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SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

Construction Noise and Vibration Impact Statement Portion 3 - Artarmon Substation and Bulk Power Supply Works

20 April 2020

Systems Connect

TK685-03-04F01 CNVIS C2B_P3 BPS Artarmon (r3)

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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 3 – Chatswood to Sydenham Tunnel and Underground Stations and Bulk Power Supply Works delivered under Critical State Significant Infrastructure Approval CSSI 7400. Condition E33 of CSSI-7400 requires that:

> *Construction Noise and Vibration Impact Statements must be prepared for each construction site before construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers.*

This CNVIS applies to Artarmon Substation Service Building Works (Artarmon Substation) and Artarmon Bulk Power Supply Works (Artarmon BPS), which includes works to be undertaken along the Bulk Power Supply route between Ausgrid's Willoughby Sub-Transmission Substation to the Artarmon bulk supply infeed substation. Works will be completed during standard construction hours as well as works outside of standard construction hours. 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 Artarmon Substation works and Artarmon BPS works, which includes providing cable routes and cable protection, feeder cables and cable joints, control and pilot cable and connections and terminations 33kV feeders from Ausgrid's Willoughby Sub-Transmission Substation to the Artarmon bulk supply infeed substation. Figure 2.1 shows the construction route. Details on activities carried out within each stage follow the figure.

Figure 2.1: Artarmon Substation and Artarmon Bulk Power Supply route

The Artarmon Substation Service Building construction activities will include:

- **Compound** – general worksite, carparking, storage, delivery
- **Site establishment** – installation of environmental controls, construction of crane pads, demolition of existing slab, site sheds and hoarding installation
- **Site demobilisation** – removing site sheds and hoarding

- **Platform and buildings** - Footings and foundations, in-situ concrete slab, precast concrete walls, steel platforms and modules and transformers installation
- **Platform and buildings** – perimeter retaining wall and façade installation

The Artarmon BPS construction activities will include:

- **Compound** – general worksite, carparking, storage, delivery
- **Site establishment** – installation of environmental controls/ traffic controls.
- **Artarmon to Willoughby BPS Route**
    - Cable routes excavation, conduits installation, temporary surface reinstatement
    - Cable Installation and Jointing.

The proposed works, likely plant and equipment and estimated Project timing is summarised in APPENDIX C. Works are planned to occur during standard construction hours, however due to the proximity of the works area to the arterial roads, some works will need to occur under Road Occupancy License, as outlined in Section 2.2.3 and APPENDIX C.

2.1.2 Construction traffic

The Artarmon Substation and Artarmon BPS construction 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
- Concrete trucks

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

CSSI 7400 Condition of Approval E39 requires Systems Connect to consult with proponents of other construction works in the vicinity of the worksite and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers. Further to this, Condition E40 requires works to be coordinated to provide the required respite periods identified in accordance with the terms of the CSSI 7400 approval.

All concurrent Sydney Metro construction site works have been considered and addressed in Section 9 of this CNVIS. Potentially concurrent construction activities within the vicinity of the Artarmon Substation and Artarmon BPS worksites have also been considered, as discussed in Section 9.

2.2 Construction hours

The construction hours for the Project are defined by Project Planning Approval (PPA) Conditions E36, E37, E38, E41, E42, E44 and E48.

2.2.1 Standard construction hours

The standard construction hours of work are defined by the CSSI-7400 Condition E36. The standard construction hours for the Project are summarised in the table below.

Table 2-1: Standard construction hours

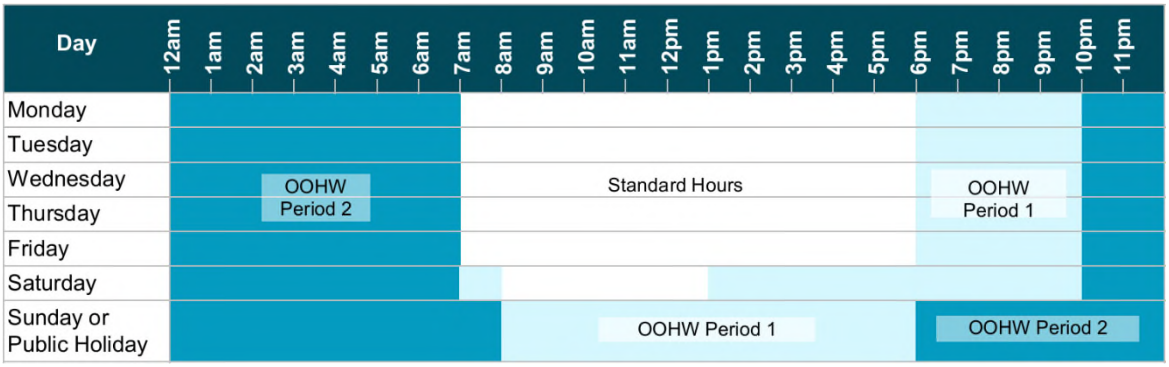
Construction Activity	Monday to Friday	Saturday	Sunday/ Public holiday
Above ground activities: construction sites and construction traffic	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work

2.2.2 Out of hours work periods

CSSI-7400 Condition E44 and E48 allow standard construction hours to be varied under specific conditions (where justified), including Road Occupancy License. The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [9] 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-7400 Condition E36 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 1:00pm.
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 Friday 6:00pm to 10:00pm (evening/OOHE), Saturday 7:00am to 8:00am and 1:00pm to 10:00pm (day/ OOHD and evening/ OOHE) and Sunday and public holidays 8:00am to 6:00pm (day/ OOHD).
   - **OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (night/ OOHN) and Sundays and public holidays 6:00pm to 8:00am (evening/ OOHE and night/ OOHN).

2.2.3 Justification for OOHW

Construction works for the Artarmon Substation works and Artarmon BPS 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 Works that apply to the Artarmon Substation and Artarmon BPS works include for example, where works cross intersections of arterial roads, road traffic would impose major risks to construction workers due to the extremely close proximity between all parties involved. Conducting works under a Road Occupancy License would minimise the risks of road traffic and work site interaction, however this disruption to traffic could not occur during standard construction hours without impacting the road traffic network. Works would need to be conducted outside peak road traffic periods (i.e. between 8:00pm and 5:00am) to reduce the impact on the road network.

For Artarmon Substation some Out of Hours Works may need to be undertaken during the evening period, for example, where building installation works are required to extend into the evening period to ensure the works are compete to a safe and secure state to ensure the safety of workers. In addition, for contingency, some concrete pours may be required to extend into the evening period to ensure the works are complete.

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].

3 Nearest sensitive receivers

3.1 Residential receivers

To assess and manage construction noise and vibration impacts, the residential areas surrounding the Artarmon Substation and Artarmon BPS 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, 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-7400 Condition E34 states:

> *Noise generating works in the vicinity of potentially-affected, religious, educational, community institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) must not be timetabled within sensitive periods, unless other reasonable arrangements to the affected institutions are made at no cost to the affected institution or as otherwise approved by the Secretary.*

Sydney Metro and 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.

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 A.2 of the CNVMP. There are no known heritage-listed buildings close to the work areas.

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)[10], CSSI-7400 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [8] and as set out in the CNVMP.

For the Artarmon Substation and Artarmon BPS works, internal NMLs are applicable at residential receiver locations during the 8 pm to 7 am period per CSSI-7400 Conditions E41 and E42. During daytime and evening periods (between 7 am and 8 pm), external NMLs are derived from the ICNG, as identified in Section 5.1.1 of the CNVMP[1] and summarised in Table 4-1 below.

Table 4-1: Application of NMLs at C2S Artarmon Substation and Artarmon BPS (CSSI 7400 Conditions of Approval)

Time Period	Area	Receiver Type	Condition	Noise management level[3]
Day[1] (D/ D(O))	All	All	CEMF 9.2a[2]	ICNG (see Table B1 in APPENDIX B)
Evening[1] 6pm to 8pm (E1)	All	All	CEMF 9.2a[2]	ICNG (see Table B1 in APPENDIX B)
Evening[1] 8pm to 10pm (E2)	All	All	CEMF 9.2a[2]	ICNG (see Table B1 in APPENDIX B)
Night[1] 10pm to 7am (N)	All	All	CEMF 9.2a[2]	ICNG (see Table B1 in APPENDIX B)
Evening[1] 8pm to 9pm (E2)	Non-residential zones[2]	Residential	SSI-7400 E41	$L_{Aeq(15minute)}$ 60 dB(A) (internal)
Evening[1] 9pm to 10pm				$L_{Aeq(15minute)}$ 45 dB(A) (internal)
Night[1] 10pm to 7am (N)				
Evening[1] 8pm to 10pm (E2) Night[1] 10pm to 7am (N)	Residential zones[2]	Residential	SSI-7400 E42	$L_{Aeq(15minute)}$ 45 dB(A) (internal)
All	All	All	SSI-7400 E43	$L_{Aeq(8hour)}$ 85 dB(A) (external) near the CCSI

1. Day refers to 7am to 6pm Monday to Friday and 8am to 6pm Saturday, Sunday and Public Holidays; Evening refers to Monday to Sunday 6:00pm to 10:00pm; Night refers to Monday to Friday 10:00pm to 7:00am and Saturdays, Sundays and public holidays 10:00pm to 8:00am.
2. These are identified by the applicable Local Environmental Plan land zoning of the receiver.
3. Construction Environmental Management Framework – City & Southwest (Sydney Metro 2017)
4. A 5 dB penalty shall be applied if rock breaking or any other annoying activity likely to result in ground-borne noise or a perceptible level of vibration is planned

ICNG NMLs

For residential receivers, the ICNG NMLs 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]. Additional pre-construction noise monitoring was carried out prior to the Tunnels and Stations Excavation (TSE) works to establish more accurate noise goals. This additional long-term, unattended noise monitoring was carried out in July

2017 by RT&A following a review of the EIS noise monitoring and has been incorporated into the CNVMP.

The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 5.2.3 of the CNVMP. These are applicable when the other sensitive receiver is in use.

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) [3] 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.

Internal NMLs (CSSI-7400 Conditions E41 and E42)

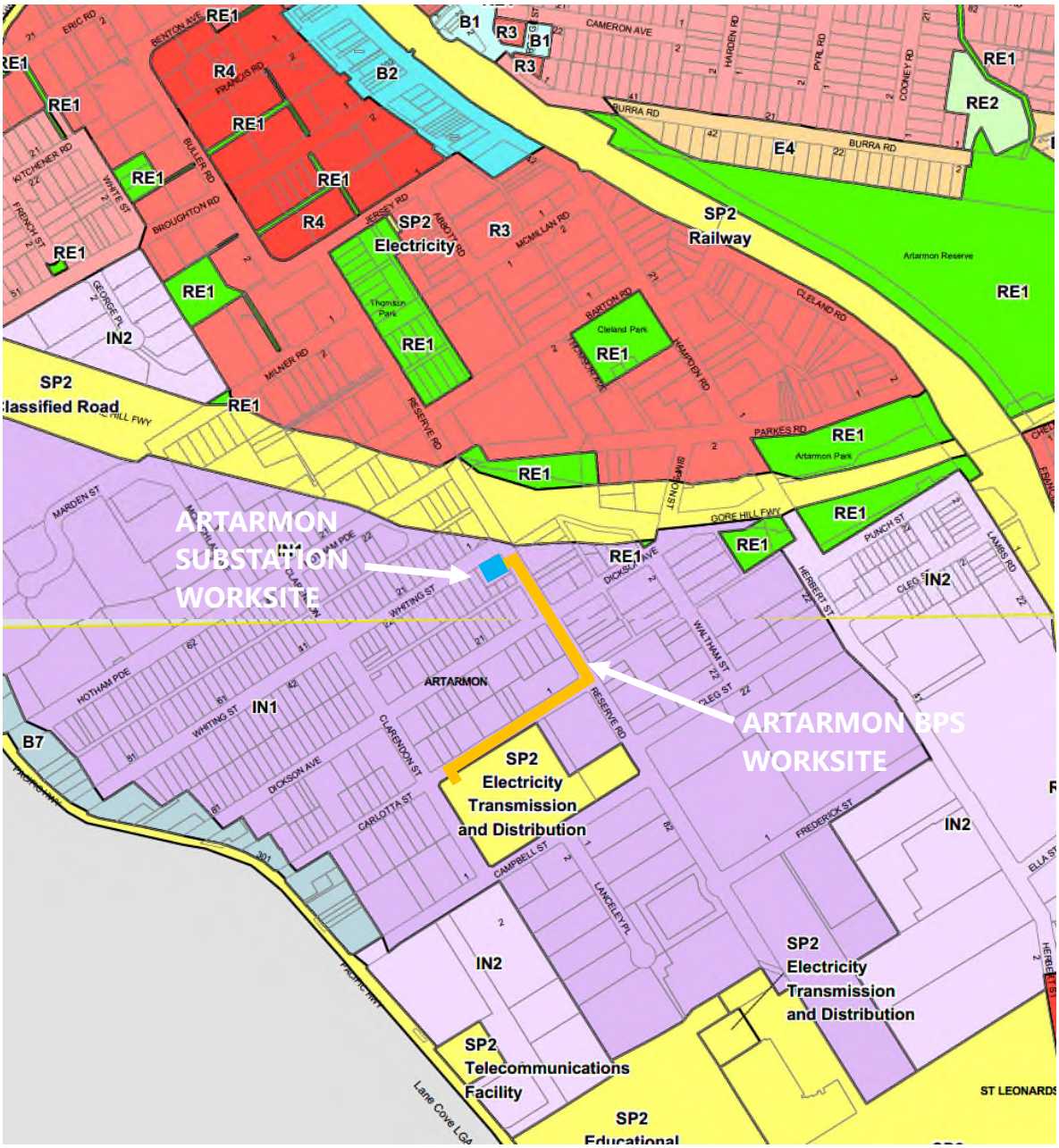
CSSI-7400 Conditions E41 and E42 require that residential receivers within non-residential zones or residential zones (respectively) are not above the internal noise levels identified in Table 4-1. In accordance with CSSI-7400 Conditions E41 and E42, if construction works are particularly annoying (as described in *ICNG NMLs* above) or include ground-borne noise or a perceptible level of vibration at the affected receiver, a 5 dB(A) penalty should be added to the predicted construction noise level.

Where the above internal noise levels cannot be achieved, additional mitigation in accordance with the *Sydney Metro City and South West Noise and Vibration Strategy (SMCSNVS)* [8] is to be offered.

Addendum A of the SMCSNVS notes that the applicable Local Environmental Plan land zoning of the receiver be used to identify if residential receivers are located within residential or non-residential zones. An extract from the Willoughby Local Environmental Plan (2012) land zoning map (accessed 26/11/2017) is provided in Figure 4.1. Red and pink areas (R2, R3 and R4) indicate residential zones.

The zoning map indicates that the nearest residential receivers along the BPS (Artarmon) works are in residential areas. The nearest residential receivers are north of the Gore Hill Freeway and are in residential areas (R3 zone in Figure 4.1).

Figure 4.1: Extract from the Willoughby Local Environmental Plan (2012) land zoning map



For this assessment, all residential receivers are conservatively assumed to be in residential zones, with a corresponding internal noise threshold level of $L_{Aeq(15minute)}$ 45 dB(A) between 8pm and 7am. Based on a minimum (conservative) external to internal noise difference of 10 dB(A) (assuming windows open), an equivalent external noise threshold of $L_{Aeq(15minute)}$ 55 dB(A) is applicable between 8pm and 7am. However, for some residential receivers near the Gore Hill Freeway, it is likely that the design of the buildings included upgraded window glazing and air conditioning systems to reduce the potential impact of road traffic noise. At these locations, the assumed external to internal noise reduction are presented in APPENDIX D Table D1.

Where these external equivalent levels are above the external noise threshold, additional mitigation may be required in accordance with the SMCSNVS.

The assessment presented in Section 5.4 has assessed all receivers against the approach outlined in the SMCSNVS [8] and the CNVMP [1] which achieves the requirements of PPA Conditions E41 and E42, and is consistent with the ICNG [3] and the EIS [2].

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 National Standard for exposure to noise

In accordance with PPA Condition E43, Systems Connect worksites will be managed to ensure that noise generated by construction will not be above the National Standard for exposure to noise in the occupational environment of an eight-hour equivalent continuous A-weighted sound pressure level of LAeq,8h, of 85 dB(A) for any employee working at a location near a Systems Connect worksite.

4.1.4 Construction related road traffic noise objectives

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the Artarmon Substation and Artarmon BPS 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) [4]
- 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 [5] and
    - German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures [6].

4.2.1 Disturbance to building occupants (human annoyance)

For disturbance to human occupants of buildings, we refer to '*Assessing Vibration; a technical guideline*' [4]. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'* [7].

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 4-2.

Table 4-2: 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 is given below:

- Reinforced or framed structures (Line 1): 25.0 mm/s
- Unreinforced or light framed structures (Line 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 and the likely timing of each activity/aspect.
- 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 Team. This information is presented in APPENDIX C and formed the basis for all modelling assumptions used in this assessment. A plan of the likely timing of each activity is presented in Table C.1 to ensure that cumulative noise impacts from the site are assessed and managed. Table C.2 outlines the key construction noise and vibration management measures included in the predictions.

5.2 Construction activities

The Artarmon BPS works is a linear worksite that will move progressively between Ausgrid's Willoughby Sub-Transmission Substation and the Artarmon bulk supply infeed substation. The active worksite will at any time be between 50 metres and 250 metres long. Typically, a temporary worksite will be established, the works will be undertaken, then the temporary worksite will be closed and relocated to the next work area. The construction work areas for the Artarmon Substation and Artarmon BPS works are identified in the land use survey drawings presented in APPENDIX B.

Table 5-1 presents a summary of the construction activities and aspects that are proposed to take place. Each aspect was subdivided into two categories with similar overall sound power levels (i.e. High impact

activities and Typical activities). A representative High impact activities sound power level of 123 dB(A) and a Typical activities sound power level of 109 dB(A) were adopted.

As described above, for each work area, predictions have been undertaken for the following two categories:

- High impact activities, which will include rock hammer, concrete saw;
- Typical activities, which will exclude high impact sources (e.g. rock hammer, concrete saw).

Table 5-1: Summary of construction activities

Works Area (see APPENDIX B)	Activity	Aspect	Category		Duration
			High[3]	Typical[4]	
A1 – Artarmon bulk supply infeed substation[2] A2 – Reserve Rd[1, 2] A3 – Reserve Rd (Junction of Dickson Ave)[2] A4 – Reserve Rd[1, 2] A5 – Reserve Rd (Junction of Carlotta St)[2] A6 – Carlotta St[1]	Compound	General worksite, car parking, storage, delivery	No	Yes	June 2020 to May 2021
	Site Establishment	Installation of enviro controls / traffic controls	No	Yes	
	Construction	Cable routes excavation, conduits installation, temporary surface reinstatement.	Yes	Yes	July 2020 to December 2020
		Cable Installation and Jointing	No	Yes	December 2020 to March 2021
A7 – Substation[1,2]	Compound	General worksite, car parking, storage, delivery	No	Yes	May 2020 to July 2021
	Site Establishment	Installation of environmental controls, construction of crane pads, demolition of existing slab, site sheds and hoarding installation	Yes	Yes	May 2020 to July 2020
	Site Demobilisation	Removing site sheds and hoarding	No	Yes	June 2021 to July 2021
	Platform & Buildings	Footings and foundations and insitu concrete slab	No	Yes	July 2020 to December 2020
		Precast concrete walls and steel platforms	No	Yes	September 2020 to March 2021
		Modules and transformers installation	No	Yes	January 2021 to May 2021
	Perimeter Façade	Perimeter retaining wall and façade installation	No	Yes	March 2021 to July 2021

Notes 1 Work period: Standard Hours
2. Work period: OOHW Periods 1 and 2
3 High impact activities which will include rock hammer and concrete saw
4 Typical activities, which will exclude high impact sources (e.g. rock hammer and concrete saw)

5.3 Predicted noise levels

Predicted L_{Aeq} noise levels from the worksite are assessed against the NMLs and summarised in the following sections, with colour coding to denote the highest level of exceedance of the NML. Detailed results for each receiver are given in APPENDIX D. Note that in addition to a High impact activity and a

Typical activity prediction for each work area, a cumulative worst-case prediction has been undertaken for A7 operating concurrently with A2 during the day and with A1 during OOH.

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.

5.3.1 ICNG NMLs

5.3.1.1 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	A1		A2		A3		A4		A5		A6		A7		A7[1]+A2[1]
	T[2]	H[1]	T[2]	H[1]	T[2]	H[1]	T[2]	H[1]	T[2]	H[1]	T[2]	H[1]	T[2]	H[1]	
AS_01	❍	□	❍	◆	●	❍	●	◆	●	❍	●	❍	❍	□	□
AS_03	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CDS_06	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
OSR	◆	◆	◆	◆	❍	◆	❍	◆	❍	◆	❍	◆	◆	◆	◆

Notes:
1 High impact activities which will include rock hammer and concrete saw
2 Typical activities, which will exclude high impact sources (e.g. rock hammer and concrete saw)

Standard hours (7am to 6pm Monday to Friday and 8am to 6pm Saturday)
OSR: this includes all commercial, industrial and other sensitive receivers.

Exceedances of the NMLs have been predicted at noise sensitive receivers around the works locations. The nearest receivers in NCA AS_01 have been identified to be highly noise affected when high impact activities are occurring at Area 1 and 7. For NCA AS-01, noise levels are predicted to be 10 dB(A) greater than the NML when high impact activities are occurring in Area 2 and 4 but within 10dB(A) of the NML for all remaining activities. Once the high impact activities are completed, exceedances will be substantially reduced.

Noise levels are predicted to be below the corresponding NMLs for NCA AS_03, CDS_06 and CN_02 throughout all work areas. Noise levels are predicted to be 10dB(A) greater than the corresponding NMLs for nearby OSRs, particularly for Area 1, Area 2 and Area 7 works.

5.3.1.2 OOHW period 1

As part of the construction works, there are some planned out of hours work periods, as noted in Table 5-1, between May 2020 and July 2021. 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

Table 5-3: Summary of construction noise impacts at nearby receivers – OOHW period 1 (ICNG)

NCA	E1[1]/E2[2]														
	A1		A2		A3		A4		A5		A6		A7		A7[5,6]+A1[4]
	T[5]	H[4]	T[5]	H[4]	T[5]	H[4]	T[5]	H[4]	T[5]	H[4]	T[5]	H[4]	T[5]	H[4]	
AS_01	◆	■	◆	■	◔	■	◆	■	◔	■	-	-	◆	-	■
AS_03	●	●	●	◔	●	●	●	◔	●	◔	-	-	●	-	●
CDS_06	●	◔	●	◔	●	●	●	◔	●	◔	-	-	●	-	◔
OSR[3]	■	□	■	□	◆	■	◆	■	◆	■	-	-	◆	-	□

Notes:
1. E1: early evening period from 6pm to 8pm.
2. E2: late evening period from 8pm to 10pm. Assessment against ICNG NMLs for this period is used to guide additional mitigation measures (Section 5.4.3). PPA Conditions E41/42 are applicable for this assessment period (see Section 5.3.2)
3. OSR: this includes all commercial, industrial and other sensitive receivers.
4. High impact activities which will include rock hammer and concrete saw
5. Typical activities, which will exclude rock hammer and concrete saw
6. There are no high impact activities outside standard construction hours in A7

Exceedances of the NMLs have been predicted at the closest noise sensitive receivers around the work locations, especially in NCA AS_01 and nearby OSRs during high impact activities. Noise levels are predicted to be within 5 dB(A) of the NMLs for NCA AS_03 and CDS_06. There will be no OOH work in works area A6.

Specific mitigation measures outlined in Table C2 (APPENDIX C) and in Section 5.4 are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable. However, as some of these works include partial road closure, the options for mitigation are limited and impacts need to be managed.

Proposed measures for managing potential noise impacts are provided in Section 5.4. For more detailed predictions, see APPENDIX D. For more detailed additional noise mitigation measures, refer to APPENDIX E.

5.3.1.3 OOHW period 2

Predicted construction noise levels were compared with the ICNG NMLs during the night time period to determine applicable additional mitigation measures (Section 5.4.3) at the noise affected receivers from the construction stages identified in Table 5-1. The impacts presented in Table 5-4 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

Where reasonable and feasible, high impact activities (i.e. H) should be undertaken prior to 12am. However, due to late ROLs this may not always be possible. Therefore, high impact, as well as typical activities, have been assessed during the night period in this CNVIS.

Table 5-4: Summary of construction noise impacts at nearby receivers – OOHW period 2 (ICNG)

NCA	A1		A2		A3		A4		A5		A6		A7		A7[5,6]+A1[4]
	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	
AS_01	■	□	◆	□	◆	■	◆	□	◆	■	-	-	■	-	□
AS_03	●	◔	●	◆	●	◔	●	◆	●	◆	-	-	●	-	◔
CDS_06	●	◆	●	◆	●	◆	●	◆	●	◆	-	-	●	-	◆
OSR[1]	■	□	■	□	◆	■	◆	■	◆	■	-	-	◆	-	□

Notes:
1. OSR: this includes all commercial, industrial and other sensitive receivers.
2. Assessment against ICNG NMLs for this period is used to guide additional mitigation measures (Section 5.4.3). PPA Conditions E41/42 are applicable for this assessment period (see Section 5.3.2)
3. High impact activities which will include rock hammer and concrete saw
4. Typical activities, which will exclude rock hammer and concrete saw
5. There are no high impact activities outside standard construction hours in A7

Exceedances of the NMLs have been predicted at the closest noise sensitive receivers around the work locations, especially in NCA AS_01 and nearby OSRs during high impact activities. Noise levels are predicted to be below the NMLs for NCA AS_03 and CDS_06, except during high impact activities. There will be no OOH work in works area A6.

Specific mitigation measures outlined in Table C2 (APPENDIX C) and in Section 5.4 are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable. However, as some of these works include partial road closure, the options for mitigation are limited and impacts need to be managed.

Proposed measures for managing potential noise impacts are provided in Section 5.4. For more detailed predictions, see APPENDIX D. For more detailed additional noise measures, refer to APPENDIX E.

5.3.2 PPA Conditions E41/42

Table 5-5 summarises the predicted noise impacts for each construction stage in each NCA compared with the internal NMLs in CSSI-7400 Conditions E41 and E42. Where predicted levels are above the NMLs at residential receivers, additional mitigation measures will be implemented in accordance with the documented procedure in Addendum A of the SMCSNVS.

The impacts presented are as follow:

- ● Noise levels predicted to be below internal NMLs in PPA Conditions E41 and E42;
- ☐ Noise levels predicted to be above internal NMLs in PPA Conditions E41 and E42.

Table 5-5: Noise level summary for PPA Conditions E41/42 (residential only)

NCA	E2[1]/N[2]													
	A1		A2		A3		A4		A5		A6		A7	A7[4,5]+A1[3]
	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	H[3]	T[4]	
AS_01	☐	☐	☐	☐	●	☐	☐	☐	●	☐	-	-	☐	☐
AS_03	●	●	●	●	●	●	●	●	●	●	-	-	●	●
CDS_06	●	●	●	●	●	●	●	●	●	●	-	-	●	●

Notes:
1) E2: late evening period from 8pm to 10pm.
2) N: Night-time period from 10pm to 7am.
3) High impact activities which will include rock hammer and concrete saw
4) Typical activities, which will exclude rock hammer and concrete saw
5) There are no high impact activities outside standard construction hours in A7

The results in Table 5-5 indicate that construction noise is predicted to be above the internal noise threshold of PPA Conditions E41/E42 at the nearest residential receivers within NCA AS_01 when works are occurring in work area A1 and A7 and when high impact activities are occurring in work areas A3 and A5. There will be no OOH work in works area A6.

Proposed measures for managing potential noise impacts are provided in Section 5.4. For more detailed predictions, see APPENDIX D. For more detailed additional noise measures, refer to APPENDIX E.

5.3.3 Sleep disturbance

Construction equipment may produce instantaneous noise events during operation. The nearest residential receivers are located at a relatively large distance of approximately 150m from works, however it is still likely that maximum noise levels from concrete saws and excavators with hammer attachments will exceed the sleep disturbance NML of 65 dB(A) L_{Amax} during the night period works.

Exceedance of the sleep disturbance NML of 10 dB(A) and 5 dB(A) have been predicted when these equipment items are operating at Area 1 and Area 3. However, given the proximity of the Gore Hill Freeway and the M2 Hills Motorway, any construction L_{Amax} events are expected to be lower than what these residents already experience from road traffic. These activities his will be managed by restricting saw cutting and excavator with hammers to be completed before midnight, where feasible with consideration of the ROL.

Even though truck air brakes and banging from dropped chains are not expected, these activities will be managed by setting up relevant traffic management measures to minimise the use of compression brakes when leaving the work area, installing air brake silencers and broadband reversing alarms on heavy vehicles, and minimising heavy vehicle movements where practicable. 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 accordingly.

In addition, Toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods, including warning personnel of the need to respect the residential receivers surrounding the local area work sites. Other management measures are outlined in Section 5.4.3 to aid in providing additional noise reduction benefits where predicted levels are above the objective.

5.4 Noise mitigation and management

5.4.1 Consultation with affected receivers (CSSI-7400 Condition E33)

CSSI-7400 Condition E33 requires consultation with affected receivers to assist in determining site-specific mitigation measures.

Systems Connect will continue consultation with affected sensitive receivers during early investigation works carried out prior to commencement of construction along the Bulk Power Supply (Artarmon) worksite. That consultation has included doorknocking of affected residents and businesses prior to night time investigation works.

Systems Connect will continue to consult with potentially affected sensitive receivers, both prior to and following commencement of construction.

Consultation with affected sensitive receivers is informing and will continue to inform the identification of specific mitigation measures for the Bulk Power Supply (Artarmon) works. These measures may include minimising high noise impact works during night time hours; limiting night time works in individual locations to no more than two consecutive nights; scheduling high noise impact works around sensitive periods where feasible and reasonable; offers of movie or dinner vouchers; alternative accommodation offers.

It must noted that offers of such vouchers or alternative accommodation may not be viable during COVID-19 restrictions, in which case alternative respite arrangements may need to be developed in consultation with affected receivers.

5.4.2 Site Noise Control Measures

Table 5-6 shows the noise control measures recommended to reduce potential noise impacts.

Table 5-6: Site Noise Control Measures

Control type	Control measure	Typical use
At-Source Control Measures	Noise control kits	Plant that is brought to site for regular use should meet the sound power limits identified in Table C1. Where plant are above limits then the plant may require installation of 'noise control kits' to comply with the noise limits in Table C1. Such 'noise control kits' comprise: • high performance 'residential-grade' exhaust mufflers, • additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and • air intake and discharge silencers / louvres. The need to fit 'noise control kits' onto the identified plant, will be confirmed once each plant item is tested prior to its regular use on site.
	Limit equipment in use	Only the equipment necessary during each stage of the works 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, temporary noise screens (e.g. Flexshield, Echo-barrier, or similar) should be used to provide additional noise reduction during works. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of sight.
	Truck movements	Where practicable, avoid the use of park air brakes at night. 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 vehicles & mobile plant regularly used on site and on all vehicles & mobile plant required for OOHW.
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	During standard construction hours, high noise impact activities (i.e. above 75dB(A) at the closest residential receivers) 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 religious, educational, community institutions (e.g. schools, theatres, laboratories and operating theatres) noisy activities would be scheduled around sensitive periods (e.g. exam times, child care sleep times and other identified sensitive times), 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 5.4.4.

5.4.3 Additional Noise Mitigation Measures

Table 5-7 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [9] and the CNVMP [1].

Table 5-7: Additional Airborne Noise Mitigation Measures

When is the work being undertaken?	How much does the predicted noise level exceed the ANML by?	Identify additional management measures to be implemented
Standard Hours M-F 7am to 6pm Sat 8am to 1pm	0 dB(A)	- -
	≤ 10 dB(A)	- -
	10 to 20 dB(A)	LB, V [MM2]
	> 20 dB(A)	LB, V [MM2]
	Highly noise affected	LB, SN, RO, V [MM4]
OOHW Period 1 M-F 6pm to 10pm Sat 1pm to 10pm Sun/ PH 8am to 10pm	< 5 dB(A)	- -
	5 to 15 dB(A)	LB [MM1]
	15 to 25 dB(A)	LB, V [MM2]
	> 25 dB(A)	LB, SN, IB, RO, V [MM4]
OOHW Period 2 M-F 10pm to 7am Sat 10pm to 8am Sun/ PH 6pm to 8am	< 5 dB(A)	LB [MM1]
	5 to 15 dB(A)	LB, V [MM2]
	15 to 25 dB(A)	LB, SN, IB, RO, V [MM4]
	> 25 dB(A)	LB, SN, IB, RO, AA, V [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
V = Verification of predicted noise levels
SN = Specific notifications (personalised letter, phone call, email, individual briefing)
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 (as outlined in Section 5.4.2), predicted construction noise levels still exceed the NMLs.

Prior to the commencement of the site establishment works, residential receivers around the Bulk Power Supply (Artarmon) 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 5.4.5).

5.4.4 Attended Noise Monitoring

Real time noise monitoring in accordance with CSSI-7400 Condition C11 is not proposed to be undertaken for the Bulk Power Supply (Artarmon) worksite. Attended noise monitoring will be undertaken as required by this CNVIS. 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.

Attended noise monitoring will be undertaken during works at one of the representative residential receivers identified in the table below. Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels.

Table 5-8: Nominated verification monitoring locations

NCA	Nominated receiver address	Monitoring location at 1 m from
A1 – Artarmon bulk supply infeed substation		
AS_01	23 Barton Rd, Artarmon	southern property boundary
A2 – Reserve Rd		
AS_02	94A Reserve Rd, Artarmon	Eastern property boundary
AS_02	115 Reserve Rd, Artarmon	Western property boundary
A3 – Reserve Rd (Junction of Dickson Ave)		
AS_02	99 Reserve Rd, Artarmon NSW 2064	Western property boundary
A4 – Reserve Rd		
AS_02	77 Reserve Rd, Artarmon NSW 2064	Western property boundary
AS_02	89 Reserve Rd, Artarmon	Western property boundary
A5 – Reserve Rd (Junction of Carlotta St)		
AS_02	83-85 Reserve Rd, Artarmon	Western property boundary
A6 – Carlotta St		
AS_02	25 Carlotta St, Artarmon	Southern property boundary
AS_03	23 Campbell St, Artarmon	Northern property boundary
A7 –Substation		
AS_01	23 Barton Rd, Artarmon	Southern property boundary
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.

5.4.5 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

From the plant and equipment listed in APPENDIX C, the dominant vibration generating plant and equipment include:

- Compactor / roller (4-12 tonnes)
- Excavator with rock hammer (12-30 tonnes);

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure.

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 minimum working 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]
Compactor / roller (4-12t) - low vibration	5	5	10
Excavator with rock hammer (12-30T)	5	10	15

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

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

3) Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

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]		
Compactor / roller (4-12t) - low vibration	25	10	15	10	5
Excavator with rock hammer (12-30T)	45	30	40	20	15

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.

6.2 Vibration assessment

6.2.1 Structural damage

The numbers of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6-3. More detailed results are presented in APPENDIX F.

Table 6-3: Number of buildings within minimum working distances for cosmetic damage

Plant item	Work Area	Number of buildings	
		Screening criteria for non-heritage structures	Screening criteria for heritage structures[1]
Compactor / roller (4-12t) - low vibration	A1-6	0	0
	A7	2	0
Excavator with rock hammer (12-30T)	A1-6	0	0
	A7	2	0

Note 1: There are no know heritage structures located near the work areas

There are two non-heritage buildings potentially within the minimum working distances established for cosmetic damage during use of a roller or excavator w hammer in work area A7. These buildings/structures are identified in APPENDIX F.

CSSI-7400 Condition E29 requires owners of properties at risk of exceeding the screening criteria for cosmetic damage to be notified before the commencement of vibration-generating works.

Vibration monitoring is recommended to verify that vibration levels achieve compliance with the structural damage objectives where plant is 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.

Vibration control and management measures are presented in Section 6.3.

6.2.2 Human annoyance

The assessing vibration guideline [4] 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 4-2 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

Plant item	Work Area	Critical areas[1,4]	Residences[5]		Offices[3,4]	Workshops[4]
			Day[2]	Night[2]		
Compactor / roller (4-12t) - low vibration	A1-6	-	-	-	-	-
	A7	-	-	-	-	2
Excavator with rock hammer (12-30T)	A1	-	1[5]	1[5]	-	-
	A2	-	1[5]	1[5]	-	4
	A3	-	-	-	1	3
	A4	-	-	-	1	1
	A5	-	-	-	-	1
	A6	-	-	-	1	4
	A7	-	-	-	-	2

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.

Table 6-4 indicates that there is one hotel (included in the residential category), one commercial property and several workshops that may experience vibration which can cause adverse comment when vibration-generating plant is operated nearby. Properties are further identified in APPENDIX F.

The above assessment is based on vibration-generating equipment being operating 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).

6.2.3 Sensitive equipment

Vibration levels may be above vibration objectives for sensitive equipment at the Ausgrid's Willoughby Sub-Transmission Substation at 2/6 Campbell St, Artarmon during cable route excavation and surface reinstatement/compaction works. This facility should be investigated prior to undertaking high vibration generating activities to determine the presence of potential vibration sensitive structures. Should such items be identified by Systems Connect, then relevant vibration criteria will be established for each item per Section 5.5.3 of the CNVMP [1], and any corresponding management or mitigation measures determined.

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

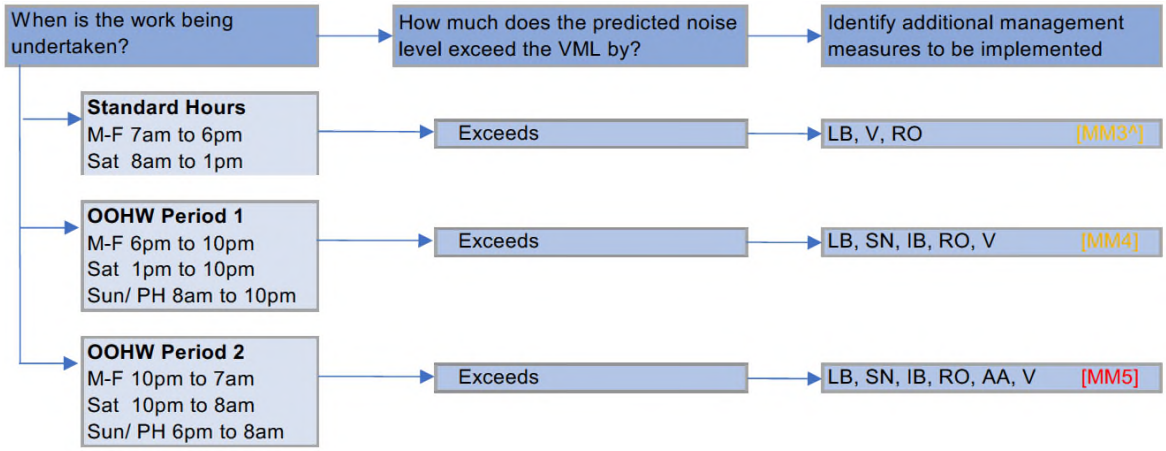
Control type	Control measure	Typical use
Construction Planning	Building condition surveys	Undertake building dilapidation surveys on all buildings located within the minimum working distances established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1 and APPENDIX F).
	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.

Control type	Control measure	Typical use
Complaints Management	Construction Complaints Management System	Complaints will be managed in accordance with the Construction Complaints Management System (see Section 6.3.4). 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 minimum working distances 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



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
V = Verification monitoring
SN = Specific notifications
IB = individual briefing
RO = Project specific respite offer
AA = Alternative accommodation

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. Properties located within the minimum working distances for human annoyance are identified in APPENDIX F.

As a minimum, it is recommended that attended monitoring is undertaken at the locations in Table 6-7 when vibration significant plant items operate close to or within the minimum working distances. Additional monitoring may also be required in response to vibration complaints.

Real-time vibration monitoring in accordance with PPA Condition C11 is not proposed for this site.

Table 6-7: Attended vibration monitoring – nominated representative locations

Plant	Work areas	Address	Vibration objectives to check		
			Vibration sensitive equipment	Unreinforced or light framed structures (e.g. residential buildings)	Human annoyance[1]
Compactor / roller (4-12t) - low vibration Excavator with rock hammer (12-30T)	A1/2	Freeway Hotel, 113 Reserve Road, Artarmon			√[1]
	A7	4 Whiting St, Artarmon		√	√[1]
		96 Reserve Rd Artarmon		√	√[1]
	A6	Ausgrid's Willoughby Sub-Transmission Substation at 2/6 Campbell St, Artarmon	√[3]		

Notes: 1: In the event of complaint related to vibration.

2. 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.

3: Should vibration sensitive equipment be found

6.3.4 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 Artarmon Substation and Artarmon BPS works, which are surface works, airborne noise is expected to be much higher than ground-borne noise levels at the nearest sensitive receivers.

The risk of annoyance due to ground-borne noise is therefore 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 Artarmon Substation and Artarmon BPS works. In addition, for the Artarmon BPS, 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. There are no other construction works that are expected to occur concurrently with the Sydney Metro construction works.

10 Conclusion

Works associated with the Artarmon Substation and Artarmon BPS works 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.

Expected construction noise levels have been predicted and presented in Section 5.3 and APPENDIX D. The expected duration of construction activities is outlined in Table C1 of APPENDIX C.

The highest noise impacts are predicted to occur when excavators with rock hammer attachments and road saws are utilised in proximity to sensitive receivers. Where possible, and subject to Road Occupancy Licence (ROL) approvals, these activities will be completed prior to midnight (where practicable) to minimise impacts. The potential noise and vibration impacts associated with remaining activities are significantly reduced.

Noise mitigation and management measures have been presented in Section 5.4 to aid in providing additional noise reduction benefits where exceedance of the objective occurs.

Vibration impacts and management measures have been presented in Section 6 to aid in minimising any potential vibration impacts.

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 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016

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

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

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

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

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

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

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

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

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

[12] 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.
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

SMCSWLWC-SYC-ATS-EM-REP-000330

CDS_01 CDS_05 CDS_06 AS_01 AS_02 AS_03 CN_01 CN_02

A1 A2 A3 A4 A5 A6 A7

KITCHENER ROAD, WHITE STREET, FRENCH STREET, BROUGHTON ROAD, GEORGE PLACE, JERSEY ROAD, HAMPDEN LANE, MILNER ROAD, BUTCHERS LANE, BARTON ROAD, HAMPDEN ROAD, OLIVE LANE, CLELAND ROAD, BURRA ROAD, ARTARMON ROAD, EDWARD STREET, CHELMSFORD AVENUE, RICHMOND AVENUE, PARKES ROAD, LANE COVE TUNNEL, GORE HILL FREEWAY, OLYMPIA ROAD, GRANDVIEW STREET, BROWN LANE, STATION STREET, PUNCH STREET, CLEG STREET, LAMBS ROAD, FRANCIS STREET, PIPER LANE, PARK ROAD, BURKE LANE, CROWLEY LANE, MARDEN STREET, MCLACHLAN AVENUE, HOTHAM PARADE, SAWYER LANE, WHITING STREET, CURRY LANE, HESKY LANE, TAYLOR LANE, WALTHAM STREET, HERBERT STREET, DICKSON AVENUE, CARLOTTA STREET, CLARENDON STREET, CAMPBELL STREET, RESERVE ROAD, FREDERICK STREET, ELLA STREET, LANCELEY PLACE, BROADCAST WAY, PACIFIC HIGHWAY, DALLEYS ROAD, BERRY AVENUE, WATERS ROAD, OSBORNE ROAD, PANORAMA ROAD, ROMALD AVENUE, SECOND AVENUE, CROWTHER AVENUE, INNES ROAD, WESTBOURNE STREET, STURT DRIVE, PLUNKETT STREET, SCHULTZ LANE, EVANS LANE, GARDINER LANE

700 m
600
500
400
300
200
100
0

LEGEND

Land Uses

- Childcare
- Commercial
- Educational
- Ground inspection required
- Hotel/Motel/Hostel
- Industrial
- Medical
- Mixed
- Mixed-use
- NonReceiverBuilding
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Sydney Metro Construction site
- Theatre/Auditorium
- NCAs

Work Areas

- A1
- A2
REV	BY	DATE	DESCRIPTION	APPD.
r0	RZ	30.01.2020	Prepare figures	MT

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 50 100 150 200 250 300 m

1:5500

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO

ARTARMON SUBSTATION & ARTARMON BULK POWER SUPPLY

Land use, NCAs and Work areas

Status:	Sheet 0 of 0
Drawing No.	Rev. No. 0

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels **ARTARMON SUBSTATION & ARTARMON BULK POWER SUPPLY**

			Existing Noise Levels, dB(A)			Residential NMLs based on ICNG (external)				Sleep Dist. L_{A1}		Comments
NCA	Receiver Type	Reference RBL	RBL Day	RBL Evening	RBL Night	D(S)	D(O)	E	N	Screening	L_{Amax}	
CDS_06	Predominantly Residential	EIS B.24	50	47	39	60	55	52	44	54	65	
AS_01	Predominantly Residential	EIS B.21	49	46	41	59	54	51	46	56	65	
AS_02	Commercial/ industrial area	EIS B.21	49	46	41	59	54	51	46	56	65	
AS_03	Commercial/ industrial area/ Medical	EIS B.21	49	46	41	59	54	51	46	56	65	
CN_02	Predominantly Residential	RTA TG360	48	44	40	58	53	49	45	55	65	
Other sensitive receivers												
Studio building (music recording studio)						25						AS2107 'maximum' (internal noise level)
Studio building (film or television studio)						30						AS2107 'maximum' (internal noise level)
Cinema Space						35						AS2107 'maximum' (internal noise level)
Hotel (Sleeping areas: Hotels near major roads)						40						AS2107 'maximum' (internal noise level)
Classrooms at schools and other educational institutions						45						ICNG (internal noise level)
Hospital wards and operating theatres						45						ICNG (internal noise level)
Places of worship						45						ICNG (internal noise level)
Library (reading areas)						45						AS2107 'maximum' (internal noise level)
Office building (general office areas)						45						AS2107 'maximum' (internal noise level)
Community centres – Municipal Buildings						50						AS2107 'maximum' (internal noise level)
Cafe/ Restaurant/ Bar (bars and lounges) – indoor areas						50						AS2107 'maximum' (internal noise level)
Medical facilities						55						AS2107 'maximum' (internal noise level)
Railway platform and concourse areas						55						AS2107 'maximum' (internal noise level)
Cafe/ Restaurant/ Bar (bars and lounges) – outdoor areas						60						AS2107 'maximum'[-1] (external noise level)
Passive recreation areas (e.g. area used for reading, meditation)						60						ICNG (external noise level)
Active recreation areas (e.g. sports fields)						65						ICNG (external noise level)
Commercial premises (including offices and retail outlets)						70						ICNG (external noise level)
Industrial premises						75						ICNG (external noise level)

Notes:
1 - Outdoor noise level based on recommended maximum internal noise level in AS 2107 plus 10 dB (10dB is a conservative estimate of the difference between internal and external noise levels, taken from ICNG p13)
D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
E: evening period from 6pm to 10pm (Monday to Saturday) - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm to 8 am Saturday, Sunday and Public holidays - OOHW P2

APPENDIX C Construction timetable/ activities/ management

Table C1.1: Construction Timetable/ Activities/ Equipment **ARTARMON BULK POWER SUPPLY WORKS**

Activity/ Work Area	Aspect	Timing of Activity (Aprox No. weeks/ months)	Plant/ Equipment	Net Power kW	Operating Weight kg	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A) Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	L_{Aeq}	Penality	L_{amax}	Notes
COMPOUND												
Artarmon to Willoughby BSP Route - Construction Compound / Laydown Area	General worksite, car parking, storage, delivery	Jun 2020 to May 2021	Light Vehicle			3	3	3	89			
			Truck			1	1	1	106			
			Water Cart		5T	1	1	1	104			
			Telehandler		4T	1	1	1	98			
			Power Tools			Various	Various	Various	107			
SITE ESTABLISHMENT												
Artarmon to Willoughby BSP Route - Site Establishment	Installation of enviro controls / traffic controls	Jun 2020 to May 2021	Small Truck <20T			1	1	1	103			
			Telehandler		4T	1	1	1	98			
			Light Vehicle			3	3	3	89			
			Power Tools			Various	Various	Various	107			
CONSTRUCTION												
Artarmon to Willoughby BSP Route - Cable route excavation, conduits installation, surface reinstatement.	Earthworks and Electrical Installation	Jul 2020 to Dec 2020	Truck/Tipper		15T	1	1	1	103			
			Excavator 12T with hammer			2	2	2	118	5		
			Excavator 12T			2	2	2	103			
			Road Saw	55kW		2	2	2	121	5		
			Compactor			1	1	1	108			
			Generator	10kVA		1	1	1	94			
			Light Vehicle			3	3	3	89			
			Crane			1	1	1	105			
			Concrete Truck			1	1	1	108			
			Concrete pump			1	1	1	104			
			Lighting Tower			1	1	1	93			
			Water Cart		5T	1	1	1	104			
			Grader			1	1	1	109			
			Roller		4T	1	1	1	109			
			Skidsteer bobcat		1T	1	1	1	101			
			Power Tools			Various	Various	Various	107			
Artarmon to Willoughby BSP Route - Cable Installation and Jointing	Earthworks and Electrical Installation	Dec 2020 to Mar 2021	Truck			1	1	1	106			
			Crane			1	1	1	105			
			Cable Winch			1	1	1	98			
			EWP			1	1	1	95			
			Lighting Tower			1	1	1	93			
			Generator	10kVA		1	1	1	94			
			Light vehicle			1	1	1	89			
			Power Tools			Various	Various	Various	107			

Table C1.2: Construction Timetable/ Activities/ Equipment **ARTARMON SUBSTATION BUILDING**

Activity/ Work Area	Aspect	Timing of Activity (Aprox No. weeks/ months)	Plant/ Equipment	Net Power kW	Operating Weight kg	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			Notes
						7am - 6pm	6pm - 10pm	10pm - 7am	L_{Aeq}	Penality	L_{amax}	
COMPOUND												
Construction Compound & Car Park	General worksite and Car parking	05/20 to 07/21	Light vehicle			5 per hour	1 per hour	1 per hour	89			OOHW required when needed to support construction
[Operational for duration of works]	Workshop; Deliveries; Maintenance; Storage	05/20 to 07/21	Delivery truck			2 p.h.			106			
			Generator			2	1	1	94			
			Workshop Hand Tools			1			107			
			Water cart		15kL	1	-	-	104			
SITE ESTABLISHMENT												
Site Establishment	Installation of enviro controls	05/20 to 07/20	Light vehicle			1	-	-	89			
			Hand Tools			1	-	-	107			
	Construction of Crane Pads and access tracks	05/20 to 07/20	Excavator		20t	1	-	-	103			
			Roller		12t	1	-	-	109			
	Demolition of existing slab	05/20 to 07/20	Excavator w bucket		25 tonne	1	-	-	103			
			Excavator w rockhammer		30 tonne	1	-	-	118	5		
			Truck & Dog			2 p.h.	-	-	106			
Mobilisation	Site sheds/hoarding Installation	05/20 to 07/20	Delivery truck			2 p.h.	1 p.h.	1 p.h.	106			OOHW required due to road occupancy
			Hand Tools			1	1	1	107			
			150t Mobile Crane			1	1	1	105			
SITE DEMOBILISATION												
Demobilisation	Removing site sheds/hoarding	06/21 to 07/21	Delivery truck			2 p.h.	1 p.h.	1 p.h.	106			OOHW required due to road occupancy
			Hand Tools			1	1	1	107			
			150t Mobile Crane			1	1	1	105			
PLATFORM & BUILDINGS												
Footings & Foundations	Reinforced concrete works	07/20 to 12/20	Excavator w bucket		25 tonne	1	-	-	103			Evening OOHW may be required in order to complete concrete pours
			Piling rig (bored)			1			108			
			Delivery truck			10 deliveries			106			Total number of deliveries over course of activity
			Concrete truck and pump			1	1	-	108			
			Concrete vibrators			1	1	-	97			
Insitu Concrete slab	Reinforced concrete works	07/20 to 12/20	Excavator w bucket		25 tonne	1	-	-	103			Evening OOHW may be required in order to complete concrete pours
			Hand tools			1	1		107			
			Delivery truck			7 deliveries			106			Total number of deliveries over course of activity
			Concrete truck and pump			1	1	-	108			
			Concrete vibrators			1	1	-	97			
Precast Concrete Walls	Precast panels installation	09/20 - 02/21	Hand tools			1	1		107			Evening OOHW may be required to complete installation works to a safe and secure state
			Delivery truck			15 deliveries	1		106			Total number of deliveries over course of activity
			Crane 50t			1	1		105			
Steel Platforms	Steel columns & platforms	09/20 to 03/21	Hand tools			1	1		107			Evening OOHW may be required to complete installation works to a safe and secure state
			Delivery truck			12 deliveries	1		106			Total number of deliveries over course of activity
			Telehandler			1	1		98			
Modules & Transformers installation		01/21 to 05/21	Hand tools			1	1	1	107			OOHW required due to road occupancy
			Delivery truck			2 p.h.	1 p.h.	1 p.h.	106			
			150t Mobile Crane			1	1	1	105			
PERIMETER FAÇADE												
Perimeter retaining wall	Reinforced concrete works	03/21 to 06/21	Excavator w bucket		25 tonne	1	-	-	103			Evening OOHW may be required in order to complete concrete pours
			Generator			1	1		94			
			Hand tools			1	1		107			
			Delivery truck			5 deliveries			106			Total number of deliveries over course of activity
			Concrete truck and pump			1	1	-	108			
			Concrete vibrators			1	1	-	97			
Façade	Façade installation	04/21 to 07/21	Hand tools			1	1		107			OOHW required due to road occupancy
			Delivery truck			2 p.h.	2 p.h.		106			
			Crane 50t			1	1		105			

Table C2: Construction Noise Management Schedule **ARTARMON SUBSTATION & ARTARMON BULK POWER SUPPLY**

Mitigation/ Management Measure		Comments
1	Temporary screens	Temporary noise screens (e.g. FlexShield, Echo-barrier or similar) will be installed around the work areas. The screen should be located on all sides of the work areas and as close as possible to the plant. This will reduce the noise from the construction activities by up to 10 dB(A) when there is no direct line of sight between construction plant and receivers. The exceptions are for areas where work is carried out during standard construction hours.
2	High noise impact works	High noise activities such as saw cutting and excavator with hammers are to be limited to before midnight, where feasible with consideration of the ROL.
3	Sleep Disturbance - Maximum noise level management	1.Maximum noise levels with potential to cause sleep disturbance may be caused by concrete saws and excavators with hammers.These activites will be managed by: - restricting the use of saws and excavator with hammers to before midnight, where feasible with consideration of the ROL. 2 Activities such as air brakes and general clangs and bangs will be managed by: - warning personnel of the need to respect the residential receivers surrounding the local area work sites as part of the toolbox talk for these works, stressing the lower night-time background noise levels in the works areas. - Minimise the use of air brakes when travelling to and from the site. - Identify and eliminate or manage the potential of loose items or plant/equipment that could generate metal-on-metal bangs during the night period.
4	Verification monitoring - Noise	Verification monitoring must be conducted to validate predictions in the nominated positions against the project requirements, as outlined in Section 5.3.4
5	Receiver notification/briefing - Noise	A large range of receivers may be impacted by the works. Some properties close to the work areas will be exposed to highly noise impacts during the OOHW period. All additional mitigation measures outlined in APPENDIX E should be applied.
6	Verification monitoring - Vibration	Plant and equipment have been identified to operate within the minimum buffer distances for both cosmetic damage and human annoyance. Verification monitoring must be conducted to validate predictions in the nominated positions against the project requirements, as outlined in Section 6.3.3
7	Receiver notification/briefing - Vibration	Plant and equipment have been identified to operate within the minimum buffer distances for human annoyance. Vibration may be perceivable at times. Notifications should be sent to receivers included within the minimum working distances shown in APPPENDIX F, and additional mitigation measures where applicable following monitoring.

APPENDIX D Detailed predicted noise levels

The impacts presented in the following table are identified by colour coding of the text.

For **Standard Hours:**

- XX Complies with NML
- **XX** < 10dB(A) above NML - construction noise clearly audible
- **XX** > 10dB(A) above NML - construction noise moderately intrusive
- **XX** > 75dB(A) - highly noise affected

For **OOH**

- XX Complies with NML
- **XX** < 5 dB(A) above NML - construction noise noticeable
- **XX** 5 to 15 dB(A) above NML - construction noise clearly audible
- **XX** > 15 to 25 dB(A) above NML - construction noise moderately intrusive
- **XX** > 25 dB(A) above NML - construction noise highly intrusive

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 table below is replicated from Table 5-7, and identifies the additional mitigation measures to be applied at construction noise affected receivers.

When is the work being undertaken?	How much does the predicted noise level exceed the ANML by?	Identify additional management measures to be implemented
Standard Hours M-F 7am to 6pm Sat 8am to 1pm	0 dB(A)	- -
	≤ 10 dB(A)	- -
	10 to 20 dB(A)	LB, V [MM2]
	> 20 dB(A)	LB, V [MM2]
	Highly noise affected	LB, SN, RO, V [MM4]
OOHW Period 1 M-F 6pm to 10pm Sat 1pm to 10pm Sun/ PH 8am to 10pm	< 5 dB(A)	- -
	5 to 15 dB(A)	LB [MM1]
	15 to 25 dB(A)	LB, V [MM2]
	> 25 dB(A)	LB, SN, IB, RO, V [MM4]
OOHW Period 2 M-F 10pm to 7am Sat 10pm to 8am Sun/ PH 6pm to 8am	< 5 dB(A)	LB [MM1]
	5 to 15 dB(A)	LB, V [MM2]
	15 to 25 dB(A)	LB, SN, IB, RO, V [MM4]
	> 25 dB(A)	LB, SN, IB, RO, AA, V [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
V = Verification of predicted noise levels
SN = Specific notifications (personalised letter, phone call, email, individual briefing)
RO = Project specific respite offer
AA = Alternative accommodation

In the following results table, an additional management measure code (MM1, MM2 et al) is given to each receiver if construction noise levels are expected to exceed the Noise Management Level (NML). Each additional management measure code corresponds to a collection of measures identified in the CNVS [9]. The extent of the additional management measures is proportional to the exceedance of the NML and the period in which the exceedance is experienced.

For example, if a receiver experiences construction noise of 10 to 20 dB(A) above the NML during Standard Hours, then the letterbox drop (LB) and verification of predicted noise levels (V) measures are to be adopted for the receiver.

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

Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:14

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330

210 m

0 30 60 90 180 150 120 90 60 30 0

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

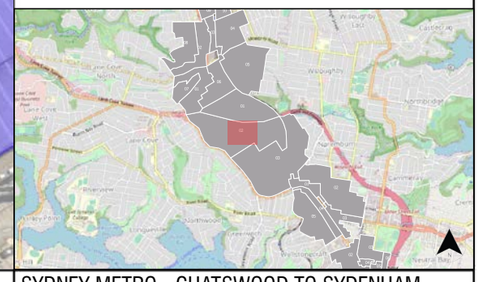
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route

MWD for cosmetic damage and human annoyance

Work area: A1

Status:

Sheet 1 of 14

Drawing No.

Rev. No.

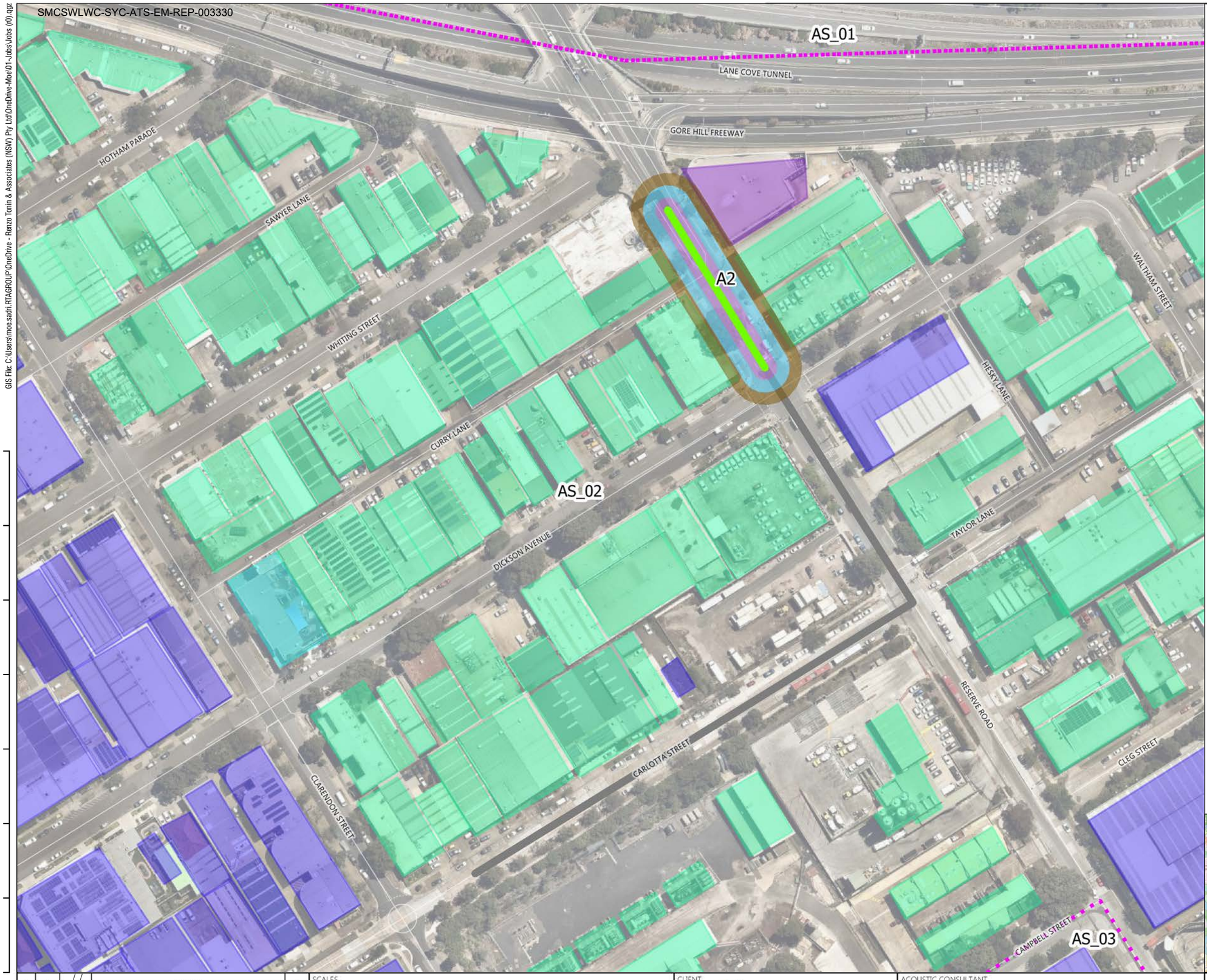
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:14

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 180 150 120 90 60 30 0

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

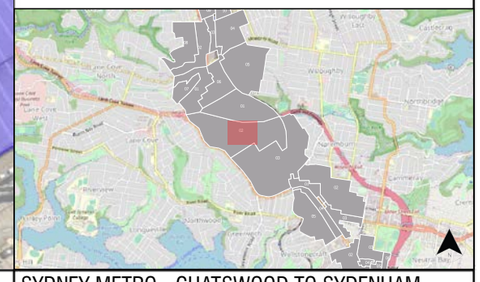
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route

MWD for cosmetic damage and human annoyance

Work area: A2

Status:

Sheet 2 of 14

Drawing No.

Rev. No.

Land-Use file revision_date: r7_ 27/03/20

Plot Date: 27/03/20 - 17:14 Layout: TK685-03 MWD Artarmon BPS Route (r1)

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330

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

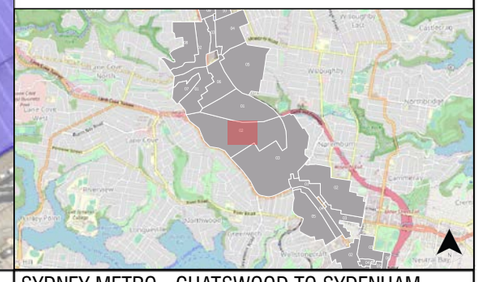
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A3

Status:

Sheet 3 of 14

Drawing No.

Rev. No.

Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:15

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330

210 m

0 30 60 90 180 150 120 90 60 30 0

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

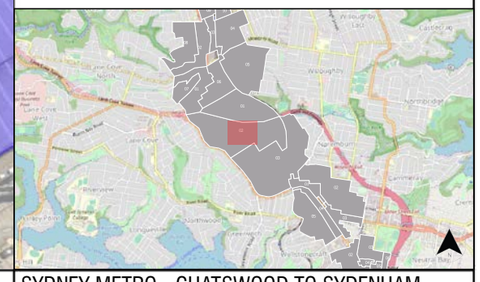
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A4

Status:

Sheet 4 of 14

Drawing No.

Rev. No.

Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:15

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330

210 m

0 30 60 90 180 150 120 90 60 30 0

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

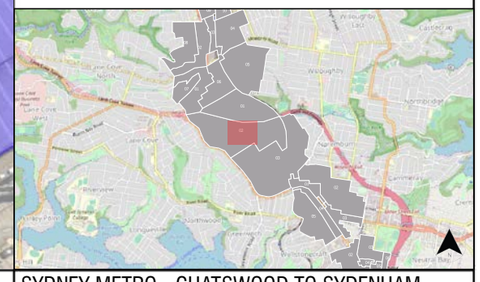
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A5

Status:

Sheet 5 of 14

Drawing No.

Rev. No.

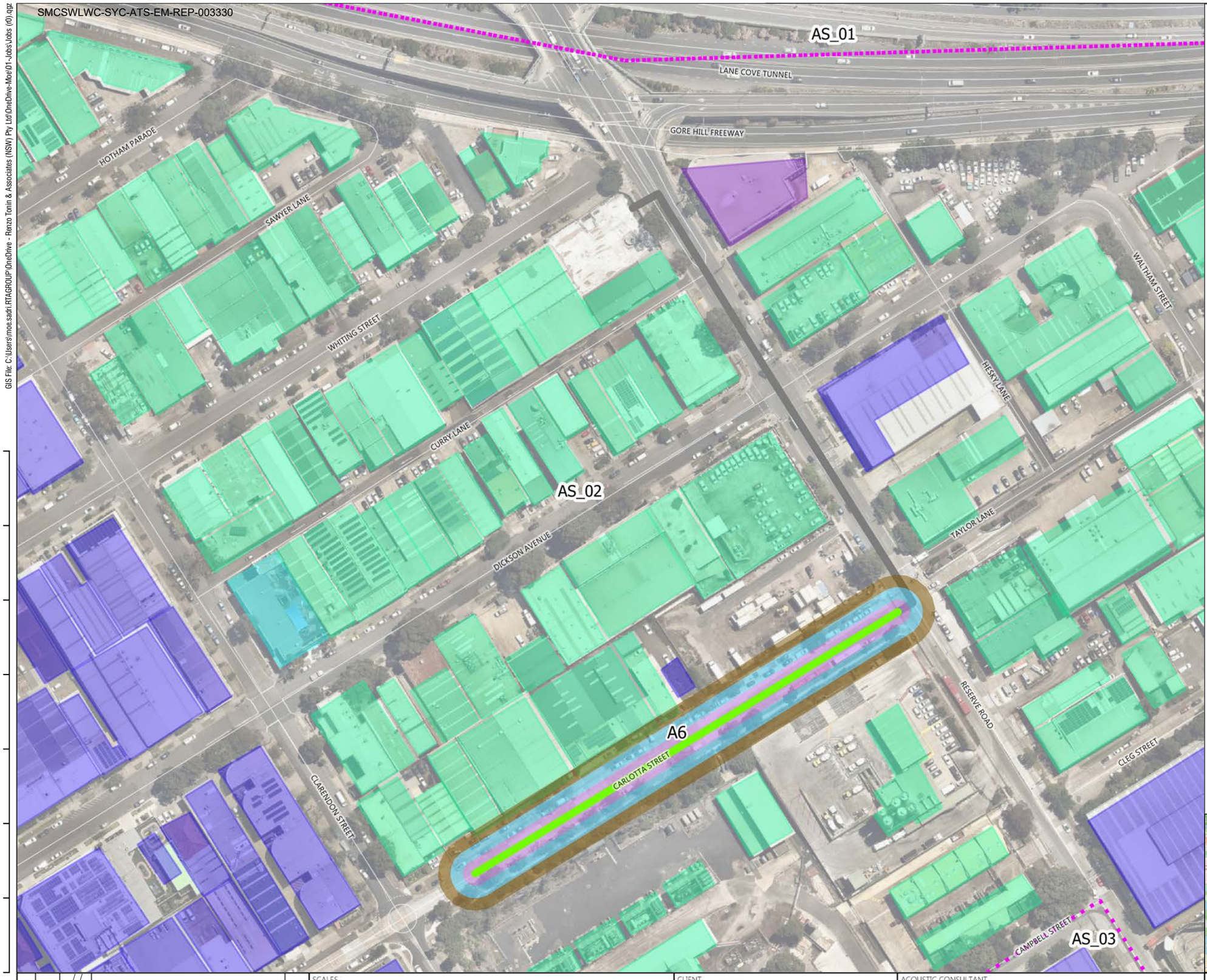
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:15

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 180 150 120 90 60 30 0

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

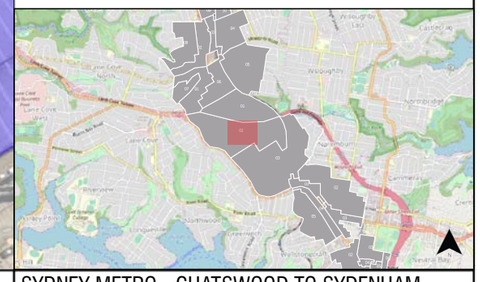
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A6

Status:

Sheet 6 of 14

Drawing No.

Rev. No.

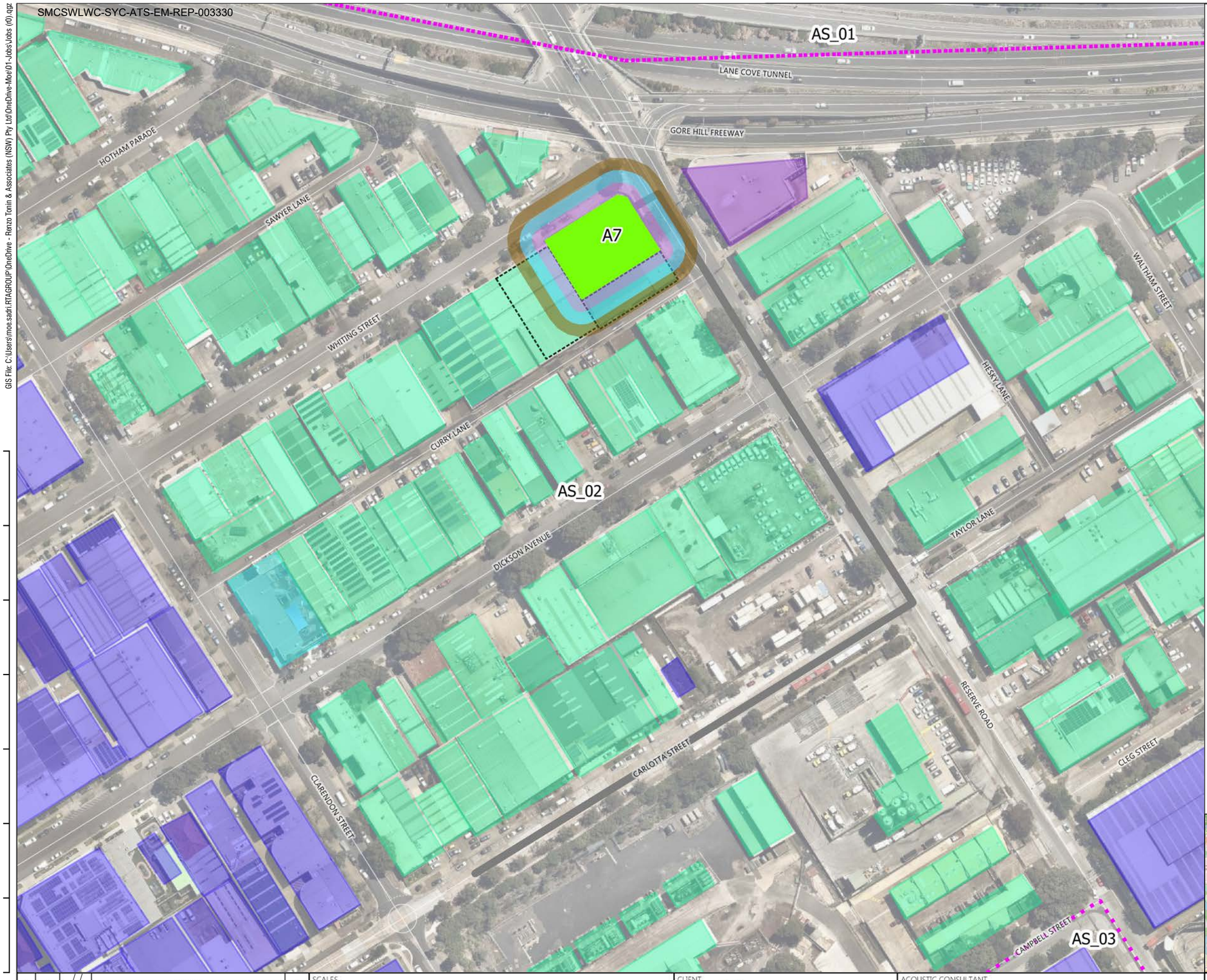
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:16

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 120 150 180

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

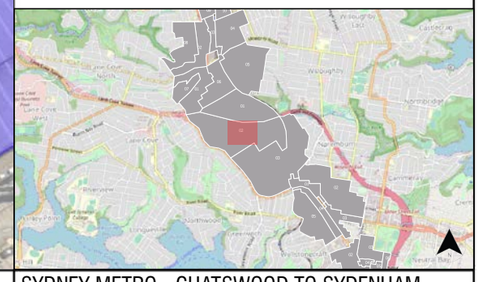
MWD for cosmetic damage and human annoyance for Compactor / roller (4-12t) - low vibration

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A7

Status:

Sheet 7 of 14

Drawing No.

Rev. No.

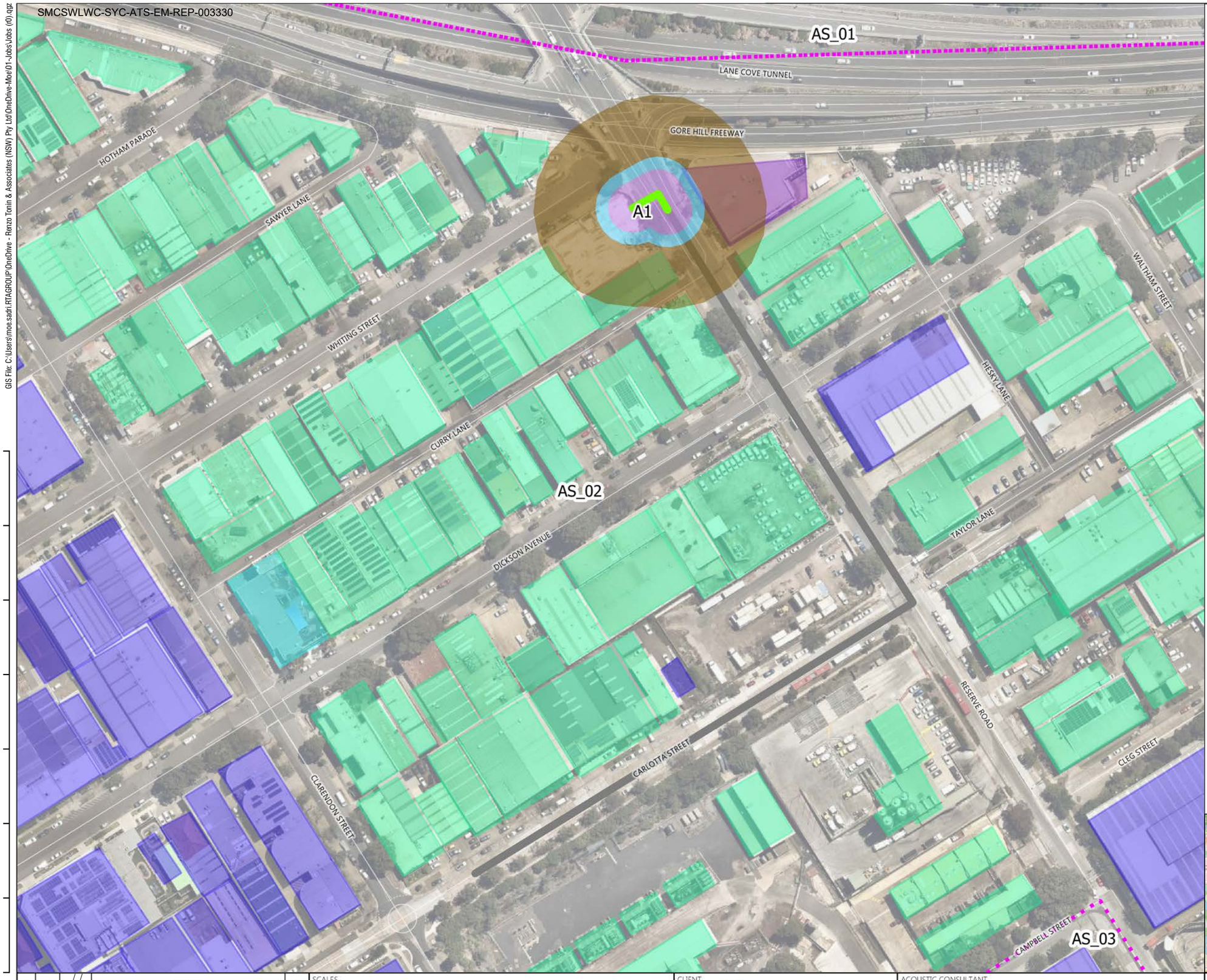
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:16

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 180 150 120 90 60 30 0

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

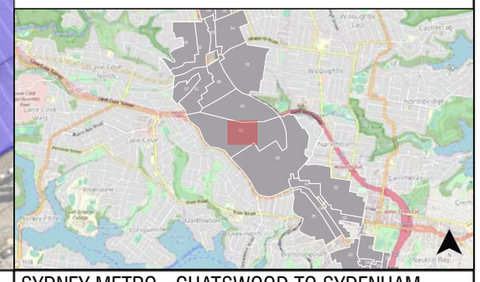
MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12-30T)

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A1

Status:

Sheet 8 of 14

Drawing No.

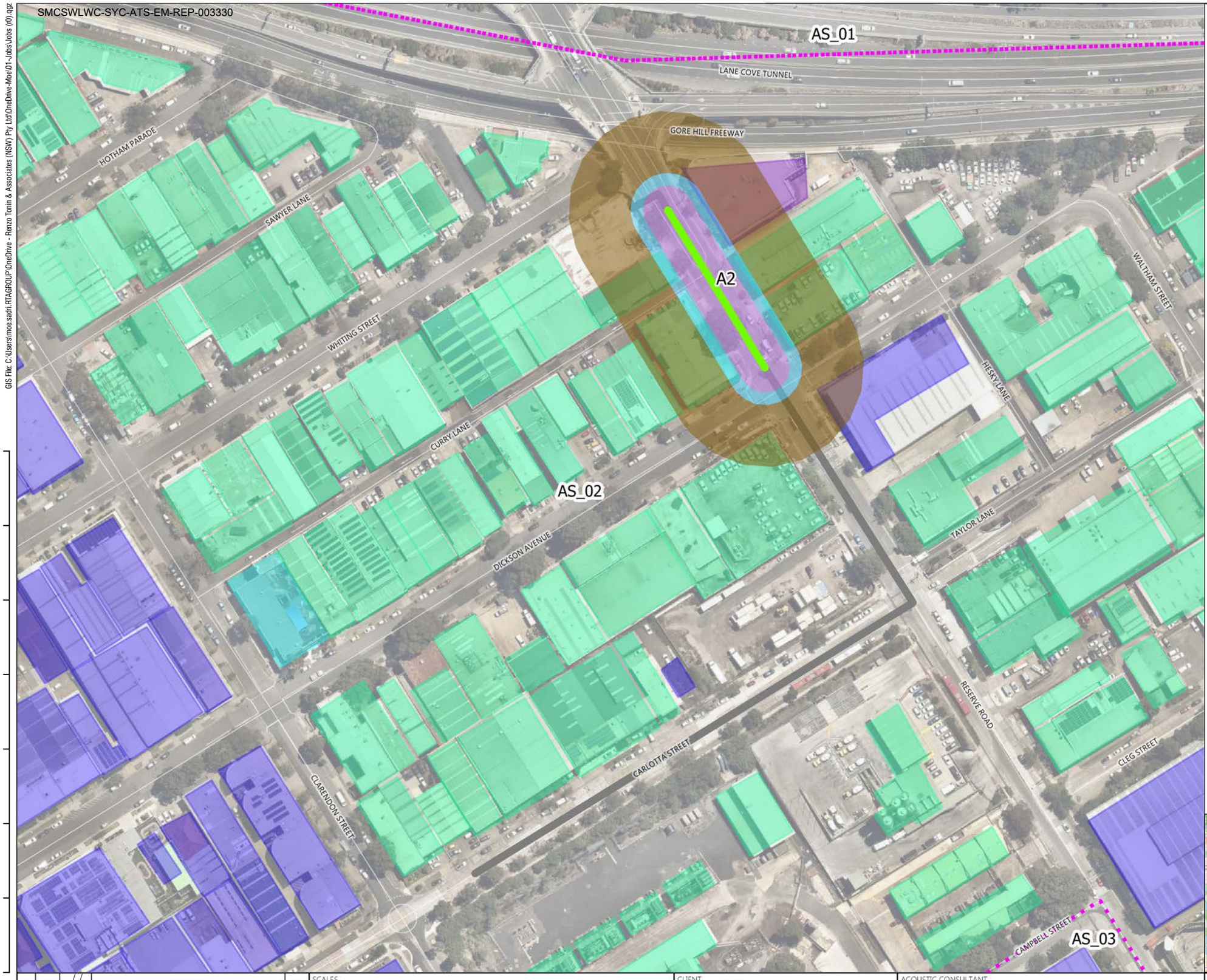
Rev. No.

Land-Use file revision_date: r7_ 27/03/20

Plot Date: 27/03/20 - 17:16 Layout: TK685-03 MWD Artarmon BPS Route (r1)

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 180 150 120 90 60 30 0

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

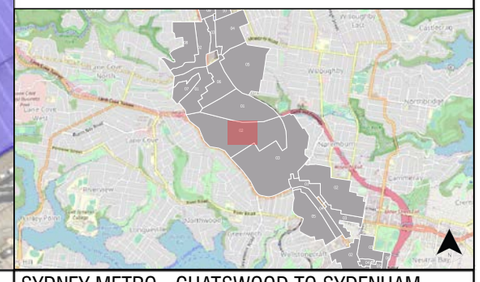
MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12-30T)

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A2

Status:

Sheet 9 of 14

Drawing No.

Rev. No.

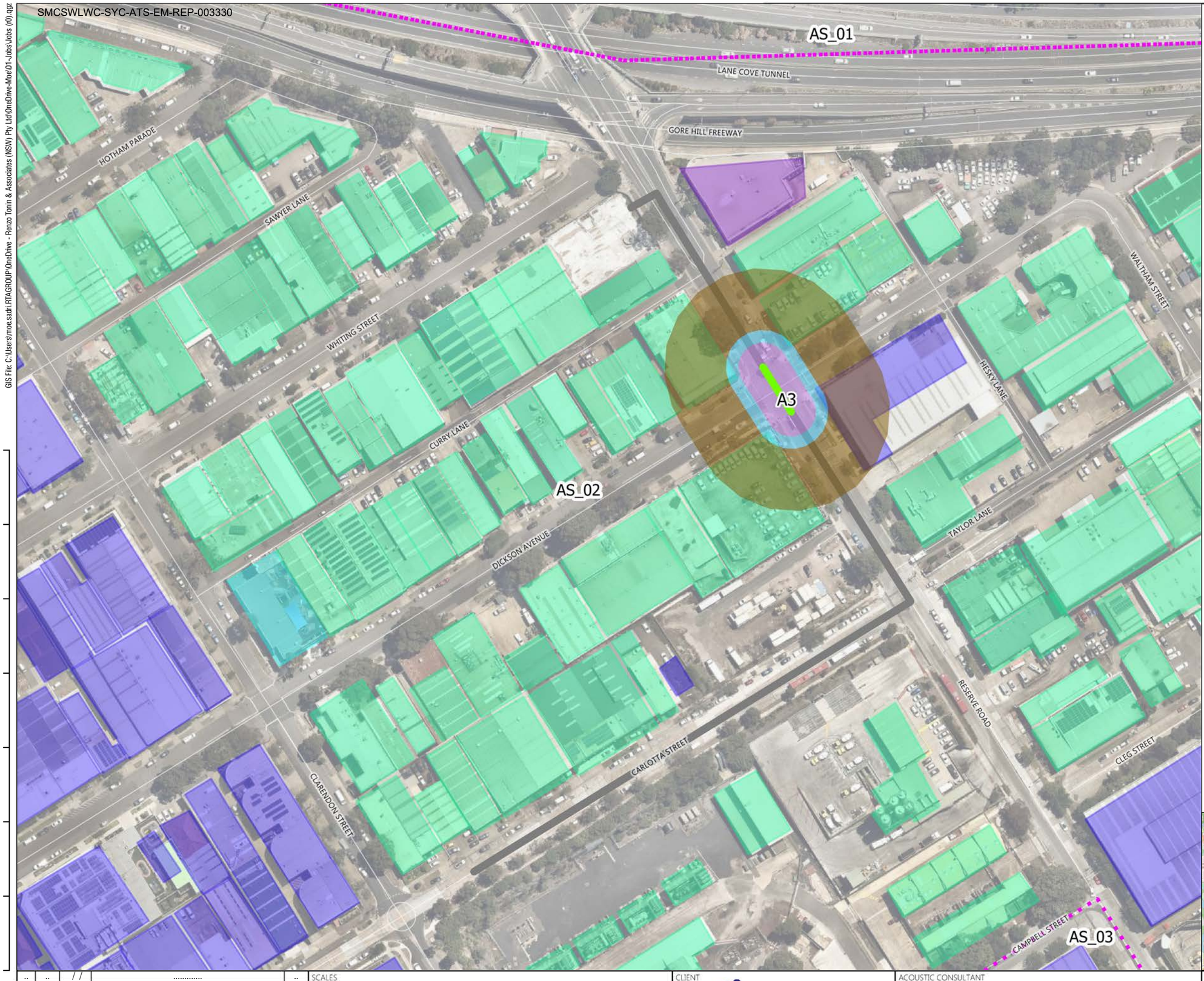
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:17

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



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

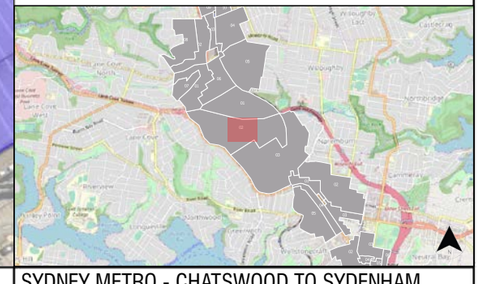
MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12-30T)

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A3

Status:

Sheet 10 of 14

Drawing No.

Rev. No.

SMCSWLWC-SYC-ATS-EM-REP-003330

Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:17

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

AS_01

AS_02

AS_03

A4

LANE COVE TUNNEL

GORE HILL FREEWAY

HOTHAM PARADE

SAWYER LANE

WHITING STREET

CURRY LANE

DICKSON AVENUE

CARLOTTA STREET

CLARENDON STREET

RESERVE ROAD

TAYLOR LANE

HESKY LANE

WALTHAM STREET

CLEG STREET

CAMPBELL STREET

210 m

180

150

120

90

60

30

0

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

MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12-30T)

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

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route

REV	BY	DATE	DESCRIPTION	APPD.
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..	..	/ /	.....	..
..	..	/ /	.....	..
r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A4

Status:	Sheet 11 of 14
Drawing No.	Rev. No.

Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:17

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

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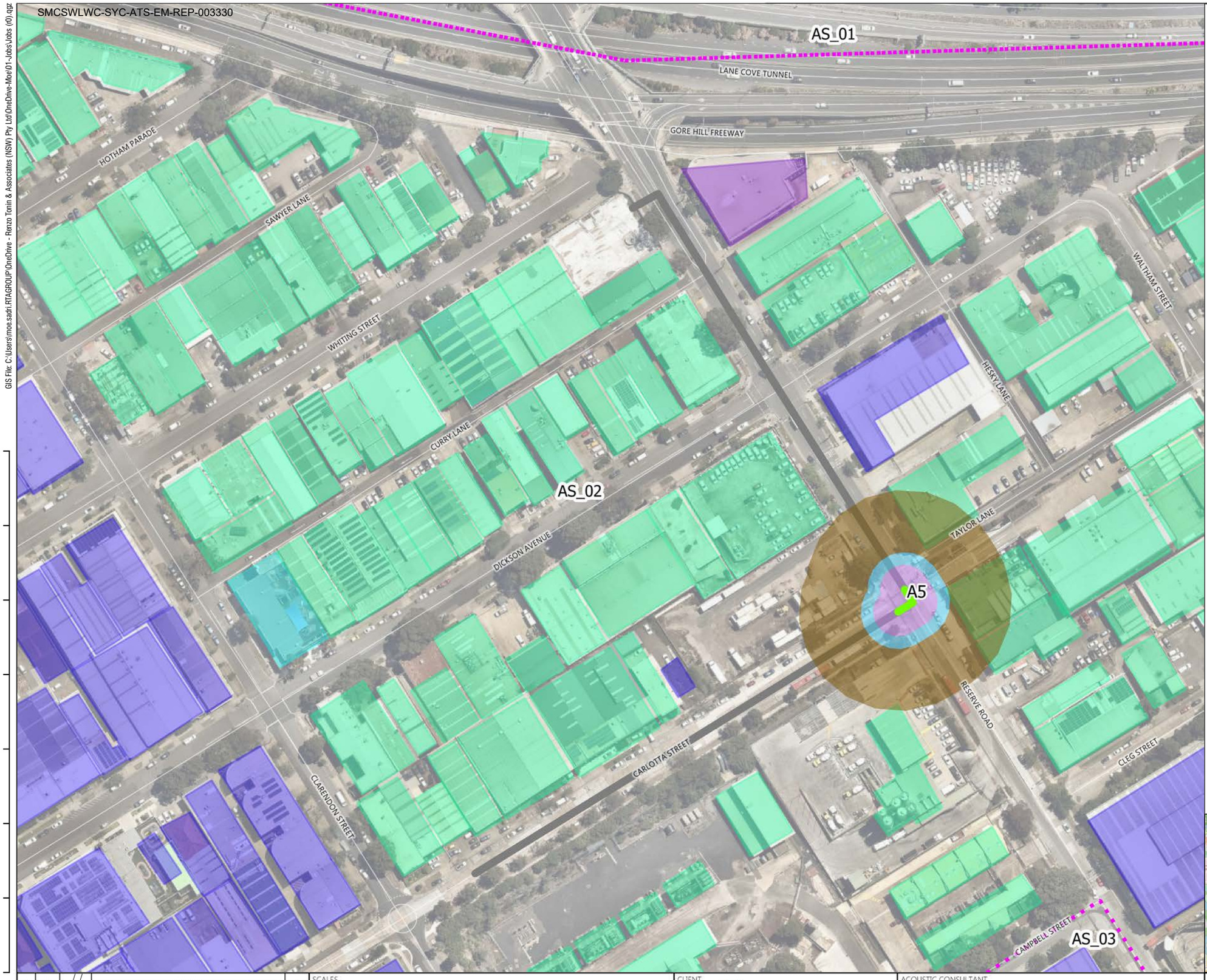

210 m

0 30 60 90 180 150 120 90 60 30 0

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

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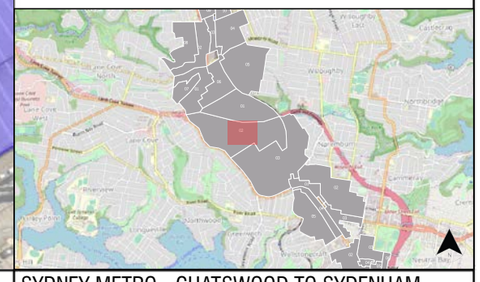
- Human annoyance - Residential (night)
- Human annoyance - Commercial
- Human annoyance - Critical
- Human annoyance - Workshop

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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..	..	/ /	.....	..
r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route

MWD for cosmetic damage and human annoyance

Work area: A5

Status:

Sheet 12 of 14

Drawing No.

Rev. No.

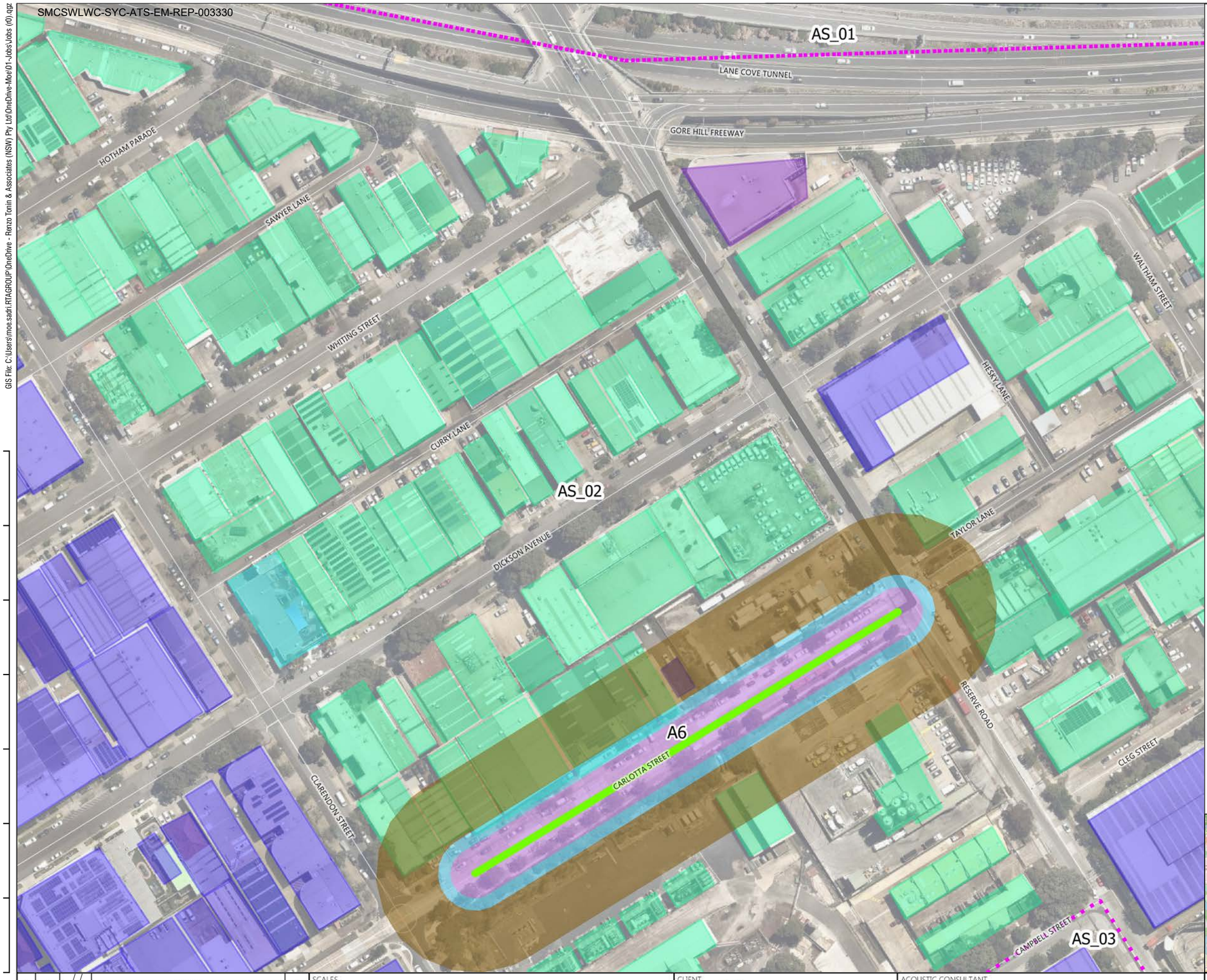
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:17

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

0 30 60 90 180 150 120 90 60 30 0

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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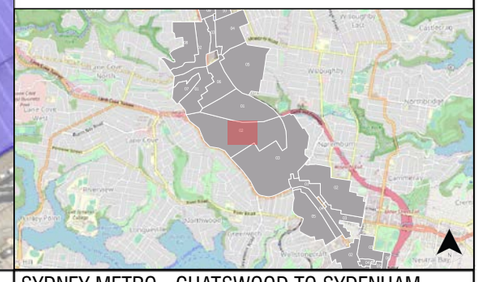
- Human annoyance - Residential (night)
- Human annoyance - Commercial
- Human annoyance - Critical
- Human annoyance - Workshop

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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..	..	/ /	.....	..
r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A6

Status:

Sheet 13 of 14

Drawing No.

Rev. No.

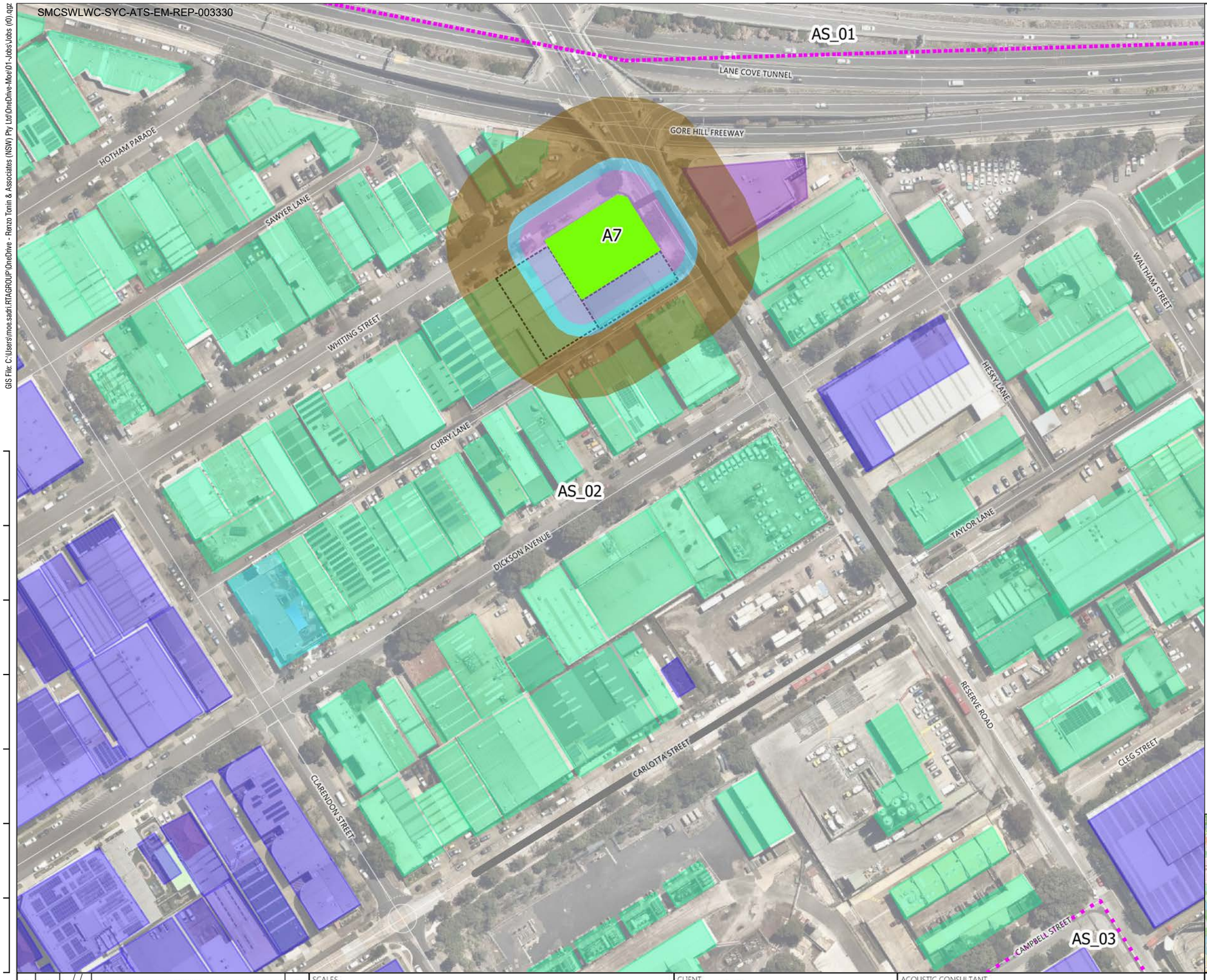
Land-Use file revision_date: r7_ 27/03/20

Layout: TK685-03 MWD Artarmon BPS Route (r1)

Plot Date: 27/03/20 - 17:18

GIS File: C:\Users\moe.sadri.RTAGROUP\OneDrive - Renzo Tonin & Associates (NSW) Pty Ltd\OneDrive-Moe\01-Jobs\Jobs (r0).qgz

SMCSWLWC-SYC-ATS-EM-REP-003330



210 m

180

150

120

90

60

30

0

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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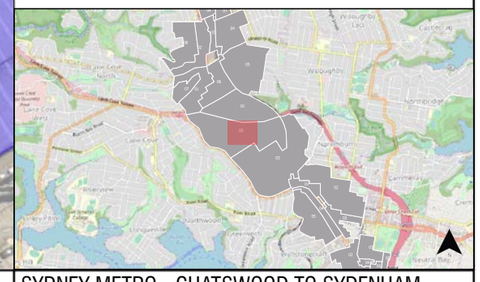
- Human annoyance - Residential (night)
- Human annoyance - Commercial
- Human annoyance - Critical
- Human annoyance - Workshop

Receivers affected by MWD for cosmetic damage

Work area

Artarmon BPS Route



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..	..	/ /	.....	..
r0	MS	27/03/20	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

SCALES

0 30 60 90 m

1:1500

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Artarmon BPS Route
MWD for cosmetic damage and human annoyance
Work area: A7

Status:

Sheet 14 of 14

Drawing No.

Rev. No.