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SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

Construction Noise and Vibration Impact Statement - Traction Substations (Possession WE17)

21 October 2020

Systems Connect

TK685-03-12F01 CNVIS S2B_P4 Traction Substations (WE17) (r2)

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1 Introduction

This Construction Noise and Vibration Impact Statement (CNVIS) has been prepared on behalf of Systems Connect in accordance with the Construction Noise and Vibration Management Plan (CNVMP) [SMCSWLWC-SYC-1NL-PM-PLN-000032] [1], for the Design and Construction of the Line-Wide Works (LWW) of the Sydney Metro City & Southwest Project (the Project).

1.1 Relevant requirements and purpose of this CNVIS

As defined in the CNVMP, the works covered by this CNVIS are part of the Portion 4 - Power Supply Works delivered under Critical State Significant Infrastructure Approval SSI 8256. Condition E27 of CSSI-8256 requires that:

> *Construction Noise and Vibration Impact Statements must be prepared for Construction sites before Construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers. The Statements must augment the Construction Noise and Vibration Management Sub-plan and must be implemented for the duration of Work. The Statements must be informed by a suite of potential management/mitigation options provided in the Construction Noise and Vibration Sub-plan.*

This CNVIS applies to Traction Substation Works, more specifically to the Traction Substation enabling works. This report will be updated to include the remainder of the Traction Substation works closer to the date of commencement of those works in early 2021.

Traction Substation enabling works will be completed during standard construction hours as well as works outside of standard construction hours over the weekend rail possession on October 24th and 25th. The construction hours of work are defined by the Project Planning Approval conditions as outlined in the CNVMP.

This CNVIS forms part of the CNVMP for the Project.

1.2 Structure of this CNVIS

This CNVIS is structured as follows:

- **Section 2** - Description of construction works and hours
- **Section 3** - Nearest sensitive receivers
- **Section 4** - Construction Noise and Vibration objectives
- **Section 5** - Construction Noise Assessment
- **Section 6** - Construction vibration impacts
- **Section 7** - Ground-borne noise assessment

- **Section 8 –** Traffic noise assessment
- **Section 9 –** Cumulative impacts.

1.3 Quality assurance

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Description of construction works and hours

2.1 Summary of works addressed in this CNVIS

2.1.1 Construction activities

This CNVIS provides an assessment of noise and vibration impacts from activities associated with the Traction Substation enabling works, which includes:

- Jersey kerb installation at the Dulwich Hill, Canterbury, Campsie, Lakemba, Punchbowl Traction Substation sites;
- Services relocation works at the Campsie Traction Substation site
- Temporary power supply to Campsie Station during services relocation works.

The worksite locations are depicted in APPENDIX B.

The proposed works, likely plant and equipment and indicative Project timing are summarised in APPENDIX C. Works are planned to occur during standard construction hours, however due to the proximity of the works area to the existing rail corridor, some works will need to occur under Rail Possession, as outlined in Section 2.2.3 and APPENDIX C.

2.1.2 Construction traffic

The Traction Substation enabling works will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by delivery vehicles bringing materials, plant and equipment to the worksite

Construction traffic on-site (i.e. within the Project footprint) is included as part of the construction noise assessment of the works activities identified in Sections 5 and APPENDIX C. When construction related traffic moves onto the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site's activities. Construction traffic noise is addressed in Section 7.

2.1.3 Cumulative construction impacts

All concurrent Sydney Metro construction site works have been considered and addressed in Section 9 of this CNVIS. CSSI-8256 Condition of Approval E26 requires work undertaken for the delivery of the CSSI, including those undertaken by third parties (such as utility relocations) to be coordinated to ensure respite periods are provided. Potentially concurrent construction activities within the vicinity of the Traction Substation worksites have also been considered, as discussed in Section 9.

2.2 Construction hours

The construction hours for the Project are defined in the CSSI-8256 Conditions E19 to E24.

2.2.1 Standard construction hours

The standard construction hours of work are defined by the CSSI-8256 Condition E19. The standard construction hours for the Project are summarised in the Table 2.1 below.

In addition to this, highly noise intensive work that results in an exceedance of the applicable Noise Management Level at the same receiver is limited by CSSI-8256 Condition E24, except where permitted by an Environment Protection License (EPL) as noted in Table 2.1.

Table 2.1: Standard construction hours

Construction Activity	Monday to Friday	Saturday	Sunday/ Public holiday
Standard construction hours	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work
Highly noise intensive Work	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work

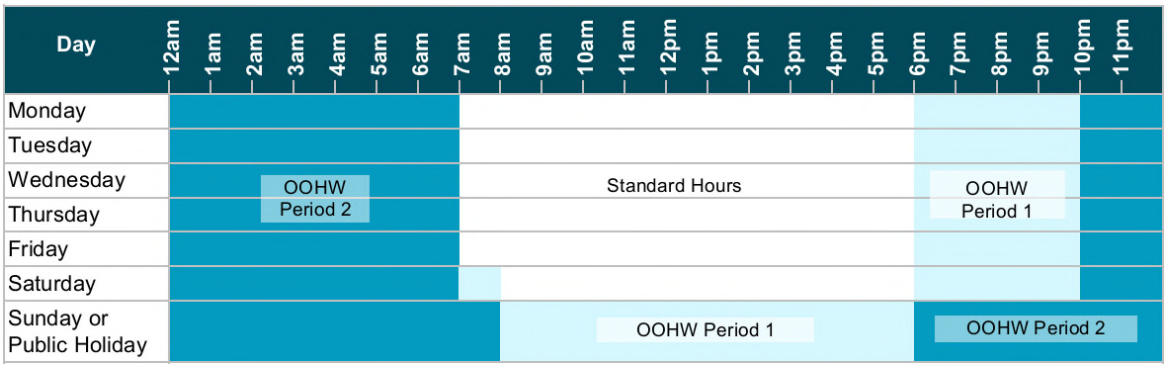
Notes: 1. Works may only be undertaken in continuous blocks not exceeding three (3) hours each with a minimum respite from those activities and Works of not less than one (1) hour between each block. 'Continuous' includes any period during which there is less than a one (1) hour respite between ceasing and recommencing any of the highly noise intensive work.

2.2.2 Out of hours work periods

CSSI-8256 Condition E20 and E23 allow standard construction hours to be varied under specific conditions (where justified), including work permitted under an EPL or under an Out of Hours Work Protocol as required by CSSI-8256 Condition E25. This may, for example include work under a Rail Possession or Road Occupancy License.

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [10] provides a hierarchy of Out of Hours (OOH) work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the day out of hours (OOHD) and evening out of hours (OOHE) periods. Table 2.2 presents the construction work periods as Standard Hours, Out of Hours Work (OOHW) Period 1 and OOHW Period 2.

Table 2.2: Construction hours



1. Standard construction hours are defined in CSSI-8256 Condition E19 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 6:00pm.
2. Work outside of standard construction hours is defined as Out-of-Hours Work (OOHW) and has been divided by the CNVS into 2 periods of sensitivity.
    - **OOHW Period 1** is the least sensitive OOH period and is defined as Monday to Saturday 6:00pm to 10:00pm (evenings; OOHE), Saturday 7:00am to 8:00am (days; OOHD) and Sunday and public holidays 8:00am to 6:00pm (days; OOHD).
    - **OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (nights; OOHN) and Sundays and public holidays 6:00pm to 8:00am (nights, OOHN).

2.2.3 Justification for OOHW

Construction works for the Traction Substation enabling works will be undertaken where reasonable and feasible during standard construction hours, as described above. However, some works will need to be undertaken outside of standard construction hours due to safety or quality control considerations, or to comply with regulatory requirements.

Out of Hours (OOH) Works that apply to the Traction Substation enabling works include:

- E22(e) where Sydney Trains (or other rail authority) has advised the Proponent in writing that a Rail Possession is required

It is noted that the jersey kerb installation works being carried out as part of the enabling works will allow construction works within the Traction Substation work area to be completed safely during standard construction hours.

Oversize deliveries may need to take place outside of standard construction hours in order to comply with RMS requirements for oversize vehicle movements.

Any work outside standard construction hours must be undertaken in accordance with the Out of Hours Works Protocol and the CNVMP [1].

2.2.1 COVID-19 extended construction hours

The Environmental Planning and Assessment (COVID-19 Development – Construction Work Days) Order 2020 is now in place and will continue until the COVID-19 pandemic is over, or the advice of NSW Health changes. The order permits standard construction hours on this project to be extended as follows:

- Saturday from 1pm to 6pm (no high noise work permitted)
- Sundays from 8am to 6pm (no high noise work permitted)
- Public holidays from 8am to 6pm (no high noise work permitted).

High noise work means activities such as rock breaking, rock hammering, sheet piling, pile driving or similar noisy activities, unless an existing consent or approval already allows these works to occur on any of the extended days.

Activities would be carried out during the COVID-19 extended construction hours, where they meet above requirements. Appropriate noise management levels for the extended hours period (i.e. Sundays/ Public Holidays 8am to 6pm) are as outlined for the Day (D/ D(O)) period in Section 4.1.1.

3 Nearest sensitive receivers

3.1 Residential receivers

To assess and manage construction noise and vibration impacts, the residential areas surrounding the Sydenham to Bankstown alignment, including the Traction Substation worksites have been divided into Noise Catchment Areas (NCAs) based on each area's similar acoustic environment prior to the start of construction work. The NCAs are based on those established in the EIS for the Project [2], with some modifications to allow for site specific characteristics.

All relevant residential sensitive receivers near the worksite are identified on an aerial photograph located in APPENDIX B.

3.2 Other sensitive receivers (PPA Condition E34)

Additional to residential receivers above, 'other' noise and vibration sensitive receivers such as passive recreation areas and places of worship surrounding the construction area have been identified and are summarised and identified on an aerial photograph located in in APPENDIX B.

CSSI-8256 Condition E28 states:

> *Noise generating Work in the vicinity of potentially-affected, religious, or educational institutions resulting noise levels above the noise management levels must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected institutions are made at no cost to the affected institution or as otherwise approved by the Planning Secretary.*

Systems Connect have undertaken consultation with identified sensitive receivers to determine sensitive periods. This has been taken into consideration in finalising respite strategies for high noise impacts. Sydney Metro and Systems Connect are working with sensitive receivers to further assess and determine other reasonable arrangements to be implemented.

3.3 Commercial and industrial premises

All commercial and industrial premises near the worksite have been considered in this assessment.

3.4 Heritage receivers

Heritage receivers have been identified in the Land Use Survey in Annexure B of the CNVMP. There are seven heritage-listed receivers close to the work areas, summarised in Table 3.1.

Table 3.1: Assessment heritage receivers

Name	Address/Location	Significance
Dulwich Hill Traction Substation		
Dulwich Hill Railway Station Group	Wardell Road, Dulwich Hill	State
Inter-War Heritage Conservation Area Group	Hollands Avenue; Jocelyn Avenue and Woodbury Street	Local
Gladstone Hall, including interiors	114 Ewart Street, Dulwich Hill	State
Maronite Sisters Convent and High School (former Carmelite Convent), including interiors	194–210 Wardell Road, Dulwich Hill	Local
Canterbury Traction Substation		
Canterbury Sugar Mill (former)	2–4 Sugar House Road; Lot 1437, DP 1015590	State
Electricity Substation no. 275	94 Church Street	State
Campsie Traction Substation		
Campsie Railway Station Group	Wilfred Avenue, Campsie	State
Inter war court house (former Campsie Court House)	56–58 Campsie Street, Campsie	Local
Lakemba Traction Substation		
Federation weatherboard house	12 The Boulevarde, Lakemba; Lot 4, DP 6691	Local
Electricity Substation no. 143	Railway Parade, Lakemba	State
Punchbowl Traction Substation		
Punchbowl Railway Station Group	Punchbowl Road, Punchbowl	State

4 Construction Noise and Vibration objectives

4.1 Noise goals

4.1.1 Noise management levels (NMLs)

Construction noise management levels (NMLs) have been determined using the Construction Environmental Management Framework (CEMF)[11], CSSI-8256 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [9] and as set out in the CNVMP.

For the Traction Substation works external NMLs are derived from the ICNG, as identified in Section 5.1.2 of the CNVMP[1]. Airborne NMLs are determined using the ICNG. For residential receivers these are based on the background noise levels derived from long-term noise logging conducted by SLR on behalf of Transport for NSW (TfNSW) to quantify ambient noise levels for the Environmental Impact Statement (EIS) [2]. This has been incorporated into the CNVMP.

The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Table 10 of the CNVMP. These are applicable when the other sensitive receiver is in use.

Airborne NMLs are summarised and presented in APPENDIX B.

Receivers are considered 'noise affected' where construction noise levels are greater than the NMLs identified in APPENDIX B. The noise affected level represents the point above which there may be some community reaction to noise. Where predicted and/or measured construction noise levels are above the NMLs, all feasible and reasonable work practices will be applied to meet the NMLs.

Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, 5 dB(A) must be added to the activity noise. Activities that are defined in the Interim Construction Noise Guideline (ICNG) [4] as particularly annoying include but are not limited to the use of 'beeper' style reversing or movement alarms; power saws; vibratory rolling; jack hammering, rock hammering or rock breaking; impact piling.

During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75 dB(A) applies in relation to airborne noise at all residential receivers.

4.1.2 Sleep disturbance

Consistent with Section 5.1.3 of the CNVMP [1], an initial screening level of $L_{Amax} \leq L_{A90(15min)} + 15$ dB(A) is used. In situations where this results in an external screening level of less than 55 dB(A), a minimum screening level of 55 dB(A) is set. Note that this is equivalent to a maximum internal noise level of 45 dB(A) with windows open.

Where noise events are found to be above the screening level, further analysis is made to identify:

- the likely number of events above 45 dB(A) (internal) that might occur during the night assessment period
- whether events are above an 'awakening reaction' level of 55 dB(A) L_{Amax} (internal) that equates to NML of L_{Amax} 65 dB(A) (assuming open windows).

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights, maximum noise levels and the extent and frequency of maximum noise level events above the RBL should be considered.

During construction works at night, attended noise monitoring will be undertaken at representative residences most impacted by the works during night-time periods (see Section 5). The noise monitoring will follow the procedures outlined in APPENDIX E of the CNVMP [1], which includes measurement of L_{Amax} noise metrics. If maximum noise levels are found to be above the sleep NML of 45 dB(A), the responsible noise source(s) will be identified and further analysis undertaken to quantify the extent and frequency of events above the NML. Additional feasible and reasonable mitigation measures may need to be considered to reduce potential impacts.

4.1.3 Construction related road traffic noise objectives

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the Traction Substation works. Construction traffic movements on public roads will aim to limit any increase in existing road traffic noise levels to no more than 2 dB(A). All feasible and reasonable noise mitigation and management measures will be implemented.

4.2 Construction vibration goals

As reported in Section 5.4 and 5.5 of the CNVMP [1], construction vibration goals have been determined using:

- for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) [5]
- for structural damage, the vibration limits set out in the
    - British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from ground-borne vibration [6] and
    - German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures [7].

4.2.1 Disturbance to building occupants (human annoyance)

For disturbance to human occupants of buildings, we refer to '*Assessing Vibration; a technical guideline*' [5]. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'* [8].

Intermittent vibration is assessed using vibration dose values (VDVs). For the assessment of potential vibration at the nearest vibration sensitive receivers preferred and maximum VDV goals for the day period (7:00am to 10:00pm) are presented in Table 4.1.

Table 4.1: Construction vibration disturbance goals

Location	Assessment period[1]	Vibration Dose Value (VDV), m/s$^{1.75}$	
		Preferred values	Maximum values
Critical areas[2]	Day or Night	0.10	0.20
Residences	Day	0.20	0.40
	Night	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or Night	0.40	0.80
Workshops	Day or Night	0.80	1.60

Notes: 1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

4.2.2 Structural damage to buildings

A conservative vibration damage screening level per receiver type, assuming vibration predominantly has a frequency of 20 Hz, is given below:

- Reinforced or framed structures (Group 1): 25.0 mm/s
- Unreinforced or light framed structures (Group 2): 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

4.2.3 Heritage

Section 4.2.3 of the CNVMP [1] outlines the approach to manage potential vibration impacts on heritage items, where identified. The actions to be taken shall be to:

1) Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities

2) Structural engineering report to be undertaken on identified heritage items, to confirm structural integrity of the building and confirm if item is 'structurally sound'

3) If item confirmed as 'structurally sound', the screening criteria in Section 4.2.2 shall be adopted, or

4) If item confirmed as 'structurally unsound', the more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity would be adopted.

4.2.4 Sensitive scientific and medical equipment

No sensitive scientific or medical equipment are known to be located near the assessed works. If they are identified, relevant vibration criteria should be established for each item in line with Section 5.5.3 of the CNVMP [1], and any corresponding management or mitigation measures determined.

4.2.5 Utilities and other vibration sensitive structures

Where utilities or other vibration sensitive structures are identified, relevant vibration criteria will be established for each item per Section 5.5.4 of the CNVMP [1], and any corresponding management or mitigation measures determined.

5 Construction Noise Assessment

5.1 Noise prediction methodology

Modelling and assessment of airborne noise impacts from activities associated with the construction works were determined by modelling the noise sources, receiver locations, topographical features, and possible noise mitigation measures using a Cadna-A computer noise model developed for this project. The model calculates the contribution of each noise source at identified sensitive receiver locations and allows for the prediction of the total noise from a site for the various stages of the construction works.

The noise prediction models take into account:

- Location of noise sources and sensitive receiver locations.
- Height of sources and receivers referenced to one metre digital ground contours for the site area and surrounding area.
- Sound Power Levels (L_w) of plant and equipment likely to be used during the various construction activities (see Table C1 in APPENDIX C). Table C1 also identifies the plant and equipment that will operate during each assessment period.
- Separation distances between sources and receivers.
- Ground type between sources and receivers.
- Attenuation from barriers (natural and purpose built).

Key details regarding the construction site layout, the likely plant and equipment (including truck movements), and hours of operation were informed by the Design and Construction Teams. This information is presented in APPENDIX C and formed the basis for all modelling assumptions used in this assessment.

5.2 Predicted noise levels

The Traction Substation enabling works will occur within each worksite over the weekend rail possession period WE17, from 24 to 25 October 2020. The purpose of the works is to establish a temporary worksite adjacent to the rail corridor to allow future traction substation works to be undertaken safely during standard construction hours, whilst the rail line is operational. The safe work area will remain in place for the duration of the traction substation works.

The construction work areas are identified in the land use survey drawings presented in APPENDIX B. Each traction substation is located more than 2 km from the nearest traction substation work area. Cumulative construction noise impacts from concurrent construction works at the traction substations is unlikely.

A detailed computer noise model was prepared to predict noise levels at all relevant sensitive receivers. Various combinations of work activities outlined in Section 2.1.1 are likely to occur, with some activities using different equipment during out of hours works.

The assessment considered combinations of work activities at key project stages, which are summarised in Table 5.1.

Table 5.1: Summary of construction activities

Works Area (see APPENDIX B)	Activity	Aspect	Assessment reference	Indicative timing
Dulwich Hill Traction Substation[1]	Jersey Kerb Installation	Jersey kerb delivery; installation	DH	October to November 2020
Canterbury Traction Substation[1]	Jersey Kerb Installation	Jersey kerb delivery; installation	CB	Approx. 1 day per site during
Campsie Traction Substation[1]	Jersey Kerb Installation	Jersey kerb delivery; installation	CP	
Lakemba Traction Substation[1]	Jersey Kerb Installation	Jersey kerb delivery; installation	LK	
Punchbowl Traction Substation[1]	Jersey Kerb Installation	Jersey kerb delivery; installation	PB	
Campsie Traction Substation[1, 2]	Services Relocation	Utilities relocation	CP_SR	October to November 2020
		Temporary power supply	CP_TP	Approx. 2 days

Notes 1 Work period: Standard Hours and OOHW Period 1

2. Work period: OOHW Period 2

Noise levels were determined by modelling the noise sources during each stage identified in Table 5.1, receiver locations, and construction activities. Details of the plant and adopted sound power levels are presented in APPENDIX C.

Predicted L_{Aeq} noise levels from the worksite are assessed against the NMLs and summarised in Sections 5.2.1 and 5.2.2, with colour coding to denote the highest level of exceedance of the NML. Detailed results for each receiver are given in APPENDIX D.

The noise predictions presented in this CNVIS represent a realistic worst-case scenario when construction occurs at work locations close to residences and other sensitive receivers. At each receiver, noise levels will vary during the construction period based on the position of equipment within the worksite, the distance to the receiver, the construction activities being undertaken and the noise levels of particular plant items and equipment. Actual noise levels will often be less than the predicted levels presented in this CNVIS.

5.2.1 Standard construction hours

Table 5.2 presents the predicted worst-case construction noise levels for each of the construction stages identified in Table 5.1 at the most affected residential receiver in each NCA. The results are presented in terms of level above the NML. For **Standard Hours** construction noise impacts are presented as follows:

- ● Below NML
- ❍ < 10dB(A) above NML - construction noise clearly audible
- ◆ > 10dB(A) above NML - construction noise clearly moderately intrusive
- □ > 75dB(A) - highly noise affected (for residential receivers)

Table 5.2: Summary of construction noise impacts at nearby receivers – standard hours

NCA	DH	CB	CP	LK	PB	CP_SR	CP_TP
S2B_01	❍	-	-	-	-	-	-
S2B_02	□	-	-	-	-	-	-
S2B_03	-	◆	-	-	-	-	-
S2B_04	-	◆	-	-	-	-	-
S2B_05	-	-	-	-	-	●	●
S2B_06	-	-	◆	-	-	◆	❍
S2B_07	-	-	●	●	-	●	●
S2B_08	-	-	-	◆	-	-	-
S2B_10	-	-	-	-	❍	-	-
S2B_11	-	-	-	-	◆	-	-
OSR	❍	●	❍	●	◆	❍	●

Notes: Standard hours (7am to 6pm Monday to Friday and 8am to 6pm Saturday)
OSR: this includes all commercial, industrial, and other sensitive receivers.
Dash symbol ("-") shows where predicted levels are less than 30dB(A)

Exceedances of the NMLs have been predicted at noise sensitive receivers around the Traction Substation worksites. The worksites are typically in close proximity to residential receivers. This means that the nearest residential receivers to the worksites may experience moderately intrusive noise during the works, depending on the location of the work activity relative to the receiver. Up to 4 receivers may be highly noise affected during works at the Dulwich Hill Traction Substation site, when the works are closest to residential receivers.

The jersey kerb installation works would progress along the length of each Traction Substation worksite, parallel to the rail line. The noise sources will also progress with the installation, with the noise impacts increasing and then decreasing with the works. Receivers would not be impacted for a lengthy period of time as the works are anticipated to be completed in less than 1 day per site.

The results above confirm that due to the substantial distance between each Traction Substation worksite, there is no cumulative impact predicted should works at the sites be carried out concurrently. Should the services relocation works be carried out concurrently with the jersey kerb installation at the Campsie Traction Substation worksite, the cumulative noise impact would not increase predicted noise levels by more than 2 dB(A).

The provision of temporary power to Campsie Station during the services relocation works at Campsie Traction Substation may be clearly audible at the nearest affected residential receivers. The cumulative noise impact from the services relocation works and the temporary power supply would not increase predicted noise levels by more than 2 dB(A).

Proposed measures to minimise noise levels are outlined in Section 5.3. For more detailed predictions, see APPENDIX D. For more detailed additional noise management measures, refer to APPENDIX E.

5.2.2 Out of hours work

As part of the Traction Substation enabling works, there are some planned out of hours works during out of hours work period 1 and period 2, as noted in Table 5.1, between 24 and 25 October 2020.

Predicted construction noise level were compared with the project NML to give an indication of the likely noise impact at receiver locations from the construction stages identified in Table 5.1. The impacts presented in Table 5.3 are as follows:

- ● Below NML
- ❍ < 5dB(A) above NML - construction noise noticeable
- ◆ 5 to 15dB(A) above NML - construction noise clearly audible
- ■ > 15 to 25dB(A) above NML - construction noise moderately intrusive
- □ >25dB(A) above NML - construction noise highly intrusive

It is noted that no high noise impact works are proposed for this weekend possession period.

Table 5.3: Summary of construction noise impacts at nearby receivers – OOH

NCA	OOH D							OOH E		OOH N	
	DH	CB	CP	LK	PB	CP_SR	CP_TP	CP_SR	CP_TP	CP_SR	CP_TP
S2B_01	◆	-	-	-	-	-	-	-		-	
S2B_02	□	-	-	-	-	-	-	-		-	
S2B_03	-	■	-	-	-	-	-	-		-	
S2B_04	-	■	-	-	-	-	-	-		-	
S2B_05	-	-	-	-	-	●	●	●	●	●	●

NCA	OOH D							OOH E		OOH N	
	DH	CB	CP	LK	PB	CP_SR	CP_TP	CP_SR	CP_TP	CP_SR	CP_TP
S2B_06	-	-	■	-	-	■	◆	■	◆	□	■
S2B_07	-	-	●	●	-	◔	●	●	●	◔	●
S2B_08	-	-	-	■	-	-	-	-		-	
S2B_10	-	-	-	-	◆	-	-	-		-	
S2B_11	-	-	-	-	■	-	-	-		-	
OSR	◔	●	◔	●	■	◆	●	◔	●	◔	●

Notes: OOH D: day period out-of-hours (1pm to 6pm, Saturdays and 8am to 6pm, Sundays and Public Holidays)
OOH E: evening period out-of-hours (6pm to 10pm, Monday to Sunday).
OOH N: night period out-of-hours (10pm to 7am Monday to Friday and 10pm to 8pm Saturdays, Sundays and Public Holidays).
OSR: this includes all commercial, industrial and other sensitive receivers.
Dash symbol ("-") shows where predicted levels are less than 30dB(A)

The Traction Substation enabling works will be completed over a rail possession weekend, resulting in works being completed during the daytime and outside standard construction hours. Due to the close proximity of residential receivers to the worksites, the nearest residential receivers are likely to experience moderately intrusive noise levels when the works are nearby. Up to 7 residential receivers near the Dulwich Hill Traction Substation may experience highly intrusive noise levels when works are close by. As noted in Section 5.2.1, receivers would not be impacted for a lengthy period of time as the works are anticipated to be completed in less than 1 day per site.

During the services relocation works at the Campsie Traction Substation worksite, noise levels may be highly noise intrusive at up to 8 locations, depending on the specific location of the relocation work and the type of activity that is completed during the night period.

The provision of temporary power to Campsie Station during the services relocation works at Campsie Traction Substation may be clearly audible during the OOH Day and Evening periods and moderately intrusive at night at the nearest affected residential receivers. The cumulative noise impact from the services relocation works and the temporary power supply would not increase predicted noise levels by more than 2 dB(A).

Specific mitigation measures outlined in Table C2 (APPENDIX C) and in Section 5.3 are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable. The use of temporary noise screens would reduce noise to the nearest single storey receivers by approximately 5 dB(A) (sometimes more if line of sight is broken), and should be used, where practicable, where works are required during the more sensitive night period.

Measures for managing potential noise impacts are provided in Section 5.3. For more detailed predictions, see APPENDIX D. For more detailed additional noise measures, refer to APPENDIX E.

5.2.3 Sleep disturbance

Construction equipment may produce instantaneous noise events during operation. Due to the proximity of the residential receivers to the works, it is likely that maximum noise levels from sources such as truck airbrakes and banging from metal on metal contact will exceed the sleep disturbance NML of 65 dB(A) $L_{A,max}$ during the night period works.

These activities will be managed by setting up relevant traffic management measures to minimise the use of air brakes when on site, using broadband reversing alarms on heavy vehicles, and minimising heavy vehicle movements where possible (note there is only 1 delivery truck likely to be required during the night period). Truck drivers will be instructed to avoid excessive acceleration from a stopped position and vigorous slamming of truck doors. The potential of loose items or plant/equipment that could generate metal-on-metal bangs will be identified and managed.

The installation of the temporary power supply to Campsie Station to facilitate the services relocation works at Campsie Traction Substation may cause disturbance when the generator is switched on, as there may be a noticeable change in ambient noise levels at the nearest residential receivers. This will be managed by delaying the switch to temporary power to as late in the morning (i.e. closer to 7am) as much as practical, so that the emergence level of the generator noise above the existing ambient noise level is less. Temporary noise barriers will also be installed around the generator, where reasonable and feasible, to reduce noise impacts.

In addition, Toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods, including limiting the need for car door closing and warning personnel of the need to respect the residential receivers surrounding the local area work sites. No high noise impact activities are required for these works.

Other management measures are outlined in Section 5.3.3 to aid in providing additional noise reduction benefits where predicted levels are above the objective.

5.3 Noise mitigation and management

5.3.1 Consultation with affected receivers

CSSI-8256 Condition E28 requires consultation with affected community, religious or educational institutions where construction noise is found to exceed the NMLs to assist in managing works outside sensitive periods. Systems Connect will continue consultation with potentially affected landholders (taking into consideration consultation outcomes undertaken by Sydney Metro to date) regarding specific mitigation measures applicable to the works at the Traction Substation worksite:

- Ongoing direct contact with residents and businesses on streets surrounding the site via doorknocks, phone and email.
- Bi-annual newsletters distributed to businesses and residents within 500m of the site.

- Monthly notification distributed to businesses and residents within 100m of the site and include updates on recent works and works coming up.
- Community information session on site with environment, engineers, community on an as-needed basis.
- Specific consultation with businesses impacted by our works (adjacent to work areas).
- Invitation to all property owners within 500m to register for weekly email updates included in the bi-annual newsletter.

5.3.2 Site Noise Control Measures

The following standard noise control measures, in addition to those outlined in APPENDIX C, are recommended to reduce potential noise impacts:

Table 5.4: Site Noise Control Measures

Control type	Control measure	Typical use
At-Source Control Measures	Limit equipment in use	Only the equipment necessary during each stage of the OOHW will be used.
	Timing of equipment in use	Where practicable, activities and plant will be limited as outlined in Table C1 (APPENDIX C).
	Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.
	Use and siting of plant	Avoid/ limit simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver. Direct noise-emitting plant away from sensitive receivers where practicable. Locate fixed location plant items as far from sensitive receivers as practicable.
	Equipment selection	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable.
	Temporary noise screens	Where practicable, out of hours works should utilise temporary noise screens (e.g. Echo-barrier, or similar) to provide noise screening during noisier works, such as concrete pours etc that are required to be completed during more sensitive time periods. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of site.
	Truck movements	Avoid the use of park air brakes on site at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving the site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site.
	Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all plant and equipment, where practicable.
Noise Management Measures	Site inductions & Toolbox Talks	All employees, contractors and subcontractors will receive a Project induction. The environmental component may be covered in toolboxes and should include: • location of nearest sensitive receivers • relevant project specific and standard noise and vibration mitigation measures; • permitted hours of work; • OOHW Procedure and Form • construction employee parking areas.

Control type	Control measure	Typical use
	Community consultation	Inform community of construction activity and potential impacts.
	Respite periods	High noise impact activities are carried out in continuous blocks of up to 3 hours. Respite from high noise impact activities will be provided between each block for at least 1 hour. No high noise impact activities will be carried out during this 1 hour respite period.
	Work scheduling around sensitive areas	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods. When working adjacent to schools, medical facilities and childcare centres, scheduling noisy activities around HSC exam times, child care sleep times and other identified sensitive times should be considered, where feasible and reasonable. When working adjacent to churches and places of worship noisy activities should be scheduled outside services, where feasible and reasonable.
	Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
	Noise monitoring	Noise monitoring is to be carried out as detailed in Section 5.3.4.

5.3.3 Additional Noise Mitigation Measures

Table 5.5 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [10] and the CNVMP [1].

Table 5.5: Additional Airborne Noise Mitigation Measures

When is the work being undertaken?	Predicted $L_{Aeq,15min}$ noise level above		Identify additional management measures to be implemented	
	Background (RBL)	Noise Management Level (NML)		
Standard Hours M-F 7am to 6pm Sat 8am to 1pm	0 to 10 dB(A)	-	-	-
	> 10 to 20 dB(A)	≤ 10 dB(A)	-	-
	> 20 to 30 dB(A)	> 10 to 20 dB(A)	LB, M	[MM2]
	> 30 dB(A)	> 20 dB(A)	LB, M	[MM2]
OOHW Period 1 M-F 6pm to 10pm Sat 1pm to 10pm Sun/ PH 8am to 10pm	0 to 10 dB(A)	≤ 5 dB(A)	-	-
	> 10 to 20 dB(A)	> 5 to 15 dB(A)	LB	[MM1]
	> 20 to 30 dB(A)	> 15 to 25 dB(A)	LB, M	[MM2]
	> 30 dB(A)	> 25 dB(A)	LB, M, IB, PC, RO, SN	[MM4]
OOHW Period 2 M-F 10pm to 7am Sat 10pm to 8am Sun/ PH 6pm to 8am	0 to 10 dB(A)	≤ 5 dB(A)	-	-
	> 10 to 20 dB(A)	> 5 to 15 dB(A)	LB, M	[MM2]
	> 20 to 30 dB(A)	> 15 to 25 dB(A)	LB, M, IB, PC, RO, SN	[MM4]
	> 30 dB(A)	> 25 dB(A)	LB, M, IB, PC, RO, SN, AA	[MM5]

Notes: Use the abbreviation codes in the table above to confirm management measures required
Code in square brackets [] refers to noise management code for affected receivers identified in each CNVIS
LB = Letter box drops
M = Monitoring
IB = Individual briefings
SN = Specific notifications
PC = Phone calls and emails
RO = Project specific respite offer
AA = Alternative accommodation

APPENDIX E presents a summary of the additional noise mitigation measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, predicted construction noise levels still exceed the NMLs.

Prior to the commencement of the site establishment works, residential receivers around the Traction Substation worksite, in particular those identified in APPENDIX E will be notified to advise that noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given the project enquiries and complaints 1800 numbers (see Section 5.3.6).

5.3.4 Attended Noise Monitoring

Attended noise monitoring will be undertaken during works at one of the representative residential receivers identified in the table below in the NCAs most impacted by the works (i.e. a minimum of one location for each NCA). Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels. Noise monitoring is subject to obtaining the property owner/occupier's consent to access the property (where required). If consent to access property is denied, monitoring will be done on public land on the property boundary, provided it is safe to do so.

Table 5.6: Nominated verification monitoring locations

NCA	Nominated receiver address	Monitoring location
Dulwich Hill Traction Substation		
S2B_02	29 ALBERMARLE STREET, MARRICKVILLE	Northern property boundary (in rail reserve)
S2B_02	20 RANDALL STREET, MARRICKVILLE	North eastern property boundary (on Randall Street)
Canterbury Traction Substation		
S2B_03	2 CANBERRA STREET, HURLSTONE PARK	Southern property boundary (in rail reserve)
S2B_04	8 HUTTON STREET, HURLSTONE PARK	Northern property boundary (on Hutton Street)
Campsie Traction Substation		
S2B_06	50 LILIAN STREET, CAMPSIE, NSW	North western property boundary (on Lillian Street)
S2B_06	62 LILIAN STREET, CAMPSIE, NSW	North western property boundary (on Lillian Street)
S2B_06	13-15 AGLO STREET, CAMPSIE, NSW	North western property boundary (on Lillian Lane)
Lakemba Traction Substation		
S2B_08	11 THE BOULEVARDE , LAKEMBA, NSW	North western property boundary (on The Boulevarde)
S2B_08	17 THE BOULEVARDE , LAKEMBA, NSW	North western property boundary (on The Boulevarde)
Punchbowl Traction Substation		
S2B_11	105 STANSFIELD AVENUE, BANKSTOWN	Southern property boundary (in reserve to south of property)
S2B_11	72 SOUTH TERRACE, BANKSTOWN	North eastern property boundary (on South Terrace)

Notes: Monitoring on private property is subject to owner consent and where relevant, occupier consent. If consent to access property is denied, monitoring will be done on public land on the property boundary, provided it is safe to do so.

If verification monitoring shows that the external noise levels are consistently above the predicted levels, investigation will be undertaken to understand the cause of the exceedance.

Periodic assessment of plant noise levels will be undertaken in accordance with Section 9.2.3 and Table 20 of the CNVMP to confirm the plant noise levels are within the APPENDIX C Table C1.

All noise monitoring will follow the procedures outlined in Appendix D of the CNVMP.

5.3.5 Managing site specific activities and cumulative noise impacts (Gatewave)

This CNVIS has established the overall impacts associated with the Traction Substation enabling works. A 3D construction noise and vibration management tool (Gatewave, www.gatewave.com.au) has been developed specifically for the Sydney Metro LWW to allow specific work areas and activities to be assessed as construction works progress. It also allows cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, to be assessed and managed in accordance with the CNVMP.

Gatewave will be used regularly to plan, assess and manage works progressively and to coordinate works to ensure relevant mitigation measures are in place.

Gatewave incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict construction noise in accordance with the International Standard ISO 9613-2:1996 implementing quality standard ISO 17534-1:2015. All sensitive receivers identified by the land use survey (see Section 3) are integrated into the Gatewave tool.

5.3.6 Complaints Handling

Noise complaints received and responded to will be managed in accordance with the CNVMP and the Community Consultation Strategy.

Transport for NSW operate a 24-hour construction complaints line (1800 171 386).

Enquiries/ complaints may also be received through the Sydney Metro project email (linewide@transport.nsw.gov.au).

6 Construction vibration impacts

6.1 Minimum working distances for vibration intensive plant

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure. From the plant and equipment listed in APPENDIX C, the dominant vibration generating plant and equipment include:

- Drill Rig.

The recommended minimum working distances for vibration intensive plant are presented in Table 6.1 and Table 6.2. These distances are conservatively based on excavation of hard rock. Site specific buffer distances for vibration intensive plant items must be measured on site where plant and equipment are likely to operate close to or within the minimum working distances for cosmetic damage (Table 6.1).

Unlike noise, vibration cannot be readily predicted. There are many variables from site to site, such as soil type and conditions, sub surface rock, building types and foundations, and actual plant on site.

The data relied upon in this assessment (tabulated below) is taken from a database of vibration levels measured at various sites or obtained from other sources (such as BS5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Table 6.1: Minimum working distances (m) for cosmetic damage (continuous vibration)

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings)[1]	Unreinforced or light framed structures (e.g. residential buildings) [1]	Sensitive structures (e.g. heritage structures) [2]
Drill Rig	5	5	10

Note 1: Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.

Note 2: In accordance with Section 5.8.1 of CNVMP, a site inspection should determine whether a heritage structure is structurally unsound.

Note 3: Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Jackhammers and direction drills are likely to have minimum working distances smaller than 5 m (e.g. 1m in accordance with TfNSW CNS).

Table 6.2: Minimum working distances (m) for human annoyance (continuous vibration)

Plant item	Minimum working distances, m				
	Critical areas[1,4]	Residences		Offices[3,4]	Workshops[4]
		Day[2]	Night[2]		
Drill Rig	30	20	N/A	10	10

Notes 1: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.

2: Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.

3: Examples include offices, schools, educational institutions and place of worship.

4: Applicable when in use.

5: Operating for 30% of the time in high vibration mode.

6.2 Vibration assessment

6.2.1 Structural damage

The number of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6.3 and in APPENDIX F.

Table 6.3: Number of buildings within minimum working distances for cosmetic damage

Work Area	Plant item	Number of buildings[1]		
		Reinforced or framed structures (e.g. commercial buildings)	Screening criteria for non-heritage structures	Screening criteria for heritage structures[2]
Campsie TSS	Drill Rig	0	0	0

Note: 1. Site inspection should determine structural conditions of all potentially vibration affected buildings.
2. Potential heritage structures – reference (Land Use Survey in Annexure B of the CNVMP).

There are no buildings located within the minimum working distances established for cosmetic damage during the works, as identified in Table 6.4 and APPENDIX F.

Vibration monitoring is recommended to determine site specific conditions and/or to verify that vibration levels achieve compliance with the structural damage objectives should plant be required to operate within the safe working distance identified in Table 6.1. If the monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels will be considered.

6.2.2 Human annoyance

APPENDIX F and Table 6.4 identifies specific receivers that may be exposed to vibration that may cause adverse comments during construction works. However, due to the limited time the vibration intensive plant will be operating close to these properties, the risk of annoyance is considered low.

Attended vibration measurement should be carried out in the event of complaint from the nearest receiver to confirm that vibration is within the acceptable range for human annoyance (see Section 6.3.3). The assessing vibration guideline [5] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control), and assume that the vibration has the potential to damage their building or contents.

However, it is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

At properties near the worksite, it is likely that the nearest receivers will be able to feel vibration levels when vibration-generating equipment is being utilised. Properties where vibration levels may be above the vibration disturbance goals in Table 4.1 and there is a probability of adverse comment are shown in Table 6.4.

Table 6.4: Number of buildings within minimum working distances for human annoyance

Work Area	Plant item	Critical areas[1,4]	Residences[5]		Offices[3,4]	Workshops[4]
			Day[2]	Night[2]		
Campsie TSS	Drill Rig	0	1	N/A	0	0

Notes: 1: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
2: Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
3: Examples include offices, schools, educational institutions and place of worship.
4: Applicable when in use.
5: Hotels and childcare centres are included in the residence category.

From the above table, there is one (1) residential properties that may experience vibration which can cause adverse comment when vibration-generating plant is operated nearby (drill rig). The property is identified in APPENDIX F.

The above assessment is based on vibration-generating equipment being operating continuously at the closest location to nearby receivers. When vibration-generating equipment operates further from the closest point, the predicted vibration levels will reduce along with the probability of adverse comment.

Attended vibration measurements are proposed to be carried out proactively and in response to vibration complaints. If measurement results indicate exceedances of the vibration objectives for human annoyance at these locations, vibration control and management measures will be provided to reduce vibration impact (see Section 6.3.1).

After applying all feasible and reasonable vibration mitigation measures, if vibration monitoring still identifies that measured vibration levels are above the relevant vibration criteria for human annoyance, appropriate additional mitigation measures should be considered (see Section 6.3.2).

6.3 Vibration mitigation measures

6.3.1 Vibration control and management measures

In addition to the vibration control measures presented in the CNVMP, the following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort vibration and structural damage limits identified in Section 4.2.

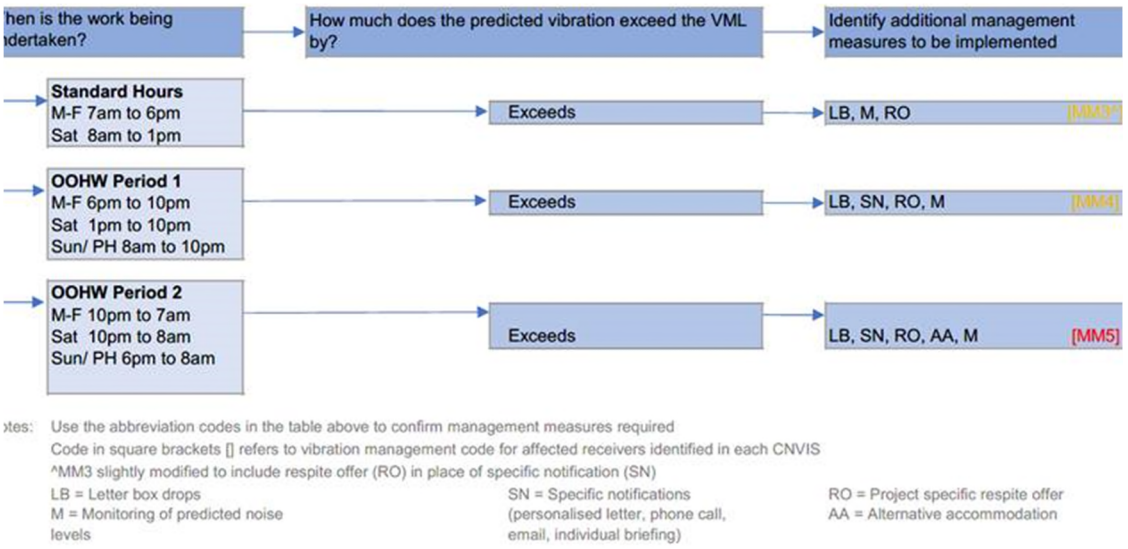
Table 6.5: Site vibration control measures

Control type	Control measure	Typical use
Construction Planning	Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zones established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).
	Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur
	Equipment selection/ construction method	Use less vibration emitting construction methods where feasible & reasonable, for example vibratory rollers can, where practicable, be operated with the vibratory mode switched off to reduce vibration impact.
	Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.
Complaints Management	Construction Complaints Management System	Complaints will be managed in accordance with the Construction Complaints Management System (see Section 6.2.2). Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of safe buffer zones as mentioned above.

6.3.2 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6.5, if vibration monitoring at representative locations are still above relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, as outlined in Section 8.2 of the CNVMP.

Table 6.6: Additional vibration mitigation measures



6.3.3 Vibration monitoring

Attended vibration monitoring is to be undertaken to determine and verify site specific minimum working distances for cosmetic damage and human annoyance. Attended vibration monitoring will be undertaken during works whenever vibration significant plant items are operating close to or within the determined minimum working distances or in response to a vibration complaint.

6.3.4 Managing site specific activities and cumulative vibration impacts (Gatewave)

The Project environment team will use Gatewave to manage construction vibration impact by defining specific work areas and identifying properties within minimum working distances established for cosmetic damage and human annoyance.

6.3.5 Management of complaints

Vibration complaints received and responded to will be managed in accordance with the CNVMP and the Community Consultation Strategy.

Transport for NSW operate a 24-hour construction complaints line (1800 171 386).

Enquiries/ complaints may also be received through the Sydney Metro project email (linewide@transport.nsw.gov.au).

7 Ground-borne noise assessment

Due to the nature of the Traction Substation works, which are surface works, airborne noise is expected to be much higher than ground-borne noise levels at the nearest sensitive receivers. On this basis, the potential impact of ground-borne noise from construction activities is expected to be negligible.

As such, the risk of annoyance due to ground-borne noise is considered low and has not been addressed further in this CNVIS.

8 Traffic noise assessment

Low levels of heavy vehicle movements are likely to be associated with Traction Substation (Possession WE17) works, and the majority of the these will be at the start and end of the works period. As such, the increase in road traffic noise levels is likely be less than 2 dB(A) and so construction traffic will have minimal impact on the main roads used to access the site.

Notwithstanding this, the Heavy Vehicle Code of Conduct includes several measures, including limiting of compression braking, minimisation of vehicle idling, which will ensure that noise impacts of heavy vehicle traffic on surrounding streets are minimised.

9 Cumulative impacts

All concurrent Sydney Metro construction works have been considered and addressed in this CNVIS, including works within the South West Corridor which fall under the Systems Connect work scope. Systems Connect are aware of ongoing, potentially concurrent construction activities within the vicinity of the Traction Substation worksite. The works, summarised in Table 9.1, may have the potential to generate cumulative noise impacts on receivers.

These works have been considered but it has been determined that, due to the nature of the other unrelated construction works, no additional physical mitigation measures are deemed reasonable. Nevertheless, in accordance with the CNVMP Systems Connect will endeavour to take all reasonable steps to collaborate with other Projects to minimise cumulative noise and vibration impact where Systems Connect are above management levels and coordinate respite for affected sensitive receivers, whenever practicable.

Gatewave, a 3D construction noise and vibration management tool (www.gatewave.com.au) will be used to assess and manage cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, in accordance with the CNVMP.

Table 9.1: Other construction works close to S2B P4 Traction Substation worksites

Construction company	Project	Timing of activities	Hours of works	Works location	Activity types	General plant types
John Holland & Laing O'Rourke	Sydney Metro – Sydenham Metro Upgrade	TBC	Standard construction hours, outside construction hours and rail possession works	Sydenham Station	New station entrances at Burrows Road and Railway Parade New concourse over the station with lifts and stairs to each platform, including the two new Sydney Metro platforms	
Not awarded yet	Sydney Metro - South West Corridor Station Works	TBC	Standard construction hours, outside construction hours and rail possession works	Stations from Sydenham to Bankstown	Station upgrade construction works	
Sydney Trains	Sydney Train maintenance works	Based on Sydney Trains trackwork schedule	Based on Sydney Trains trackwork schedule	Any point along the railway corridor. Immediately adjacent to Systems Connect worksite	Rail and signalling maintenance works	Utility relocation, minor earthworks, signal and rail modification.
Systems Connect	Sydney Metro - Line-wide Works		Bulk Power Supply (Campsie) works	Campsie Station to Canterbury Transmission Substation	Trenching, cable pulling, rehabilitation	Excavator with bucket, tipper trucks, vibratory roller

10 Conclusion

Works associated with the Traction Substation worksites have been identified and described in this report. Potentially affected noise and vibration sensitive receivers and relevant construction noise and vibration objectives have been identified and discussed to allow the assessment of potential construction impacts.

The expected construction noise levels have been predicted and presented in Section 5.2 and APPENDIX D. The expected duration of construction activities is outlined in Table C1 of APPENDIX C.

The nearest residential receivers to the worksites may experience moderately intrusive noise during standard construction hours, depending on the location of the work activity relative to the receiver. The nearest receivers to the Dulwich Hill Traction Substation site may experience highly intrusive noise levels when the works are closest to each receiver. Receivers would not be impacted for a lengthy period of time as the works are anticipated to be completed in less than 1 day per site.

During the services relocation works at the Campsie Traction Substation worksite, noise levels during the out of hours work period may be moderately intrusive, depending on the specific location of the relocation work and the type of activity that is completed. During the night period highly noise intrusive noise levels are predicted at up to 8 locations when the works are closest to each receiver. The temporary power supply to Campsie Station during the services relocation works may generate noise that is moderately intrusive to the nearest residential receiver building.

Specific mitigation measures outlined in Table C2 (APPENDIX C) and in Section 5.3 are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable.

Vibration impacts and management measures have been presented in Section 6 to aid in minimising any potential vibration impacts. The risk of structural damage to buildings near the worksites is assessed as low. Several receivers may be exposed to vibration that may cause adverse comments during construction works. However, due to the limited time the vibration intensive plant will be operating close to these properties, the risk of annoyance is considered low.

The potential impact of ground-borne noise from construction activities is expected to be negligible due to the expectation that airborne noise will be much higher than ground-borne noise levels at the nearest sensitive receivers.

Minimal construction vehicles are proposed as part of the works, and so construction traffic noise on the local road network associated with the works will have minimal impact on receivers in proximity to public roads.

References

[1] Sydney Metro City & Southwest – Line Wide Works Contract Construction Noise and Vibration Management Plan (SMCSWLWC-SYC-1NL-PM-PLN-000032-A-CNVMP-C2B)

[2] SLR Consulting Australia Pty Ltd 2017 Sydney Metro Sydenham to Bankstown - Technical Paper 2: Noise and Vibration Report Number 610.15897-R02 – 28 August 2017

[3] SLR Consulting Australia Pty Ltd 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016

[4] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline

[5] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline

[6] British Standard BS 7385 Part 2 1993, Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration

[7] German Standard DIN 4150-3:2016-12 Vibration in buildings – Part 3: Effects on structures

[8] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

[9] Transport for NSW Sydney Metro City & Southwest Construction Noise Strategy (ref: 610.14213-R3) 08 August 2016

[10] Transport for NSW Construction Noise and Vibration Strategy (ref: 7TP-ST-157/4.0) May 2018

[11] Transport for NSW Sydney Metro Construction Environmental Management Framework August 2016

[12] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy

[13] NSW Department of Planning – Development near rail corridors and busy road – interim guideline 2008

APPENDIX A Glossary of terminology

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

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (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).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
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 L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
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.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
OOH	Out of Hours (i.e. outside standard construction hours)
OOHW	Out of Hours Work (i.e. works carried out outside standard construction hours)
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
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.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Nearest sensitive receivers and noise management levels

Table B1: Noise sensitive receivers and construction noise management levels

TRACTION SUBSTATIONS POSSESSION WE17

NCA	Nearest construction work area	Receiver Type	Reference RBL	Existing Noise Levels, dB(A)			Residential NMLs based on ICNG (external)				Sleep Dist. L_{Amax}		Comments
				RBL Day	RBL Evening	RBL Night	NMLDS	NMLDO	NMLE	NMLN	Screening[1]	Max[1]	
Portion 4	**Sydenham to Bankstown (S2B)**												
S2B_01	Rail corridor	Residential buildings up and down side of railway line with some commercial buildings	S2B EIS B.04	41	41	34	51	46	46	39	55	65	
S2B_02	Rail corridor	Predominantly residential buildings up and down side of railway line	S2B EIS B.05	40	40	33	50	45	45	38	55	65	
S2B_03	Rail corridor and Bulk Power Supply	Predominantly residential buildings up and down side of railway line	S2B EIS B.06	38	38	34	48	43	43	39	55	65	
S2B_04	Rail corridor and Bulk Power Supply	Commercial around Canterbury Railway Station and residential buildings up side of railway line and south west of Cooks River	S2B EIS B.07	40	40	35	50	45	45	46	55	65	
S2B_05	Rail corridor and Bulk Power Supply	Predominantly residential buildings up and down side of railway line	S2B EIS B.09	36	36	32	46	41	41	46	55	65	
S2B_06	Rail corridor and Bulk Power Supply	Commercial around Campsie Railway Station and residential buildings up and down side of railway line	S2B EIS B.10	45	42	35	55	50	47	40	55	65	
S2B_07	Rail corridor	Commercial around Belmore Railway Station and residential buildings up and down side of railway line	S2B EIS B.13	41	41	35	51	46	46	40	55	65	
S2B_08	Rail corridor	Commercial around Lakemba Railway Station andresidential buildings up and down side of railway line	S2B EIS B.14	47	47	41	57	52	52	46	56	65	
S2B_09	Rail corridor	Predominantly residential buildings up and down side of railway line with educational buildings	S2B EIS B.16	44	44	36	54	49	49	41	55	65	
S2B_10	Rail corridor	Commercial buildings surrounding Punchbowl Railway Station with residential.	S2B EIS B.19	47	47	41	57	52	52	46	56	65	
S2B_11	Rail corridor	Residential buildings up and down side of railway line	S2B EIS B.20	47	47	39	57	52	52	44	55	65	
S2B_12	Rail corridor	Commercial buildings surrounding Bankstown Railway Station	S2B EIS B.22	54	51	42	64	59	56	47	57	65	
S2B_13	Rail corridor	Residential buildings up and down side of railway line with some commercial buildings	S2B EIS B.23	42	42	39	52	47	47	44	55	65	
Other sensitive receivers													
Studio building (music recording studio)							45	45	45	45			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Studio building (film or television studio)							50	50	50	50			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Cinema space, theatre, auditorium							55	55	55	55			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Hotel (Sleeping areas: Hotels near major roads)							60	60	60	60			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Classrooms at schools and other educational institutions							55	55	55	55			Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Chilcare centre (internal play and sleeping areas)							50	50	50	50			Source: AAAC - guideline for Child Care Centre Acoustic Assessment, assuming a conservative façade loss of 10 dB(A)
Hospital wards and operating theatres							65	65	65	65			Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship							55	55	55	55			Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Library (reading areas)							65	65	65	65			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Office building (general office areas)							65	65	65	65			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Hotel (bars and lounges)							70	70	70	70			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Community centres – Municipal Buildings							60	60	60	60			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 10 dB(A)
Restaurant, bar (Bars and lounges/ Restaurant)							70	70	70	70			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Railway platform and concourse areas							75	75	75	75			Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Café/ Restaurant/ Bar (outdoors)							60	60	60	60			Source: AS2107 ‘maximum1’
Passive recreation areas (e.g. area used for reading, meditation)							60	60	60	60			Source: ICNG
Active recreation areas (e.g. sports fields)							65	65	65	65			Source: ICNG
Commercial premises (including offices and retail outlets)							70	70	70	70			Source: ICNG
Industrial premises							75	75	75	75			Source: ICNG

Notes: 1 - Levels are estimated assuming an open windows (i.e. 10dBA façade losss)

D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday

D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1

E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1

NS: night shoulder period from 10 pm to 12 am Monday to Sunday - OOHW P1

N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2

MS: morning shoulder period from 5 am to 7 am Monday to Friday, from 6 am to 8 am Saturday, Sunday and Public holidays - OOHW P1

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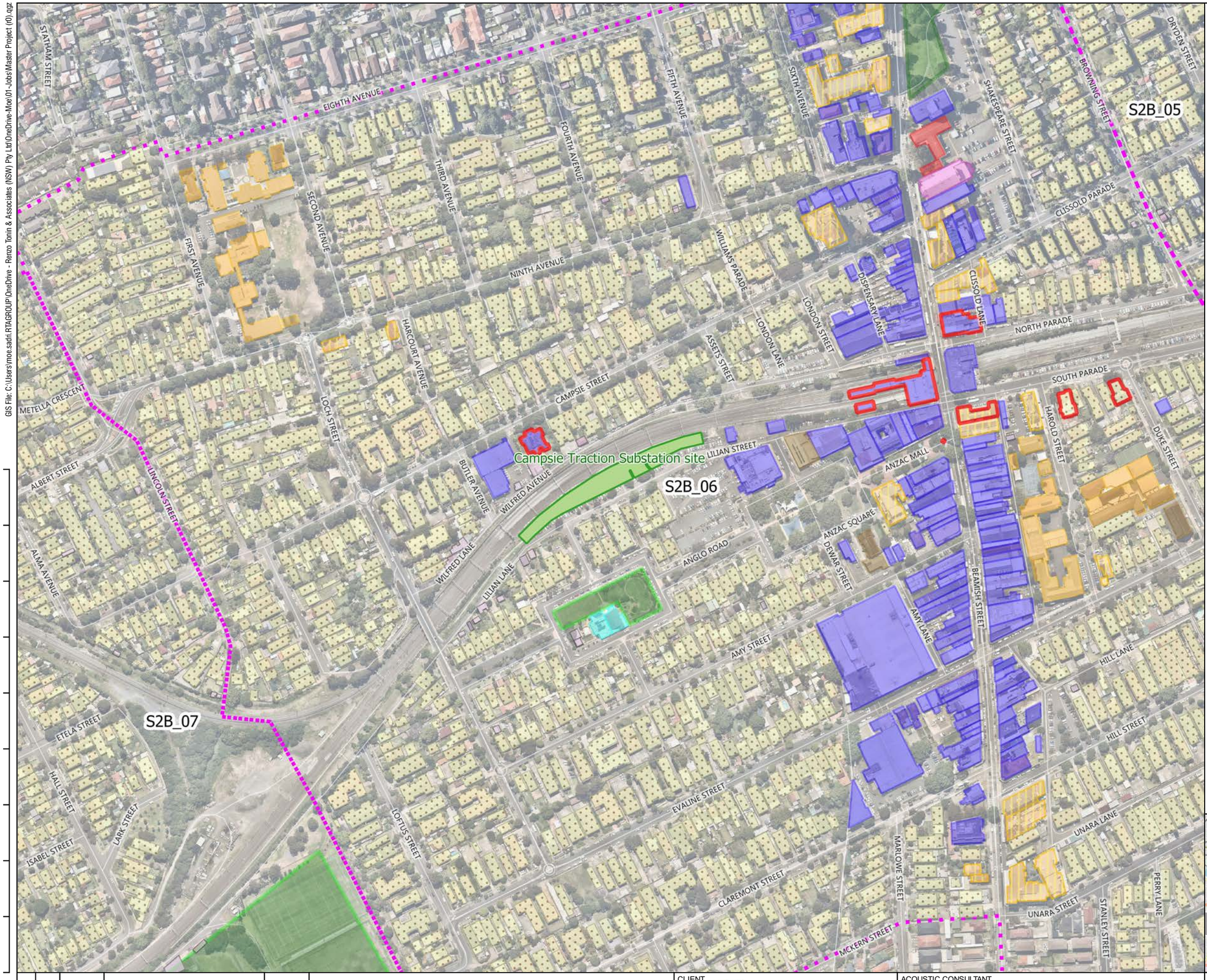

0 60 120 180 240 300 360 420 480 540 m

LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

Work area

REV	BY	DATE	DESCRIPTION	APPROVER
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A3 Original

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FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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TSS WE17
Land Use, NCAs
Work area: Campsie Traction Substation site

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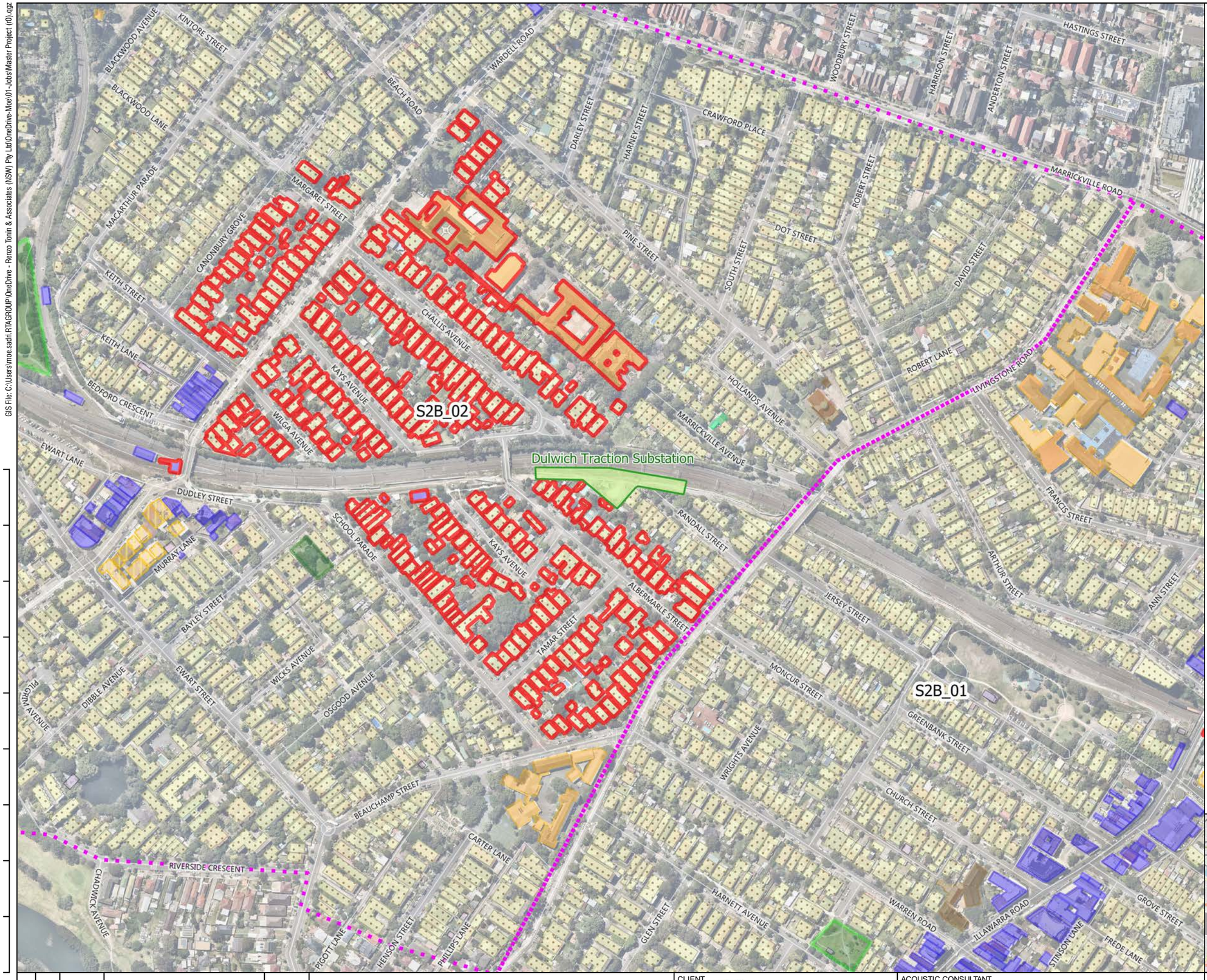

LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

Work area

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TSS WE17
Land Use, NCAs
Work area: Dulwich Traction Substation

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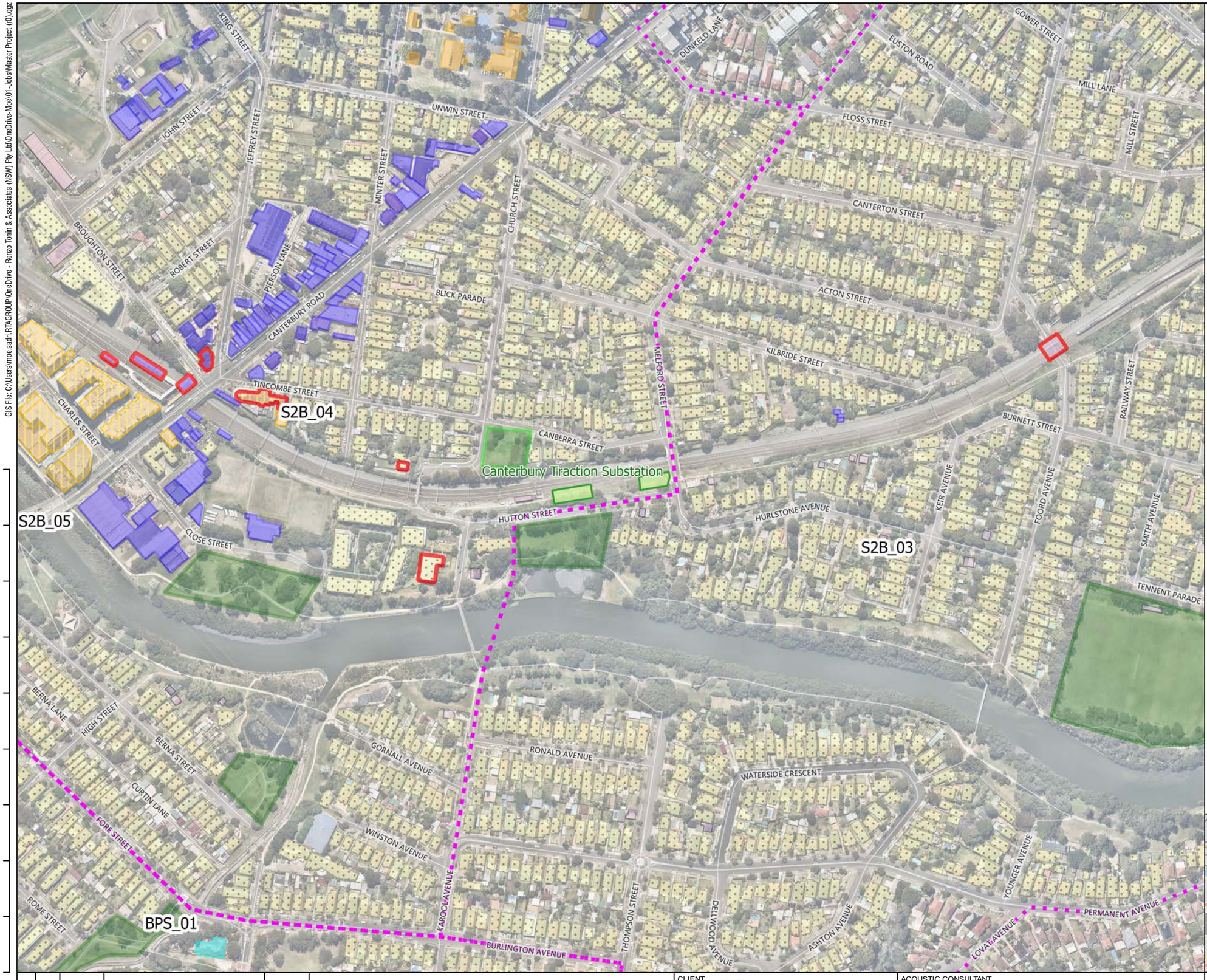

540 m

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LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

Work area

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TSS WE17
Land Use, NCAs
Work area: Canterbury Traction Substation

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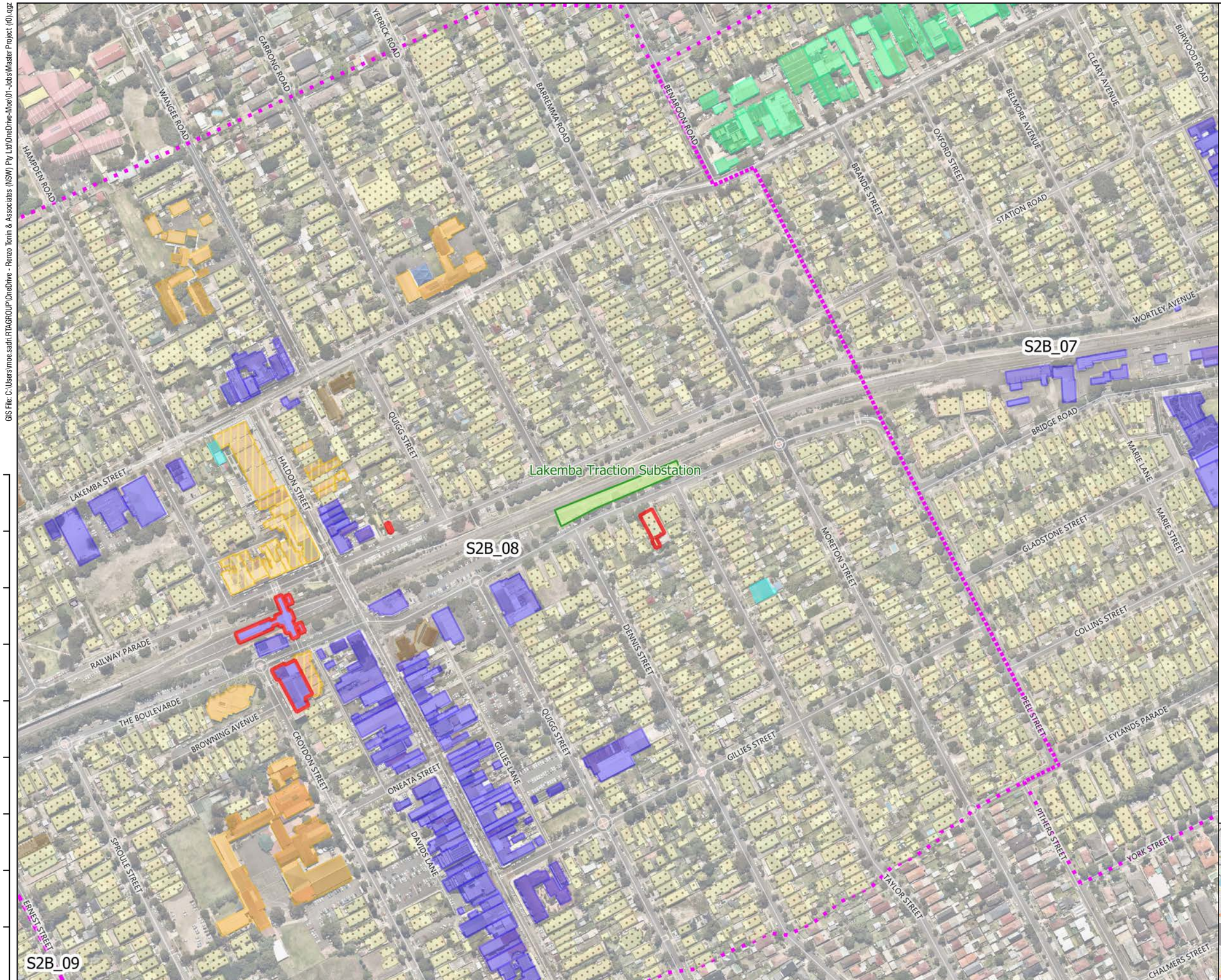


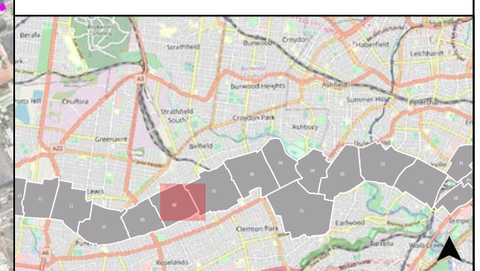
LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

Work area



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TSS WE17

Land Use, NCAs

Work area: Lakemba Traction Substation

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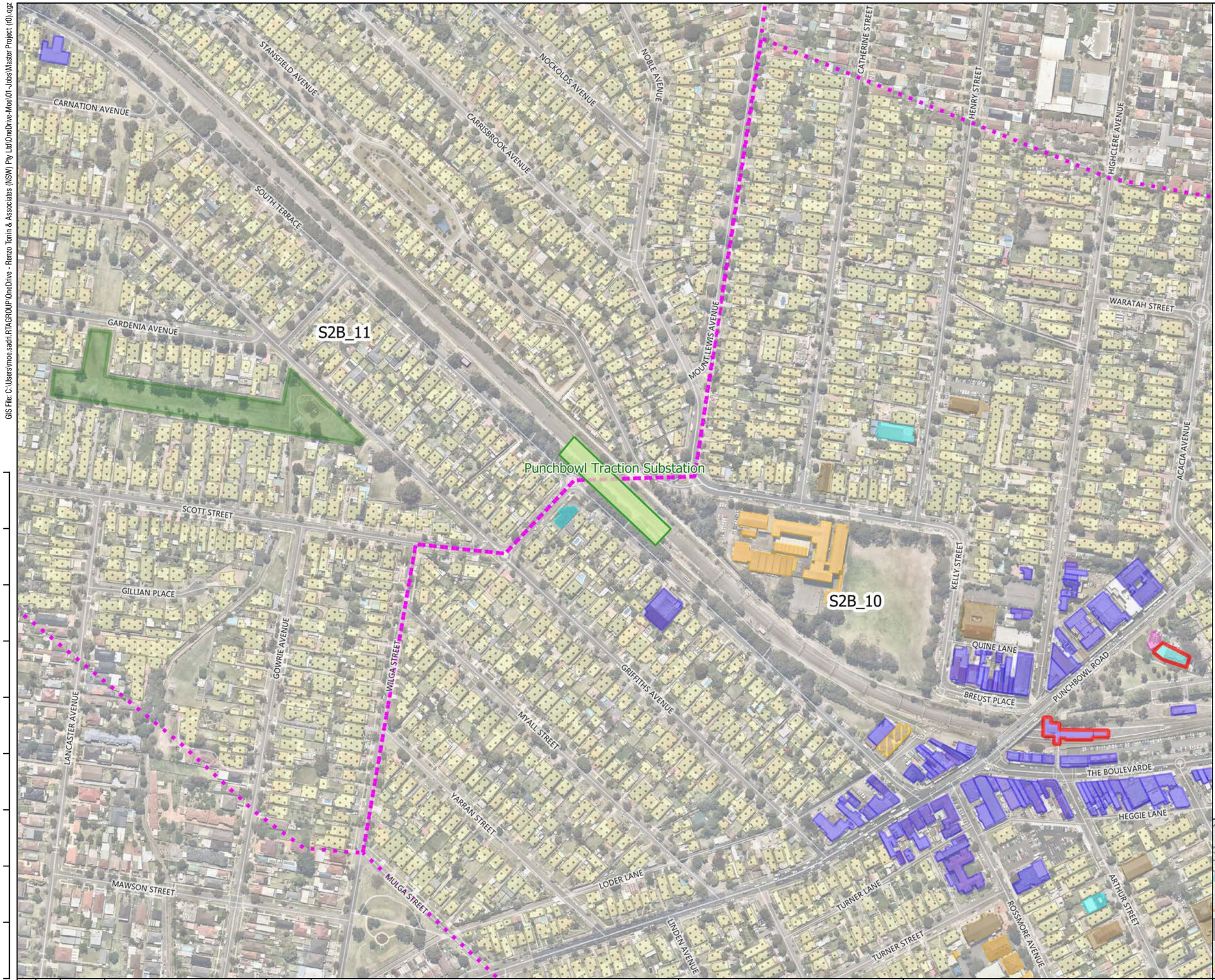

LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
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- Cinema
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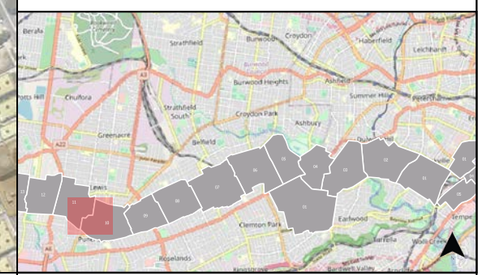
- Library
- Laboratory
- Other
- Heritage

NCA

Work area



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FULL SIZE A3

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

TSS WE17
Land Use, NCAs
Work area: Punchbowl Traction Substation

APPENDIX C Construction timetable/ activities/ management

Table C1: Construction Timetable/ Activities/ Equipment

TRACTION SUBSTATIONS POSSESSION WE17

Work acitvity/ Work Area	Details	Indicative timing/ duration	Modelling ID	Plant/ Equipment	Plant/ Equipment (as provided by client)	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant	Vibration intensive plant	Notes
						7am - 6pm	6pm - 10pm	10pm - 7am	L_{Aeq}	Penalty	L_{Amax}			
CAMPSIE SERVICES RELOCATION														
Services Relocation	- 33kV 704 Feeder Relocation Works - 11kV 687/7 Feeder Relocation Works - Stand 4x18.5m power poles between 12.500 to 12.700 - Non destructive excavation - Augering holes	24 & 25 October 2020		Light vehicles / traffic control utes	Light vehicle	4		2	89	-	100	-	-	
				Delivery truck	Road truck (deliveries to site)	3		1	106	-	111	-	-	
				Water cart	Water cart	1			104	-	107	-	-	for 2 days
				Hand tools	Workshop Hand Tools	Various			103	-	111	-	-	for 2 days
				Excavator w bucket (13t)	Excavator 13t	1			103	-	108	-	-	for 2 days
				Crane (Grove GMK5130)	55t Crane	1			105	-	103	-	-	for 2 days
				Crane - Truck with lifting boom	Insulated tower trucks	3		2	105	-	111	-	-	for 2 days
				Drill Rig	Small drill rig	1			106	-	116	-	X	for 1 day
				Delivery truck	Flat bed truck	1			106	-	111	-	-	for 2 days
TRACTION SUBSTATION POSSESSION WORKS - Dulwich Hill, Canterbury, Campsie, Lakemba, Punchbowl														
Jersey Kerb Intallation	Jersey kerb delivery Jersey kerb install	24 & 25 October 2020		Delivery truck	Semi Trailer	1			106	-	111	-	-	at each site
				Hand tools	Hand tools	Various			103	-	111	-	-	at each site
				Telehander / Franna crane (20t)	Franna	1			99	-	103	-	-	at each site
				EWP	EWP	1			95	-	98	-	-	at each site
Temp power installation	intallation of temp power for substation sites			Light vehicles / traffic control utes	Light Vehicle	1			89	-	100	-	-	at each site

APPENDIX D Detailed predicted noise levels

The detailed predicted levels have provided to Systems Connect in a spreadsheet table in order to more adequately mitigate and manage potential noise impacts.

APPENDIX E Additional noise mitigation

The detailed additional noise and mitigation measures have provided to Systems Connect in a spreadsheet table in order to more adequately mitigate and manage potential noise impacts.

APPENDIX F Minimum working distances

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LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
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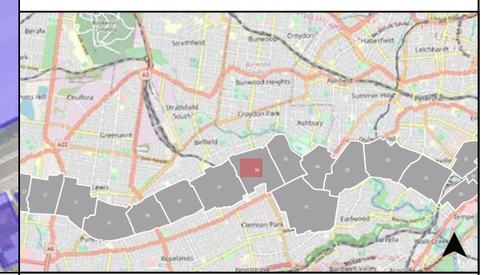
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

MWD for cosmetic damage and human annoyance for Drill Rig

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (day)
- Human annoyance - Critical

Work area



REV	BY	DATE	DESCRIPTION	APPROVER
r0	MS	23/09/20	Prepare figures	TG

FULL SIZE A3

A3 Original

Co-ordinate System: MGA Zone 56

NOTE: Do not scale from this drawing.

1:2000

CLIENT

Systems Connect

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES
inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO - SYDENHAM TO BANKSTOWN

TSS WE17
MWD for cosmetic damage and human annoyance
Work area: Campsie Traction Substation site