672-1:2019 [31]
NML-PLM01	ARL Ngara	8780FB	Class 1 Environmental noise logger
NML-PLM02	ARL Ngara	878012	Class 1 Environmental noise logger
NML-PLM03	ARL Ngara	8780A2	Class 1 Environmental noise logger
NML-PLM04	ARL Ngara	8780B0	Class 1 Environmental noise logger
NML-PLM05	ARL Ngara	87802E	Class 1 Environmental noise logger
NML-PLM06	ARL Ngara	878042	Class 1 Environmental noise logger
NML-PLM07	ARL Ngara	878007	Class 1 Environmental noise logger
NML-PLM08	ARL Ngara	878000	Class 1 Environmental noise logger
NML-PLM09	ARL Ngara	8780EA	Class 1 Environmental noise logger
NML-PLM10	ARL Ngara	8780A3	Class 1 Environmental noise logger
NML-PLM11	ARL Ngara	878002	Class 1 Environmental noise logger

Weather data

Weather data, including rainfall (mm) and wind speed (km/h), in 15-minute increments was obtained for the monitoring period from the Bureau of Meteorology (BOM) Horsley Park Equestrian Centre weather station, located within 15 km of all noise monitoring locations. Where appropriate, correction factors to the wind speed have been applied based on Table C.1 of ISO 4354:2009 [32]. This rainfall and wind data has been used to identify periods of adverse weather during the monitoring period (i.e. rain > 0 mm, wind speed > 5 m/s). Where appropriate, periods of high winds and/or rain will be excluded from the analysis in accordance with the NSW *Noise Policy for Industry* [3].

Appendix D Derivation of NPfl criteria

Airborne noise from fixed facilities is assessed to criteria derived from the NPfl. The assessment has adopted the operational noise criteria for the day, evening and night periods, as derived in accordance with the NPfl.

The assessment procedure in terms of the NPfl has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

Intrusive noise criteria

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $dBL_{Aeq, 15minute} \leq \text{Rating Background Level (RBL) plus 5 dB}$

(where $dBL_{Aeq, 15minute}$ represent the equivalent continuous noise level of the source)

Note that as the Intrusive Noise Trigger Level is established from the prevailing background noise levels at the residential receiver location, the existing background noise level is to be measured.

Amenity noise criteria

The NPfl's amenity criteria are designed to maintain noise level amenity for particular land uses, including residential and other land uses. The NPfl recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and other sensitive receivers in Table 2.2 of the NPfl. Noise from new sources need to be designed such that the cumulative effect does not produce levels that would be significantly above the criterion.

TABLE 63: RECOMMENDED AMENITY NOISE LEVELS

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) L_{Aeq} , dB(A)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward	All	Noisiest 1-hour	35
Internal	All	Noisiest 1-hour	50
External			

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) L_{Aeq} , dB(A)
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, gold course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes:

The recommended amenity noise levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

1. The NPI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.
- Where shoulder period is applicable Night period is from 10pm-5pm and Shoulder periods are between 5:00pm-7:00pm on Monday to Saturday and 5:00pm-8:00pm on Sunday & Public Holidays.

The recommended amenity noise levels (RANLs) represent the objective for **total** industrial noise at a receiver location, where as the project amenity noise level (PANL) represents the objective for noise from a **single** industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)

The NPfI also provides the following exceptions to the above method for deriving the project amenity noise level:

1. *In areas with high traffic noise levels.*
2. *In proposed developments in major industrial clusters.*
3. *Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.*
4. *Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.*

Where ambient noise levels at the sensitive receivers is controlled by traffic the NPI sets the PANLs to $L_{Aeq}(\text{period}(\text{traffic}))$ minus 15 dB(A) in the case that the level of transport $L_{Aeq}(\text{period}(\text{traffic}))$ exceeds the RANL by 10 dB or more.

Sleep disturbance criteria

The NSW NPI recommends the following screening criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am:

- $dBL_{Aeq, 15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or;
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater

As the former is equivalent to the intrusive noise trigger levels at night, the $L_{Amax(night)}$ parameter has been assessed, as it provides an additional and alternative assessment.

Background noise monitoring

Refer to Appendix C for the monitoring methodology and Table 6 for the summarised result table in Section 4.

Project Specific Noise Trigger Levels (PSNTLs)

For existing receivers, this assessment has adopted the operational noise criteria derived in accordance with the NPfI. The operational noise goals for sensitive receivers are in the criteria section of each station respectively.

The designated NCAs are predominantly categorised as urban with exception of the SMF.

Regarding the derivation of amenity noise levels at the SMF, the areas surrounding the SMF site were categorised as suburban and rural. In establishing the Project Amenity Noise Level (PANL), consideration has been given to the number of potential industrial sites that receivers may be affected by. Two industrial sites potentially affecting the SMF NCAs were identified:

- Patons Lane Resource Recovery Centre (PLRRC).
- Proposed Industrial zone subject to planning proposal.

The default correction from the Recommended Amenity Noise Level (RANL) is minus 5 dB is based on receivers being affected by three to four sites. For receivers to the west and northwest (SMF01), they are potentially affected only by the SMF and Patons Lane Resource and Recovery Centre (PLRRC). For the residential receivers to the east and southeast of the SMF (SMF02) receivers could be affected by two to three sites, being the SMF, PLRRC and future industrial land to the south of Patons Lane (see Figure 3). The nearest most potentially affected receiver in SMF02, 24376-471D-RES-EX-SMF02, is further removed from the future industrial zone and therefore considered to be affected only by the SMF and PLRRC. While the residential receivers to the north of the SMF (SMF03) are potentially affected only by the SMF, it has been assumed that another potential industrial site might be introduced in the future. Accordingly, the PANL for SMF01, SMF02 and SMF03 has been established as RANL minus 3 dB.

The result table summarises the intrusive noise trigger levels derived from the baseline monitoring results tabulated in Table 6. and the project amenity noise level based on zone categories.

Appendix E SMF operation scenarios

Appendix E.1 SMF Operations – Day 1

Appendix E.1 SMF Operations - Stage 1 Day 1

SMF noise sources and operations (3 car train sets)				No. of source events/items per typical worst-case 15-minute period																
No.	Area/Building	Operation	Details / Source location	Night 3.30am to 4.00am	4.00am - 4:15am	4.15am-4.30am	Shoulder 5.00am-5.30am	5.30am- 6.00am	Day 7.00am - 9.00am	9.00am - 10.00am	10.00am - 4.00pm	3.15pm- 3.45pm	3.45pm- 4.00pm	05.30pm- 06.00pm	Evening 6.00pm-7.00pm	7.00pm-8.00pm	8.00pm- 10.00pm	Night 12.00am -1.00am	1.00am-3.00am	
1	Stabling Yard	Sleep mode	- ASU operates only in exceptional circumstances (1 per train set) - Single ASU turns On every 37.5 min for 3.6 min based on max allowable leakage rates per EN 50215 2009-10. - Half of fleet active in any 15min period.	3 trains (6 trains in total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6 trains (12 trains in total)
2	Stabling Yard	Start of revenue Service	- Commences approx. 20 minutes prior to departure during night/shoulder periods, 30 minutes during the daytime period - ASU (max nominal) on 5 min for first 15min (1 per train set) - Door tests with chimes enabled (18 doors per train set) <u>Day/Evening</u> - HVAC (max cooling) (6 per train set) - APS on (nominal max) operation (2 per train set) <u>Night</u> - HVAC (partial cooling) (6 per train set) - APS on reduced operation (2 per train set)	4 trains	2 trains	2 trains (from previous period until departure)	4 trains	-	-	-	-	4 trains	-	-	-	-	-	-	-	
3	Stabling Yard	Train departing	- Train travelling at slow speed/ Stabling Yard neck (average 25 km/h) - Controlled by train systems sources - TM on acceleration 0-40km/hr (8 per train set) - TIC on reduced operation (2 fans 50% rpm) pump ON (2 per train set) - MT RF Transformer on reduced operation (2 fans, 50% rpm, pump ON) (1 per train set) <u>Day/Evening</u> - HVAC (max cooling) (6 per train set) - APS on (nominal max) operation (2 per train set) <u>Night</u> - HVAC (partial cooling) (6 per train set) - APS on reduced operation (2 per train set)	-	4 trains (Sweeper)	2 trains (includes 1 x Hot Standby STM)	-	2 trains (4 trains - over the half hour)	-	-	-	-	4 trains	-	-	-	-	-	-	
4	Stabling Yard	Trains returning	- Train travelling at slow speed/ Stabling Yard neck (average 25 km/h) - Controlled by train systems sources - HVAC partial cooling (6 per train set) - APS on nominal max (2 per train set) - TM on acceleration 0-40km/hr (8 per train set) - TIC on max operation (2 fans 100% rpm) pump ON (2 per train set) - MT RF Transformer on max operation (2 fans, 100% rpm, pump ON) (1 per train set)	-	-	-	-	-	-	2 trains (4 trains in total)	-	-	-	-	-	-	2 trains (4 trains in total)	-	2 trains (6 trains in total)	-
5	Stabling Yard	Train cleaning (internal)	- Services take up to one hour per train set - HVAC on partial cooling during all times. (6 per train set) - Internal vacuum cleaning in trains, doors to be closed during cleaning. - APS on reduced operation (2 per train set) - ASU on max nominal operation (1 per train set) for 3.6min in any given 15min period for half of the operational fleet	-	-	-	-	-	-	-	-	-	-	-	-	up to 4 trains	up to 4 trains (same trains as previous period)	up to 4 trains	up to 4 trains (6 in total incl. previous period)	
6	Stabling Yard	Train readiness (MOS inspection)	- Trains will have visual inspection and functional/performance checks (1hr/trainset) HVAC partial cooling (6 per train set) - APS on reduced operation (2 per train set)	-	-	-	-	-	-	-	-	-	-	-	-	-	up to 4 trains (same trains as cleaning)	up to 4 trains (same trains as cleaning)	up to 4 trains (same trains as cleaning, 6 in total)	
7	Train wash (Bldg 13)	Train wash plant	- In use 9:00 to 15:30; 19:00 to 01:00, 7 days/ week - Train washing to operate for 10min in a given 15 min period. Note that typical operations will be that 8 trains are cleaned for 6 min and 2 trains for 10 min.	-	-	-	-	-	-	-	1 train (2 trains cleaned in total)	1 train (2 trains cleaned in total)	1 train (2 trains cleaned in total)	-	-	1 train (2 trains cleaned in total)	1 train (2 trains cleaned in total)	1 train (2 trains in total)	-	
8	UFWL	Reprofiling wheels	- Tandem UFWL operates reprofiling of 2 wheelsets at the same time - A typical bogie wheelset turning inclusive of all operation time for rolling in, holding, measurement, rolling out of the wheelset will be less than 40 minutes. - Based on UFWL operating continuously (conservative) - Usage will be 40 mins in total per week and can occur anytime between 9.00 and 8.00pm - Electric shunter not modelled due to low contribution when being used intermittently.	-	-	-	-	-	-	1 train	1 train	1 train	1 train	1 train	1 train	1 train	-	-	-	
9	Graffiti Blowwash	Train cleaning	- Conservatively based on Graffiti Wash used on 1 x Train per Day - Between 9.00am and 8.00pm for 1-2 hrs - Assessment external cleaning of train	-	-	-	-	-	-	-	-	-	-	-	-	1 Train (1-2hrs cleaning)	-	-	-	
10	Depot Personnel Protection System (DPPS)	Auditory alarms	- Train Warning System in the Maintenance Area - Noise level no more than 15dB(A) above ambient noise level. - On 2min in 15min period while train arriving/ departing shed	-	-	-	-	-	2min	2min	2min	2min	2min	2min	2min	2min	2min	-	-	
11	Maintenance Building	Maintenance activities	1 train in the Shed each week - MR3 will be the Low Maintenance Rd (Low noise inspections) - every 30 days - Early Stages: - MR1 & 2 (months) RST Modifications - All day every day for 1st 6 months - Based on 24 hr working - Design for Day & Night operations - Lifting & Operation of Mobile Lifting System / jacks - Small Tools / Mobile Compressors	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating
12	Maintenance Building	Maintenance at various workshops	- Infrastructure Workshops each day - Late afternoon & early morning (before the peak) - Based on 2 hrs concurrently for each workshop	-	All workshops	All workshops	All workshops	-	-	-	-	-	-	-	All workshops	All workshops	-	-	-	
13	Substation		To operate at all times, unless isolation from network full shutdown and maintenance.	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	
14	Maintenance Road 2	Battery Electric Locomotive and Track Inspection Unit	- Based on weekly operations through the network and minor repairs. - Major work each 6 months. - IMV (Most used will be the Track Inspection Unit)	2 BEL return	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 BELs departing	
15	Sitewide	Track maintenance	- General Inspections x 1 per month at night time 4 x 24 hr possessions per year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
16	Sitewide	Deliveries and rubbish collection	- Normal deliveries with usual delivery trucks throughout the day 7am to 6pm 1 rubbish truck per day for 30 mins	-	-	-	-	-	1 truck	1 truck	1 truck	1 truck	1 truck	1 truck	-	-	-	-	-	
17	Sitewide	Carpark	- Vehicular movements in and out of carpark over 24 hour period. Carpark 80% full during the day. - Refer to Car Parking Memo by RATP	31 car movements	-	-	-	45 car movements	44 car movements (occurs during 7.30am-8.00am)	-	-	-	-	44 car movements -	-	-	44 car movements (occurs between 8.30pm-9.00pm)	3 car movements	-	

Appendix E.1 SMF Operations - Stage 1 Day 1

SMF noise sources and operations (3 car train sets)

[illegible]

Appendix E.2 SMF Operations – Ultimate Service

Appendix E.2 SMF Operations - Stage 1 Ultimate

SMF noise sources and operations (4 car train sets)				No. of source events/items per typical worst-case 15-minute period																	
				Night 3.30am to 4.00am	4.00am - 4.15am	4.15am-4.30am	Shoulder 5.00am-5.30am			5.30am- 6.00am	6.00am- 6.30am	Day 7.00am - 9.00am	9.00am - 10.00am	10.00am - 4.00pm	3.15pm- 3.45pm	3.45pm- 4.00pm	05.30pm- 06.00pm	Evening 6.00pm-7.00pm	7.00pm- 8.00pm	8.00pm- 10.00pm	Night 12.00am - 1.00am
1	Stabling Yard	Sleep mode	- ASU operates only in exceptional circumstances (1 per train set) - Single ASU turns On every 37.5 min for 3.6 min based on max allowable leakage rates per EN 50215 2009-10. - Half of fleet active in any 15min period.	5 trains (10 trains in total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9 trains (18 trains in total)
2	Stabling Yard	Start of revenue Service	- Commences approx. 20 minutes prior to departure during night/shoulder periods, 30minutes during the daytime period - ASU (max nominal) on 5 min for first 15min (1 per train set) - Door tests with chimes enabled (24 doors per train set) <u>Day/Evening</u> - HVAC (max cooling) (8 per train set) - APS on (nominal max) operation (2 per train set) <u>Night</u> - HVAC (partial cooling) (8 per train set) - APS on reduced operation (2 per train set)	6 trains	5 trains (2 from previous period)	5 trains until departure	6 trains	up to 3 trains (2 - from the previous period until departure)	-	-	-	6 trains	up to 3 trains (2 - from the previous period until departure)	-	-	-	-	-	-	-	
3	Stabling Yard	Train departing	- Train travelling at slow speed/ Stabling Yard neck (average 25 km/h) - Controlled by train systems sources - TM on acceleration 0-40km/hr (8 per train set) - TIC on reduced operation (2 fans 50% rpm) pump ON (2 per train set) - MT RF Transformer on reduced operation (2 fans, 50% rpm, pump ON) (1 per train set) <u>Day/Evening</u> - HVAC (max cooling) (8 per train set) - APS on (nominal max) operation (2 per train set) <u>Night</u> - HVAC (partial cooling) (8 per train set) - APS on reduced operation (2 per train set)	-	4 trains (Sweeper)	5 trains (includes 1 x Hot Standby STM)	up to 4 trains (total 7 trains)	-	-	-	up to 4 trains (total 7 trains)	-	-	-	-	-	-	-	-	-	
4	Stabling Yard	Trains returning	- Train travelling at slow speed/ Stabling Yard neck (average 25 km/h) - Controlled by train systems sources - HVAC partial cooling (8 per train set) - APS on nominal max (2 per train set) - TM on acceleration 0-40km/hr (8 per train set) - TIC on max operation (2 fans 100% rpm) pump ON (2 per train set) - MT RF Transformer on max operation (2 fans, 100% rpm, pump ON) (1 per train set)	-	-	-	-	-	-	up to 3 trains (7 trains in total)	-	-	-	-	-	-	up to 3 trains (7 trains in total)	-	3 trains (9 trains in total)	-	
5	Stabling Yard	Train cleaning (internal)	- Services take up to one hour per train set - HVAC on partial cooling during all times. (8 per train set) - Internal vacuum cleaning in trains, doors to be closed during cleaning. - APS on reduced operation (2 per train set) - ASU on max nominal operation (1 per train set) for 3.6min in any given 15min period for half of the operational fleet	-	-	-	-	-	-	-	-	-	-	-	-	-	up to 4 trains	up to 4 trains (7 in total incl. previous period)	up to 4 trains (same trains as cleaning)	up to 4 trains (9 in total incl. previous period)	
6	Stabling Yard	Train readiness (MOS inspection)	- Trains will have visual inspection and functional/performance checks (1hr/trainset) - HVAC partial cooling (6 per train set) - APS on reduced operation (2 per train set)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	up to 4 trains (same trains as cleaning)	up to 4 trains (same trains as cleaning)	up to 4 trains (same trains as cleaning)	
7	Train wash (Bldg 13)	Train wash plant	- In use 9:00 to 15:30; 19:00 to 01:00, 7 days/ week - Train washing to operate for 10min in a given 15 min period. Note that typical operations will be that 8 trains are cleaned for 6 min and 2 trains for 10 min.	-	-	-	-	-	-	-	-	1 train (4 trains cleaned in total)	1 train (4 trains cleaned in total)	1 train (4 trains cleaned in total)	-	-	-	1 train (4 trains cleaned in total)	1 train (2 trains in total)	-	
8	TUWL	Reprofiling wheels	- TUWL operates reprofiling of 2 wheelsets at the same time - A typical bogie wheelset turning inclusive of all operation time for rolling in, holding, measurement, rolling out of the wheelset will be less than 40 minutes. - Based on UFWL operating continuously (conservative) - Usage will be 40 mins in total per week and can occur anytime between 9.00 and 8.00pm - Electric shunter not modelled due to low contribution when being used intermittently.	-	-	-	-	-	-	1 train	1 train	1 train	1 train	1 train	1 train	1 train	1 train	-	-	-	
9	Graffiti Biowash	Train cleaning	- Conservatively based on Graffiti Wash used on 1 x Train per Day - Between 9.00am and 8.00pm for 1-2 hrs - Assessment external cleaning of train	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 Train (1-2hrs cleaning)	-	-	
10	Depot Personnel Protection System (DPPS)	Auditory alarms	- Train Warning System in the Maintenance Area - Noise level no more than 15dB(A) above ambient noise level. - On 2min in 15min period while train arriving/ departing shed	-	-	-	-	-	-	2min	2min	2min	2min	2min	2min	2min	2min	2min	-	-	
11	Maintenance Building	Maintenance activities	2 trains in the Shed each week - MR3 will be the Low Maintenance Rd (Low noise inspections) - every 30 days - Early Stages: - MR1 & 2 (months) RST Modifications - All day every day for 1st 6 months - Based on 24 hr working - Design for Day & Night operations - Lifting & Operation of Mobile Lifting System / jacks - Small Tools / Mobile Compressors	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	
12	Maintenance Building	Maintenance at various workshops	- Infrastructure Workshops each day - Late afternoon & early morning (before the peak) - Based on 2 hrs concurrently for each workshop	-	All workshops	All workshops	All workshops	-	-	-	-	-	-	-	-	All workshops	All workshops	-	-	-	
13	Substation		To operate at all times, unless isolation from network full shutdown and maintenance.	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Operating	
14	Maintenance Road 2	Battery Electric Locomotive and Track Inspection Unit	IMV (Most used will be the Track Inspection Unit)	2 BEL return	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 BELs departing	
15	Sitewide	Track maintenance	- General Inspections x 1 per month at night time 4 x 24 hr possessions per year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
16	Sitewide	Deliveries and rubbish collection	- Normal deliveries with usual delivery trucks throughout the day 7am to 6pm 1 rubbish truck per day for 30 mins	-	-	-	-	-	-	1 truck	1 truck	1 truck	1 truck	1 truck	1 truck	-	-	-	-	-	
17	Sitewide	Carpark	- Vehicular movements in and out of carpark over 24 hour period. Carpark 80% full during the day. - Refer to Car Parking Memo by RATP	31 car movements	-	-	-	45 car movements	-	44 car movements (occurs during 7.30am-8.00am)	-	-	-	-	-	44 car movements	-	-	44 car movements (occurs between 8.30pm-9.00pm)	3 car movements -	

Appendix E.2 SMF Operations - Stage 1 Ultimate

SMF noise sources and operations (4 car train sets)

[illegible]

Appendix F STM operation scenarios

Appendix F STM Operational Assessment Scenarios

Mode of Operation	NPfl Time Period	Source Considered	Capacity	
Normal	N/A: Determined to not be worst case as congested/emergency modes of operation are assessed to the same criteria with additional plant active.			
Congested (Multiple Single Train – Extended Line)	Day/Evening (assessed to evening criteria)	CT	2x CT at 66% Design Operating Point	
		TVF	1x TVF at 100% Capacity Per Station End (180m ³ /s East, 180m ³ /s West)	
		TEF	1x at 90m ³ /s	
		Non-emergency ECS	AHU/B02/0001A/B, BEF/L00/0001A/B, BEF/L00/0002A/B, BEF/L01/0001A/B, CEF/L01/0001A/B, GEF/L00/0001A/B, GEF/L00/0002A/B, GEF/L00/0003A/B, GEF/L00/0004, GEF/L00/0005A/B, GEF/L01/0001A/B, GEF/L01/0002A/B, GEF/L01/0003, OAF/B02/0001A/B, OAF/B02/0002A/B, OAF/L00/0001A/B, OAF/L00/0002A/B, OAF/L00/0003, OAF/L00/0004, OAF/L01/0001A/B, OAF/L01/0001A/B, OAF/L01/0002A/B, OAF/L01/0003A/B, TEF/L00/0001, TEF/L00/0002, TEF/L01/0001, WEF/L00/0001A/B, WEF/L00/0002A/B, WEF/L00/0003, WEF/L01/0001A/B	
	Night	CT	2x CT at 44.5% Design Operating Point	
		TVF	1x TVF at ~77% Capacity Per Station End (140m ³ /s East, 140m ³ /s West)	
		TEF	1x at 90m ³ /s	
		Non-emergency ECS	As above for congested evening	
		Notes:		
		Day one operation TVF includes future (extended line) attenuation provisions and has been screened to have negligible impact.		

Appendix G OHE operation scenarios

Appendix G OHE Operational Assessment Scenarios

Mode of Operation	NPfl Time Period	Source Considered	Capacity
Normal	N/A: Determined to not be worst case as congested/emergency modes of operation are assessed to the same criteria with additional plant active.		
Congested (Multiple Single Train – Extended Line)	Day/Evening (assessed to evening criteria)	CT	2x CT at 66% Design Operating Point
		TVF	1x TVF at 100% Capacity (180m ³ /s North)
		Non-emergency ECS	NSB [GEF/L00/0001, TEF/L00/0001, OAF/L01/0001A/B, OAF/L01/0002A/B, OAF/L01/0003A/B, OAF/L01/0004, TEF/L01/0001A/B, BEF/L01/0001A/B, WEF/L01/0001A/B, GEF/L01/0001A/B, GPF/L01/0001A/B, GEF/L01/0003,AHU/B01/0001]
	Night		SSB [TEF/B01/0001A, OAF/B01/0001A/B, WEF/B01/0001A/B, GEF/B01/0001A/B, BEF/B01/0001A/B, GEF/B01/0002, CEF/B01/0001A/B, TEF/L00/0002, AHU/B01/0002]
		CT	2x CT at 44.5% Design Operating Point
		TVF	1x TVF at ~77% Capacity (140m ³ /s North)
		Non-emergency ECS	As above for congested evening
DRS	All	Rolling Stock Noise via DRS Shaft	DRA-01 at 40m ³ /s, DRA-02 at 70m ³ /s

Appendix H LDN operation scenarios

Appendix H LDN Operational Assessment Scenarios

Mode of Operation	NPfl Time Period	Source Considered	Capacity
Normal	Day/Evening/Night (assessed to Night criteria)	Air cooled Chiller (ACC)	2x ACC at 50% Design Operating Point
		Non-emergency ECS	BEF-L00-0002, BEF-L00-0004, CEF-L00-0001, FCU-L00-0002, FCU-L00-0014, FCU-L00-0015, GEF-L00-0001, GEF-L00-0003, GEF-L00-0005, GEF-L00-0006, GEF-L00-0008, GEF-L00-0009, OAF-L00-0001, OAF-L00-0002, OAF-L00-0003, OAF-L00-0004, OAF-L00-0005, TEF-L00-0001, TEF-L00-0002, TEF-L00-0003, WEF-L00-0001

Appendix I AEC operation scenarios

Appendix I AEC Operational Assessment Scenarios

Mode of Operation	NPfl Time Period	Source Considered	Capacity
Normal	N/A: Determined to not be worst case as congested/emergency modes of operation are assessed to the same criteria with additional plant active.		
Congested (Multiple Single Train – Extended Line)	Day/Evening (assessed to evening criteria)	CT	2x CT at 66% Design Operating Point
		TVF	1x TVF at 100% Capacity Per Station End (155m ³ /s North, 160m ³ /s South)
		TEF	1x at 90m ³ /s
		Non-emergency ECS	AHU/B02/0001A/B, BEF/L01/0001A/B, BEF/L01/0002A/B, BEF/L02/0001A/B, CEF/L01/0001A/B, GEF/B02/0001A/B, GEF/L01/0001A/B, GEF/L01/0002, GEF/L01/0003A/B, GEF/L01/0004A/B, GEF/L02/0001A/B, GEF/L02/0002A/B, GEF/L03/0001A/B, OAF/B02/0001A/B, OAF/B02/0002A/B, OAF/B02/0003A/B, OAF/L01/0001A/B, OAF/L01/0002A/B, OAF/L01/0003A/B, OAF/L02/0001A/B, OAF/L02/0002A/B, OAF/L03/0001A/B, TEF/L01/0001, TEF/L01/0002, TEF/L01/0003, WEF/L01/0001A/B, WEF/L01/0002A/B, WEF/L02/0001A/B
	Night	CT	2x CT at 44% Design Operating Point
		TVF	1x TVF at ~77% Capacity Per Station End (140m ³ /s North, 140m ³ /s South)
		TEF	1x at 90m ³ /s
		Non-emergency ECS	As above for congested evening
	All	Rolling Stock Noise via DRS Shaft	DRA-01 and DRA-02 at 110m ³ /s
		AHU	2x ASH156 (11150L/s each)
Congested (Multiple Single Train – Extended Line)	All	AHU	2x ASH156 (11150L/s each)
		TEF	In Tunnel: 1x at 90m ³ /s
		TVF	1x TVF at 100% Capacity Per Station End (155m ³ /s North, 160m ³ /s South). Saccardo and damper assessments for supply/exhaust air configurations.

Appendix J Rail operations predictions

Appendix J.1 Rail operations – Predicted ground-borne noise and vibration results

TABLE 64: UP TRACK (NORTHBOUND) ASSESSMENT PREDICTED GROUND-BORNE NOISE AND VIBRATION RESULTS

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
16960-054U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	37	1	54	60	0.8	0.8	VC-A	17	0.02	0.02	40	42	45	52	73	85	91	89	79	67	63	57	44	38	38	42
17001-066U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	37	1	66	60	0.8	0.8	VC-A	16	0.02	0.01	39	41	43	51	72	84	91	88	77	66	62	55	42	37	37	42
17012-055D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	42	0	69	35	0.2	0.13	VC-B	14	0.01	0.01	36	36	39	46	64	73	84	86	77	66	61	51	42	39	41	39
17013-013D-RES-UR-STM03	NV B standard tunnel	40	0	0	20	41	0	27	35	0.2	0.13	VC-A	20	0.02	0.02	39	40	43	50	68	77	86	92	84	73	68	58	49	45	46	41
17035-087D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	1	101	35	0.2	0.13	VC-A	12	0.01	0.01	35	35	39	48	68	81	88	83	70	60	56	49	35	32	34	40
17036-066D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	1	81	35	0.2	0.13	VC-A	13	0.02	0.01	36	37	41	50	70	82	89	85	73	62	58	51	38	34	35	41
17046-005D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	42	0	19	35	0.2	0.13	VC-A	22	0.02	0.02	39	41	44	51	69	78	86	93	86	75	70	60	51	47	47	41
17055-055D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	69	35	0.2	0.13	VC-B	14	0.01	0.01	35	35	38	45	63	73	83	86	76	66	61	50	42	39	41	39
17062-087D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	44	1	101	35	0.2	0.13	VC-A	11	0.01	0.01	34	35	39	48	68	80	88	83	70	60	56	48	35	31	34	40
17063-065D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	41	1	80	35	0.2	0.13	VC-A	14	0.02	0.01	36	37	41	50	70	82	89	85	73	63	59	52	38	34	36	41
17064-023D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	37	35	0.2	0.13	VC-A	18	0.02	0.01	37	38	41	48	66	76	84	90	81	70	66	55	46	43	44	40
17066-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	58	35	0.2	0.13	VC-B	15	0.01	0.01	35	36	39	46	64	74	83	87	77	67	62	51	43	40	42	39
17073-004D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	18	35	0.2	0.13	VC-A	21	0.02	0.02	39	41	44	51	69	78	86	93	85	75	70	60	51	47	47	42
17095-055U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	0	55	60	0.8	0.8	VC-B	16	0.01	0.01	36	37	40	47	65	74	84	88	78	68	63	52	44	41	42	39
17112-093U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	41	0	93	60	0.8	0.8	VC-B	13	0.01	0.01	35	35	37	44	62	72	83	85	74	64	59	48	40	37	40	38
17117-065D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	79	35	0.2	0.13	VC-B	12	0.01	0.01	33	33	36	44	62	72	82	84	73	64	59	48	39	37	40	39
17118-004D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	45	0	18	35	0.2	0.13	VC-A	21	0.02	0.02	38	40	44	51	68	78	85	93	85	74	70	60	50	46	47	42
17119-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	1	58	35	0.2	0.13	VC-A	14	0.02	0.01	36	37	41	51	70	83	89	86	74	64	60	52	39	35	37	42
17120-021D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	36	35	0.2	0.13	VC-A	17	0.02	0.01	36	37	41	48	66	75	84	89	80	70	65	55	45	42	44	40
17122-082D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	96	35	0.2	0.13	VC-B	11	0.01	0.01	32	31	35	43	61	71	81	83	71	62	57	46	37	35	39	38
17123-055U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	1	55	60	0.8	0.8	VC-A	16	0.02	0.01	37	39	43	51	72	84	90	87	76	65	61	54	41	37	38	42
17128-001D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	45	0	15	35	0.2	0.13	VC-A	22	0.02	0.02	39	41	44	52	69	79	86	94	85	75	71	61	51	47	48	42
17129-012D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	26	35	0.2	0.13	VC-A	19	0.02	0.01	37	38	42	49	67	77	85	91	82	72	67	57	47	44	45	41
17136-093U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	1	93	60	0.8	0.8	VC-A	13	0.02	0.01	36	36	40	49	69	81	89	84	72	62	57	50	37	33	35	41
17145-043D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	57	35	0.2	0.13	VC-B	14	0.01	0.01	34	34	38	46	63	73	83	86	75	66	61	50	41	39	41	39
17147-021D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	35	35	0.2	0.13	VC-A	17	0.02	0.01	36	37	40	48	65	75	84	89	79	69	65	54	45	42	44	40
17147-061D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	75	35	0.2	0.13	VC-B	12	0.01	0.01	33	33	36	44	62	72	82	84	73	64	59	48	39	37	40	39
17147-084U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	0	84	60	0.8	0.8	VC-B	13	0.01	0.01	35	34	37	45	63	72	83	85	75	65	60	49	40	38	40	39
17150-003D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	17	35	0.2	0.13	VC-A	21	0.02	0.02	38	40	43	51	68	78	85	93	84	74	70	59	50	46	47	42
17170-006D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	20	35	0.2	0.13	VC-A	20	0.02	0.01	37	39	43	50	68	77	85	92	83	73	68	58	49	45	46	41
17173-053U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	44	0	53	60	0.8	0.8	VC-B	15	0.01	0.01	35	36	39	47	64	74	84	87	77	67	63	52	43	40	42	40
17174-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	50	0	77	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39
17175-085U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	43	0	85	60	0.8	0.8	VC-B	13	0.01	0.01	34	34	37	44	62	72	83	85	74	64	60	48	40	37	40	39
17179-045D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	59	35	0.2	0.13	VC-A	14	0.02	0.01	34	36	40	50	70	82	88	85	72	63	59	51	38	34	36	42
17180-024D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	1	38	35	0.2	0.13	VC-A	16	0.02	0.01	36	38	43	52	72	84	89	88	76	66	62	55	41	37	39	43

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	
17188-006D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	20	35	0.2	0.13	VC-A	20	0.02	0.01	37	39	43	50	67	77	85	92	83	73	68	58	48	45	46	41	
17200-083D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	98	35	0.2	0.13	VC-C	10	0.01	0.01	31	30	34	43	60	70	81	82	70	61	56	45	36	34	38	38	
17203-064D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	50	0	78	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	61	71	82	84	72	63	58	47	38	36	40	39	
17204-003D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	17	35	0.2	0.13	VC-A	20	0.02	0.02	37	39	43	51	68	78	85	92	83	74	69	59	49	46	47	42	
17205-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	59	35	0.2	0.13	VC-A	13	0.02	0.01	34	35	40	50	70	82	88	85	72	63	59	51	37	34	36	42	
17206-023D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	38	35	0.2	0.13	VC-A	16	0.02	0.01	36	38	43	52	72	84	89	88	76	66	62	55	41	37	39	43	
17260-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	76	35	0.2	0.13	VC-B	12	0.01	0.01	32	31	35	44	61	71	81	84	72	63	58	47	38	36	40	39	
17261-075D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	52	0	90	35	0.2	0.13	VC-B	11	0.01	0.01	31	30	35	43	60	70	81	83	70	62	57	45	36	35	39	38	
17278-056D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	70	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	72	82	84	72	64	59	48	38	36	40	39	
17278-058U-IND-EX-NCA00	NV B standard tunnel	40	0	0	21	45	1	58	60	0.8	0.8	VC-A	15	0.02	0.01	36	37	42	51	71	83	89	86	74	64	60	53	39	35	37	42	
17279-072D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	51	0	86	35	0.2	0.13	VC-B	11	0.01	0.01	31	31	35	43	61	71	81	83	70	62	57	46	37	35	39	38	
17298-056D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	51	0	70	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	72	82	84	72	64	59	48	39	37	40	39	
17299-072D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	51	0	86	35	0.2	0.13	VC-B	11	0.01	0.01	31	31	35	43	61	71	81	83	71	62	57	46	37	35	39	38	
17300-091D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	51	0	105	35	0.2	0.13	VC-C	9	0.01	0.01	30	30	34	42	60	69	80	81	68	60	55	43	34	32	36	36	
17315-061D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	0	75	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39	
17315-099D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	52	0	114	35	0.2	0.13	VC-C	8	0.01	0.00	30	29	33	42	59	69	80	80	67	59	54	41	32	30	34	33	
17332-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	0	77	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39	
17341-053U-IND-EX-NCA00	NV C standard crossover	40	0	Y	21	43	1	53	60	0.8	0.8	VC-A	16	0.02	0.01	37	39	43	51	71	83	89	86	75	68	63	55	42	38	39	44	
17350-064D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	49	0	78	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39	
17357-094D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	1	108	35	0.2	0.13	VC-B	9	0.01	0.01	32	32	37	47	67	79	87	81	66	57	53	45	31	28	31	38	
17370-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	48	0	77	35	0.2	0.13	VC-B	12	0.01	0.01	33	33	36	44	62	72	82	84	73	64	59	48	39	37	40	39	
17371-053U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	42	1	53	60	0.8	0.8	VC-A	16	0.02	0.01	38	39	43	52	72	84	90	86	76	68	64	56	42	39	39	44	
17380-094D-RES-EX-STM03	NV C standard crossover	40	0	0	21	50	1	108	35	0.2	0.13	VC-B	9	0.01	0.01	32	32	37	47	66	79	86	79	66	60	55	46	32	30	33	40	
17388-059D-RES-EX-STM03	NV C standard crossover	40	0	0	21	47	1	74	35	0.2	0.13	VC-B	13	0.01	0.01	35	35	40	49	69	81	88	83	71	64	60	51	38	35	37	43	
17402-053U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	41	1	53	60	0.8	0.8	VC-A	16	0.02	0.01	38	39	43	52	72	84	90	86	76	69	64	56	43	39	39	44	
17408-060D-RES-EX-STM03	NV C standard crossover	40	0	0	21	46	0	74	35	0.2	0.13	VC-B	13	0.01	0.01	34	33	37	45	62	72	82	83	74	67	61	50	41	39	42	40	
17425-060D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	74	35	0.2	0.13	VC-B	13	0.01	0.01	34	34	37	45	62	72	82	84	74	67	62	50	41	40	42	40	
17443-055U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	40	1	55	60	0.8	0.8	VC-A	17	0.02	0.01	39	40	44	52	72	84	90	86	77	69	64	56	43	39	39	44	
17468-070D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	84	35	0.2	0.13	VC-B	13	0.01	0.01	34	33	36	44	62	71	82	83	73	67	61	49	40	39	41	40	
17473-034D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	1	48	35	0.2	0.13	VC-A	16	0.02	0.01	37	39	43	52	71	84	89	86	76	68	64	56	42	39	40	44	
17480-098D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	112	35	0.2	0.13	VC-C	10	0.01	0.01	32	32	35	42	60	70	81	80	70	63	57	45	36	34	36	35	
17481-055U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	39	1	55	60	0.8	0.8	VC-A	17	0.02	0.01	39	40	44	52	72	84	90	87	77	69	64	57	43	40	40	44	
17496-097D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	111	35	0.2	0.13	VC-C	10	0.01	0.01	33	32	35	43	60	70	81	81	70	64	57	45	36	35	37	36	
17497-032D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	1	46	35	0.2	0.13	VC-A	16	0.02	0.01	37	39	43	52	72	84	89	86	76	69	64	56	43	39	40	44	
17498-065D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	0	80	35	0.2	0.13	VC-B	13	0.01	0.01	34	34	37	44	62	72	82	83	74	67	61	50	41	39	42	40	

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
17516-047D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	1	61	35	0.2	0.13	VC-A	15	0.02	0.01	37	38	42	51	71	83	89	85	74	67	62	54	41	38	39	44
17530-032D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	0	46	35	0.2	0.13	VC-B	17	0.01	0.01	37	37	40	47	65	74	84	87	79	72	66	55	46	44	45	41
17532-048D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	1	62	35	0.2	0.13	VC-A	15	0.02	0.01	37	38	42	51	71	83	89	85	74	67	62	54	40	37	38	44
17542-050U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	39	1	50	60	0.8	0.8	VC-A	17	0.02	0.01	39	41	44	52	73	84	90	87	78	70	65	58	44	40	40	44
17555-087D-RES-EX-STM03	NV C standard crossover	40	0	Y	21	43	1	101	35	0.2	0.13	VC-B	12	0.01	0.01	35	35	39	48	68	80	88	82	70	63	58	50	36	34	35	42
17622-039D-RET-UR-STM03	NV B standard tunnel	40	0	0	21	41	1	53	50	2	2	VC-A	16	0.02	0.01	38	40	43	52	72	84	90	88	77	66	62	55	42	37	38	42
17708-096D-RET-EX-STM03	NV B standard tunnel	48	0	0	21	39	1	110	50	2	2	VC-A	14	0.02	0.01	38	38	39	47	69	82	90	86	74	63	57	50	37	32	33	38
17773-090D-RET-EX-STM03	NV B standard tunnel	65	0	0	19	37	1	104	50	2	2	VC-A	17	0.02	0.01	37	40	42	47	66	81	92	89	79	68	61	53	40	35	36	42
17778-022D-RET-EX-STM03	NV B standard tunnel	59	0	0	20	37	1	36	50	2	2	Operating Room	24	0.04	0.03	42	46	47	51	72	87	95	96	88	75	69	62	49	43	42	45
17778-037D-RET-EX-STM03	NV B standard tunnel	63	0	0	19	37	1	51	50	2	2	VC-A	22	0.03	0.02	41	44	46	50	70	85	94	94	86	73	67	60	46	41	40	44
17782-043D-RET-EX-STM03	NV B standard tunnel	62	0	0	19	37	1	57	50	2	2	VC-A	21	0.03	0.02	40	43	45	49	70	84	94	93	85	72	66	59	46	41	40	44
17784-065D-RET-EX-STM03	NV B standard tunnel	65	0	0	19	37	1	79	50	2	2	VC-A	20	0.02	0.02	38	42	44	48	67	82	93	91	82	70	63	56	43	38	38	44
17819-024D-RET-UR-STM02	NV B standard tunnel	69	0	0	18	37	0	39	50	2	2	Operating Room	25	0.03	0.02	39	43	45	48	63	75	88	96	91	79	71	60	52	48	47	43
17822-037D-RET-UR-STM02	NV B standard tunnel	68	0	0	18	37	1	51	50	2	2	Operating Room	23	0.03	0.02	40	44	47	51	69	84	94	94	86	74	67	60	47	42	41	45
17826-000D-RET-UR-STM02	NV B standard tunnel	69	0	0	18	36	1	0	50	2	2	Office	38	0.11	0.08	47	54	58	61	78	94	98	107	103	90	83	78	63	56	52	49
17832-064D-HTL-EX-STM02	NV B standard tunnel	71	0	0	18	36	1	78	35	0.2	0.13	VC-A	20	0.02	0.02	38	42	45	50	67	81	93	92	83	72	64	57	44	39	39	44
17835-013D-RET-UR-STM02	NV B standard tunnel	69	0	0	18	36	0	27	50	2	2	Operating Room	27	0.04	0.03	41	45	47	49	65	77	89	98	93	81	74	63	54	50	49	43
17838-038D-RET-UR-STM02	NV B standard tunnel	71	0	0	18	37	0	52	50	2	2	Operating Room	23	0.03	0.02	38	41	44	47	62	74	87	95	89	77	69	58	49	46	45	42
17844-027D-RET-UR-STM02	NV B standard tunnel	72	0	0	17	36	0	41	50	2	2	Operating Room	25	0.03	0.02	39	42	45	48	63	75	88	96	91	79	71	60	51	47	47	43
17852-038D-RET-UR-STM02	NV F IST	73	0	0	17	36	0	53	50	2	2	Operating Room	19	0.03	0.02	40	43	47	53	70	84	95	92	79	65	53	36	24	17	12	4
17863-000U-RES-EX-STM02	NV F IST	80	0	0	16	35	0	0	35	0.2	0.13	Residential Day	31	0.08	0.06	48	52	58	64	81	93	98	105	97	82	70	55	41	32	23	9
17886-080U-IND-EX-NCA00	NV F IST	87	0	0	14	32	0	80	60	0.8	0.8	VC-A	18	0.02	0.01	42	41	46	54	72	82	93	90	78	65	52	35	23	16	11	4
17922-091D-RES-EX-STM02	NV F IST	82	0	0	15	35	0	105	35	0.2	0.13	VC-A	16	0.02	0.01	38	39	44	51	69	80	92	87	74	61	48	30	18	12	7	1
17924-001D-RES-EX-STM02	NV F IST	84	0	0	15	35	0	15	35	0.2	0.13	Operating Room	25	0.04	0.03	45	47	53	60	77	88	96	98	88	75	62	46	33	25	18	7
17925-027D-RES-EX-STM02	NV F IST	83	0	0	15	35	0	41	35	0.2	0.13	VC-A	20	0.03	0.02	42	43	48	56	73	84	94	93	82	69	56	39	27	19	14	5
17925-060D-RES-EX-STM02	NV F IST	84	0	0	15	35	1	74	35	0.2	0.13	Operating Room	17	0.04	0.03	41	42	49	58	78	91	98	89	75	62	50	36	19	11	6	6
17929-014D-RES-EX-STM02	NV F IST	85	0	0	15	35	0	28	35	0.2	0.13	Operating Room	22	0.03	0.02	43	45	50	58	75	86	94	95	85	71	59	42	29	21	15	6
17931-002D-RES-EX-STM02	NV F IST	84	0	0	15	35	0	3	35	0.2	0.13	Residential Night	29	0.06	0.04	47	51	57	64	81	92	97	103	94	80	68	52	39	30	22	8
17941-079U-IND-EX-NCA00	NV F IST	93	0	0	13	31	0	79	60	0.8	0.8	VC-A	17	0.02	0.01	43	41	46	55	74	83	92	89	79	66	53	35	23	16	11	4
17948-080D-RES-EX-STM02	NV F IST	88	0	0	14	35	0	94	35	0.2	0.13	VC-A	16	0.02	0.01	40	39	44	53	71	81	91	88	75	63	50	32	20	13	9	3
17949-000D-RES-EX-STM02	NV F IST	87	0	0	14	34	0	4	35	0.2	0.13	Residential Night	29	0.06	0.04	48	50	56	64	81	92	96	102	94	80	68	52	39	30	22	8
17949-021D-RES-EX-STM02	NV F IST	87	0	0	14	34	0	35	35	0.2	0.13	VC-A	21	0.03	0.02	43	44	49	57	75	85	94	94	83	70	58	40	28	20	14	5
17949-054D-RES-EX-STM02	NV F IST	87	0	0	14	35	0	68	35	0.2	0.13	VC-A	17	0.02	0.01	41	40	46	54	72	82	92	90	78	66	53	35	23	16	11	4
17960-093D-RES-EX-STM02	NV F IST	88	0	0	14	34	0	107	35	0.2	0.13	VC-A	15	0.02	0.01	40	38	43	52	70	80	91	87	74	62	49	30	18	11	7	1
17964-024D-RES-EX-STM02	NV F IST	90	0	0	14	34	0	38	35	0.2	0.13	VC-A	20	0.02	0.02	43	43	49	57	76	85	93	93	83	70	57	40	27	20	14	5
17966-000D-RES-EX-STM02	NV F IST	89	0	0	14	34	0	4	35	0.2	0.13	Residential Night	29	0.06	0.04	48	50	56	64	82	92	96	102	94	81	68	52	39	30	22	8
17967-057D-RES-EX-STM02	NV F IST	91	0	0	13	34	0	71	35	0.2	0.13	VC-A	17	0.02	0.01	41	40	45	54	73	82	91	89	78	66	53	35	22	16	11	4
17974-084D-RES-EX-STM02	NV F IST	90	0	0	13	34	0	98	35	0.2	0.13	VC-A	15	0.02	0.01	40	39	44	53	71	81	91	87	75	63	50	32	20	13	9	3

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	
17978-024D-RES-EX-STM02	NV F IST	91	0	0	13	34	0	38	35	0.2	0.13	VC-A	20	0.02	0.02	44	43	49	57	76	85	93	93	83	70	58	40	27	20	14	5	
17979-000D-RES-EX-STM02	NV F IST	91	0	0	13	34	0	6	35	0.2	0.13	Residential Night	28	0.05	0.04	48	49	55	63	82	91	95	101	93	80	67	51	37	28	21	8	
17987-088D-RES-EX-STM02	NV F IST	91	0	0	13	34	0	102	35	0.2	0.13	VC-A	15	0.02	0.01	40	39	43	53	72	81	90	87	75	63	50	32	19	13	8	3	
17988-057D-RES-EX-STM02	NV F IST	93	0	0	13	34	0	71	35	0.2	0.13	VC-A	17	0.02	0.01	42	40	45	55	74	83	91	89	78	66	53	35	23	16	11	4	
17991-000D-RES-EX-STM02	NV F IST	93	0	0	13	33	0	6	35	0.2	0.13	Residential Night	28	0.05	0.04	48	49	55	64	82	92	95	100	93	80	68	51	37	29	21	8	
17992-022D-RES-EX-STM02	NV F IST	92	0	0	13	33	0	36	35	0.2	0.13	VC-A	20	0.02	0.02	44	44	49	58	76	86	93	93	83	71	58	41	28	20	15	6	
18002-089D-RES-EX-STM02	NV F IST	93	0	0	13	33	0	103	35	0.2	0.13	VC-A	15	0.01	0.01	41	39	43	53	72	81	90	87	75	63	50	31	19	13	8	2	
18003-059D-RES-EX-STM02	NV F IST	94	0	0	12	33	0	73	35	0.2	0.13	VC-A	16	0.02	0.01	42	40	45	55	74	83	91	89	78	66	53	35	23	16	11	4	
18005-000D-RES-EX-STM02	NV F IST	95	0	0	12	33	0	6	35	0.2	0.13	Residential Night	27	0.05	0.03	48	49	55	64	83	92	95	100	93	80	68	51	37	28	21	8	
18006-024D-RES-EX-STM02	NV F IST	94	0	0	12	33	0	38	35	0.2	0.13	VC-A	20	0.02	0.02	44	43	48	58	77	86	92	93	83	71	58	40	27	20	14	6	
18015-057D-RES-EX-STM02	NV F IST	95	0	0	12	33	0	71	35	0.2	0.13	VC-A	17	0.02	0.01	42	41	45	55	74	84	91	89	78	67	53	35	23	16	11	4	
18016-089D-RES-EX-STM02	NV F IST	95	0	0	12	33	0	103	35	0.2	0.13	VC-A	15	0.01	0.01	41	39	43	53	72	82	90	87	75	63	50	32	19	13	8	2	
18019-000D-RES-EX-STM02	NV F IST	97	0	0	12	33	0	6	35	0.2	0.13	Operating Room	27	0.05	0.03	49	50	55	64	83	93	94	100	93	80	68	51	37	29	21	8	
18019-026D-RES-EX-STM02	NV F IST	95	0	0	12	32	1	40	35	0.2	0.13	Operating Room	20	0.04	0.03	46	46	51	62	84	96	98	92	81	68	56	42	25	16	10	8	
18019-096U-IND-EX-NCA00	NV F IST	94	0	0	12	30	1	96	60	0.8	0.8	Operating Room	16	0.03	0.02	44	43	48	59	80	92	97	88	75	63	50	36	19	11	5	6	
18029-057D-RES-EX-STM02	NV F IST	96	0	0	12	32	0	71	35	0.2	0.13	VC-A	17	0.02	0.01	43	41	45	55	75	84	91	89	78	67	54	35	23	16	11	4	
18031-090D-RES-EX-STM02	NV F IST	97	0	0	12	32	0	105	35	0.2	0.13	VC-A	14	0.01	0.01	41	39	43	53	73	82	89	86	75	63	50	31	19	12	8	2	
18034-000D-RES-EX-STM02	NV F IST	98	0	0	11	32	0	4	35	0.2	0.13	Residential Night	28	0.05	0.04	50	51	55	65	84	94	94	101	94	82	69	52	39	30	22	9	
18034-026D-RES-EX-STM02	NV F IST	98	0	0	11	32	1	40	35	0.2	0.13	Operating Room	19	0.04	0.03	46	46	51	63	85	97	97	92	80	68	57	42	25	16	10	8	
18040-001U-RES-EX-STM02	NV F IST	100	0	0	10	32	0	2	35	0.2	0.13	Residential Night	30	0.06	0.04	50	52	56	66	86	95	95	102	96	83	71	54	40	31	23	9	
18043-083D-RES-EX-STM02	NV F IST	99	0	0	11	32	0	97	35	0.2	0.13	VC-A	15	0.01	0.01	42	40	43	54	74	83	89	87	75	65	52	33	21	14	10	4	
18045-057D-RES-EX-STM02	NV F IST	98	0	0	11	32	0	71	35	0.2	0.13	VC-A	16	0.02	0.01	43	41	45	55	75	84	90	89	78	67	54	36	23	16	11	4	
18046-023D-RES-EX-STM02	NV F IST	99	0	0	11	32	0	37	35	0.2	0.13	VC-A	20	0.02	0.02	45	44	48	58	78	88	91	92	83	72	59	41	28	20	15	6	
18046-090D-RES-EX-STM02	NV F IST	99	0	0	11	32	0	104	35	0.2	0.13	VC-A	14	0.01	0.01	42	39	43	53	73	83	89	86	75	64	51	32	19	13	8	2	
18048-000D-RES-EX-STM02	NV F IST	99	0	0	11	32	0	4	35	0.2	0.13	Residential Night	29	0.05	0.04	50	51	56	65	85	94	94	101	95	82	70	53	39	30	22	9	
18057-025D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	39	35	0.2	0.13	VC-A	19	0.02	0.02	45	44	48	58	78	88	91	92	83	71	59	41	28	20	14	6	
18061-055D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	69	35	0.2	0.13	VC-A	16	0.02	0.01	43	41	45	55	76	85	90	89	78	67	54	36	23	16	12	5	
18066-000D-RES-EX-STM02	NV F IST	100	0	0	10	31	1	13	35	0.2	0.13	Residential Night	24	0.06	0.04	49	50	55	67	89	101	99	97	87	75	63	49	31	22	14	10	
18068-058D-RES-EX-STM02	NV F IST	100	0	0	10	31	0	72	35	0.2	0.13	VC-A	16	0.02	0.01	43	41	45	55	75	85	90	88	78	67	54	36	23	16	11	4	
18069-020D-RES-EX-STM02	NV F IST	100	0	0	10	31	0	34	35	0.2	0.13	VC-A	20	0.02	0.02	46	45	49	59	79	88	91	93	84	72	60	42	29	21	15	6	
18072-078D-RES-EX-STM02	NV F IST	100	0	0	10	31	0	92	35	0.2	0.13	VC-A	15	0.01	0.01	42	40	44	54	74	84	89	87	76	65	52	34	21	14	10	4	
18074-090D-RES-EX-STM02	NV F IST	100	0	0	10	31	0	104	35	0.2	0.13	VC-A	14	0.01	0.01	42	39	43	53	74	83	89	86	75	64	51	32	19	13	8	2	
18952-045U-TGT-EX-NCA00	NV B standard tunnel	100	0	0	3	22	0	45	60	2	2	Operating Room	26	0.03	0.02	44	42	45	52	68	74	83	95	92	83	74	61	52	49	48	44	
19246-099U-RES-EX-NCA00	NV B standard tunnel	100	0	0	5	25	1	99	35	0.2	0.13	VC-A	20	0.01	0.01	42	40	44	53	72	79	88	89	83	75	66	56	43	39	39	45	
19581-090D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	26	0	105	40	0.4	0.4	VC-A	19	0.01	0.01	41	38	40	48	64	70	81	89	85	77	67	54	45	42	42	41	
19594-083D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	26	1	98	40	0.4	0.4	VC-A	20	0.02	0.01	42	41	44	53	72	80	88	89	84	75	67	57	44	39	39	45	
19610-073D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	26	0	88	40	0.4	0.4	VC-A	21	0.02	0.01	42	39	42	49	65	71	82	91	87	78	69	56	47	44	44	42	
19639-017D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7																											

Receiver ID	Track Details					Receiver		Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
19790-056D-RET-EX-NCA00	NV B standard tunnel	100	0	0	8	28	1	72	50	2	2	VC-A	22	0.02	0.01	43	42	46	55	73	81	88	91	86	77	69	59	46	41	40	46
19800-041D-RET-EX-NCA00	NV B standard tunnel	100	0	0	8	28	1	57	50	2	2	VC-A	24	0.02	0.02	44	43	47	56	74	82	89	93	88	79	71	61	48	43	42	46
19955-062U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	62	35	0.2	0.13	VC-A	24	0.02	0.01	43	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
19956-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	86	35	0.2	0.13	VC-A	21	0.02	0.01	42	39	42	49	66	71	82	91	87	79	70	56	48	44	44	43
19968-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	98	35	0.2	0.13	VC-A	20	0.01	0.01	41	39	41	49	65	70	82	90	86	78	69	55	47	43	43	42
19970-052U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	52	35	0.2	0.13	VC-A	25	0.02	0.02	43	42	44	52	68	73	83	94	91	82	73	60	52	48	47	44
19989-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	51	35	0.2	0.13	VC-A	25	0.02	0.02	44	42	44	52	68	73	83	94	91	82	74	61	52	48	47	44
20001-095D-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	32	0	110	35	0.2	0.13	VC-B	17	0.01	0.01	39	36	39	47	63	69	80	88	82	75	65	51	42	39	40	39
20003-066U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	66	35	0.2	0.13	VC-A	23	0.02	0.01	43	41	43	51	67	72	83	92	89	81	72	58	50	46	46	43
20012-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	48	35	0.2	0.13	VC-A	25	0.02	0.02	43	42	45	52	68	73	83	94	92	83	74	61	52	48	47	44
20022-049U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	49	35	0.2	0.13	VC-A	25	0.02	0.02	43	42	44	52	68	73	83	94	91	82	74	61	52	48	47	44
20033-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	95	35	0.2	0.13	VC-A	21	0.01	0.01	42	39	41	49	65	70	82	90	87	78	69	55	47	44	44	42
20041-044U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	44	35	0.2	0.13	Operating Room	26	0.03	0.02	44	42	45	52	68	74	83	95	92	83	74	61	52	49	48	44
20046-084U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	84	35	0.2	0.13	VC-A	22	0.02	0.01	42	39	42	49	66	71	82	91	87	79	70	56	48	45	44	43
20048-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	68	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	50	67	72	82	92	89	80	71	58	49	46	45	43
20069-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	60	35	0.2	0.13	VC-A	24	0.02	0.01	43	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
20070-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	76	35	0.2	0.13	VC-A	22	0.02	0.01	42	40	42	50	66	71	82	91	88	79	70	57	48	45	45	43
20075-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	96	35	0.2	0.13	VC-A	21	0.01	0.01	41	39	41	49	65	70	82	90	86	78	69	55	47	44	44	42
20081-047U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	30	0	47	35	0.2	0.13	VC-A	25	0.02	0.02	43	42	44	52	68	73	83	94	91	83	74	61	52	48	47	44
20099-043U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	43	35	0.2	0.13	Operating Room	26	0.02	0.02	43	42	45	52	68	74	83	95	92	83	74	61	52	49	48	44
20117-042U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	42	35	0.2	0.13	Operating Room	26	0.03	0.02	44	42	45	53	69	74	83	95	92	83	75	62	53	49	48	44
20120-081U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	29	1	81	35	0.2	0.13	VC-A	22	0.02	0.01	43	42	45	54	73	81	88	91	85	76	68	58	45	41	40	45
20122-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	29	0	95	35	0.2	0.13	VC-A	20	0.01	0.01	41	39	41	49	65	70	82	90	86	78	69	55	47	44	44	42
20124-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	65	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	92	89	80	71	58	49	46	46	43
20144-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	64	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	92	89	80	72	58	49	46	46	43
20144-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	78	35	0.2	0.13	VC-A	22	0.02	0.01	42	39	42	50	66	71	82	91	87	79	70	57	48	45	45	43
20144-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	97	35	0.2	0.13	VC-A	20	0.01	0.01	41	38	41	49	65	70	82	90	86	77	68	55	46	43	43	42
20148-039U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	39	35	0.2	0.13	Operating Room	26	0.03	0.02	44	42	45	53	69	74	83	95	92	84	75	62	53	49	48	44
20166-039U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	39	35	0.2	0.13	Operating Room	26	0.03	0.02	43	42	45	53	69	74	83	95	92	83	75	62	53	49	48	44
20184-042U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	42	35	0.2	0.13	Operating Room	25	0.02	0.02	43	42	45	52	68	74	83	94	92	83	74	61	52	48	48	44
20187-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	96	35	0.2	0.13	VC-A	20	0.01	0.01	41	38	41	49	65	70	82	90	86	77	68	55	46	43	43	42
20189-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	80	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	42	49	66	71	82	91	87	79	70	56	48	44	44	43
20192-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	60	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	92	89	80	72	58	49	46	46	43
20213-035U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	35	35	0.2	0.13	Operating Room	26	0.03	0.02	43	42	45	53	69	74	83	95	93	84	75	62	53	49	48	44
20217-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	53	35	0.2	0.13	VC-A	24	0.02	0.01	42	40	43	51	67	72	82	93	90	81	72	59	50	47	46	44
20220-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	69	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	71	82	91	88	79	71	57	48	45	45	43
20224-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	86	35	0.2	0.13	VC-A	21	0.01	0.01	41	38	41	49	65	70	82	90	86</							

Receiver ID	Track Details					Receiver		Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20273-075U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	32	0	75	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	42	50	66	71	82	91	87	79	70	56	47	44	45	43
20273-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	32	0	95	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	40	48	65	70	81	89	85	77	68	54	46	43	43	42
20293-046U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	46	35	0.2	0.13	VC-A	24	0.02	0.02	42	41	44	52	68	73	82	93	90	82	73	60	51	47	47	44
20300-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	33	0	68	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	71	82	91	87	79	70	57	48	45	45	43
20303-082U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	33	0	82	35	0.2	0.13	VC-A	21	0.01	0.01	41	38	41	49	65	70	81	90	86	78	69	55	46	44	44	43
20304-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	33	0	100	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	69	81	89	84	76	67	54	45	42	43	42
20310-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	28	35	0.2	0.13	Operating Room	28	0.03	0.02	44	43	46	54	69	75	83	96	94	85	77	64	54	50	49	45
20325-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	28	35	0.2	0.13	Operating Room	27	0.03	0.02	43	42	46	54	69	75	83	96	94	85	76	63	54	50	49	45
20344-026U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	0	26	35	0.2	0.13	Operating Room	28	0.03	0.02	44	43	46	54	70	75	83	96	94	85	77	64	54	51	50	45
20345-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	76	35	0.2	0.13	VC-A	21	0.01	0.01	40	38	41	49	65	71	81	90	86	78	69	56	47	44	44	43
20350-092U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	92	35	0.2	0.13	VC-A	20	0.01	0.01	40	37	40	48	64	70	81	89	85	77	68	54	45	43	43	42
20354-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	51	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	93	89	81	72	59	50	46	46	44
20376-044U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	0	44	35	0.2	0.13	VC-A	24	0.02	0.02	42	40	44	52	67	73	82	93	90	82	73	60	51	47	47	44
20377-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	67	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	71	82	91	87	79	70	57	48	45	45	43
20382-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	1	20	35	0.2	0.13	Operating Room	29	0.03	0.02	45	46	50	60	77	86	90	97	93	84	77	68	53	48	46	48
20386-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	86	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	41	49	65	70	81	90	85	77	68	55	46	43	44	42
20407-016U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	36	0	16	35	0.2	0.13	Operating Room	30	0.04	0.03	44	44	48	56	71	77	84	98	97	88	80	67	57	53	52	46
20409-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	93	35	0.2	0.13	VC-A	20	0.01	0.01	40	37	40	48	64	70	81	89	85	77	68	54	45	43	43	42
20422-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	20	35	0.2	0.13	Operating Room	29	0.03	0.03	44	43	47	55	70	76	84	97	95	87	78	65	55	52	51	45
20426-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	35	1	69	35	0.2	0.13	VC-A	21	0.02	0.01	42	41	45	55	72	81	88	90	85	76	68	58	44	40	40	46
20427-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	34	0	95	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20443-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	15	35	0.2	0.13	Operating Room	30	0.04	0.03	44	44	48	56	71	77	84	98	97	88	80	67	57	53	52	46
20463-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	15	35	0.2	0.13	Operating Room	30	0.04	0.03	44	44	48	56	71	77	84	98	97	88	80	67	57	53	52	46
20472-071U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	71	35	0.2	0.13	VC-A	21	0.02	0.01	40	38	41	50	65	71	81	91	86	78	70	56	47	44	45	43
20473-090U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	35	0	90	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	70	81	89	85	77	68	54	45	43	43	42
20476-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	53	35	0.2	0.13	VC-A	23	0.02	0.01	41	39	42	51	66	72	82	92	88	80	72	58	49	46	46	43
20479-029U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	29	35	0.2	0.13	Operating Room	26	0.03	0.02	43	41	45	53	69	74	83	95	92	84	76	62	53	49	49	45
20499-036U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	36	35	0.2	0.13	VC-A	25	0.02	0.02	42	40	44	52	68	74	82	94	91	83	74	61	51	48	48	44
20505-057U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	57	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	72	82	92	88	80	71	58	48	45	46	43
20507-074U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	74	35	0.2	0.13	VC-A	21	0.01	0.01	40	38	41	49	65	71	81	90	86	78	69	56	46	44	44	43
20507-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	35	0	93	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20511-021U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	21	35	0.2	0.13	Operating Room	28	0.03	0.02	43	42	46	55	70	76	83	97	94	86	78	65	55	51	50	45
20553-024U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	24	35	0.2	0.13	Operating Room	27	0.03	0.02	43	42	46	54	69	75	83	96	93	85	77	64	54	50	50	45
20558-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	98	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	39	48	64	69	80	88	83	76	67	53	44	42	43	42
20560-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	64	35	0.2	0.13	VC-A	21	0.02	0.01	40	38	41	50	65	71	81	91	86	79	70	56	47	44	45	43
20562-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	80	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	64	70	81	90	85	77	68	54	45	43	44	43
20571-024U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	24	35	0.2	0.13	Operating Room	27	0.03	0.02	43	42	46	54	69	75	83	96	93	85	77	63	54	50	50	45
20586-021U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	21	35	0.2	0.13	Operating Room	28	0.03	0.02	43	42	46	55	70	75	83	97	94	86	77	64	54	51	50	45
20586-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	95	35	0.2	0.13	VC-A	18	0.01	0.01	39	36	39	48	64	69	80	88	83	76	67	53	44	41	43	42

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20591-063U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	63	35	0.2	0.13	VC-A	21	0.02	0.01	40	37	41	50	65	71	81	91	86	78	70	56	47	44	45	43
20603-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	40	0	20	35	0.2	0.13	Operating Room	28	0.03	0.02	43	42	46	55	70	76	83	97	94	86	78	65	54	51	50	45
20603-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	38	0	96	35	0.2	0.13	VC-A	18	0.01	0.01	39	36	39	48	64	69	80	88	83	76	67	53	44	41	43	42
20607-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	1	65	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	44	54	72	80	87	90	84	76	68	58	43	40	40	46
20619-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	39	0	93	35	0.2	0.13	VC-A	18	0.01	0.01	38	36	39	48	64	69	80	88	83	76	67	53	44	42	43	42
20620-012U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	12	35	0.2	0.13	Operating Room	31	0.04	0.03	44	44	48	56	71	77	84	99	97	88	80	67	57	53	52	46
20628-070U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	70	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	77	69	55	46	43	44	43
20648-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	14	35	0.2	0.13	Operating Room	30	0.04	0.03	43	43	47	56	71	77	83	98	96	87	79	66	56	52	52	46
20649-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	93	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	83	76	67	53	44	41	43	42
20650-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	1	60	35	0.2	0.13	VC-A	21	0.02	0.01	41	40	44	55	72	81	87	90	84	76	68	58	44	40	41	46
20655-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	28	35	0.2	0.13	Operating Room	26	0.03	0.02	42	41	45	53	68	74	82	95	92	84	75	62	52	49	49	45
20679-031U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	31	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	91	83	75	61	51	48	48	45
20682-059U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	59	35	0.2	0.13	VC-A	21	0.02	0.01	40	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
20686-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	78	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20687-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	94	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	83	75	67	53	43	41	43	42
20688-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	23	35	0.2	0.13	Operating Room	27	0.03	0.02	42	41	45	54	69	75	83	96	93	85	76	63	53	50	50	45
20710-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	14	35	0.2	0.13	Operating Room	29	0.04	0.03	43	43	47	56	71	76	83	98	95	87	79	66	56	52	52	46
20731-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	19	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	75	83	97	94	86	77	64	54	51	50	45
20731-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	76	35	0.2	0.13	VC-A	20	0.01	0.01	39	36	40	49	64	70	81	89	84	77	68	54	45	43	44	43
20731-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	94	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	83	75	67	53	44	41	43	42
20732-058U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	58	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
20735-045U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	45	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	42	51	66	72	81	92	88	80	72	58	48	46	47	44
20765-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	43	0	14	35	0.2	0.13	Operating Room	29	0.04	0.03	43	43	47	56	71	76	83	98	95	87	79	66	56	52	52	46
20767-032U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	32	35	0.2	0.13	VC-A	25	0.02	0.02	41	40	44	53	68	74	82	94	90	83	74	61	51	48	48	44
20768-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	48	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	51	66	72	81	92	87	80	71	58	48	45	46	44
20769-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	68	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	78	69	55	46	43	44	43
20770-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	1	86	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	53	71	79	86	88	81	74	66	55	41	38	39	45
20809-059D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	75	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	49	64	70	80	89	84	76	68	54	44	42	44	43
20809-075D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	92	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	52	70	78	86	87	80	72	65	54	40	37	38	45
20810-020D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	36	35	0.2	0.13	VC-A	24	0.02	0.01	42	41	46	57	74	83	88	93	87	79	71	61	47	43	43	47
20810-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	56	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
20816-012U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	12	35	0.2	0.13	Operating Room	30	0.04	0.03	44	43	48	56	71	77	83	99	96	88	80	67	57	53	52	46
20816-084U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	84	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	39	48	64	70	80	89	84	76	68	54	44	42	43	42
20817-036U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	36	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	94	90	82	74	60	50	47	48	44
20817-049U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	49	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	51	66	72	81	92	87	80	71	58	48	45	46	44
20817-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	67	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	78	69	55	46	43	45	43
20829-066U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	66	35	0.2	0.13	VC-A	20	0.01																	

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20835-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	92	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	38	48	63	69	80	88	82	75	66	52	43	41	43	42
20836-057D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	73	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	54	71	79	86	89	82	74	66	56	42	38	39	45
20846-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	55	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
20847-012U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	12	35	0.2	0.13	Operating Room	30	0.04	0.03	44	43	48	56	71	77	84	99	96	88	80	67	57	53	52	46
20847-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	34	35	0.2	0.13		VC-A	24	0.02	0.02	41	39	43	52	67	73	82	94	89	82	74	60	50	47	48
20849-055U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	55	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	50	66	71	81	91	87	79	71	57	47	45	46	43
20852-037U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	37	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	93	90	82	73	60	50	47	48	44
20853-087U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	87	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	39	48	64	69	80	89	84	76	67	53	44	42	43	42
20861-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	67	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	50	65	71	81	90	86	78	69	56	46	44	45	43
20870-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	89	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
20874-089D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	105	35	0.2	0.13	VC-B	16	0.01	0.01	38	36	41	52	69	78	85	86	78	71	63	52	38	35	36	43
20876-098D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	114	35	0.2	0.13	VC-B	15	0.01	0.01	38	36	40	51	69	77	85	85	77	70	62	50	36	32	33	40
20878-019D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	35	35	0.2	0.13	VC-A	24	0.02	0.02	42	41	46	57	74	83	88	93	87	79	72	62	47	43	43	47
20878-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	52	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	41	50	66	71	81	91	87	79	71	57	47	45	46	43
20879-017U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	17	35	0.2	0.13	Operating Room	29	0.03	0.03	43	43	47	55	70	76	83	97	95	87	79	66	55	52	51	46
20881-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	89	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
20891-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	88	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
20894-016D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	32	35	0.2	0.13	VC-A	25	0.02	0.02	41	39	44	53	68	73	82	94	90	82	74	60	51	48	48	44
20895-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	23	35	0.2	0.13	Operating Room	28	0.03	0.02	43	42	46	54	69	75	83	96	93	85	77	64	54	50	50	45
20900-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	89	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
20900-087U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	39	0	87	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20911-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	52	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	41	50	66	71	81	91	86	79	71	57	47	45	46	43
20912-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	34	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	94	90	82	74	60	50	47	48	44
20912-070U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	70	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	49	65	71	81	90	86	78	69	55	46	44	45	43
20918-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	19	35	0.2	0.13	Operating Room	28	0.03	0.02	43	42	46	55	70	76	83	97	94	86	78	65	55	51	51	45
20921-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	98	35	0.2	0.13	VC-A	18	0.01	0.01	39	36	39	48	64	69	80	88	83	76	67	53	44	41	43	42
20929-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	68	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	50	65	71	81	90	86	78	70	56	46	44	45	43
20930-069D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	85	35	0.2	0.13	VC-A	18	0.01	0.01	39	37	42	53	70	79	86	88	81	73	65	55	41	37	39	45
20930-085D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	101	35	0.2	0.13	VC-B	17	0.01	0.01	39	37	41	52	70	78	86	87	79	72	64	53	39	36	37	44
20935-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	18	35	0.2	0.13	Operating Room	29	0.03	0.02	43	43	47	55	70	76	83	97	95	86	78	65	55	51	51	45
20937-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	34	35	0.2	0.13	VC-A	24	0.02	0.02	42	41	47	57	74	83	88	93	87	79	72	62	47	43	43	47
20937-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	52	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	41	50	66	71	81	91	87	79	71	57	47	45	46	43
20939-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	97	35	0.2	0.13	VC-A	18	0.01	0.01	38	36	39	48	63	69	80	88	83	75	67	53	44	41	43	42
20942-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	68	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	49	65	71	81	90	86	78	69	56	46	44	45	43
20952-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	1	23	35	0.2	0.13	Operating Room	27	0.03	0.02	44	44	49	59	76	85	89	96	91	82	75	66	51	46	45	48
20953-015D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	32	35	0.2	0.13	VC-A	25	0.02	0.02	41	39	44	53	68	73	82	94	90	82	74	61	51	48	48	44
20955-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	41	0	93	35	0.2	0.13	VC-A	18	0.01	0.0																

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20970-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	1	18	35	0.2	0.13	Operating Room	28	0.03	0.02	44	44	50	60	77	85	89	97	92	84	76	67	52	47	46	48
20970-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	1	52	35	0.2	0.13	VC-A	22	0.02	0.01	41	40	45	55	73	81	87	91	84	77	69	59	44	41	41	46
20972-099U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	41	0	99	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	66	52	43	41	42	42
20973-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	41	0	68	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	49	65	71	81	90	86	78	69	55	46	44	45	43
20986-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	23	35	0.2	0.13	Operating Room	27	0.03	0.02	42	42	46	54	69	75	83	96	93	85	77	64	54	50	50	45
20989-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	41	0	68	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	41	49	65	71	81	90	85	78	69	55	46	44	45	43
20990-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	100	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	38	47	63	69	80	88	82	75	66	52	43	41	42	42
20995-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	1	34	35	0.2	0.13	VC-A	24	0.02	0.02	42	41	47	57	74	83	88	93	87	79	72	62	47	43	43	47
20995-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	55	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
21002-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	18	35	0.2	0.13	Operating Room	29	0.03	0.02	43	42	46	55	70	76	83	97	94	86	78	65	55	51	51	45
21005-071U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	71	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	78	69	55	46	43	44	43
21006-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	93	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
21017-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	97	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	38	47	63	69	80	88	82	75	66	52	43	41	42	42
21018-074U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	74	35	0.2	0.13	VC-A	20	0.01	0.01	39	36	40	49	64	70	81	90	84	77	68	54	45	43	44	43
21021-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	15	35	0.2	0.13	Operating Room	29	0.04	0.03	43	43	47	56	71	76	83	98	95	87	79	66	56	52	51	46
21028-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	34	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	94	90	82	74	60	50	47	48	44
21028-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	52	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	41	50	66	71	81	91	86	79	71	57	47	45	46	43
21029-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	64	35	0.2	0.13	VC-A	21	0.01	0.01	39	37	41	50	65	71	81	90	86	78	69	56	46	44	45	43
21030-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	94	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	66	52	43	41	43	42
21036-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	51	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	51	66	72	81	92	87	80	71	57	48	45	46	44
21037-030U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	30	35	0.2	0.13	Operating Room	26	0.02	0.02	42	40	44	53	68	74	82	95	91	83	75	62	52	49	49	45
21042-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	98	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	69	80	88	82	75	66	52	42	41	42	42
21054-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	55	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	46	44	45	43
21055-017D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	1	33	35	0.2	0.13	VC-A	24	0.02	0.02	42	41	46	57	74	83	88	93	87	79	72	62	47	43	43	47
21060-038U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	38	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	82	73	60	50	47	47	44
21062-057U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	57	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	47	44	45	43
21065-073U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	73	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	42	44	43
21067-088U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	88	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
21071-016D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	32	35	0.2	0.13	VC-A	24	0.02	0.02	40	39	43	52	67	73	82	94	90	82	74	60	50	47	48	44
21072-022U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	22	35	0.2	0.13	Operating Room	27	0.03	0.02	42	41	46	54	69	75	83	96	93	85	77	64	53	50	50	45
21087-017D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	33	35	0.2	0.13	VC-A	24	0.02	0.01	40	39	43	52	67	73	82	93	89	82	74	60	50	47	48	44
21088-035D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	51	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	71	57	47	44	46	43
21089-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	76	83	97	94	86	78	64	54	51	51	45
21107-022D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	38	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	42	52	67	72	81	93	88	81	72	59	49	46	47	44
21107-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	98	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	68	79	87	81	74	66	51	42	40	42	42
21108-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	41	46	55	70	76	83	97	94	86	78	64	54	51	51	45
21108-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	1	65	35	0.2	0.13	VC-A	20	0.01	0.01	3															

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
21122-025D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	41	35	0.2	0.13	VC-A	23	0.02	0.01	39	38	42	51	66	72	81	92	87	80	72	58	48	46	47	44
21132-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	53	35	0.2	0.13	VC-A	21	0.02	0.01	39	37	41	50	65	71	81	91	86	79	70	56	46	44	45	43
21132-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	45	0	89	35	0.2	0.13	VC-B	18	0.01	0.01	37	34	38	48	63	69	80	88	82	75	66	52	43	41	43	42
21133-027U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	27	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	95	91	83	75	61	51	48	49	45
21133-085U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	85	35	0.2	0.13	VC-A	18	0.01	0.01	37	34	38	48	63	69	80	88	82	75	67	52	43	41	43	42
21134-024D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	40	35	0.2	0.13	VC-A	23	0.02	0.01	39	38	42	51	66	72	81	92	88	80	72	58	48	46	47	44
21135-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	69	35	0.2	0.13	VC-A	19	0.01	0.01	38	35	39	49	64	70	80	89	84	77	68	54	44	42	44	43
21137-097D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	44	0	113	35	0.2	0.13	VC-B	15	0.01	0.01	37	33	37	46	62	67	79	86	79	72	63	49	39	37	38	38
21147-026D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	42	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	42	51	66	72	81	92	87	80	72	58	48	46	47	44
21149-016U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	16	35	0.2	0.13	Operating Room	28	0.03	0.02	42	41	46	55	70	76	83	97	94	86	78	64	54	51	51	46
21155-071D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	88	35	0.2	0.13	VC-A	18	0.01	0.01	37	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
21159-023D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	39	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	42	51	66	72	81	92	88	80	72	58	48	46	47	44
21159-098D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	45	0	114	35	0.2	0.13	VC-B	15	0.01	0.01	37	33	37	46	62	67	79	86	79	72	63	48	39	37	38	37
21171-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	19	35	0.2	0.13	Operating Room	27	0.03	0.02	41	40	45	54	69	75	82	96	92	85	77	63	53	50	50	45
21171-070D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	86	35	0.2	0.13	VC-A	18	0.01	0.01	37	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
21172-021D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	37	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	42	52	67	73	81	93	88	81	73	59	49	46	47	44
21177-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	96	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	69	78	85	87	79	72	64	53	39	36	38	45
21180-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	80	35	0.2	0.13	VC-A	18	0.01	0.01	37	34	39	48	63	69	80	88	82	75	67	53	43	41	43	43
21182-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	60	35	0.2	0.13	VC-A	20	0.01	0.01	38	36	40	49	64	70	80	90	84	77	69	55	45	43	45	43
21185-024D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	51	1	40	35	0.2	0.13	VC-A	22	0.02	0.01	40	39	45	56	73	82	87	91	84	77	70	59	45	41	42	47
21189-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	49	0	23	35	0.2	0.13	Operating Room	26	0.02	0.02	41	40	44	54	68	74	82	95	91	84	76	62	52	49	49	45
21193-093D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	109	35	0.2	0.13	VC-B	16	0.01	0.01	36	33	37	47	62	68	79	86	80	73	64	49	40	38	39	39
21195-068D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	84	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	54	40	37	38	45
21197-022D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	38	35	0.2	0.13	VC-A	23	0.02	0.01	39	38	42	51	66	72	81	92	88	81	72	58	48	46	47	44
21234-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	98	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	69	78	85	87	79	71	64	53	39	36	37	45
21243-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	78	35	0.2	0.13	VC-A	18	0.01	0.01	37	35	39	48	63	69	80	88	82	76	67	53	43	41	43	43
21248-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	34	35	0.2	0.13	VC-A	24	0.02	0.01	40	38	43	52	67	73	81	93	89	81	73	59	49	47	48	44
21248-090D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	106	35	0.2	0.13	VC-B	16	0.01	0.01	37	34	37	47	62	68	79	86	80	73	64	50	40	38	40	40
21259-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	100	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	69	78	85	87	78	71	64	53	39	36	37	45
21270-067D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	1	84	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	55	40	37	38	45
21278-026D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	1	42	35	0.2	0.13	VC-A	22	0.02	0.01	41	40	45	56	73	82	87	92	85	77	70	60	45	41	42	47
21279-050U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	49	0	50	35	0.2	0.13	VC-A	21	0.01	0.01	38	36	41	50	65	71	80	91	86	79	70	56	46	44	46	44
21294-071D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	1	87	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	54	40	37	38	45
21294-092D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	44	1	109	35	0.2	0.13	VC-B	16	0.01	0.01	38	36	41	52	69	78	85	86	78	71	63	52	38	34	35	42
21295-028D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	1	44	35	0.2	0.13	VC-A	22	0.02	0.01	41	40	45	56	73	82	87	91	85	77	70	60	45	41	42	46
21310-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	47	35	0.2	0.13	VC-A	22	0.02	0.01	41	40	45	56	73	81	87	91	85	77	70	59	45	41	42	46
21328-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	46	35	0.2	0.13	VC-A	22	0.02																	

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
21358-075D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	91	35	0.2	0.13	VC-B	18	0.01	0.01	38	36	41	52	70	78	86	87	80	72	64	54	40	37	38	45
21361-033D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	48	1	49	35	0.2	0.13	VC-A	21	0.02	0.01	40	39	44	55	72	81	87	91	84	77	69	59	44	41	41	46
21375-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	0	92	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	48	63	69	80	88	81	75	66	52	42	41	43	42
21378-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	49	1	47	35	0.2	0.13	VC-A	21	0.02	0.01	40	39	44	55	73	81	87	91	84	77	69	59	44	41	41	46
21402-077D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	48	1	93	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	70	78	85	87	79	72	64	53	39	36	38	45
21429-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	51	1	48	35	0.2	0.13	VC-A	21	0.02	0.01	40	38	44	55	72	81	86	91	83	76	69	58	44	40	41	46
21436-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	49	1	92	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	70	78	85	87	79	72	64	53	39	36	38	45
21447-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	51	1	47	35	0.2	0.13	VC-A	21	0.02	0.01	40	38	44	55	72	81	86	91	84	76	69	59	44	40	41	46
21463-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	51	1	46	35	0.2	0.13	VC-A	21	0.02	0.01	40	39	44	55	72	81	86	91	84	76	69	59	44	40	41	46
21475-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	49	1	88	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	70	78	85	87	79	72	64	54	39	36	38	45
21492-097D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	113	35	0.2	0.13	VC-B	15	0.01	0.01	37	35	40	51	68	77	85	85	77	69	61	50	36	32	33	40
21495-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	51	1	47	35	0.2	0.13	VC-A	21	0.02	0.01	40	39	44	55	72	81	87	91	84	76	69	59	44	40	41	46
21495-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	49	1	88	35	0.2	0.13	VC-B	18	0.01	0.01	38	36	41	52	70	78	86	87	80	72	65	54	40	37	38	45
21528-084D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	101	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	69	78	85	87	79	71	64	53	39	36	37	45
21539-067D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	83	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	55	40	37	38	45
21539-093D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	109	35	0.2	0.13	VC-B	15	0.01	0.01	38	35	40	51	69	77	85	86	77	70	62	51	37	34	35	42
21540-047D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	49	0	63	35	0.2	0.13	VC-A	20	0.01	0.01	38	36	40	49	65	70	80	90	84	77	69	55	45	43	45	43
21547-082D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	98	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	70	78	86	87	79	72	64	53	39	36	38	45
22464-093U-RES-EX-OHE01	NV B standard tunnel	64	0	0	30	42	0	93	35	0.20	0.13	Residential Night	32	0.06	0.05	51	52	53	56	69	83	91	100	101	83	73	67	57	48	39	27
37521-063U-RES-EX-NCA00	NV B standard tunnel	100	0	0	45	79	1	63	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	43	54	71	80	86	89	81	74	67	56	41	38	40	46
37665-006U-RES-EX-NCA00	NV B standard tunnel	100	0	0	46	75	0	6	35	0.2	0.13	Residential Night	33	0.05	0.04	45	45	50	58	73	79	84	101	99	91	83	70	60	56	54	47
37698-072U-RES-EX-NCA00	NV B standard tunnel	100	0	0	46	77	0	72	35	0.2	0.13	VC-A	19	0.01	0.01	38	35	39	49	64	70	80	89	83	76	68	54	44	42	44	43
38217-060D-RES-EX-NCA00	NV B standard tunnel	100	0	0	49	75	0	74	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	77	69	55	46	43	44	43
38267-018D-RES-EX-NCA00	NV D High Tunnel	100	0	0	49	76	0	32	35	0.2	0.13	Operating Room	20	0.02	0.02	42	41	45	54	71	79	91	94	78	73	68	53	41	38	40	36
38293-000U-RES-EX-NCA00	NV D High Tunnel	100	0	0	49	75	0	0	35	0.2	0.13	Residential Day	31	0.06	0.05	48	49	54	62	79	87	95	104	92	85	81	67	54	50	49	39
38378-007U-RES-EX-NCA00	NV B standard tunnel	100	0	0	50	76	1	7	35	0.2	0.13	Residential Night	33	0.05	0.04	47	48	53	63	80	88	91	100	97	88	81	72	57	51	49	49
38430-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	50	76	0	48	35	0.2	0.13	VC-A	23	0.02	0.01	41	39	43	51	67	72	82	92	88	80	72	58	49	46	46	44
39582-0U-COM-FU-NCA00	NV B standard tunnel	40	0	0	55	77	1	0	40	0.4	0.4	Operating Room	30	0.06	0.04	44	49	54	62	81	94	94	100	93	81	78	72	57	51	49	47

TABLE 65: DOWN TRACK (SOUTHBOUND) ASSESSMENT PREDICTED GROUND-BORNE NOISE AND VIBRATION RESULTS

Receiver ID	Track Details					Receiver		Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
16960-054U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	37	1	68	60	0.8	0.8	VC-A	16	0.02	0.01	39	41	43	51	72	84	91	88	77	66	61	55	42	37	37	42
17001-066U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	37	1	80	60	0.8	0.8	VC-A	15	0.02	0.01	38	40	42	50	71	83	90	86	76	64	60	53	40	36	36	41
17012-055D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	42	0	55	35	0.2	0.13	VC-B	16	0.01	0.01	36	37	40	47	65	74	84	88	78	68	63	53	44	41	42	39
17013-013D-RES-UR-STM03	NV B standard tunnel	40	0	0	20	41	0	13	35	0.2	0.13	Operating Room	24	0.03	0.02	41	43	46	53	70	80	87	95	88	77	73	63	54	49	49	42
17035-087D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	1	87	35	0.2	0.13	VC-A	13	0.02	0.01	35	36	40	49	69	81	89	84	72	62	57	50	37	33	35	41
17036-066D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	1	66	35	0.2	0.13	VC-A	14	0.02	0.01	36	38	42	50	71	83	89	86	74	64	60	53	39	35	37	42
17046-005D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	42	0	5	35	0.2	0.13	Operating Room	27	0.04	0.03	42	45	48	55	72	82	88	98	92	80	76	67	57	52	51	43
17055-055D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	55	35	0.2	0.13	VC-B	15	0.01	0.01	36	36	39	47	64	74	84	87	78	68	63	52	43	40	42	39
17062-087D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	44	1	87	35	0.2	0.13	VC-A	12	0.01	0.01	35	36	40	49	69	81	88	84	71	61	57	50	36	33	35	41
17063-065D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	41	1	66	35	0.2	0.13	VC-A	15	0.02	0.01	37	38	42	51	71	83	90	86	75	64	60	53	40	36	37	42
17064-023D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	23	35	0.2	0.13	VC-A	20	0.02	0.02	38	40	43	50	68	78	85	92	84	73	69	59	49	46	46	41
17066-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	44	35	0.2	0.13	VC-A	17	0.02	0.01	36	37	40	48	65	75	84	89	79	69	64	54	45	42	43	40
17073-004D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	43	0	4	35	0.2	0.13	Operating Room	27	0.04	0.03	42	45	48	55	72	82	87	98	92	80	76	67	57	52	52	43
17095-055U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	0	70	60	0.8	0.8	VC-B	14	0.01	0.01	35	36	38	46	64	73	83	86	76	66	61	50	42	39	41	39
17112-093U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	41	0	107	60	0.8	0.8	VC-B	11	0.01	0.01	34	34	36	43	62	71	82	83	73	63	57	46	38	35	37	36
17117-065D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	65	35	0.2	0.13	VC-B	13	0.01	0.01	34	34	37	45	63	72	82	85	74	65	60	49	40	38	41	39
17118-004D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	45	0	4	35	0.2	0.13	Operating Room	26	0.04	0.03	41	44	48	55	72	82	87	98	91	80	76	66	56	52	52	43
17119-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	1	44	35	0.2	0.13	VC-A	16	0.02	0.01	36	38	43	52	72	84	89	88	76	66	62	55	41	37	38	43
17120-021D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	21	35	0.2	0.13	VC-A	20	0.02	0.01	38	39	43	50	68	77	85	92	83	73	69	58	49	45	46	41
17122-082D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	82	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	58	47	38	36	39	39
17123-055U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	1	69	60	0.8	0.8	VC-A	14	0.02	0.01	37	38	42	50	71	83	90	86	74	64	60	53	39	35	36	42
17128-001D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	45	0	1	35	0.2	0.13	Operating Room	28	0.05	0.04	42	45	49	56	73	83	88	99	93	82	78	69	58	54	53	44
17129-012D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	12	35	0.2	0.13	Operating Room	22	0.03	0.02	39	41	45	52	69	79	86	94	86	76	72	61	52	48	48	42
17136-093U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	1	107	60	0.8	0.8	VC-A	11	0.01	0.01	35	36	39	48	68	80	88	83	70	60	56	48	35	31	32	38
17145-043D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	43	35	0.2	0.13	VC-B	16	0.01	0.01	35	35	39	47	64	74	83	88	77	68	63	52	43	41	43	40
17147-021D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	21	35	0.2	0.13	VC-A	20	0.02	0.01	37	39	43	50	67	77	85	92	83	73	68	58	48	45	46	41
17147-061D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	61	35	0.2	0.13	VC-B	14	0.01	0.01	33	34	37	45	63	73	82	86	74	65	61	49	40	38	41	39
17147-084U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	42	0	98	60	0.8	0.8	VC-B	12	0.01	0.01	34	34	36	44	62	71	83	84	73	63	58	47	39	37	39	38
17150-003D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	46	0	3	35	0.2	0.13	Operating Room	26	0.04	0.03	41	44	48	55	72	82	87	98	91	80	76	66	56	52	52	43
17170-006D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	47	0	6	35	0.2	0.13	Operating Room	25	0.03	0.02	40	42	46	54	71	81	86	96	89	78	74	64	54	50	50	43
17173-053U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	44	0	68	60	0.8	0.8	VC-B	14	0.01	0.01	35	35	38	45	63	73	83	86	76	66	61	50	41	39	41	39
17174-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	50	0	62	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	45	62	72	82	85	74	65	60	49	40	38	41	39
17175-085U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	43	0	99	60	0.8	0.8	VC-B	12	0.01	0.01	34	34	36	44	62	71	83	84	73	63	58	47	39	36	39	38
17179-045D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	45	35	0.2	0.13	VC-A	15	0.02	0.01	35	37	42	51	71	84	89	87	74	65	61	54	40	36	38	42
17180-024D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	1	24	35	0.2	0.13	VC-A	19	0.02	0.02	38	40	45	54	74	86	90	90	79	69	66	59	44	40	41	44
17188-006D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	6	35	0.2	0.13	Operating Room	25	0.03	0.02	39	42	46	54	71	81	86	96	89	78	74	64	54	50	50	43
17200-083D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	83	35	0.2	0.13	VC-B	11	0.01	0.01	31	31	35	44	61	71	81	83	71	62	58	46	37	35	39	38
17203-064D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	50	0	64	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	45	62	72	82	85	73	64	60	48	39	37	41	39

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
17204-003D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	48	0	3	35	0.2	0.13	Operating Room	26	0.04	0.03	40	43	48	55	72	82	87	98	90	80	76	66	56	52	52	43
17205-044D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	44	35	0.2	0.13	VC-A	15	0.02	0.01	35	37	42	52	71	84	89	87	74	65	61	54	40	36	38	43
17206-023D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	49	1	23	35	0.2	0.13	VC-A	19	0.02	0.02	37	40	45	54	74	86	90	90	79	69	66	59	44	40	41	44
17260-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	62	35	0.2	0.13	VC-B	13	0.01	0.01	32	32	37	45	62	72	82	85	73	64	60	49	39	37	41	39
17261-075D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	52	0	75	35	0.2	0.13	VC-B	12	0.01	0.01	32	31	35	44	61	71	81	84	71	63	58	47	38	36	40	39
17278-056D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	56	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	46	63	73	82	86	74	65	61	49	40	38	41	39
17278-058U-IND-EX-NCA00	NV B standard tunnel	40	0	0	20	45	1	72	60	0.8	0.8	VC-A	13	0.02	0.01	35	36	40	50	70	82	89	85	72	62	58	51	38	34	36	42
17279-072D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	72	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39
17298-056D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	56	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	46	63	73	82	86	74	65	61	49	40	38	41	39
17299-072D-RES-EX-STM03	NV B standard tunnel	40	0	0	20	51	0	72	35	0.2	0.13	VC-B	12	0.01	0.01	32	32	36	44	62	71	82	84	72	63	59	47	38	36	40	39
17300-091D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	51	0	91	35	0.2	0.13	VC-B	11	0.01	0.01	31	30	34	43	60	70	81	82	70	61	57	45	36	34	39	38
17315-061D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	0	61	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	45	62	72	82	85	74	65	60	49	40	37	41	39
17315-099D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	52	0	100	35	0.2	0.13	VC-C	10	0.01	0.01	31	30	34	43	60	70	81	82	69	61	56	44	35	34	38	38
17332-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	0	62	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	45	62	72	82	85	74	65	60	49	40	38	41	39
17341-053U-IND-EX-NCA00	NV C standard crossover	40	0	Y	21	43	1	67	60	0.8	0.8	VC-A	14	0.02	0.01	36	37	41	50	70	82	89	84	74	66	61	53	40	37	38	43
17350-064D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	49	0	64	35	0.2	0.13	VC-B	13	0.01	0.01	33	33	37	45	63	72	82	85	74	65	60	49	40	38	41	39
17357-094D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	50	1	94	35	0.2	0.13	VC-B	11	0.01	0.01	33	33	38	48	67	80	87	82	68	59	55	47	34	31	34	41
17370-062D-RES-EX-STM03	NV B standard tunnel	40	0	0	21	48	0	62	35	0.2	0.13	VC-B	13	0.01	0.01	33	34	37	45	63	73	82	86	74	65	61	49	40	38	41	39
17371-053U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	42	1	67	60	0.8	0.8	VC-A	15	0.02	0.01	37	38	42	50	71	83	89	85	74	67	62	54	41	37	38	43
17380-094D-RES-EX-STM03	NV C standard crossover	40	0	0	21	50	1	94	35	0.2	0.13	VC-B	11	0.01	0.01	33	33	38	48	67	80	87	81	68	62	57	48	35	33	36	43
17388-059D-RES-EX-STM03	NV C standard crossover	40	0	0	21	47	1	59	35	0.2	0.13	VC-A	14	0.01	0.01	35	36	41	50	70	82	88	84	73	66	61	53	39	37	38	44
17402-053U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	41	1	67	60	0.8	0.8	VC-A	15	0.02	0.01	37	38	42	51	71	83	89	85	75	67	62	54	41	38	38	43
17408-060D-RES-EX-STM03	NV C standard crossover	40	0	0	21	46	0	60	35	0.2	0.13	VC-B	14	0.01	0.01	34	34	38	46	63	73	82	85	75	69	63	51	42	41	43	41
17425-060D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	60	35	0.2	0.13	VC-B	14	0.01	0.01	35	35	38	46	63	73	82	85	76	69	63	52	43	41	43	41
17443-055U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	40	1	70	60	0.8	0.8	VC-A	15	0.02	0.01	38	39	42	51	71	83	89	85	75	67	62	55	41	38	38	43
17468-070D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	70	35	0.2	0.13	VC-B	14	0.01	0.01	34	34	37	45	63	72	82	84	75	68	62	50	42	40	42	41
17473-034D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	1	34	35	0.2	0.13	VC-A	18	0.02	0.01	38	40	44	53	73	85	90	88	78	71	66	59	45	41	41	45
17480-098D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	98	35	0.2	0.13	VC-C	12	0.01	0.01	33	33	36	43	61	71	81	82	72	65	59	48	39	38	40	40
17481-055U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	39	1	70	60	0.8	0.8	VC-A	15	0.02	0.01	38	39	43	51	71	83	90	85	76	67	62	55	42	38	38	43
17496-097D-RES-EX-STM03	NV C standard crossover	40	0	0	21	45	0	97	35	0.2	0.13	VC-C	12	0.01	0.01	33	33	36	43	61	71	82	82	72	66	60	48	39	38	40	40
17497-032D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	1	32	35	0.2	0.13	VC-A	18	0.02	0.02	38	41	45	54	73	85	90	88	79	71	67	59	45	42	42	45
17498-065D-RES-EX-STM03	NV C standard crossover	40	0	0	21	44	0	65	35	0.2	0.13	VC-B	14	0.01	0.01	35	35	38	45	63	73	82	84	75	69	63	51	42	41	43	41
17516-047D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	1	47	35	0.2	0.13	VC-A	16	0.02	0.01	38	39	43	52	72	84	89	86	77	69	64	56	43	39	40	44
17530-032D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	0	32	35	0.2	0.13	VC-A	19	0.02	0.01	38	39	42	49	67	76	84	89	82	74	68	57	48	46	46	42
17532-048D-RES-EX-STM03	NV C standard crossover	40	0	0	21	43	1	48	35	0.2	0.13	VC-A	16	0.02	0.01	37	39	43	52	72	84	89	86	76	69	64	56	42	39	40	44

Receiver ID	Track Details					Receiver			Criteria			Prediction			1/3 octave band vibration velocity (dBV) predicted																			
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200			
17542-050U-IND-EX-NCA00	NV C standard crossover	40	0	0	21	39	1	64	60	0.8	0.8	VC-A	16	0.02	0.01	38	40	43	51	71	83	90	86	76	68	63	56	42	39	39	44			
17555-087D-RES-EX-STM03	NV C standard crossover	40	0	Y	21	43	1	87	35	0.2	0.13	VC-A	13	0.01	0.01	35	36	40	49	69	81	88	83	72	64	59	51	38	35	37	43			
17622-039D-RET-UR-STM03	NV B standard tunnel	40	0	0	21	41	1	39	50	2	2	VC-A	18	0.02	0.02	39	41	45	53	73	86	91	90	79	68	64	58	44	39	40	43			
17708-096D-RET-EX-STM03	NV B standard tunnel	40	0	0	21	39	1	96	50	2	2	VC-A	14	0.02	0.01	37	38	41	49	70	82	90	85	74	63	58	51	39	34	35	41			
17773-090D-RET-EX-STM03	NV B standard tunnel	52	0	0	20	37	1	90	50	2	2	VC-A	17	0.02	0.02	39	40	41	47	69	83	92	89	78	66	61	53	41	36	37	42			
17778-022D-RET-EX-STM03	NV B standard tunnel	42	0	0	20	37	1	22	50	2	2	Operating Room	23	0.04	0.03	43	46	48	56	77	89	93	94	86	74	70	64	50	44	43	44			
17778-037D-RET-EX-STM03	NV B standard tunnel	49	0	0	20	37	1	37	50	2	2	VC-A	22	0.03	0.02	42	44	45	52	74	87	94	93	85	72	67	61	48	42	41	44			
17782-043D-RET-EX-STM03	NV B standard tunnel	47	0	0	20	37	1	43	50	2	2	VC-A	21	0.03	0.02	41	43	45	52	74	86	93	92	83	71	66	59	46	41	40	44			
17784-065D-RET-EX-STM03	NV B standard tunnel	53	0	0	19	37	1	65	50	2	2	VC-A	19	0.02	0.02	40	42	43	49	71	84	93	91	81	69	63	56	44	39	38	43			
17819-024D-RET-UR-STM02	NV B standard tunnel	59	0	0	19	37	0	24	50	2	2	Operating Room	26	0.04	0.03	42	45	45	48	67	79	89	98	92	80	73	63	54	50	48	43			
17822-037D-RET-UR-STM02	NV B standard tunnel	59	0	0	19	37	1	37	50	2	2	Operating Room	24	0.03	0.02	42	45	47	51	72	87	94	95	87	75	68	62	48	43	42	45			
17826-000D-RET-UR-STM02	NV B standard tunnel	59	0	0	19	36	1	0	50	2	2	Residential Day	37	0.10	0.08	48	54	56	60	80	95	98	106	102	88	82	77	63	55	51	49			
17832-064D-HTL-EX-STM02	NV B standard tunnel	63	0	0	18	36	1	64	35	0.2	0.13	VC-A	21	0.03	0.02	40	43	45	49	69	84	93	93	84	72	65	58	45	40	39	44			
17835-013D-RET-UR-STM02	NV B standard tunnel	59	0	0	19	36	0	13	50	2	2	Residential Night	30	0.05	0.04	43	47	48	50	69	81	90	101	96	83	77	67	58	53	51	44			
17838-038D-RET-UR-STM02	NV B standard tunnel	63	0	0	18	37	0	38	50	2	2	Operating Room	24	0.03	0.02	40	43	44	47	64	76	88	96	90	78	70	60	51	47	47	42			
17844-027D-RET-UR-STM02	NV B standard tunnel	64	0	0	18	36	0	27	50	2	2	Operating Room	26	0.04	0.03	41	45	46	48	65	78	89	98	92	80	73	62	54	49	48	43			
17852-038D-RET-UR-STM02	NV F IST	66	0	0	18	36	0	38	50	2	2	Operating Room	21	0.03	0.02	41	45	47	52	71	87	96	93	80	66	54	38	26	18	13	4			
17863-000U-RES-EX-STM02	NV F IST	78	0	0	16	35	0	8	35	0.2	0.13	Residential Night	27	0.05	0.04	45	50	55	61	78	91	97	101	91	77	65	49	36	27	20	7			
17886-080U-IND-EX-NCA00	NV F IST	87	0	0	15	32	0	94	60	0.8	0.8	VC-A	17	0.02	0.01	41	41	45	53	72	81	92	89	77	64	51	34	22	15	10	3			
17922-091D-RES-EX-STM02	NV F IST	80	0	0	16	35	0	91	35	0.2	0.13	VC-A	17	0.02	0.01	39	40	45	52	69	81	93	89	76	63	50	33	21	14	9	3			
17924-001D-RES-EX-STM02	NV F IST	82	0	0	16	35	0	1	35	0.2	0.13	Residential Day	31	0.07	0.05	48	52	58	64	81	93	98	104	96	82	70	54	41	31	23	9			
17925-027D-RES-EX-STM02	NV F IST	81	0	0	16	35	0	27	35	0.2	0.13	Operating Room	22	0.03	0.02	43	46	51	57	75	86	95	96	85	71	59	42	30	22	16	6			
17925-060D-RES-EX-STM02	NV F IST	84	0	0	15	35	1	60	35	0.2	0.13	Operating Room	18	0.04	0.03	42	44	50	59	79	92	99	91	77	64	52	38	21	13	7	7			
17929-014D-RES-EX-STM02	NV F IST	84	0	0	15	35	0	14	35	0.2	0.13	Operating Room	25	0.04	0.03	45	48	53	60	78	89	96	99	89	75	63	47	34	25	18	7			
17931-002D-RES-EX-STM02	NV F IST	85	0	0	15	35	0	2	35	0.2	0.13	Residential Day	30	0.07	0.05	48	51	57	64	82	92	97	103	96	81	69	53	40	31	23	9			
17941-079U-IND-EX-NCA00	NV F IST	94	0	0	14	31	0	93	60	0.8	0.8	VC-A	17	0.02	0.01	43	41	45	54	74	83	91	89	78	66	52	34	23	15	10	4			
17948-080D-RES-EX-STM02	NV F IST	88	0	0	15	35	0	80	35	0.2	0.13	VC-A	17	0.02	0.01	41	40	45	53	72	82	92	89	77	65	52	34	22	15	10	4			
17949-000D-RES-EX-STM02	NV F IST	88	0	0	15	34	0	0	35	0.2	0.13	Residential Day	32	0.07	0.05	50	52	58	66	84	94	97	104	98	84	71	55	42	32	24	9			
17949-021D-RES-EX-STM02	NV F IST	87	0	0	15	34	0	21	35	0.2	0.13	Operating Room	23	0.03	0.03	45	46	52	59	77	87	95	97	87	74	61	44	32	23	17	6			
17949-054D-RES-EX-STM02	NV F IST	87	0	0	15	35	0	54	35	0.2	0.13	VC-A	19	0.02	0.02	42	42	47	55	73	83	93	92	80	67	55	37	25	18	12	5			
17960-093D-RES-EX-STM02	NV F IST	88	0	0	15	34	0	93	35	0.2	0.13	VC-A	16	0.02	0.01	40	39	44	53	71	81	91	88	76	64	51	33	21	14	10	3			
17964-024D-RES-EX-STM02	NV F IST	90	0	0	14	34	0	24	35	0.2	0.13	Operating Room	23	0.03	0.02	45	46	51	59	78	87	94	96	86	73	61	44	31	23	16	6			
17966-000D-RES-EX-STM02	NV F IST	91	0	0	14	34	0	0	35	0.2	0.13	Residential Day	32	0.07	0.05	50	52	58	66	84	94	97	104	98	84	72	56	42	32	24	9			
17967-057D-RES-EX-STM02	NV F IST	92	0	0	14	34	0	57	35	0.2	0.13	VC-A	18	0.02	0.01	43	42	47	56	75	84	92	91	80	68	55	37	25	17	12	5			
17974-084D-RES-EX-STM02	NV F IST	91	0	0	14	34	0	84	35	0.2	0.13	VC-A	16	0.02	0.01	41	40	45	54	73	82	91	89	77	65	52	34	22	15	10	4			
17978-024D-RES-EX-STM02	NV F IST	92	0	0	14	34	0	24	35	0.2	0.13	Operating Room	23	0.03	0.02	46	46	51	60	78	88	94	96	87	74	61	44	31	23	17	6			
17979-000D-RES-EX-STM02	NV F IST	94	0	0	14	34	0	0	35	0.2	0.13	Residential Day	31	0.07	0.05	51	52	58	66	85	94	96	104	98	84	72	56	42	33	24	9			
17987-088D-RES-EX-STM02	NV F IST	94	0	0	14	34	0																											

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted																
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	
17991-000D-RES-EX-STM02	NV F IST	94	0	0	14	33	0	0	35	0.2	0.13	Residential Day	32	0.07	0.05	51	53	58	67	85	94	96	104	98	84	72	56	42	33	24	9	
17992-022D-RES-EX-STM02	NV F IST	94	0	0	14	33	0	22	35	0.2	0.13	Operating Room	23	0.03	0.02	46	46	51	60	79	88	93	96	87	74	62	45	32	23	17	7	
18002-089D-RES-EX-STM02	NV F IST	95	0	0	13	33	0	89	35	0.2	0.13	VC-A	16	0.02	0.01	42	40	44	54	74	83	90	88	77	65	52	34	22	15	10	4	
18003-059D-RES-EX-STM02	NV F IST	97	0	0	13	33	0	59	35	0.2	0.13	VC-A	18	0.02	0.01	44	42	46	56	76	85	91	90	80	68	55	37	25	18	12	5	
18005-000D-RES-EX-STM02	NV F IST	96	0	0	13	33	0	0	35	0.2	0.13	Residential Day	31	0.07	0.05	51	53	58	67	86	95	96	104	98	85	72	56	42	33	24	10	
18006-024D-RES-EX-STM02	NV F IST	97	0	0	13	33	0	24	35	0.2	0.13	Operating Room	22	0.03	0.02	46	46	51	60	80	89	93	95	87	74	62	44	31	23	17	7	
18015-057D-RES-EX-STM02	NV F IST	98	0	0	13	33	0	57	35	0.2	0.13	VC-A	18	0.02	0.01	44	42	46	56	76	86	91	90	80	69	56	38	25	18	13	5	
18016-089D-RES-EX-STM02	NV F IST	98	0	0	13	33	0	89	35	0.2	0.13	VC-A	15	0.02	0.01	42	40	44	54	74	83	90	87	77	65	52	34	22	15	10	4	
18019-000D-RES-EX-STM02	NV F IST	98	0	0	13	33	0	0	35	0.2	0.13	Residential Day	31	0.07	0.05	51	53	58	67	86	96	95	103	98	85	73	56	42	33	24	10	
18019-026D-RES-EX-STM02	NV F IST	98	0	0	13	32	1	26	35	0.2	0.13	Operating Room	22	0.05	0.03	48	48	53	65	87	99	98	94	84	72	60	46	28	19	12	9	
18019-096U-IND-EX-NCA00	NV F IST	97	0	0	13	30	1	111	60	0.8	0.8	Operating Room	15	0.03	0.02	44	43	47	58	80	92	96	86	74	61	49	34	17	8	2	3	
18029-057D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	57	35	0.2	0.13	VC-A	18	0.02	0.01	44	43	46	56	77	86	91	90	80	69	56	38	25	18	13	5	
18031-090D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	90	35	0.2	0.13	VC-A	15	0.01	0.01	43	40	44	54	75	84	90	87	77	66	53	34	22	15	10	4	
18034-000D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	0	35	0.2	0.13	Residential Night	31	0.07	0.05	51	53	57	67	87	96	95	103	98	85	73	56	42	33	24	10	
18034-026D-RES-EX-STM02	NV F IST	100	0	0	12	32	1	26	35	0.2	0.13	Operating Room	22	0.05	0.03	48	48	53	65	87	99	98	94	84	72	60	46	28	19	12	9	
18040-001U-RES-EX-STM02	NV F IST	100	0	0	12	32	0	1	35	0.2	0.13	Residential Night	31	0.06	0.05	51	53	57	67	86	96	95	103	97	84	72	55	42	32	24	10	
18043-083D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	83	35	0.2	0.13	VC-A	16	0.02	0.01	43	41	44	55	75	84	90	88	77	66	53	35	22	15	11	4	
18045-057D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	57	35	0.2	0.13	VC-A	18	0.02	0.01	44	43	46	56	77	86	91	90	80	69	56	38	25	18	13	5	
18046-023D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	23	35	0.2	0.13	Operating Room	22	0.03	0.02	47	47	51	60	80	90	92	95	87	75	62	45	32	23	17	7	
18046-090D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	90	35	0.2	0.13	VC-A	15	0.01	0.01	43	40	44	54	75	84	90	87	77	66	53	34	22	15	10	4	
18048-000D-RES-EX-STM02	NV F IST	100	0	0	12	32	0	0	35	0.2	0.13	Residential Day	31	0.07	0.05	52	53	58	67	87	96	95	103	98	85	73	56	42	33	24	10	
18057-025D-RES-EX-STM02	NV F IST	100	0	0	12	31	0	25	35	0.2	0.13	Operating Room	22	0.03	0.02	47	46	50	60	80	89	92	95	86	74	62	44	31	23	17	7	
18061-055D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	55	35	0.2	0.13	VC-A	18	0.02	0.01	44	43	47	57	77	86	91	90	81	69	56	38	26	18	13	5	
18066-000D-RES-EX-STM02	NV F IST	100	0	0	11	31	1	0	35	0.2	0.13	Residential Day	31	0.10	0.07	53	55	61	72	93	106	101	103	95	82	71	58	39	29	20	12	
18068-058D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	58	35	0.2	0.13	VC-A	18	0.02	0.01	44	43	46	56	77	86	91	90	80	69	56	38	25	18	13	5	
18069-020D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	20	35	0.2	0.13	Operating Room	23	0.03	0.02	47	47	51	61	81	90	93	96	88	76	63	46	33	24	18	7	
18072-078D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	78	35	0.2	0.13	VC-A	16	0.02	0.01	43	41	45	55	75	85	90	88	78	67	54	35	23	16	11	4	
18074-090D-RES-EX-STM02	NV F IST	100	0	0	11	31	0	90	35	0.2	0.13	VC-A	15	0.02	0.01	43	41	44	54	75	84	90	87	77	66	53	34	22	15	10	4	
18952-045U-TGT-EX-NCA00	NV B standard tunnel	100	0	0	3	22	0	59	60	2	2	VC-A	24	0.02	0.01	43	41	44	51	67	72	83	93	90	81	72	59	50	47	46	43	
19246-099U-RES-EX-NCA00	NV B standard tunnel	100	0	0	5	25	1	114	35	0.2	0.13	VC-B	18	0.01	0.01	41	39	43	52	70	78	87	88	81	72	64	53	40	35	34	40	
19581-090D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	6	26	0	90	40	0.4	0.4	VC-A	21	0.02	0.01	41	39	41	49	65	70	82	90	87	78	69	56	47	44	44	42	
19594-083D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	6	26	1	83	40	0.4	0.4	VC-A	21	0.02	0.01	43	42	45	54	73	80	88	90	85	76	68	58	45	40	40	45	
19610-073D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	26	0	73	40	0.4	0.4	VC-A	22	0.02	0.01	42	40	42	50	66	71	82	92	88	80	71	57	49	45	45	43	
19639-017D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	26	1	17	40	0.4	0.4	Operating Room	32	0.04	0.03	48	49	52	61	79	87	91	99	97	87	79	70	56	50	47	48	
19672-099D-EDU-EX-NCA00	NV B standard tunnel	100	0	0	7	27	0	99	40	0.4	0.4	VC-A	20	0.01	0.01	41	38	41	48	65	70	82	90	86	77	68	55	46	43	43	42	
19790-056D-RET-EX-NCA00	NV B standard tunnel	100	0	0	8	28	1	56	50	2	2	VC-A	24	0.02	0.02	44	43	47	56	74	82	89	93	88	79	71	61	48	43	42	46	
19800-041D-RET-EX-NCA00	NV B standard tunnel	100	0	0	8	28	1	41	50	2	2	Operating Room	26	0.03	0.02	45	44	48	57	75	84	89	94	90	81	73	64	50	45	43	47	
19955-062U-RES-EX-NCA00																																

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
19968-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	114	35	0.2	0.13	VC-A	18	0.01	0.01	41	38	40	48	64	69	81	88	84	75	66	52	43	40	39	37
19970-052U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	67	35	0.2	0.13	VC-A	23	0.02	0.01	43	41	43	50	67	72	83	92	89	80	71	58	49	46	45	43
19989-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	66	35	0.2	0.13	VC-A	23	0.02	0.01	43	41	43	51	67	72	83	92	89	80	72	58	50	46	46	43
20001-095D-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	32	0	95	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20003-066U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	81	35	0.2	0.13	VC-A	22	0.02	0.01	42	40	42	50	66	71	82	91	88	79	70	57	48	45	44	43
20012-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	64	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	83	92	89	81	72	58	50	46	46	43
20022-049U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	65	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	83	92	89	80	72	58	49	46	46	43
20033-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	28	0	111	35	0.2	0.13	VC-A	19	0.01	0.01	41	38	40	48	64	69	81	89	85	76	67	53	44	40	40	39
20041-044U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	60	35	0.2	0.13	VC-A	24	0.02	0.01	43	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
20046-084U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	99	35	0.2	0.13	VC-A	20	0.01	0.01	41	38	41	49	65	70	82	90	86	77	68	55	46	43	43	42
20048-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	83	35	0.2	0.13	VC-A	21	0.02	0.01	42	39	42	49	66	71	82	91	87	79	70	56	48	44	44	43
20069-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	75	35	0.2	0.13	VC-A	22	0.02	0.01	42	40	42	50	66	71	82	91	88	79	70	57	48	45	45	43
20070-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	92	35	0.2	0.13	VC-A	21	0.01	0.01	41	39	41	49	65	70	82	90	86	78	69	55	47	44	44	42
20075-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	29	0	111	35	0.2	0.13	VC-A	18	0.01	0.01	41	38	40	48	64	69	81	88	84	76	66	52	43	40	40	38
20081-047U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	30	0	62	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	92	89	80	72	58	49	46	46	43
20099-043U-RES-EX-NCA00	NV B standard tunnel	100	0	0	9	30	0	59	35	0.2	0.13	VC-A	24	0.02	0.01	42	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
20117-042U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	57	35	0.2	0.13	VC-A	24	0.02	0.01	42	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
20120-081U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	29	1	96	35	0.2	0.13	VC-A	20	0.02	0.01	42	41	44	53	72	80	88	89	84	75	67	57	44	39	39	45
20122-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	29	0	111	35	0.2	0.13	VC-A	18	0.01	0.01	40	38	40	48	64	69	81	88	84	75	66	52	43	40	40	38
20124-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	80	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	42	49	66	71	82	91	87	79	70	56	48	44	44	43
20144-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	79	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	42	49	66	71	82	91	87	79	70	56	48	44	44	43
20144-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	94	35	0.2	0.13	VC-A	20	0.01	0.01	41	38	41	49	65	70	82	90	86	77	68	55	46	43	44	42
20144-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	113	35	0.2	0.13	VC-A	18	0.01	0.01	40	37	40	48	64	69	81	88	84	75	66	52	43	40	39	38
20148-039U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	55	35	0.2	0.13	VC-A	24	0.02	0.01	42	41	43	51	67	72	83	93	90	81	72	59	50	47	46	43
20166-039U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	54	35	0.2	0.13	VC-A	24	0.02	0.01	42	40	43	51	67	72	82	93	90	81	72	59	50	47	46	44
20184-042U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	58	35	0.2	0.13	VC-A	23	0.02	0.01	42	40	43	51	67	72	82	92	89	81	72	58	49	46	46	43
20187-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	112	35	0.2	0.13	VC-A	18	0.01	0.01	40	37	40	48	64	69	81	88	84	75	66	52	43	40	40	38
20189-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	30	0	95	35	0.2	0.13	VC-A	20	0.01	0.01	41	38	41	49	65	70	81	90	86	77	68	55	46	43	43	42
20192-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	76	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	42	50	66	71	82	91	87	79	70	56	48	45	45	43
20213-035U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	51	35	0.2	0.13	VC-A	24	0.02	0.01	42	40	43	51	67	73	82	93	90	81	73	59	50	47	47	44
20217-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	69	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	71	82	91	88	79	70	57	48	45	45	43
20220-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	85	35	0.2	0.13	VC-A	21	0.01	0.01	41	38	41	49	65	70	81	90	86	78	69	55	46	44	44	43
20224-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	31	0	102	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	69	81	89	85	76	67	53	45	42	42	41
20266-029U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	33	0	45	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	44	52	68	73	83	94	90	82	73	60	51	48	47	44
20267-059U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	75	35	0.2	0.13	VC-A	21	0.02	0.01	41	39	41	50	66	71	82	91	87	79	70	56	47	44	45	43
20273-075U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	91	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	40	49	65	70	81	90	85	77	68	54	46	43	43	42
20273-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	10	32	0	110	35	0.2	0.13	VC-B	18	0.01	0.01	40															

Receiver ID	Track Details					Receiver		Criteria			Prediction			1/3 octave band vibration velocity (dBV) predicted																	
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20303-082U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	33	0	98	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20304-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	33	0	116	35	0.2	0.13	VC-B	17	0.01	0.01	39	36	39	47	63	68	80	87	82	74	65	50	41	38	38	37
20310-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	44	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	44	52	68	73	82	94	90	82	73	60	51	48	47	44
20325-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	44	35	0.2	0.13	VC-A	24	0.02	0.02	42	40	44	52	67	73	82	93	90	82	73	60	51	47	47	44
20344-026U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	0	42	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	44	52	68	73	82	94	90	82	74	60	51	48	47	44
20345-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	92	35	0.2	0.13	VC-A	19	0.01	0.01	40	37	40	48	64	70	81	89	85	77	68	54	45	43	43	42
20350-092U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	108	35	0.2	0.13	VC-B	18	0.01	0.01	39	36	39	47	63	69	80	88	83	75	66	52	43	40	40	39
20354-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	67	35	0.2	0.13	VC-A	22	0.02	0.01	41	38	42	50	66	71	82	91	87	79	70	57	47	45	45	43
20376-044U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	0	60	35	0.2	0.13	VC-A	22	0.02	0.01	41	39	42	50	66	72	82	92	88	80	71	57	48	45	46	43
20377-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	83	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	41	49	65	70	81	90	86	78	69	55	46	43	44	43
20382-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	1	36	35	0.2	0.13	VC-A	25	0.02	0.02	44	43	48	57	75	83	89	94	89	80	73	63	49	44	43	47
20386-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	102	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	40	48	64	69	81	89	84	76	67	53	44	42	42	42
20407-016U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	36	0	32	35	0.2	0.13	Operating Room	26	0.03	0.02	43	41	45	53	69	74	83	95	92	84	75	62	52	49	49	45
20409-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	109	35	0.2	0.13	VC-B	18	0.01	0.01	39	36	39	47	63	69	80	88	83	75	66	51	42	40	40	39
20422-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	36	0	36	35	0.2	0.13	Operating Room	25	0.02	0.02	42	41	44	53	68	74	83	94	91	83	74	61	52	48	48	44
20426-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	35	1	85	35	0.2	0.13	VC-A	20	0.01	0.01	41	39	43	53	71	80	87	89	83	75	67	56	43	39	39	45
20427-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	34	0	112	35	0.2	0.13	VC-B	17	0.01	0.01	39	36	39	47	63	68	80	87	82	74	65	51	42	39	39	38
20443-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	37	0	31	35	0.2	0.13	Operating Room	26	0.03	0.02	42	41	45	53	69	74	83	95	92	84	75	62	52	49	49	45
20463-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	11	37	0	31	35	0.2	0.13	Operating Room	26	0.03	0.02	42	41	45	53	68	74	83	95	92	84	75	62	52	49	49	45
20472-071U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	87	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	64	70	81	89	85	77	68	54	45	43	43	42
20473-090U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	35	0	106	35	0.2	0.13	VC-B	18	0.01	0.01	39	36	39	47	63	69	80	88	83	75	66	52	43	40	41	40
20476-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	69	35	0.2	0.13	VC-A	21	0.01	0.01	40	38	41	50	65	71	81	91	86	78	70	56	47	44	45	43
20479-029U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	46	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	51	67	73	82	93	89	81	73	59	50	47	47	44
20499-036U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	52	35	0.2	0.13	VC-A	23	0.02	0.01	41	39	42	51	66	72	82	92	88	80	72	58	48	46	46	44
20505-057U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	73	35	0.2	0.13	VC-A	21	0.01	0.01	40	37	41	49	65	70	81	90	86	78	69	55	46	44	44	43
20507-074U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	36	0	90	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20507-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	35	0	109	35	0.2	0.13	VC-B	17	0.01	0.01	39	36	39	47	63	68	80	87	82	74	65	51	42	39	40	39
20511-021U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	37	35	0.2	0.13	VC-A	25	0.02	0.02	42	40	44	52	68	73	82	94	90	82	74	60	51	48	48	44
20553-024U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	40	35	0.2	0.13	VC-A	24	0.02	0.02	41	40	43	52	67	73	82	93	90	82	73	60	50	47	47	44
20558-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	37	0	114	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	63	68	80	87	81	73	64	50	40	38	38	37
20560-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	80	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	64	70	81	89	84	77	68	54	45	43	44	43
20562-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	96	35	0.2	0.13	VC-A	18	0.01	0.01	39	36	39	48	64	69	80	88	83	76	67	53	44	42	43	42
20571-024U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	40	35	0.2	0.13	VC-A	24	0.02	0.01	41	40	43	52	67	73	82	93	90	82	73	60	50	47	47	44
20586-021U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	37	35	0.2	0.13	VC-A	24	0.02	0.02	41	40	44	52	68	73	82	94	90	82	74	60	50	47	48	44
20586-095U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	112	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	62	68	79	87	81	73	64	50	40	38	39	38
20591-063U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	79	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	49	64	70	81	89	84	77	68	54	45	43	44	43
20603-020U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	40	0	36	35	0.2	0.13	VC-A	25	0.02	0.02	41	40	44	52	68	73	82	94	90	82	74	60	51	48	48	44
20603-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	38	0	112	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	62	68	79	87	81	73	64	50	40	38	39	38
20607-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	1	81	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	53	71	79	86	89	82	74	66	56	42	38	39	45

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20619-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	39	0	109	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	63	68	80	87	81	74	65	50	41	38	40	39
20620-012U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	40	0	28	35	0.2	0.13	Operating Room	26	0.03	0.02	42	41	45	53	68	74	82	95	92	84	75	62	52	49	49	45
20628-070U-RES-EX-NCA00	NV B standard tunnel	100	0	0	12	40	0	86	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	48	64	69	80	89	83	76	67	53	44	42	43	42
20648-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	30	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	91	83	75	61	51	48	48	45
20649-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	109	35	0.2	0.13	VC-B	16	0.01	0.01	38	34	38	47	62	68	79	87	81	74	65	50	41	38	40	39
20650-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	1	76	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	54	71	80	87	89	82	74	67	56	42	39	39	45
20655-028U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	44	35	0.2	0.13	VC-A	23	0.02	0.01	40	39	42	51	67	72	81	92	88	81	72	59	49	46	47	44
20679-031U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	47	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	42	51	66	72	81	92	88	80	72	58	48	46	46	44
20682-059U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	75	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20686-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	94	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
20687-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	110	35	0.2	0.13	VC-B	16	0.01	0.01	37	34	38	47	62	68	79	87	81	73	64	50	40	38	39	39
20688-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	39	35	0.2	0.13	VC-A	24	0.02	0.01	40	39	43	52	67	73	82	93	89	81	73	59	49	47	47	44
20710-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	30	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	90	83	74	61	51	48	48	45
20731-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	35	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	93	89	82	73	60	50	47	48	44
20731-076U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	92	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	83	75	67	53	43	41	43	42
20731-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	0	111	35	0.2	0.13	VC-B	16	0.01	0.01	38	34	38	47	62	68	79	87	81	73	64	50	40	38	39	38
20732-058U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	74	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20735-045U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	61	35	0.2	0.13	VC-A	21	0.01	0.01	39	37	41	50	65	71	81	90	85	78	70	56	46	44	45	43
20765-014U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	43	0	30	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	90	83	74	61	51	48	48	45
20767-032U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	48	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	51	66	72	81	92	87	80	71	57	48	45	46	44
20768-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	42	0	65	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	71	81	90	85	78	69	55	46	43	45	43
20769-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	41	0	84	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	48	64	69	80	89	83	76	67	53	44	42	43	42
20770-086U-RES-EX-NCA00	NV B standard tunnel	100	0	0	13	40	1	102	35	0.2	0.13	VC-B	17	0.01	0.01	39	37	42	52	70	78	86	87	80	72	64	53	39	36	37	44
20809-059D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	59	35	0.2	0.13	VC-A	21	0.01	0.01	39	37	41	50	65	71	81	90	85	78	70	56	46	44	45	43
20809-075D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	75	35	0.2	0.13	VC-A	19	0.01	0.01	39	38	43	53	71	79	86	89	81	74	66	56	41	38	39	45
20810-020D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	20	35	0.2	0.13	Operating Room	27	0.03	0.02	43	43	49	59	76	85	89	96	91	82	75	66	51	46	45	48
20810-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	39	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	43	52	67	73	81	93	88	81	73	59	49	46	47	44
20816-012U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	28	35	0.2	0.13	Operating Room	26	0.02	0.02	41	40	44	53	68	74	82	95	91	83	75	62	52	49	49	45
20816-084U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	100	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	38	47	63	69	80	88	82	75	66	52	43	41	42	42
20817-036U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	52	35	0.2	0.13	VC-A	22	0.02	0.01	40	37	41	50	66	71	81	91	87	79	71	57	47	45	46	43
20817-049U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	65	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	71	81	90	85	78	69	55	46	43	45	43
20817-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	83	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	48	64	69	80	89	83	76	67	53	44	42	43	42
20829-066U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	83	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	48	64	69	80	89	83	76	67	53	44	42	43	42
20831-085U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	101	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	38	47	63	69	80	88	82	75	66	52	43	40	42	42
20834-097D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	97	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	68	80	87	81	75	66	52	42	40	42	42
20835-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	76	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	49	64	70	80	89	84	76	68	54	44	42	44	43
20836-057D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	57	35	0.2	0.13	VC-A	21	0.02																	

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20847-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	41	46	55	70	76	83	97	94	86	78	64	54	51	51	45
20849-055U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	71	35	0.2	0.13	VC-A	20	0.01	0.01	39	36	40	49	65	70	81	90	85	77	69	55	45	43	44	43
20852-037U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	53	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	42	50	66	71	81	91	87	79	71	57	47	45	46	43
20853-087U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	103	35	0.2	0.13	VC-B	17	0.01	0.01	38	35	38	47	63	68	80	88	82	75	66	51	42	40	41	41
20861-067U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	83	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	80	89	84	76	68	54	44	42	43	42
20870-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	73	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	42	44	43
20874-089D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	89	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	54	40	37	38	45
20876-098D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	98	35	0.2	0.13	VC-B	17	0.01	0.01	39	36	41	52	70	78	86	87	79	72	64	54	39	36	38	45
20878-019D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	19	35	0.2	0.13	Operating Room	28	0.03	0.02	43	44	49	59	76	85	89	96	91	83	76	66	51	47	46	48
20878-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	36	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	82	73	60	50	47	48	44
20879-017U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	0	33	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	91	83	74	61	51	48	48	44
20881-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	73	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20891-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	72	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20894-016D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	16	35	0.2	0.13	Operating Room	29	0.03	0.02	43	42	46	55	70	76	83	97	94	86	78	65	55	51	51	46
20895-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	39	35	0.2	0.13	VC-A	24	0.02	0.02	41	40	43	52	67	73	82	93	90	82	73	60	50	47	47	44
20900-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	73	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	43	44	43
20900-087U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	39	0	103	35	0.2	0.13	VC-B	18	0.01	0.01	38	35	39	47	63	69	80	88	82	75	66	52	43	40	42	41
20911-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	0	36	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	82	73	60	50	47	48	44
20912-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	76	83	97	94	86	78	64	54	51	51	45
20912-070U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	87	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20918-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	36	35	0.2	0.13	VC-A	25	0.02	0.02	41	40	44	52	68	73	82	94	90	82	74	60	51	48	48	44
20921-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	114	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	62	68	79	87	81	73	64	49	40	37	38	37
20929-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	84	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	81	89	84	77	68	54	45	42	43	42
20930-069D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	69	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	43	54	71	80	86	89	82	75	67	57	42	39	40	46
20930-085D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	43	1	85	35	0.2	0.13	VC-A	18	0.01	0.01	39	37	42	53	70	79	86	88	81	73	65	55	41	37	38	45
20935-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	34	35	0.2	0.13	VC-A	25	0.02	0.02	41	40	44	52	68	73	82	94	90	83	74	61	51	48	48	44
20937-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	18	35	0.2	0.13	Operating Room	28	0.03	0.02	44	44	49	60	77	85	89	96	92	83	76	66	51	47	46	48
20937-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	36	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	82	73	60	50	47	48	44
20939-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	113	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	62	68	79	87	81	73	64	49	40	37	38	37
20942-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	40	0	84	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	81	89	84	76	68	54	45	42	43	42
20952-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	1	39	35	0.2	0.13	VC-A	24	0.02	0.02	42	42	46	57	74	83	88	93	87	79	72	62	47	43	43	47
20953-015D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	15	35	0.2	0.13	Operating Room	29	0.03	0.02	43	42	47	55	70	76	83	97	95	87	78	65	55	52	51	46
20955-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	109	35	0.2	0.13	VC-B	16	0.01	0.01	38	35	38	47	63	68	80	87	81	74	65	50	41	38	39	39
20958-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	41	0	84	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	40	48	64	70	80	89	84	76	68	54	45	42	43	42
20970-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	76	83	97	94	86	78	64	54	51	51	45
20970-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	42	1	35	35	0.2	0.13	VC-A	25	0.02	0.02	42	42	47	57	75	83	88	93	88	80	72	63	48	44	43	47
20970-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	14	44	1	36	35	0.2	0.13																				

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
20986-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	39	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	82	73	60	50	47	47	44
20989-068U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	41	0	85	35	0.2	0.13	VC-A	19	0.01	0.01	39	36	39	48	64	69	80	89	84	76	68	53	44	42	43	42
20990-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	116	35	0.2	0.13	VC-B	15	0.01	0.01	37	34	37	46	62	67	79	86	80	72	63	48	39	36	37	37
20995-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	1	18	35	0.2	0.13	Operating Room	28	0.03	0.02	44	44	49	60	77	85	89	96	92	83	76	67	51	47	46	48
20995-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	39	35	0.2	0.13	VC-A	23	0.02	0.01	40	39	43	52	67	73	82	93	89	81	73	59	49	47	47	44
21002-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	34	35	0.2	0.13	VC-A	25	0.02	0.02	41	40	44	52	68	73	82	94	90	82	74	60	51	48	48	44
21005-071U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	87	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	39	48	64	69	80	89	83	76	67	53	44	42	43	42
21006-093U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	109	35	0.2	0.13	VC-B	16	0.01	0.01	37	34	38	47	62	68	79	87	80	73	64	50	40	38	39	39
21017-097U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	113	35	0.2	0.13	VC-B	15	0.01	0.01	37	34	37	46	62	67	79	86	80	73	64	49	39	37	38	38
21018-074U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	90	35	0.2	0.13	VC-A	18	0.01	0.01	38	35	39	48	63	69	80	88	83	76	67	53	43	41	43	42
21021-015U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	31	35	0.2	0.13	Operating Room	25	0.02	0.02	41	40	44	53	68	74	82	94	91	83	75	61	51	48	48	44
21028-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	18	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	76	83	97	94	86	78	64	54	51	51	45
21028-036D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	36	35	0.2	0.13	VC-A	24	0.02	0.01	40	39	43	52	67	73	82	93	89	82	73	60	50	47	48	44
21029-064U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	80	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	48	64	70	80	89	84	76	68	54	44	42	44	43
21030-094U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	110	35	0.2	0.13	VC-B	16	0.01	0.01	37	34	37	47	62	68	79	86	80	73	64	49	40	38	39	39
21036-051U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	67	35	0.2	0.13	VC-A	20	0.01	0.01	39	37	40	49	65	70	81	90	85	78	69	55	46	43	45	43
21037-030U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	42	0	46	35	0.2	0.13	VC-A	23	0.02	0.01	40	39	42	51	67	72	81	92	88	80	72	58	49	46	47	44
21042-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	114	35	0.2	0.13	VC-B	15	0.01	0.01	37	33	37	46	62	67	79	86	79	72	63	48	39	37	38	37
21054-039D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	39	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	43	52	67	73	81	93	88	81	73	59	49	46	47	44
21055-017D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	1	17	35	0.2	0.13	Operating Room	28	0.03	0.02	43	43	49	60	77	85	89	96	91	83	76	66	51	47	46	48
21060-038U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	43	0	54	35	0.2	0.13	VC-A	22	0.02	0.01	40	37	41	50	66	71	81	91	87	79	71	57	47	45	46	43
21062-057U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	73	35	0.2	0.13	VC-A	19	0.01	0.01	38	36	40	49	64	70	80	89	84	77	68	54	45	42	44	43
21065-073U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	89	35	0.2	0.13	VC-A	18	0.01	0.01	37	35	39	48	63	69	80	88	82	75	67	52	43	41	43	42
21067-088U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	104	35	0.2	0.13	VC-B	16	0.01	0.01	37	34	38	47	62	68	79	87	81	74	65	50	41	39	41	41
21071-016D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	16	35	0.2	0.13	Operating Room	28	0.03	0.02	42	42	46	55	70	76	83	97	94	86	78	65	54	51	51	46
21072-022U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	38	35	0.2	0.13	VC-A	24	0.02	0.01	41	39	43	52	67	73	82	93	89	81	73	59	50	47	47	44
21087-017D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	17	35	0.2	0.13	Operating Room	28	0.03	0.02	42	41	46	55	70	76	83	97	93	86	78	64	54	51	51	45
21088-035D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	35	35	0.2	0.13	VC-A	24	0.02	0.01	40	39	43	52	67	73	81	93	89	81	73	59	50	47	48	44
21089-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	34	35	0.2	0.13	VC-A	24	0.02	0.02	41	39	43	52	67	73	82	94	90	82	74	60	50	47	48	44
21107-022D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	22	35	0.2	0.13	Operating Room	26	0.03	0.02	41	40	45	54	69	75	82	95	92	84	76	63	52	49	50	45
21107-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	114	35	0.2	0.13	VC-B	15	0.01	0.01	36	33	37	46	61	67	78	85	79	72	63	48	38	36	38	37
21108-018U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	45	0	34	35	0.2	0.13	VC-A	24	0.02	0.02	40	39	43	52	67	73	82	93	89	82	74	60	50	47	48	44
21108-065U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	1	81	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	55	40	37	39	45
21110-082U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	98	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	62	68	79	87	81	74	65	51	42	40	42	42
21112-042U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	58	35	0.2	0.13	VC-A	20	0.01	0.01	39	36	40	50	65	71	80	90	85	78	70	55	46	44	45	43
21122-025D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	25	35	0.2	0.13	Operating Room	26	0.02	0.02	41	40	44	53	68	74	82	95	91	83	75	62	52	49	49	45
21132-053U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	69	35	0.2	0.13	VC-A	19																		

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
21133-085U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	46	0	101	35	0.2	0.13	VC-B	17	0.01	0.01	37	33	37	47	62	68	79	87	80	74	65	51	41	40	42	42
21134-024D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	24	35	0.2	0.13	Operating Room	26	0.02	0.02	41	40	44	53	68	74	82	95	91	84	75	62	52	49	49	45
21135-069U-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	47	0	85	35	0.2	0.13	VC-B	18	0.01	0.01	37	34	38	48	63	69	80	88	82	75	66	52	43	41	43	42
21137-097D-RES-EX-NCA00	NV B standard tunnel	100	0	0	15	44	0	97	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	69	80	88	82	75	66	52	42	40	42	42
21147-026D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	26	35	0.2	0.13	Operating Room	25	0.02	0.02	41	39	44	53	68	74	82	95	91	83	75	61	51	48	49	45
21149-016U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	33	35	0.2	0.13	VC-A	24	0.02	0.01	40	39	43	52	67	73	81	93	89	82	73	60	50	47	48	44
21155-071D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	71	35	0.2	0.13	VC-A	19	0.01	0.01	38	35	40	49	64	70	80	89	84	77	68	54	44	42	44	43
21159-023D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	23	35	0.2	0.13	Operating Room	26	0.03	0.02	41	40	44	54	68	74	82	95	91	84	76	62	52	49	49	45
21159-098D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	45	0	98	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	69	80	87	81	75	66	52	42	40	42	42
21171-019U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	35	35	0.2	0.13	VC-A	23	0.02	0.01	40	38	43	52	67	73	81	93	88	81	73	59	49	46	47	44
21171-070D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	70	35	0.2	0.13	VC-A	19	0.01	0.01	38	35	40	49	64	70	80	89	84	77	68	54	44	42	44	43
21172-021D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	21	35	0.2	0.13	Operating Room	27	0.03	0.02	41	40	45	54	69	75	82	96	92	84	76	63	52	49	50	45
21177-096U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	112	35	0.2	0.13	VC-B	15	0.01	0.01	37	35	40	51	68	77	84	85	77	69	61	50	36	32	34	41
21180-080U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	0	96	35	0.2	0.13	VC-B	17	0.01	0.01	37	33	38	47	62	68	79	87	81	74	65	51	42	40	42	42
21182-060U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	76	35	0.2	0.13	VC-A	18	0.01	0.01	37	34	39	48	63	69	80	88	82	76	67	53	43	41	43	43
21185-024D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	51	1	24	35	0.2	0.13	VC-A	25	0.02	0.02	41	41	47	58	75	84	88	94	88	80	73	63	48	44	44	48
21189-023U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	49	0	39	35	0.2	0.13	VC-A	23	0.02	0.01	39	37	42	51	66	72	81	92	87	80	72	58	48	46	47	44
21193-093D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	93	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	69	80	88	81	75	66	52	42	41	43	42
21195-068D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	68	35	0.2	0.13	VC-A	19	0.01	0.01	39	38	43	54	71	80	86	89	82	74	67	56	42	38	39	46
21197-022D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	22	35	0.2	0.13	Operating Room	26	0.03	0.02	41	40	45	54	69	75	82	95	91	84	76	62	52	49	50	45
21234-098U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	114	35	0.2	0.13	VC-B	14	0.01	0.01	37	35	40	51	68	77	84	85	76	69	61	50	35	32	33	40
21243-078U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	94	35	0.2	0.13	VC-B	17	0.01	0.01	37	34	38	47	63	68	79	87	81	74	66	51	42	40	42	42
21248-018D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	0	18	35	0.2	0.13	Operating Room	27	0.03	0.02	41	41	45	54	69	75	82	96	93	85	77	64	53	50	50	45
21248-090D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	0	90	35	0.2	0.13	VC-B	18	0.01	0.01	37	34	38	48	63	69	80	88	82	75	66	52	43	41	43	42
21259-100U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	116	35	0.2	0.13	VC-B	14	0.01	0.01	37	35	40	51	68	77	84	85	76	69	61	49	35	31	32	39
21270-067D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	1	67	35	0.2	0.13	VC-A	20	0.01	0.01	40	38	43	54	71	80	86	89	82	75	67	56	42	39	40	46
21278-026D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	1	26	35	0.2	0.13	VC-A	25	0.02	0.02	42	42	47	58	75	84	88	94	88	81	73	63	48	44	44	47
21279-050U-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	49	0	66	35	0.2	0.13	VC-A	19	0.01	0.01	37	35	39	49	64	70	80	89	83	77	68	54	44	42	44	43
21294-071D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	46	1	71	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	54	71	80	86	89	82	74	67	56	42	38	39	45
21294-092D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	44	1	92	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	54	40	37	38	45
21295-028D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	48	1	28	35	0.2	0.13	VC-A	25	0.02	0.02	42	42	47	58	75	83	88	94	88	80	73	63	48	44	44	47
21310-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	16	47	1	31	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	47	57	75	83	88	94	88	80	72	63	48	44	44	47
21328-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	30	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	47	57	75	83	88	94	88	80	73	63	48	44	44	47
21337-073D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	45	1	73	35	0.2	0.13	VC-A	19	0.01	0.01	40	38	43	54	71	80	86	89	82	74	66	56	42	38	39	45
21344-029D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	29	35	0.2	0.13	VC-A	25	0.02	0.02	42	41	47	58	75	83	88	94	88	80	73	63	48	44	44	47
21358-075D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	1	75	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	42	53	71	79	86	88	81	74	66	55	41	38	39	45
21361-033D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	48	1	33	35	0.2	0.13	VC-A	24	0.02	0.01	41	41	46	57	74	83	87	93	87	79	72	62	47	43	43	47
21375-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	47	0	76	35	0.2	0.13	VC-A	19	0.01	0.01	38	35	39	48	64	70	80	89	83	76	68	53	44	42	44	43
21378-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	49	1	30	35	0.2	0.13	VC-A	24	0.02	0.02	41	41	46	57	74	83	87	93	87	79	72	62	47	43	43	47

Receiver ID	Track Details					Receiver			Criteria			Prediction				1/3 octave band vibration velocity (dBV) predicted															
	Track type	Train Speed km/h	Curving correction	Crossover/ Turnout Exists	Rail Height, m	Receiver Height, m	Building Floor/Level	Horizontal Distance, m	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	Vibration VC-curve	GBN, dB(A)	VDV day (m/s ^{1.75})	VDV night (m/s ^{1.75})	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
21402-077D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	48	1	77	35	0.2	0.13	VC-A	18	0.01	0.01	39	37	42	53	70	79	86	88	81	73	66	55	41	38	39	45
21429-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	51	1	31	35	0.2	0.13	VC-A	24	0.02	0.01	41	40	46	57	74	83	87	93	86	79	72	62	46	43	43	47
21436-076D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	49	1	76	35	0.2	0.13	VC-A	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	66	55	41	37	39	45
21447-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	51	1	31	35	0.2	0.13	VC-A	24	0.02	0.01	41	40	46	57	74	83	87	93	87	79	72	62	47	43	43	47
21463-030D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	51	1	30	35	0.2	0.13	VC-A	24	0.02	0.01	41	40	46	57	74	83	87	93	87	79	72	62	47	43	43	47
21475-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	17	49	1	72	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	42	53	71	79	86	88	81	74	66	55	41	38	39	45
21492-097D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	97	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	69	78	85	87	79	72	64	53	39	36	38	45
21495-031D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	51	1	31	35	0.2	0.13	VC-A	24	0.02	0.01	41	41	46	57	74	83	87	93	87	79	72	62	47	43	43	47
21495-072D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	49	1	72	35	0.2	0.13	VC-A	19	0.01	0.01	39	37	42	53	71	79	86	89	81	74	66	56	41	38	39	45
21528-084D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	84	35	0.2	0.13	VC-B	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	54	40	37	38	45
21539-067D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	67	35	0.2	0.13	VC-A	20	0.01	0.01	39	38	43	54	71	80	86	89	82	74	67	56	42	39	40	46
21539-093D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	93	35	0.2	0.13	VC-B	17	0.01	0.01	38	36	41	52	70	78	86	87	79	72	64	54	40	36	38	45
21540-047D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	49	0	47	35	0.2	0.13	VC-A	22	0.02	0.01	39	37	42	51	66	72	81	92	87	79	71	57	47	45	46	44
21547-082D-RES-EX-NCA00	NV B standard tunnel	100	0	0	18	48	1	82	35	0.2	0.13	VC-A	18	0.01	0.01	39	37	42	53	70	79	86	88	80	73	65	55	41	37	39	45
22464-093U-RES-EX-OHE01	NV B standard tunnel	56	0	0	30	42	0	93	35	0.20	0.13	Operating Room	30	0.05	0.04	49	50	51	54	68	81	90	98	99	81	72	65	55	46	37	26
37521-063U-RES-EX-NCA00	NV B standard tunnel	100	0	0	45	79	1	78	35	0.2	0.13	VC-B	18	0.01	0.01	38	36	41	53	70	79	85	88	80	73	65	54	40	37	39	45
37665-006U-RES-EX-NCA00	NV B standard tunnel	100	0	0	46	75	0	20	35	0.2	0.13	Operating Room	28	0.03	0.02	42	41	46	54	69	75	83	96	93	85	77	64	54	50	50	45
37698-072U-RES-EX-NCA00	NV B standard tunnel	100	0	0	46	77	0	86	35	0.2	0.13	VC-B	18	0.01	0.01	37	34	38	48	63	69	80	88	82	75	66	52	43	41	43	42
38217-060D-RES-EX-NCA00	NV B standard tunnel	100	0	0	49	75	0	60	35	0.2	0.13	VC-A	22	0.02	0.01	40	38	41	50	66	71	81	91	87	79	70	57	47	45	45	43
38267-018D-RES-EX-NCA00	NV D High Tunnel	100	0	0	49	76	0	18	35	0.2	0.13	Operating Room	23	0.03	0.02	44	43	48	57	73	81	92	97	82	76	72	57	45	41	42	37
38293-000U-RES-EX-NCA00	NV D High Tunnel	100	0	0	49	75	0	0	35	0.2	0.13	Residential Day	31	0.06	0.05	48	49	54	62	79	87	95	104	92	85	81	67	54	50	49	39
38378-007U-RES-EX-NCA00	NV B standard tunnel	100	0	0	50	76	1	22	35	0.2	0.13	Operating Room	28	0.03	0.02	44	44	49	59	77	85	89	96	92	83	76	66	51	47	46	48
38430-048U-RES-EX-NCA00	NV B standard tunnel	100	0	0	50	76	0	62	35	0.2	0.13	VC-A	21	0.02	0.01	40	38	41	50	65	71	81	91	86	79	70	56	47	44	45	43
39582-0U-COM-FU-NCA00	NV B standard tunnel	40	0	0	55	77	1	0	40	0.4	0.4	Operating Room	30	0.06	0.04	44	49	54	62	81	94	94	100	93	81	78	72	57	51	49	47

Appendix J.2 Rail Operations - Predicted airborne noise levels

TABLE 66: RAIL NOISE ASSESSMENT AT RECEIVERS WITHIN 100 M OF ALIGNMENT OR WITHIN 10 DB OF CRITERIA, NIGHT PERIOD

Receiver ID	Period	Day 1								Ultimate service											
		Broad-band dBL _{Aeq}	Octave band centre frequency - dBL _{Zeq} , Hz							Broad-band dBL _{Amax} 95%	Broad-band dBL _{Aeq}	Octave band centre frequency - dBL _{Zeq} , Hz							Broad-band dBL _{Amax} 95%	Criteria	
			63	125	250	500	1 k	2 k	4 k			63	125	250	500	1 k	2 k	4 k		dBL _{Aeq} (period)	dBL _{Amax} 95 %
23955-325U-RES-EX-SMF01-GF	dBL _{eq} (night)	46	38	30	34	36	41	42	31	67	49	42	34	38	40	45	45	34	69	55	80
23902-316U-RES-EX-SMF01-GF	dBL _{eq} (night)	47	39	31	35	37	42	43	32	69	50	42	35	39	40	46	47	36	70	55	80
23902-316U-RES-EX-SMF01-F 1	dBL _{eq} (night)	49	38	30	35	42	46	43	35	71	53	41	34	38	45	50	47	38	72	55	80
23876-384U-RES-EX-SMF01-F 1	dBL _{eq} (night)	46	37	27	31	39	43	39	30	68	49	41	30	35	43	46	43	33	69	55	80
23861-293U-RES-EX-SMF01-GF	dBL _{eq} (night)	48	35	31	36	37	43	45	35	70	51	38	34	40	40	46	48	39	71	55	80
23824-362U-RES-EX-SMF01-F 1	dBL _{eq} (night)	46	38	27	31	39	42	40	30	66	49	42	31	34	43	45	43	33	67	55	80
23824-247U-RES-EX-SMF01-GF	dBL _{eq} (night)	49	43	34	39	40	45	45	36	72	52	46	38	42	43	48	48	39	73	55	80
23796-228U-RES-EX-SMF01-GF	dBL _{eq} (night)	50	45	36	40	42	47	45	36	73	54	48	39	43	46	50	48	40	74	55	80
23769-254U-RES-EX-SMF01-GF	dBL _{eq} (night)	49	44	34	39	41	46	45	37	71	53	47	38	43	45	49	48	40	72	55	80
23731-323U-RES-EX-SMF01-F 1	dBL _{eq} (night)	44	44	32	36	40	40	37	29	67	48	48	36	40	43	43	41	32	69	55	80
23723-247U-RES-EX-SMF01-GF	dBL _{eq} (night)	46	47	37	41	39	42	42	33	70	50	50	40	44	43	45	45	37	71	55	80
23670-261U-RES-EX-SMF01-GF	dBL _{eq} (night)	47	48	38	41	39	44	42	35	70	51	52	41	45	43	47	46	38	71	55	80
23670-261U-RES-EX-SMF01-F 1	dBL _{eq} (night)	48	48	37	40	44	44	41	33	70	52	51	40	44	47	48	44	36	72	55	80
23633-309U-RES-EX-SMF01-GF	dBL _{eq} (night)	44	48	38	42	35	38	40	32	67	47	51	41	45	39	41	44	35	69	55	80
23633-309U-RES-EX-SMF01-F 1	dBL _{eq} (night)	46	48	37	40	41	42	38	30	69	49	51	40	44	44	45	42	33	70	55	80
23615-360U-RES-EX-SMF01-F 1	dBL _{eq} (night)	43	46	35	37	38	39	35	26	66	46	49	38	41	41	43	39	29	67	55	80
23475-578U-RES-EX-SMF01-F 1	dBL _{eq} (night)	42	43	29	31	36	39	33	21	62	45	46	33	34	39	42	36	25	63	55	80
23412-364U-RES-EX-SMF01-GF	dBL _{eq} (night)	42	47	36	39	33	38	38	25	63	46	50	40	42	36	41	41	28	64	55	80
23384-513U-RES-EX-SMF01-GF	dBL _{eq} (night)	42	44	32	34	32	38	37	22	62	45	47	36	37	36	42	40	26	64	55	80
23346-522U-RES-EX-SMF01-F 1	dBL _{eq} (night)	43	43	31	33	38	39	34	23	62	46	47	35	36	41	43	37	26	63	55	80
23063-208D-RES-EX-SMF03-GF	dBL _{eq} (night)	46	45	36	39	39	43	40	31	67	50	48	39	43	43	46	43	35	68	55	80
23122-351U-RES-EX-SMF01-F 1	dBL _{eq} (night)	42	43	32	35	35	38	37	28	60	46	46	35	39	39	41	41	31	61	55	80
23063-208D-RES-EX-SMF01-GF	dBL _{eq} (night)	43	41	34	40	35	35	36	31	62	46	44	37	43	39	39	40	35	63	55	80

Receiver ID	Period	Day 1									Ultimate service										
		Broad-band dBL _{Aeq}	Octave band centre frequency - dBL _{Zeq} , Hz							Broad-band dBL _{Amax} 95%	Broad-band dBL _{Aeq}	Octave band centre frequency - dBL _{Zeq} , Hz							Broad-band dBL _{Amax} 95%	Criteria	
			63	125	250	500	1 k	2 k	4 k			63	125	250	500	1 k	2 k	4 k		dBL _{Aeq} (period)	dBL _{Amax} 95 %
23027-328U-RES-EX-SMF01-GF	dBL _{eq} (night)	42	31	29	35	34	37	37	30	62	46	35	33	38	37	40	41	33	63	55	80
23027-328U-RES-EX-SMF01-F 1	dBL _{eq} (night)	45	32	30	34	38	41	40	31	64	49	36	33	38	42	45	43	35	66	55	80
22993-212D-RES-EX-SMF01-GF	dBL _{eq} (night)	46	38	33	39	35	40	42	35	68	49	41	36	43	39	43	46	39	69	55	80
22925-316U-RES-EX-SMF01-GF	dBL _{eq} (night)	45	29	29	34	37	41	39	31	65	48	32	33	38	40	45	43	34	66	55	80
22809-297D-RES-EX-OHE01-GF	dBL _{eq} (night)	46	32	29	34	37	41	42	32	65	49	36	32	38	41	45	45	36	66	55	80
22809-297D-RES-EX-OHE01-F 1	dBL _{eq} (night)	47	32	28	34	43	43	41	32	67	51	35	32	37	46	46	44	36	68	55	80
22764-293D-RES-EX-OHE01-GF	dBL _{eq} (night)	44	33	29	35	34	38	40	31	64	47	36	32	38	38	41	44	35	66	55	80
22674-215D-RES-EX-OHE01-GF	dBL _{eq} (night)	43	26	28	35	33	36	40	34	66	47	30	32	39	36	39	43	37	67	55	80
22615-170D-RES-EX-OHE01-GF	dBL _{eq} (night)	42	26	27	34	31	34	38	33	65	45	29	31	38	34	38	42	36	67	55	80
22464-093U-RES-EX-OHE01-GF	dBL _{eq} (night)	37	26	24	29	26	29	33	26	57	40	30	27	33	29	33	36	29	58	55	80

Appendix K Independent verification certificate of noise and vibration study

Sydney Metro - Western Sydney Airport - SSTOM

Independent Verification Certificate

Renzo Tonin & Associates (RTA) have undertaken an Independent Verification (IV) of the Operational Noise and Vibration Review (ONVR) prepare for the Sydney Metro - Western Sydney Airport - Stations, Systems, Trains, Operations and Maintenance (SSTOM) package.

The approved acoustic experts for this IV role are Peter Karantonis and Neil Gross of RTA. Peter Karantonis reviewed the operational rail noise and vibration aspects of the ONVR and Neil Gross the Stabling Maintenance Facility and Stations noise and vibration emissions.

To expedite the review, the process included receipt of a working draft version C.01 to enable a preliminary assessment to be undertaken which was followed by a meeting with the project's Design Joint Venture (DJV).

Following this, a formal draft of the ONVR, version C.02 was issued and RTA undertook a thorough review and provided feedback in the form of a comments register. A meeting was held to clarify any issues where any confusion existed, which was subsequently reflected in the comments register.

Version C.03 of the draft ONVR was then provided addressing almost all comments and an update of responses in the comments register. A meeting was again held to clarify and resolve any remaining and outstanding issues, which were subsequently reflected in the comments register.

A final version C.04 of the ONVR was then provided addressing all comments and an update of responses in the comments register. RTA then either accepted and closed out comments or made recommendations for review by other stakeholders as appropriate in the comments register.

RTA have not had the opportunity to undertake a detailed review of the modelling processes but have used their experience to ensure the approach and assumptions are reasonable and suit the requirements of an ONVR.

In accordance with the terms of the engagement as IV experts, it is the professional opinions of both Peter Karantonis and Neil Gross, that the ONVR (SMWSASSM-PLD-SWD-SWD000-NV-RPT-000001, Version C.04 dated 29/10/2024) has been prepared in accordance with condition of consent E58 of the CSSI 10051 and provides an appropriate assessment of the likely noise and vibration impacts of the project.

Signed by the Independent Verifiers:



PETER KARANTONIS

30 October 2024



NEIL GROSS

30 October 2024