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Waterloo Integrated Station Development

Noise and Vibration Annual Monitoring Report

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Document and Revision History

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Client	Sydney Metro City & Southwest

Revisions

Rev #	Date	Description	Prepared by	Reviewed by	Approved by
A	15/10/2021	Draft Report	S. Reynolds		
B	02/12/2021	Updated to address Sydney Metro/AA/ER comments		S. Reynolds	A. Knispel
C	19/01/2022	Updated to address further comments from AA		S. Reynolds	A. Knispel
0	19/01/2022	Endorsed by the AA			

APPROVAL
CITY & SOUTHWEST ACOUSTICS ADVISOR

Review of:	Sydney Metro City and South West - Waterloo Integrated Station Development - Noise and Vibration Annual Monitoring Report	**Document reference:**	SMCSWSWL-JHG-SWL-EM-REP-000009
Prepared by:	Daniel Weston Acoustics Advisor		John Holland
Date of issue:	25 January 2022		19 January 2022

As approved Acoustics Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the Noise and Vibration Annual Monitoring Report October 2020 - September 2021 for the Waterloo Integrated Station Development (WISD), as required under A27 (d) of the project approval conditions.

This report is to be submitted to the NSW Department of Planning, Industry and Environment in accordance with Condition of Approval C16 and the WISD Construction Noise and Vibration Management Plan (CNVMP).

I have reviewed the report and am satisfied that my comments have been adequately addressed and that it meets the requirements of the WISD CNVMP. I endorse the report.

Daniel Weston, City & Southwest Acoustics Advisor

Glossary

Term	Explanation
CEMP	Construction Environmental Management Plan
CNVIS	Construction Noise & Vibration Impact Statement
CNVMP	Construction Noise and Vibration Management Plan
CoA	Condition of Approval
CSSI	Critical State Significant Infrastructure
ICNG	Interim Construction Noise Guideline
ISD	Integrated Station Development
JH	John Holland
MQD	Metro Quarter Development
NML	Noise Management Levels
OOHW	Out of Hours Work
OOHWA	Out of Hours Work Approval
OSD	Over-station Development
PNL	Predicted Noise Level
PPV	Peak Particle Velocity
RBL	Rating Background Level
VDV	Vibration Dose Value

Table of contents

1. Introduction

1.2 Background

The Sydney Metro City & Southwest is a 30 kilometre metro rail between Chatswood and Bankstown, including; 17 kilometres of new tunnel from Chatswood, under the harbour to Sydenham connecting 7 new underground stations at Crows Nest, Victoria Cross (North Sydney), Barangaroo, Pitt Street, Martin Place, Central and **Waterloo**. Upgrading 13 kilometres of the Bankstown line, including 11 existing stations; Sydenham, Marrickville, Dulwich Hill, Hurlstone Park, Canterbury, Campsie, Belmore, Lakemba, Wiley Park, Punchbowl and Bankstown plus southern service facilities. The Waterloo Integrated Station Development (ISD) forms part of the Sydney Metro City & Southwest Project. The Waterloo ISD comprises of construction of the new station infrastructure to support customer movement and experience. The Waterloo Station works are undertaken by John Holland

The Waterloo ISD is located within Sydney's suburb of Waterloo, as shown in Figure 1, within the Metro Quarter. The Metro Quarter Development (MQD) comprises the land bounded by Botany Road, Raglan Street, Cope Street and Wellington Street, but excluding the Congregational Church located at 103 Botany Road. It is situated approximately 3km from the Sydney CBD and is surrounded by established residential and commercial land uses. The MQD incorporates the Waterloo ISD and the Over-station Development (OSD) however, the OSD component is not subject to the CSSI Project Planning Approval (SSI15_7400) and therefore does not form part of the scope of this report.

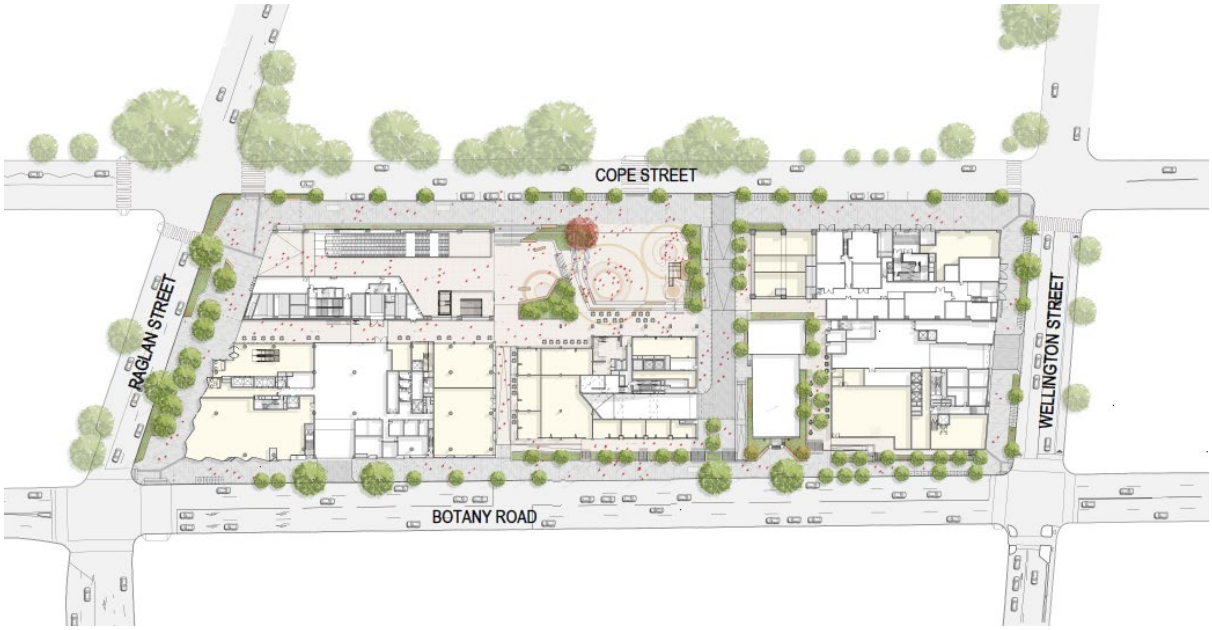

Figure 1 Location of the Waterloo ISD

1.3 Purpose

The Waterloo ISD annual noise and vibration monitoring report is a summary of all noise and vibration monitoring conducted over the 12 month period from commencement of Construction on 1st October 2020 to 30 September 2021.

The Construction Noise and Vibration Management Plan (Rev 1) (CNVMP) outlines the details of the monitoring program required by Condition of Approval (CoA) C10 and the frequency of reporting. The Construction Monitoring Program has been endorsed by the Acoustics Advisor and approved by the Secretary in accordance with CoA 13.

CoA C16 requires the results of the monitoring program to be provided to the Secretary for information at the frequency identified in the program. The approved monitoring program states the details of noise and vibration monitoring will be reported to Sydney Metro on an annual basis. The consolidated noise and vibration monitoring report will be submitted for information to the Secretary by Sydney Metro and relevant regulatory agencies and Council by Waterloo ISD.

Details of the compliance requirements are included in Table 1-1.

Table 1-1 Conditions of Approval relating to the Construction Monitoring Program

Condition	Requirement	Reference
C9	The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance. – Required Construction Monitoring Programs Relevant government agencies to be consulted for each Construction Monitoring Program – Noise and Vibration - EPA and Relevant Council(s) Blasting - EPA and Relevant Council(s) – Water Quality - EPA and Relevant Council(s) – Groundwater - DPI Water/NRAR	Noise and Vibration – refer to the Construction Noise and Vibration Management Plan Blasting – Not applicable Water Quality – Not applicable Groundwater - Not applicable
C16	The results of the Construction Monitoring Programs must be submitted to the Secretary for information, and relevant regulatory agencies, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program	The results of the Construction Noise and Vibration Monitoring Program are discussed in Section 4. In accordance with CoA C16, this report will be submitted to the following agencies for information: – Department of Planning Industry and Environment – NSW Environment Protection Authority – City of Sydney Council

The Independent Acoustic Advisor will be provided with the report for endorsement prior to submission by Sydney Metro to the Secretary and submission to the relevant regulatory agencies by Waterloo ISD.

2. Monitoring Program Criteria

2.1 Noise criteria

The three primary noise metrics used to describe construction noise emissions are:

- LA1(1minute) - The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the LAmax or maximum noise level.
- LAeq(15minute) - The "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.
- LA90 - The "background noise level" or "Rating Background Level" (RBL) in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The LAeq(15minute) construction noise management levels are based on the RBLs.
- The subscript "A" indicates that the noise levels are filtered to match normal hearing characteristics (A weighted).

The NSW EPA Interim Construction Noise Guideline (ICNG) requires project specific Noise Management Levels (NMLs) to be established for noise affected receivers. A site-specific Construction Noise and Vibration Impact Statement (CNVIS) has been prepared in accordance with CoA E33 which predicts noise impacts to nearby sensitive receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed as per Section 12 of the CNVMP.

Site specific residential construction NMLs for Waterloo ISD have been nominated in the Sydney Metro Chatswood to Sydenham EIS Technical Paper 2: *Noise and Vibration* (EIS NIA, SLR Consulting Report 610.14718R8 dated 28 April 2016). These NMLs have been reproduced in Table 2-1.

Table 2-1 Residential Construction Noise Management Levels

Receiver Types	LAeq(15minute) Construction NMLs (dBA)			
	Daytime[1]	Daytime OOH[2]	Evening[3]	Night-time[4]
Residential[5]	64	59	52	44

Note 1: The Daytime period includes Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm, except for Public Holidays.

Note 2: The Daytime Out of Hours period includes Saturdays 7.00 am to 8.00 am and 1.00 pm to 6.00 pm, and Sundays and Public Holidays 7.00 am to 6.00 pm

Note 3: The Evening period includes 6.00 pm to 10.00 pm.

Note 4: The Night-time period includes 10.00 pm to 7.00 am.

Note 5: The EIS NIA determined the NML from noise logging conducted at Monitoring Location B.06 (122 Wellington Street, Waterloo) between 31 August and 14 September 2015. The EIS NIA adopted the NML from B.06 for both Waterloo Noise Catchment Areas (NCAs), NCA29 and NCA31.

The Project specific $L_{Aeq(15minute)}$ NMLs for non-residential noise sensitive receivers from the ICNG are provided in Table 2-2.

Table 2-2 Non-Residential Sensitive Receivers Noise Management Levels

Land Use	Area	NML $L_{Aeq(15minute)}$ Noise Levels	
		External	Internal
Hotel[1]	Bars and Lounges	70 dBA	50[2,3] (Daytime & Evening)
	Sleeping Areas: - Hotels near major roads	As per Table 6 for residential[4]	40[4] (Night-time)
Café[1]	Coffee bar	70 dBA[3]	50[2,3] (when in use)
Bar/Restaurant[1]	Bars and Lounges / Restaurant	70 dBA[3]	50[2,3](when in use)
Library[1]	Reading Areas	70 dBA	45[5](when in use)
Recording Studio[1]	Music Recording Studios	70 dBA	25[6](when in use)
Theatre/ Auditorium[1]	Drama Theatres	70 dBA	30[6](when in use)
Childcare Centres	Internal Play Area	65 dBA	55 dBA
	Sleeping Area	50 dBA (when in use)	40 dBA (when in use)
Classrooms at schools and other education institutions		55 dBA	45 dBA[7] (when in use)
Hospital wards and operating theatres		70 dBA	45 dBA
Places of Worship		70 dBA	45 dBA
Active recreation areas[8]		65 dBA	-
Passive recreation areas[9]		60 dBA	-
Community centres		Depends on the intended use of the centre. Refer to the recommended upper internal design sound levels in AS 2107 for specific uses.	
Commercial premises[10]	offices, retail outlets and small commercial premises	70 dBA (when in use)	45 dBA (when in use)
Industrial premises[10]		75 dBA (when in use)	-

Note 1: Design noise levels specified in AS 2107 internal noise levels.

Note 2: Where no external seating has been identified, fixed window glazing and air conditioning is assumed to mitigate high existing ambient noise levels and/or control internal noise break-out. A minimum outside-to-inside attenuation of 20 dB is assumed. The internal ICNG noise goal then corresponds to a façade level of 70 dBA.

Note 3: Where an open frontage or outdoor seating area has been identified, the external noise goal is taken as 60 dBA.

Note 4: Hotels (sleeping areas during the night-time) are assumed to have incorporated acoustic façade design in order to mitigate high existing ambient noise levels (refer to CNVMP Section 9.7) to achieve the internal design noise level of 40 dBA specified in AS 2107. Notwithstanding, the more conservative external NML corresponding to residential receivers (refer to CNVMP Table 6) has been applied to the sleeping areas of hotels.

Note 5: These receivers are typically well insulated from external noise break-in.

Note 6: These receivers are typically well insulated from external noise break-in, with significant acoustic mitigation included in the façade design.

Note 7: Assumed based on external noise levels being 10 dB higher than internal noise levels when windows are open.

Note 8: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.

Note 9: Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg reading and meditation).

Note 10: Assess at the most affected occupied point on the premises.

2.2`Vibration Criteria

Vibration and its associated effects on people are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration: machinery, steady road traffic, continuous construction activity such as underground drilling
- Impulsive vibration: infrequent activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading
- Intermittent vibration: trains, nearby intermittent demolition activity, rock breakers and jack hammers.

Structural vibration in buildings can be detected by the occupants possibly affecting them in various ways including reducing working efficiency and quality of life. Complaint levels from occupants of the buildings subject to vibration depend on the use of the building and the time of day.

Based on the information contained in the CNVIS and EIS, site specific vibration control criteria haven been nominated and are reproduced in Table 2-3.

Table 2-3 Nominated Site Vibration Control Criteria

Building type	Included Buildings	Site Control Criteria[1]	
		Operator warning level	Operator halt level
Reinforced frame structure	All surrounding commercial	20 mm/s PPV	25 mm/s PPV
Unreinforced or light framed structures	All surrounding Residential	5 mm/s PPV	7.5 mm/s PPV
Heritage (structurally sound)	Congregational Church	5 mm/s PPV	7.5 mm/s PPV
Buried Utilities	All	20 mm/s PPV	25 mm/s PPV
Human Response[2]	All	0.2 $m/s^{1.75}$ VDV	0.4 $m/s^{1.75}$ VDV
Vibration Sensitive Equipment[3]	Medical Centre, Hospital	0.013 mm/s PPV	0.018 mm/s PPV

Note 1: An exceedance of the operator warning level does not require activities to cease, but will alert the Project Manager and Foreman to proceed with caution at a reduced force or load.

Note 2: Based on information presented in DECCW's Assessing Vibration: a technical guideline.

Note 3: Based on the Generic Vibration Criteria for Vibration-Sensitive Equipment (SPIE 1991).

3. Methodology

The Construction Noise and Vibration Monitoring Program is designed to compare actual performance of construction of the CSSI against predicted performance and to assess the effectiveness of the mitigation measures applied during construction of the Project. The program has been executed in accordance with Section 13 of the CNVMP. The Construction Monitoring Program commenced 1 October 2020 at Construction commencement and will continue for the duration of the project.

3.1 Construction Activities

An indicative schedule of work is provided in Table 3-1. Note demolition work was been completed by the Sydney Metro TSE Contractor. No building demolition or blasting works have been identified as part of the Waterloo ISD project.

Table 3-1: Indicative schedule of construction phases for Waterloo ISD

Works	Description	Time
Station Works	The works for the new underground metro station include: • Detailed excavation and drilling required for sumps, track slab-invert, onsite detention tanks, drainage, services and foundations to support the structural works; • Waterproofing of the station box; • All primary and secondary structural works including for the entire station box, entrances, all services, utilities, systems, fit out elements, concourses, station platforms, over-track exhaust plenums and vertical transport; • Track invert slab including underline crossings, earthing mats and drainage; • Plant and equipment rooms; • Public and staff toilets; • All back of house areas; • Architectural fit-out; • Low-voltage electrical, fire, hydraulics, lighting and mechanical systems; • Building management control system; • Provisions for works by Interface Contractors; • Provisions for advertising and vending machines; • Lifts and escalators; • Signage and wayfinding; • External façade to the MQD Transfer Level including over street awnings; • Landscaping, kerbs and precinct activation works; • Bicycle parking facilities; • Public art (within the Station Lot); • Security measures.	October 2020 – late 2022
Local Area Works	Resurfacing or reconstruction of affected roads, footpaths, cycle ways or other public amenities, and signage, traffic control signals, street lighting, flood mitigation and traffic and transport management.	October 2020 – late 2022

Works	Description	Time
Utility Service Works	Identification, protection, diversion, reconstruction or repair of affected utility services, new utility service connections and other general provisions.	August 2021 – late 2022
Property Works	Protection and adjustments to affected existing buildings and property.	2022
Retail Works	The works for the base build of the retail spaces in Waterloo Station and the station precinct, but excludes the retail spaces in the MQD Lot, including: - Shell of the retail space tenancy units (including storage areas); - Base building services including LV power, cold water supply, chilled water loops (for air conditioning), fire systems, sewage facilities; - Grease traps and ventilation exhausts (where appropriate); - Waste collection facility for the retail areas; - Telephone and data systems; - Glazed shopfront finishes.	2022
MQD Enabling Works	The works to be performed for the areas of the MQD which are located within the footprint of the station box and below the MQD Transfer Level which are required for the integration of the MQD Works with the Station Works and to enable further construction of the MQD Works without disruption to the operating station. The MQD Enabling Works include: - Foundations and structures to support the MQD; and - Egress and any other Building Code of Australia compliance required to support the MQD Works.	Jan 2022 – late 2022

3.2 Sensitive Receivers

The Waterloo ISD Construction Noise and Vibration Impact Statement (CNVIS) assessed the sensitive receivers potentially affected by construction noise. The receiver locations representing noise and vibration are shown in Figure 2 and Figure 3 .

In accordance with CoA E33, ongoing consultation with sensitive receivers is undertaken as the project progresses based on the scenarios identified in the CNVIS. The scenarios are reviewed and refined with the input of construction detail to determine the potential impact and appropriate mitigation. Consultation with potentially affected receivers is undertaken prior to the start of the relevant portion of works. Additional mitigation measures are then tailored based on the consultation feedback.

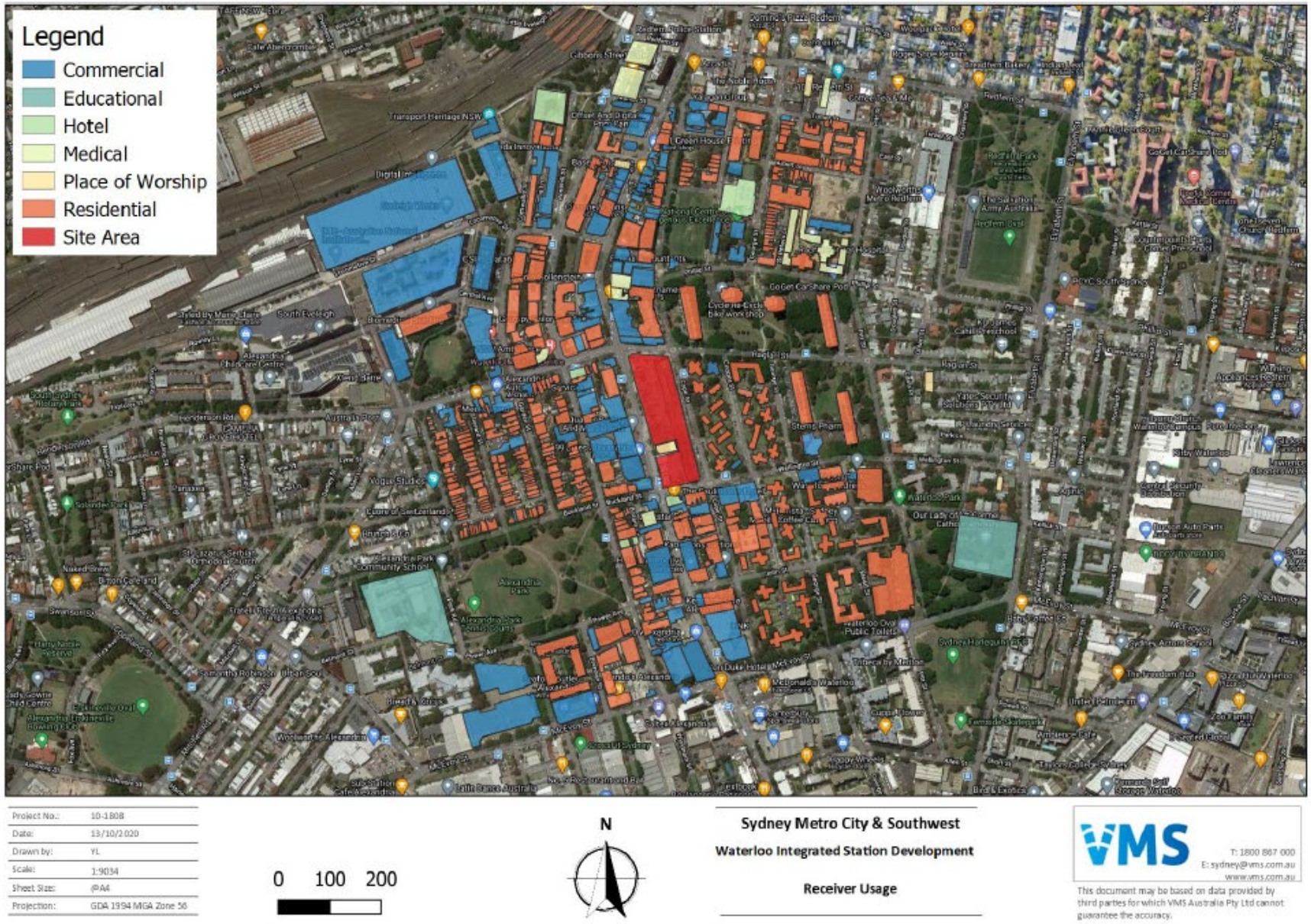

Figure 2 Noise Sensitive Receivers

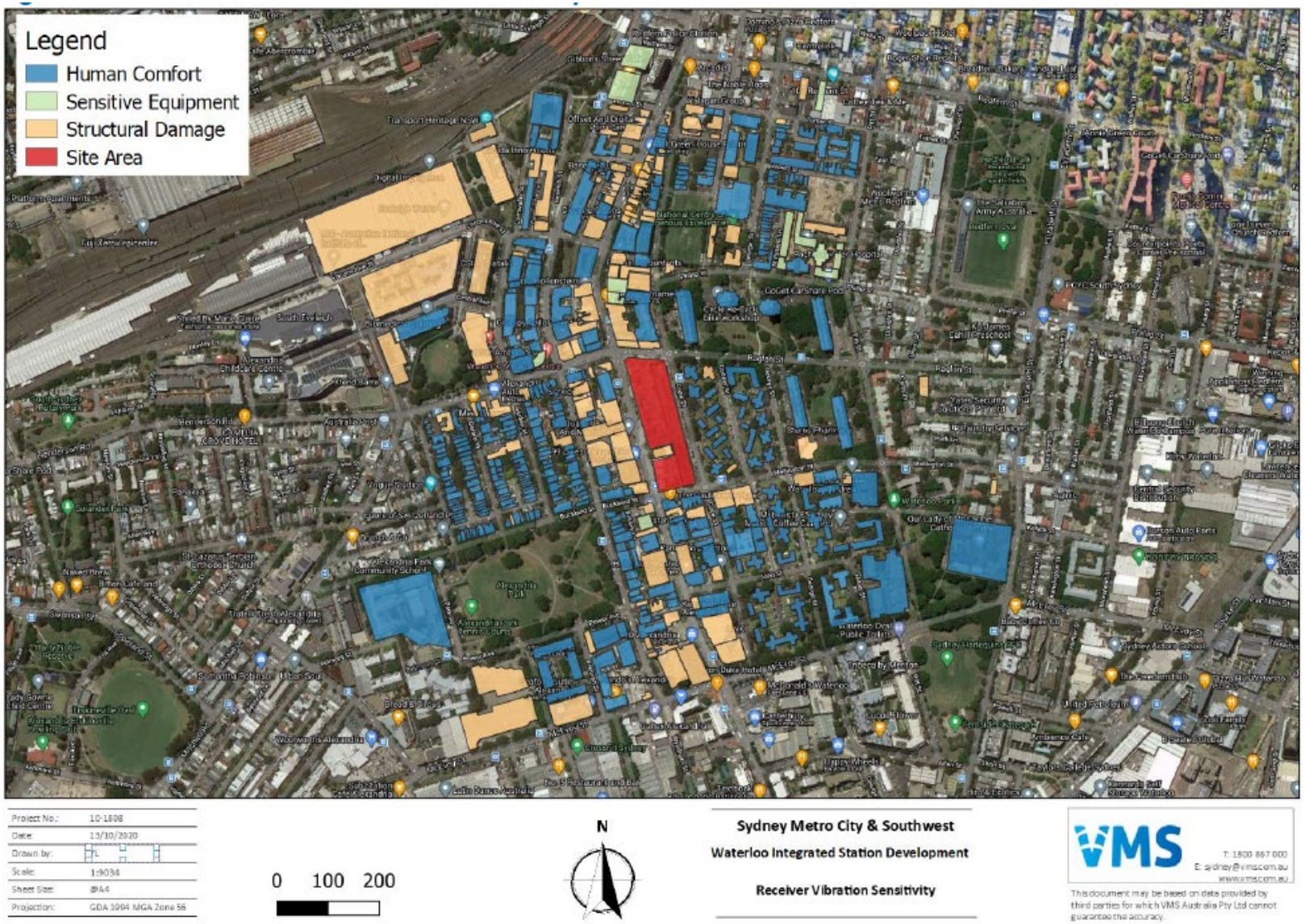

Figure 3 Vibration Sensitive Receivers

3.3 Monitoring

3.3.1 Attended noise monitoring

Noise monitoring has been undertaken by a suitably qualified person in accordance with the CNVMP. Attended measurements were undertaken from the commencement of each stage of construction in order to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS. Attended noise measurements would be repeated to ensure ongoing compliance.

The following key locations were identified in the CNVMP:

- Waterloo Congregational Church (noise and vibration)
- 104 Cope Street (noise)
- 219 Cope Street (noise)

Additional locations were monitored for noise impacts as the activities changed during the reporting period.

3.3.2 Unattended noise monitoring

Real time (unattended) noise or vibration monitoring will be undertaken to satisfy Project Planning Approval Condition C11. Real time monitoring will be deployed to manage impacts from 'high risk' activities, where the CNVIS predictions identify there is a high risk of annoyance from construction. The real-time noise monitors will be installed prior to commencement of the high risk activity. The monitor will be installed by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures. The real-time monitoring data will be available to Waterloo ISD, Sydney Metro, ER, AA, DPIE and EPA via a web based portal.

3.3.3 Noise monitoring parameters

Noise monitoring will be recorded over 15 minute sample intervals. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum noise metrics to be stored in memory and reported are the following A-weighted noise levels: L90, Leq and Lmax.

3.3.4 Vibration monitoring

Vibration monitoring was completed at the Congregational Church which is located adjacent to the construction site. A continuous vibration monitor has been installed inside the church which records vibration. The monitor has been set up to provide an alert via SMS at trigger levels corresponding to "Warning Level" and "Halt Level".

In response to vibration complaints additional monitoring may be undertaken to investigate and assess the extent and source of vibration exceedances and to apply mitigation measures preventing the complaint from reoccurring.

3.3.5 Vibration monitoring parameters

Vibration measurements will be undertaken in accordance with the procedures documented in the *OEH's Assessing Vibration - a technical guideline (2006), AS 2107.2 2006 Explosives – Storage and Use* and *DIN 4150:Part 3-1999 Structural Vibration - Effects of Vibration on Structures.*

Vibration monitoring will be recorded over a minimum 15 minute sample interval. For every sample, the data is to be processed statistically and stored in memory. The minimum vibration metrics to be stored in memory and reported are the following vibration levels: *Vibration Dose Value VDV, RMS, Peak Particle Velocity (PPV) and Frequency (Hz).*

If ongoing/continuous vibration monitoring is required, peak vibration levels are recorded and trigger an audible/visual alarm and/or SMS Alert corresponding to both "Operator Warning Level" and "Operator Halt Level" set according to nominated site vibration criteria levels presented in Table 2-3.

4. Results

The noise and vibration monitoring program includes details of the frequency of monitoring required to manage and control impacts associated with the construction activities. Refer to Section 13 Table 22 of the CNVMP.

Attended noise measurements will be undertaken within a period of 14 days from the commencement of each stage of construction in order to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS. Attended noise measurements would be repeated at a minimum interval of every month in order to ensure ongoing compliance.

The following are representative monitoring locations:

- Waterloo Congregational Church (noise and vibration)
- 104 Cope Street (noise)
- 219 Cope Street (noise)

Note, alternate monitoring locations were selected based on the location of work relative to sensitive receivers, e.g. 122 - 136 Wellington Street, Waterloo.

The results of the monitoring are communicated to relevant personnel when the noise or vibration goal is being approached so that work methodology or equipment being used can be altered, and / or additional management measures may be implemented where reasonable and feasible.

The CNVMP requires real time noise monitoring to be deployed to manage impacts from 'high risk' activities, where the CNVIS predictions identify there is a high risk of annoyance from construction. During the reporting period, 'high risk' activities have not been identified.

4.1 Summary of activities

A summary of activities, including out of hours works, is provided in Table 4-1. The monitoring schedule is detailed in Table 4-2.

Table 4-1 Activities by Month

Month	Activity	Approved out of hours activities
October	- Site establishment, site sheds, stair access - Waterproofing - Shotcrete - Piling, spoil removal - Trimming sandstone wall in station box - Interface activities	- Oversized deliveries
November	- Site establishment - Base slab installation - Waterproofing - Deliveries – steel - Steel fixing, formwork placement	- Oversized deliveries (including unloading) - Concrete finishing works

Month	Activity	Approved out of hours activities
	- Services installation within the site - Interface – concrete ramp removal	
December	- Formwork, reo/steel fixing - Base slab installation - Concrete work (blinding) - Waterproofing - Cranage of materials - Deliveries - Services installation within the site	- Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab
January	- Formwork, reo/steel fixing - Base slab and core wall pours - Wall pours - Waterproofing - Cranage of materials - Deliveries - Services installation within the site	- Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely)
February	- Formwork, reo/steel fixing - Base slab and core wall pours - Wall pours - Waterproofing - Cranage of materials - Tower crane install - Deliveries	- Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely)
March	- Formwork, reo/steel fixing - Stripping of formwork - Wall pours - Cranage of materials - Tower crane install - Deliveries - Utilities on Raglan Street for kiosk - Jump form installation	- Oversized deliveries (including unloading)/Installation of precast beams - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely)
April	- Formwork, reo/steel fixing - Stripping of formwork - Wall pours - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Tower crane install - Deliveries - Utilities on Raglan Street for kiosk - Jump form installation - Waterproofing - Pre-cast platform segment delivery	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area

Month	Activity	Approved out of hours activities
May	- Formwork, reo/steel fixing - Stripping of formwork - Wall pours - B3 floor slab pour - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Utilities on Raglan Street for kiosk - Waterproofing at headwalls - Pre-cast platform, beam and plank deliveries	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area
June	- Formwork, reo/steel fixing above b3 - Stripping of formwork - Wall pours - B3, B4, B5 concrete pour - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast beam and plank deliveries - Over track exhaust (OTE) installation	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area - Utilities to tie into the Kiosk at Raglan Street
July	- Formwork, reo/steel fixing - Stripping of formwork - Wall pours - B3, B4, B5 concrete pour - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast beam and plank deliveries - Over track exhaust (OTE) installation	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area
August	- Formwork, reo/steel fixing above b3 - Stripping of formwork - Wall pours - B3, B4, B5 concrete pour - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast beam and plank deliveries - Over track exhaust (OTE) installation	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area - Utility work (external to the site)
September	- Formwork, reo/steel fixing above b3 - Stripping of formwork - Wall pours - B3, B4, B5 concrete pour	- Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab

Month	Activity	Approved out of hours activities
	- Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast beam and plank deliveries - Over track exhaust (OTE) installation - Block work, fire spray - Structural steel install - Utility works on Cope, Wellington Street	- Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area - Utility work (external to the site) - Internal station work, eg. Fire spray, block work etc

Table 4-2 Noise and Vibration Monitoring Schedule

	Monitoring Frequency		
Aspect	Continuous	Monthly (attended)	Other
Noise	In response to complaint / start of high-risk activity	X	Start of new works or OOHW or in response to a complaint
Vibration	X		If working within minimum working distances or in response to a complaint

4.2 Noise results

4.2.1 Attended noise monitoring

Noise monitoring was conducted to verify construction noise levels with Predicted Noise Level (PNL) outlined in the CNVIS and applicable OOHWA. During the reporting period a total of 60 events were conducted. Of these events, 28 monitored works during standard hours and 32 monitored out of hours works.

The construction noise level (LAeq 15min) was observed to be greater than the PNL for 20 events in total, with 10 of these events occurring out of hours. Generally, where the PNL was less than the actual noise during the monitoring event it was determined to be due to external factors such as traffic noise rather than specific construction activities.

A summary of noise monitoring results for the reporting period is outlined in **Table 4-3**.

4.2.2 Unattended real time noise monitoring

Unattended real time noise monitoring is only required at Waterloo ISD to manage impacts from 'high risk' activities, where the CNVIS predications identify there is a high risk of annoyance from construction.

During the reporting period no high risk activities were identified and therefore no real time noise monitoring was undertaken.

4.2.2 Plant and equipment monitoring

Plant and equipment monitoring is required to be completed in accordance with CNVMP. **Table 4-4** includes monitoring for the 500T crane, saw cutting at B6 and scissor lifts. The monitoring was consistent with the sound pressure levels in the CNVMP. Obtaining the noise data is constrained due to the high number of activities also occurring at the same time in the same location.

Table 4-3: Noise monitoring results

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
October 2020	Standard	S1b - Site Establishment	08/10/2020	2:22:00 PM	Main site Station Box	122 - 136 Wellington St, Waterloo	54	62	**60**	No	-2	-	Construction activities - Ground anchor works, using EWP (inaudible) and hand drill and grinder (audible est. 56 dB) very intermittent (approx 5% of time) Linewide works currently not underway	Traffic along Botany Rd and Wellington St dominant noise source. Trucks reversing with tonal beepers (not related to the project) Rainbow lorikeets going off
October 2020	Standard	S1b - Site Establishment	09/10/2020	2:22:00 PM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	54	62	**61.9**	No	-0.1	-	Station Excavation works - rocker hammer audible (estimated construction noise 58dB). Consistent at 70% of noise monitoring event	Traffic along Botany Road and Wellington St most dominant noise source. Birds on balcony of adjacent resident.
November 2020	Standard	S4 - Basement Slab Construction	25/11/2020	10:32:00 AM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	54	68	**62.5**	No	-5.5	-	Concrete pour of base slab 1 2x concrete pumps 2x concrete trucks delivering Estimated construction noise 58dB (pumps), 62db (concrete truck arriving) Construction noise audible, consistent and background.	Pet parrot chirping on balcony behind monitoring location (annoying peaks up to 70dB) - see attached General traffic on Botany Road Background noise is intermittent (ie, buses passing monitoring location)
November 2020	OOHWA #07	S4 - Basement Slab Construction	25/11/2020	6:03:00 PM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	47	68	**61.4**	No	-6.6	-	Base Slab Finishing works - Helicopter surface finishing works in station box (inaudible) - Concrete pump washout and demob (slightly audible approx. 54dB with traffic being most dominant)	
December 2020	OOHWA #07	S1b - Site Establishment	27/11/2020	2:35:00 AM	Mainsite - Gate B1	72 Botany Road	39	51	**65.2**	Yes	14.2	No	EWP loading onto truck for remobe (EWP non-tonal beeper present) Arrival of low loader (approx 63dB - 1 minute)	General traffic on Botany Road. Large trucks and buses dominant noise source
December 2020	OOHWA #07	S1b - Site Establishment	27/11/2020	3:02:00 AM	Mainsite - Gate B1	72 Botany Road	39	51	**65.3**	Yes	14.3	No	Demobe of EWP on low loader Arrival of low loader (65db - 30 seconds)	General traffic on Botany Road. Large trucks and buses dominant noise source
December 2020	Standard	S4 - Basement Slab Construction	27/11/2020	8:52:00 AM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	54	68	**60.7**	No	-7.3	-	Crane x3 Base Slab Works - Concrete breakback (approx. 52dB) - intermittent - Steel and form work (approx. 59dB) - intermittent	General traffic along Botany Road & Wellington
December 2020	Standard	S4 - Basement Slab Construction	27/11/2020	9:07:00 AM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	54	68	**57**	No	-11	-	Crane x3 Base Slab Works - Concrete breakback (approx. 52dB) - intermittent - Steel and form work (approx. 59dB) - intermittent	General traffic along Botany Road & Wellington
December 2020	OOHWA #08	S4 - Basement Slab Construction	02/12/2020	6:25:00 AM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	39	68	**58.8**	No	-9.2	-	Setup of concrete pump (inaudible) - includes putting out legs and extending pump arm out. Concrete truck to arrive post 7am.	Traffic on Botany Road - most audible noise source Garbage truck max dB
December 2020	OOHWA #08	S4 - Basement Slab Construction	02/12/2020	6:05:00 PM	Mainsite Station Box	122 - 136 Wellington St, Waterloo	47	68	**61.5**	No	-6.5	-	Final concrete aggi arriving and discharging - approx 57dB with traffic) Concrete pump Concrete finishing works (inaudible)	Traffic along Botany Rd and Wellington St dominant noise source.
December 2020	Standard	S4 - Basement Slab Construction	11/12/2020	2:20:00 PM	Station Box	104 Raglan St, Waterloo	54	72	**62.6**	No	-9.4	-	Concrete breakback/greencutting (estimated 57 dB) Alimack (estimated 64 dB)	Dominant noise source general traffic Raglan Street Local Community and frequent bicycle activity
January 2021	Standard	S4 - Basement Slab Construction	14/01/2021	11:25:00 AM	Station Box	122 - 136 Wellington St, Waterloo	54	68	**60.4**	No	-7.6	-	Consistent high pitch rattling noise (62 dB), reverse vehicle beeping noise (57.3 dB), drilling machinery noise (67.2 dB)	Most dominant noise by traffic on Botany Road and Wellington Street, birds chirping and spotted on tree adjacent to the site on Wellington St.
February 2021	OOHWA #10	Activity 4 - Prefab Steel Placement	03/02/2021	6:03:00 PM	Station Box - South	219 Cope St, Waterloo	47	60	**58.1**	No	-1.9	-	Activity 4 - Prefabricated Steel Placement Area - Southern end of the station box Equipment - 350T crane, and elevated working platform (EWP) & hand tools (steel fixing) Work - lifting in wall mats south of church into place and fixing with steel ties. Note - Works inaudible during monitoring period	Botany Road and Wellington Road Traffic most Dominant noise source. Flock of Rainbow lorikeets nearby, constant squeaking.
February 2021	OOHWA #10	Activity 4 - Prefab Steel Placement	06/02/2021	6:30:00 PM	Station Box	219 Cope St, Waterloo	47	60	**58.2**	No	-1.8	-	Activity 4 - Prefab Steel Placement 350t crane installing Titan Tower Crane on the southern end of station box. 230t crane removing alimak on the northern end of station box Both works mostly inaudible as lift timings are spaced out.	General traffic on Wellington, Cope and Botany. Sirens in the background. Birds chirping loudly, dominant noise source

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	**LAeq (15 min) (dBA)**	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
February 2021	OOHWA #10	Activity 3 - Concrete Finishing Works	10/02/2021	6:47:00 PM	Station Box Works - Base slab 9 & South West Wall 2	104 Raglan Street Waterloo	47	60	**59**	**No**	**-1**	-	Activity 3 - Concrete Finishing Works Area - Northern end of the station box Equipment - Helicopter & hand tolls Work - Smoothing the surface of the base slap and application of ConCure Note - Works inaudible Activity 4 - Prefabricated Steel Placement Area - Southern end of the station box Equipment - Tower crane and elevated working platform (EWP) & hand tools (steel fixing) Work - holding steel mats in place (crane) while EWP and hand tools are used to fix the steel in place Note - Works inaudible	Traffic on Raglan Street - consistent and dominant noise source Parrots on Cope St - loud Approx. peak. 62dB
February 2021	Standard	S2b - Service Relocation (Raglan St)	23/02/2021	12:01:00 PM	External Works along Raglan St (Southside)	125-127 Raglan Street Waterloo	54	77	**69.8**	**No**	**-7.2**	-	Concrete cutting on footpath Raglan Street Concrete cutter machine 75 dB Steel metal clunking sound	Dominant Traffic noise on Raglan street Bird chirping along Raglan Street Motorcycle on Raglan Street 80 dB
February 2021	OOHWA #10	Activity 2 - Pump Setup & Concrete Pouring	24/02/2021	6:31:00 PM	Station Box North	104 Raglan Street Waterloo	47	72	**59.8**	**No**	**-12.2**	-	Activity 2 - Concrete Pouring Pouring of basement slab 9/10 2x Concrete Agi, 1x Concrete Pump Noise consistent when discharging at approx 56dB	General traffic on Botany Road & Raglan Street - dominant noise source Highest dB passing parrot screeching 84dB
March 2021	OOHWA #10	S5 - Wall Construction	02/03/2021	6:39:00 AM	Station Box	213 Cope Street, Waterloo	39	68	**67**	**No**	**-1**	-	Concrete Pour underway	Dominant noise white cockatoos: 75 dB - 80 dB Bus on cope street: 70 dB
March 2021	Standard	S5 - Wall Construction	08/03/2021	4:00:00 PM	Station Box	49-57 Botany Road, Waterloo	54	45	**73.8**	**Yes**	**28.8**	No	Activity 5 - Wall Construction Use of cranes, Scaffolding, Reo Install, Steel fixing, Stop ends installs, striping shutters	Dominant Traffic noise on Botany Road 74.6-90.9 dB Exceedance of NML due to local road traffic along Botany Road - dominant noise source
March 2021	Standard	S5 - Wall Construction	09/03/2021	11:42:00 AM	Station Box	74 Botany Road, Waterloo	54	53	**68.1**	**Yes**	**15.1**	No	Activity 5 - Wall Construction, Prefab mats, base frames install, stop ends install, BA anchors, Welding, Steel cutting, scaffolding	Dominant noise from TSS Activity (Excavation) on the corner of cope street near the roundabout 68-70 dB Exceedance of NML due to local road traffic along Botany Road - dominant noise source
March 2021	Standard	S5 - Wall Construction	10/03/2021	2:38:00 PM	Station Box	213-215 Cope Street, Waterloo	54	46	**61.8**	**Yes**	**15.8**	No	Activity 5 - Wall Construction, Reo Install, U bars, Jack hammering, Cranage	Low and moderate traffic on cope street 56-67 dB Nil exceedance of NML, exceedance of PNL due to local road traffic on Cope Street.
March 2021	Standard	S5 - Wall Construction	16/03/2021	3:28:00 PM	Station Box	213 Cope Street, Waterloo	54	46	**60.6**	**Yes**	**14.6**	No	Activity 5 - Wall Construction, Ringing noise 55 dB, Buzzing machinery noise 65 dB	Public resident near the noise monitor 63 dB Nil exceedance of NML, exceedance of PNL due to local road traffic on Cope Street.
March 2021	OOHWA #11	S5 - Wall Construction	17/03/2021	6:37:00 AM	Station Box	74 Botany Road, Waterloo	54	53	**68.6**	**Yes**	**15.6**	No	Activity 5 - Wall Construction (Wall pour)	Dominant noise from cockatoos along the corner of Cope & Wellington Street 77-81 dB Exceedance of NML due to local road traffic along Botany Road - dominant noise source
April 2021	-	-	08/04/2021	2:44:00 AM	Nil Construction - Background reading only	124 Wellington St, Waterloo	39	-	**49.5**	N/A	**-**	-	Nil Construction - Background reading only	General traffic along Botany Road
April 2021	OOHWA #13	Activity 1 - Delivery & Unloading	08/04/2021	4:36:00 AM	Wellington St Unloading Using Southern Tower Crane	126 Wellington Street, Waterloo	39	52	**51.1**	**No**	**-0.9**	-	OOHW Activity 1A - Delivery & Unloading - Unloading of oversized reo cage from Wellington Street via Southern Tower Crane - Rigging up of cage with lifting points, mostly inaudible - Operation of Tower Crane (inaudible) - Demobing of truck - approx. 51 - 52dB	0441hrs - Recorded max dB of 70.8dB is due to user error - knocked the noise monitoring at approx. 0441hrs. General traffic on Botany Road - dominant noise source Drain on Wellington St running with surface water due to heavy rain at 4am.
April 2021	Standard	S5 - Wall Construction	12/04/2021	2:00:00 PM	Station Box	70 Botany Road,	-	-	**68.3**	N/A	-	-	Steel and Concrete Fixing	Dominant noise from traffic on Botany Road 68-71dB, no RBL or PNL available at this location.
April 2021	Standard	S5 - Wall Construction	12/04/2021	2:45:00 PM	Station Box	213 Cope Street, Waterloo	54	46	**62.7**	**Yes**	**16.7**	No	Steel and Concrete Fixing, generator noise	Dominant noise from traffic on Cope Street 59-67dB Nil exceedance of NML, exceedance of PNL due to local road traffic on Cope Street.
April 2021	Standard	S5 - Wall Construction	13/04/2021	1:45:00 PM	Station Box	70 Botany Road,	54	-	**69**	N/A	-	-	Steel Fixing	Dominant noise from traffic pm Botany Road 57-63dB, Speeding Motorcycle 88dB Dominant noise source - local traffic
April 2021	Standard	S5 - Wall Construction	14/04/2021	9:30:00 AM	Station Box	213 Cope Street,	54	46	**57.2**	**Yes**	**11.2**	No	Steel Fixing, Wall Pour, some sort of drilling, beepers, metal clunking	Dominant noise from traffic on Cope Street 53dB

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
April 2021	OOHWA #13	Activity 4 - General Crane Operations	14/04/2021	10:17:00 PM	Station Box 2x Mobile Cranes North and South of Church	70 Botany Road,	39	65	**66**	Yes	1	No	General Crane Operations Lifting of materials into box - inaudible at this local due to large traffic noise	General Traffic on Botany Rd dominant noise source, cars constant at 60-70dB Construction noise inaudible at this location - dominant noise source local traffic along Botany Road.
April 2021	OOHWA #13	Activity 4 - General Crane Operations	14/04/2021	10:39:00 PM	Station Box 2x Mobile Cranes North and South of Church	213 Cope Street,	39	60	**51.6**	No	-8.4	-	General Crane Operations Mobile Crane, used infrequently at 50-52dB Grinding / cutting of steel in station box approx 49dB Non-tonal Beeped within statin box.	General Traffic on Botany Road Several cars passing along Cope Street - loudest noise source at 60dB Bats squawking in tree nearby
April 2021	OOHWA #13	Activity 4 - General Crane Operations	14/04/2021	11:01:00 AM	Station Box 2x Mobile Cranes North and South of Church	126 Wellington Street, Waterloo	39	55	**54.4**	No	-0.6	-	General Crane Operations Infrequent use of mobile crane approx 55dB Grinding at approx 50dB, infrequent Non tonal EWP use approx 49-50dB	General Traffic on Botany Road dominant noise source at approx. 61dB People at pub yelling frequently Some traffic along Wellington Street
April 2021	OOHWA #13	Activity 4 - General Crane Operations	15/04/2021	12:15:00 AM	Station Box 2x Mobile Cranes North and South of Church	70 Botany Road,	39	65	**63.4**	No	-1.6	-	General Crane Operations Lifting of materials into box using mobile crane, slightly audible (when no traffic) at approx 55-57dB Slight hum of WTP during quiet periods at approx 52dB	Traffic along Botany Road, dominant noise source with cars passing at approx 68-74dB frequently. Crickets in nearby bush
April 2021	OOHWA #13	Activity 4 - General Crane Operations	15/04/2021	12:36:00 AM	Station Box 2x Mobile Cranes North and South of Church	213 Cope Street	39	60	**57.1**	No	-2.9	-	General Crane Operations Lowering materials into box using mobile crane, approx 54dB EWP in box using non tonal beeper at approx 49dB - consistent Radio communication between dogman and crane operator (very faint)	General Traffic on Botany Road
April 2021	OOHWA #13	Activity 4 - General Crane Operations	15/04/2021	10:36:00 PM	Station Box 1x Mobile Crane South of Church	70 Botany Road,	39	65	**66.3**	Yes	1.3	No	General Crane Operations 1x mobile crane operating south of church lowering materails (inaudible) EWPs working within station box (inaudible) Dropping of steel approx 60dB (once) Hum of WTP during lows of traffic noise, approx 51dB.	General Traffic on Botany Road dominant noise source at approx. 60 - 75dB, consistent Loud car passing, approx. 91dB Note construction noise inaudible at this monitoring location.
April 2021	OOHWA #13	Activity 4 - General Crane Operations	15/04/2021	11:52:00 PM	Station Box 1x Mobile Crane South of Church	213 Cope Street,	54	60	**50.9**	No	-9.1	-	General Crane Operations Mobile Crane working infrequently, approx 58dB. EWP working, frequently, non-tonal beepers approx 49dB. Moving of formwork, using handtools, infrequently at approx. 52dB.	General Traffic on Botany Road, loud cars passing infrequently Crickets
April 2021	Standard	S5 - Wall Construction	21/04/2021	11:45:00 AM	Station Box	70 Botany Road,	54	-	**69.5**	N/A	-	-	Concrete pump and concrete trucks	
May 2021	OOHWA #13	Activity 1B Activity 4 - General Crane Operations	27/04/2021	8:25:00 PM	Cope St (Unloading) Station Box (Installation)	219 Cope St, Waterloo	47	68	**62.3**	No	-5.7	-	Activity 1B - Unloading of Precast Elements Monitoring approx 15m away from work activity Lifting of platform - 54dB Removing of chains - infrequently at approx 85dB - peaking at 90dB EWPs on Cope St using non tonal beepers - stable at 55dB Hum of tower crane 54dB Activity 4 - General Crane Operations EWP in station box, faint background noise source.	General Traffic on Botany Road noise source - background noise source, consistent
May 2021	OOHWA #13	Activity 1B - Precast Element Delivery & Installation Activity 4 - General Crane Operations	27/04/2021	10:33:00 PM	Wellington St (Unloading) Station Box (Installation)	136 Wellington St, Waterloo	39	52	**62.3**	Yes	**10.3**	No	Activity 1B - Precast Element Delivery EWPs working on surface using non tonal beepers, approx 50dB Lighting of platform, hum of crane 53dB Construction noise low and infrequent Lowering of platform, 55dB Works within site boundary with gate W1 closed.	Traffic along Wellington and Botany Road dominant noise source, Humm of aircon from Pub next door (consistent) Highest dB passing loud car 95dB General traffic long Botany Road & Wellington Street dominant noise source
May 2021	OOHWA #13	Activity 1B - Precast Element Delivery & Installation Activity 4 - General Crane Operations	28/04/2021	1:42:00 AM	Cope St (Unloading) Station Box (Installation)	219 Cope St, Waterloo	39	68	**65**	No	-3	-	Activity 1B Undoing cables and straps - 60dB Winding of crane due by setup of lift - 59dB EWP on surface along Cope St, non tonal beepers, approx 58dB Infrequent clang of cables and lift hooks, typically 70db, max 90dB Alimak used infrequently 54-46dB Rattlegun used to unfasten load, used 4x for less than 1 sec, 88dB - 90dB	Infrequent traffic passing Wellington Street

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	**LAeq (15 min) (dBA)**	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
May 2021	OOHWA #13	Activity 1B - Precast Element Delivery & Installation	28/04/2021	2:45:00 AM	Cope St (Unloading) Station Box (Installation)	219 Cope St, Waterloo	39	65	**55.4**	**No**	**-9.6**	-	Activity 1B Lifting of beam using electric tower crane - 50 - 55db	Infrequent traffic passing Wellington Street
July 2021	OOHWA #15	Activity 1A - Deliveries Activity 2 - Concrete Pour	29/06/2021	9:01:00 PM	Station Box Surface & Deliveries via Gate B1 & B2 off Botany Road	209 Cope St, Waterloo	47	63	**58.8**	**No**	**-4.2**	-	OOHW Activity 1A - Deliveries - Delivery truck onsite, turned off during unloading via electric crane - Intermittent use of non-tonal beepers - Tower Cranes, electric, slight sound when lifting - Occasional sound of steel moving around onsite OOHW Activity 2 - Concrete Pour - Concrete aggies arriving to site via B1 - Concrete Pump at surface of station box, directly opposite monitoring location. Construction activities consistent at 52dB	General Traffic on Botany Road, Traffic along Cope St max dB during monitoring event.
July 2021	OOHWA #15	Activity 1A - Deliveries Activity 2 - Concrete Pour	29/06/2021	9:26:00 PM	Station Box Surface & Deliveries via Gate B1 & B2 off Botany Road	70 Botany Road,	47	68	**68.3**	**Yes**	**0.3**	No	OOHW Activity 1A - Deliveries - Delivery truck arriving to site via B1, park up onsite and turned off during unloading via electric crane - Delivery truck arriving to site via B1, passing 5-10m from monitoring location, max dB during monitoring event. OOHW Activity 2 - Concrete Pour - Concrete aggie leaving site via B2. Construction activities mostly inaudible over local traffic along Botany Road, occasional sound from plant onsite (such as non tonal beepers).	Traffic along Botany Road dominant noise source, wet tyres providing additional noise. Several large trucks passing (not related to the project). Crowd of people yelling intermittently outside neighbouring building PNL was exceeded by 0.3dB, dominant noise source during monitoring event being traffic along Botany Road and the sound of tyres on wet road.
July 2021	OOHWA #16	Activity 1A - Deliveries Activity 2 - Concrete Pour	07/07/2021	8:34:00 PM	Activity 2 - Concrete Pour - South of Church (Area 21 in CNVIS) Activity 4 - General Crane Deliveries - North & South Tower Cranes and within Station Box	213-215 Cope St, Waterloo	47	63	**57**	**No**	**-6**	-	Activity 2 Concrete Pour - Wall pour along the eastern side of the station box. - consistent humming from vibrators 54dB Activity 4 General Crane Operation - occasional grinding of metal - non tonal beepers - electric tower crane use (inaudible)	General traffic along Botany Road Max dB during recording event car passing along Cope St (67.4dB) PNL for Activity 2 (Area 21) = 57dB PNL for Activity 1 = 60dB PNL for monitoring event = 63dB (60dB + 3dB due to cumulative impact of Activity 2. Refer to section 8 of OOHWA #16).
August 2021	OOHWE#06 - below NML works	Jackhammering - B5 Southern Nozzle	04/08/2021	6:00:00 PM	B5 Southern Nozzle	122-136 Wellington St Waterloo	47	50	**61.9**	**Yes**	**11.9**	No	Hand held jackhammer being used adjacent to B5 Southern Nozzle	Traffic along Botany Road, dominant noise source. Works not audible at monitoring location. Works below NML.
August 2021	OOHWE#06 - below NML works	Jackhammering - B5 Southern Nozzle	04/08/2021	10:00:00 PM	B5 Southern Nozzle	122-136 Wellington St Waterloo	39	50	**51.7**	**Yes**	**1.7**	No	Hand held jackhammer being used adjacent to B5 Southern Nozzle	Traffic along Botany Road, dominant noise source. Works not audible at monitoring location. Works below NML.
August 2021	Standard	Concrete Saw	23/08/2021	9:30:00 AM	B5 Southern Nozzle	B5 Southern Nozzle. 7m away from activity	54	93	**73.2**	**No**	**-19.8**	-	Concrete saw monitored at B5 South. Hand tools and squawkers audible in background. No acoustic tent used during monitoring. Saw cutting of block took less than 5 seconds and occurred 3 times during monitoring period. Saw running during entire monitoring period. 15 minute monitoring period taken.	PNL of 93 dB sound power level at 7 meters taken from CNVIS Laeq 15min Noise Verification of Concrete Saw at 7m sound pressure level
August 2021	OOHWA #17	Activity 2 - Concrete Pour	23/08/2021	6:40:00 AM	B3 Eastern Wall	213-215 Cope St, Waterloo	39	72	**59.9**	**No**	**-12.1**	-	Concrete Pump at surface of station box, directly opposite monitoring location.	
August 2021	OOHWA #17	Activity 2 - Concrete Pour	23/08/2021	6:57:00 AM	B3 Eastern Wall	122-136 Wellington St Waterloo	39	72	**64**	**No**	**-8**	-	Concrete Pump at surface of station box, directly opposite monitoring location.	Infrequent traffic passing Wellington Street
September 2021	Standard	Utility Works (S2b CNVIS)	03/09/2021	9:00:00 AM	Raglan St (footpath & roundabout)	104 Cope St/125-131 Raglan St	54	77	**65.2**	**No**	**-11.8**	-		Exceedance due to local traffic. Works consisted of predominantly hand tools. Service investigation works only

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	**LAeq (15 min) (dBA)**	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
September 2021	Standard	S5 - Wall Construction	10/09/2021	11:10:00 AM	Mainsite - Monthly Monitoring	104 Cope Street, Waterloo	54	55	**66.5**	**Yes**	**11.5**	No	Concrete Wall pour	Exceedance due to local traffic.
September 2021	Standard	S5 - Wall Construction	10/09/2021	11:30:00 AM	Mainsite - Monthly Monitoring	219 Cope St, Waterloo	54	49	**58.9**	**Yes**	**9.9**	No	Concrete Wall pour	Exceedance due to local traffic.
September 2021	Standard	S5 - Wall Construction	10/09/2021	11:50:00 AM	Mainsite - Monthly Monitoring	Waterloo Congregational Church	54	58	**70.7**	**Yes**	**12.7**	No	Concrete Wall pour	High amount of traffic along botany road, large trucks 86 dB Exceedance due to local traffic.
October 2021	OOHWA #18	Activity 6 Station Box Works	29/09/2021	9:30:00 PM	B5 Southern Side	122-136 Wellington St Waterloo	47	60	**62.8**	**Yes**	**2.8**	No		Traffic dominant noise source. Loud cars passing on Wellington St Works faintly audible intermittently. Traffic dominant noise source and reason for Lamax
October 2021	OOHWA #18	Activity 6 Station Box Works	29/09/2021	10:00:00 PM	B5 Southern Side	122-136 Wellington St Waterloo	39	60	**56.2**	**No**	**-3.8**	-		Traffic dominant noise source. Loud cars passing on Wellington St Works faintly audible intermittently. Traffic dominant noise source and reason for Lamax

Table 4-4: Plant and equipment monitoring results (as per Section 13.5 of the CNVMP)

Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	Maximum allowable construction plant sound levels - dBA		1-min SPL recorded	Exceedance of SPL at 7m		Construction activities	Comments/ observations during monitoring
						Sound Power Level	Sound Pressure Level (SPL) at 7m					
Standard	Concrete Saw	23/08/2021	10:00:00 AM	B5 Southern Nozzle	B5 Southern Nozzle. 7m away from activity	118	93	70.9	No	-22.1	Concrete saw monitored at B5 South. Hand tools and squawkers audible in background. No acoustic tent used during monitoring. Saw cutting of block took less than 5 seconds. Saw running during entire monitoring period. 1-minute sound pressure measurement taken.	PNL of 93 dB sound pressure level at 7 meters taken from CNVIS Laeq 1min Noise Verification of Concrete Saw at 7m sound pressure level
Standard	Operating 500T Crane	10/09/2021	12:43:00 PM	Mainsite - 500T Crane	7m away from plant	110	85	67.2	No	-17.8	S5 - Wall Construction, crane located on the surface adjacent to the station box	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	Operating 500T Crane	22/09/2021	9:05:00 AM	Mainsite - 500T Crane	7m away from plant	110	85	67.1	No	-17.9	S5 - Wall Construction, crane located on the surface adjacent to the station box	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	Operation of three scissor lifts	24/09/2021	1:43:00 PM	B5 Southern Side	7m away from ceiling/pre gyprock works	102	77	77.9	Yes	0.9	S5 - Wall Construction. Work location on B5 within the station box (~20m below the surface)	1-min sound pressure level measurement taken Sound Pressure Level slightly above predicted and a negligible difference given typical noise measurement tolerances (+/- 2dB)

Vibration results

Continuous vibration monitoring was conducted to verify construction vibration levels were not exceeding the nominated structural damage site vibration control criteria outlined in the CNVIS. During the reporting period vibration monitoring was conducted continuously at the Waterloo Congregational Church using Texcel Geophone (VM), serial number 7361.

No exceedance of the structural criteria was observed during the reporting period, refer to Table 4-5 for a summary of the peak results. In March, one construction activity occurred where concrete removal works were required adjacent to the Church. At the “operator warning” the construction method was altered. At the “halt level” work ceased and concrete broken up using a concrete saw and smaller breaker.

Table 4-5: Continuous vibration monitoring results summary at Waterloo Congregational Church

	Highest recorded vibration (PPV)					Compliance CNVIS				
Monitoring month	Date & time of Event	vSum (mm/s)	X Peak (mm/s)	Y Peak (mm/s)	Z Peak (mm/s)	Operator warning (mm/s)	Operator halt (mm/s)	No. of Events above halt warning	Events above trigger as a result of construction	Comments
October 2020	12/10/2020 11:30	**1.3**	1.3	0.5	0.5	5	7.5	0	N/A	
November 2020	28/10/2020 12:00	**1.8**	1.7	0.9	0.8	5	7.5	0	N/A	
December 2020	13/12/2020 17:00	**3.7**	3.6	0.5	0.9	5	7.5	0	**N/A**	
January 2021	12/01/2021 9:00	**1.7**	1.7	0.4	0.4	5	7.5	0	N/A	
February 2021	21/02/2021 17:30	**1**	0.8	0.9	0.2	5	7.5	0	N/A	
March 2021	08/03/2021 14:24:00 AM	**7.59**	7.24	1.68	2.98	5	7.5	1	**Yes**	Concrete removal works adjacent to Church. At the “operator warning” construction method altered. At the “halt level” work ceased and concrete broken up using concrete saw and smaller breaker. Although the activity triggered the halt warning level, the peak component particle velocity for x, y and z directions was below the applicable BS7385 criteria as per Table 13 of the CNVMP.
April 2021	11/04/2021 16:45:00 AM	**3.6**	3.1	2.3	0.6	5	7.5	0	N/A	Nil works onsite at time of peak (Sunday afternoon)
May 2021	13/05/2021 13:00:00 PM	**3.4**	2.8	2.1	0.5	5	7.5	0	N/A	Highest peak occurred for less than 1second
June 2021	27/05/2021 16:46:00 PM	**1.66**	1.6	0.48	0.6	5	7.5	0	N/A	
July 2021	15/07/2021 16:26:00 PM	**1.49**	1.38	0.34	0.87	5	7.5	0	N/A	
August 2021	11/08/2021 18:14:00 PM	**1.76**	1.74	0.45	0.33	5	7.5	0	N/A	
September 2021	11/09/2021 18:56	**3.37**	3.3	0.7	0.8	5	7.5	0	N/A	

5. Complaints

During the reporting period, a total of 49 complaints were received from the community. A breakdown of the complaints are provided in Table 5-1.

- 27 complaints related to noise and vibration.
- 14 complaints relating to noise and vibration during standard hours
- 13 complaints related to noise and vibration during out of hours work

All complaints were managed and reported to Sydney Metro as required by the Community Communication Strategy.

Each month a project update which outlines the upcoming construction works was distributed to residents and businesses in the local area. Regular doorknocks and briefings were provided by the Waterloo Community Team to inform the stakeholders of proposed works and likely impacts. Prior to the scheduled out of hours work in May 2021 that would occur over multiple nights, the directly impacted community were provided with an offer for moulded ear plugs. A total of ten receivers accepted the offer relating to this. The four out of hours complaints received in May 2021 could be contributed to the higher number of oversized deliveries (pre-cast beams) that commenced in May. The respite offer of ear moulds may have assisted in managing the number of complaints received related to this activity.

Table 5-1 Complaints breakdown

Month	Noise	Vibration	Monthly Total
October 2020	– 1*	– 0	– **1**
November 2020	– 1*	– 0	– **1**
December 2020	– 0	– 2#	– **2**
January 2021	– 1#; 2*	– 0	– **3**
February 2021	– 3#	– 0	– **3**
March 2021	– 0	– 0	– **0**
April 2021	– 2#	– 0	– **2**
May 2021	– 4*; 3#	– 0	– **7**
June 2021	– 3*	– 0	– **3**
July 2021	– 2*	– 0	– **2**
August 2021	– 0	– 0	– **0**
September 2021	– 3#	– 0	– **3**
Total	– **25**	– **2**	– **27**

* refers to OOHW complaint, # refers to standard hours

6. Conclusion

The requirements for the noise and vibration monitoring program are outlined in the CNVMP Section 13. The program identified criteria, methodology and monitoring parameters. The program was endorsed by the Acoustic Advisor and approved in accordance with the Project Planning Condition C13.

A CNVIS has been prepared for the project and outlines the predicted noise and vibration impacts as a result of construction. Attended noise monitoring has been completed in accordance with the noise monitoring program to review actual noise levels with predicted noise. This data is used to determine if the noise management measures implemented are effective at minimising the impacts of construction on the surrounding community. The attended monitoring determined the exceedance of the PNL was as a result of external factors such as traffic on the surrounding streets rather than related to construction activities.

Plant and equipment monitoring was completed during the reporting period, refer to Table 4-4 for details. Future monitoring events to review noise levels of plant and equipment will be completed over a longer duration than 1 minute to capture fluctuations in noise levels, e.g.. crane operation under load and while idling.

A continuous vibration monitor has been installed in the Waterloo Congregational Church to measure any vibration impacts and to confirm compliance with the CNVIS. During the reporting period, one event triggered a “halt” alarm which resulted in work ceasing and an alternative method used to complete the task adjacent to the church. The activity being completed was the removal of temporary works (e.g. concrete) that had been placed adjacent to the church. Although the activity triggered the halt warning level, the peak component particle velocity for x, y and z directions was below the applicable BS7385 criteria as per Table 13 of the CNVMP.

During the reporting period a total of 27 complaints were received. To manage the noise impacts during out of hours work, a respite offer for moulded ear plugs was commenced in May 2021. This offer assisted in reducing the noise impact on receivers and contributed to managing the number of complaints received.

Appendix A – Calibration Certificate

Acoustic Research Labs Pty Ltd
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2013
Calibration Certificate

Calibration Number C20372

Client Details	John Holland Pty Ltd Level 3, 65 Pirrama Road Pyrmont NSW 2009
Equipment Tested/ Model Number :	Rion NL-42EX
Instrument Serial Number :	00409019
Microphone Serial Number :	185664
Pre-amplifier Serial Number :	90464

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	20.8°C	**Ambient Temperature :**	23.8°C
Relative Humidity :	45.3%	**Relative Humidity :**	42%
Barometric Pressure :	101.97kPa	**Barometric Pressure :**	101.85kPa

Calibration Technician : Jeff Yu
Calibration Date : 7 Jul 2020
Secondary Check: Max Moore
Report Issue Date : 8 Jul 2020

Approved Signatory : Juan Aguero

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	*Pass*	17: Level linearity incl. the level range control	*Pass*
13: Electrical Sig. tests of frequency weightings	*Pass*	18: Toneburst response	*Pass*
14: Frequency and time weightings at 1 kHz	*Pass*	19: C Weighted Peak Sound Level	*Pass*
15: Long Term Stability	*Pass*	20: Overload Indication	*Pass*
16: Level linearity on the reference level range	*Pass*	21: High Level Stability	*Pass*

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
125Hz	*±0.13dB*	*Temperature*	*±0.2°C*
1kHz	*±0.13dB*	*Relative Humidity*	*±2.4%*
8kHz	*±0.14dB*	*Barometric Pressure*	*±0.015kPa*
Electrical Tests	*±0.10dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

RION CO., LTD.

3-20-41 Higashimotomachi Kokubunji Tokyo 185-8533
Phone:042(359)7888, Facsimile:042(359)7442

Certificate of Calibration

Name : **Sound Level Meter, Class 2**

Model : **NL-42** **S/No.** : **00409019**

Date of Calibration : **May, 20, 2020**

We hereby certify that the above product was tested and calibrated according to the prescribed Rion procedures, and that it fulfills specification requirements.
The measuring equipment and reference devices used for testing and calibrating this unit are managed under the Rion traceability system and are traceable according to official Japanese standards and official standards of countries belonging to the International Committee of Weights and Measures.

RION CO., LTD.

K. Ikeda

Manager, Quality Control Department

RION Supplied Accessories

Model	NL-42	Product Name	Sound Level Meter, Class 2

Ensure all the items below are in the package.
If there is a missing part, please contact your supplier.

Type	Description	Quantity	Note
NL-42	Main unit	1	
NL-42-025	Storage case	1	
WS-10	Windscreen	1	
NL-42-033	Windscreen fall prevention rubber	1	attached to the main unit
VM-63-017	Hand strap	1	
LR6	Size AA alkaline batteries	4	
	CD-ROM (Instruction manual, Serial interface manual, Technical notes, Program option manual)	1	
	Description for IEC 61672-1	1	
	SD memory card (512 MByte)	1	only when NX-42EX is pre-installed
	Inspection certificate	1	This sheet
	Document for China RoHS	1	only to China

Inspection Certificate

INSPECTOR

We hereby certify that this product has been tested and calibrated at our factory according to RION specifications and that the product satisfies all relevant requirements.

RION CO., LTD.
3-20-41 Higashimotomachi, Kokubunji,
Tokyo 185-8533,
Japan

Sound and Vibration Measuring Instrument Section Product information and software downloads can be found on our web-site:
https://rion-sv.com/
Please check it out.

№C11030302

TEXCEL
Innovative Vibration Management Solutions

1/180 Northgate Rd
Northgate, Queensland 4013
+61 7 3237 8111
ABN: 17 010 698 316

ETM CALIBRATION CERTIFICATE #736120210419

DATE: **19/04/2021**
SERIAL NUMBER: **7361**

SERVICE NOTES:

As part of this Calibration service, the monitor, sensors and accessories were tested, and found to be functioning correctly.

CERTIFIED QUANTITIES:

Monitor electronics passed all calibration tests to within **± 2·0%**.

Sensor	Sensitivity	Frequency	Tolerance
Geophone	**27 mV/mm/s**	63 Hz	± 1.2 mV/mm/s

GENERAL:

(1) Instrument calibration measurements were performed with a Calibrated Multimeter.

(2) Sensor calibration measurements were performed with a National Instruments 333 kS/s Multifunction I/O card Model PCI6052E.

(3) Geophone sensitivity was determined by comparing the output from the geophones under test with that of a reference accelerometer.

(4) Microphone sensitivity was determined by comparing the output from the microphone under test with that of a reference microphone.

CALIBRATION INSTRUMENTS USED:

	Type	Serial	Calibrated
(1) Multimeter	Tonghui TH1941	71104376	July 2020
(2) NI Multifunction I/O	PCI6052E	10A17EE	December 2019
(3) Vibration Reference Horizontal	PCB 333B50	30588	June 2020
(4) Vibration Reference Vertical	PCB 333B50	40756	June 2020

All instrument calibrations NATA Certified or traceable to the Australian Government National Measurement Institute.

Tests Performed by: _____ Date: 19/04/2021
(Calibration Station)

Warranty on Calibration Services

Warranty

Our services come with guarantees that cannot be excluded under the Australian Consumer Law. You are entitled to a replacement or refund for a major failure and for compensation for any other reasonably foreseeable loss or damage. You are entitled to have the services provided again (without charge) if they are not of an acceptable quality and the failure does not amount to a major failure.

The benefits provided to the Customer by this Warranty are in addition to the other rights and remedies of the Customer under the Australian Consumer Law.

Exclusions

Any warranty that Texcel Pty Ltd is required to provide at law for its calibration services does not cover damage or defect resulting from:

- Abnormal Use by the customer including damage to the monitor, microphones, geophones, modem or any other external accessory resulting from Abnormal Use;
- unauthorised modifications, repairs or servicing of the Goods;
- internal corrosion due to condensation or water ingress into the Goods;
- the failure of any component of the monitor that was not replaced or serviced during the Calibration Service and is no longer covered under the original purchase warranty ; and
- the failure of any accessory product, such as the modem or microphone, that was not manufactured by Texcel.

Please note:

1. **Warning:** User-generated data which has been saved to this monitor may be lost as a result of the work performed during the calibration service or any other repair or maintenance. Customers are encouraged to save their data before the work is performed. Texcel will not be responsible for any data that is lost as a result of the works.
2. **Abnormal Use** includes use of the Goods in a manner for which they were not designed or a failure by the owner to ensure that the Goods are appropriately serviced, maintained and cared for.
3. **Goods** mean the Texcel monitoring system and attachments.

TEXCEL

Innovative Vibration Management Solutions

1/180 Northgate Rd
Northgate, Queensland 4013
+61 7 3237 8111
ABN: 17 010 698 316

To: Holly Hofland **Technician:** Calibration Station

Sydney Metro City and Southwest **Ref:** 10214

Date: 19/04/2021

Service Report 7361

Item	Description
1.	Calibrated monitor and sensors
2.	Replaced coin cell
Recommendations	1. Do NOT Leave the Monitor on charge all the time 2. Top-up charge the night before monitoring and/or every 3 months 3. Check configuration prior to monitoring