

Mr Stuart Hodgson
Principal Manager,
Program Sustainability Environment & Planning
Sydney Metro
Transport for NSW
PO Box 588
NORTH RYDE BC NSW 1670

23 August 2017

Ref: CNVIS-Waterloo

Dear Stuart

**RE: Endorsement of Construction Noise and Vibration Impact Statement –
Waterloo Site, Sydney Metro City & Southwest**

Thank you for providing the following documents for Environmental Representative (ER) review and endorsement as required by the Condition of Approval E82 of the Sydney Metro City & Southwest project (SSI – 15_7400 January 9 2017).

- Construction Noise and Vibration Impact Statement (CNVIS) – Waterloo Site, (Revision E dated 20 August 2017).
- Acoustic Advisor (AA) Endorsement (of the above document) dated 21 August 2017

As an approved ER for the Sydney Metro City & Southwest project, I have reviewed the above document for its suitability for implementation. The review did not comprise a technical review, as the ER has relied upon the AA's review of technical aspects of the document. On the basis of the endorsement of the document by the AA, the ER endorses the document subject to the conditions of the AA endorsement being complied with.

Yours sincerely



Michael Woolley
Environmental Representative – Sydney Metro – City and South West

**ENDORSEMENT
CITY & SOUTHWEST ACOUSTIC ADVISOR**

Review of	CNVIS for Delta demolition works at Waterloo	Document reference:	Construction Noise & Vibration Impact Statement WATERLOO
Prepared by:	Dave Anderson		prepared by Osterman Consulting for Delta Pty Ltd
Date of issue:	21 August 2017		Report number 0116-041-06, Rev E, dated 20/8/17

As approved Acoustic Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the Construction Noise and Vibration Impact Statement for the Delta demolition works at Waterloo, as required under A27 (d) of the project approval conditions.

I have met with Osterman Consulting to discuss earlier drafts of the impact statement and to discuss my formal comments. The impact statement has been revised to address my comments and I endorse Revision E of the statement.



Dave Anderson, interim City & Southwest Acoustic Advisor



Construction Noise & Vibration Impact Statement

WATERLOO

Sydney Metro

Prepared for: Delta Group

20 August 2017

Report number: 0116-041-06

Prepared by: Mark Della Sabina & Rauf Osterman



1.	INTRODUCTION	4
1.1	CONTEXT	4
1.2	SITE OVERVIEW	4
1.3	SITE LAYOUT AND ACCESS	5
2.	APPLICABLE CRITERIA	6
2.1	AIRBORNE NOISE MANAGEMENT LEVELS	6
2.2	GROUND-BORNE NOISE MANAGEMENT LEVELS	8
2.3	CONSTRUCTION VIBRATION	9
2.3.1	WARNING LEVELS	10
3.	NOISE AND VIBRATION ASSESSMENT	11
3.1	SENSITIVE RECEIVERS	11
3.2	CONSTRUCTION ACTIVITIES AND SOURCES OF NOISE	11
3.3	AIRBORNE NOISE PREDICTIONS	12
3.4	GROUND-BORNE NOISE	14
3.5	VIBRATION PREDICTIONS	15
4.	NOISE AND VIBRATION MANAGEMENT	17
4.1	ENVIRONMENTAL MONITORING	17
4.1.1	HERITAGE-LISTED STRUCTURES	17
4.2	MITIGATION MEASURES	17
4.2.1	STANDARD MEASURES	17
4.2.2	ADDITIONAL MEASURES	19
5.	CONCLUSION	20
	APPENDICES	21
	APPENDIX A - LIST OF SENSITIVE RECEIVERS	21
	APPENDIX B - MONITORING LOCATIONS AND SENSITIVE RECEIVERS	24
	APPENDIX C - STRUCTURAL ENGINEER'S ASSESSMENT OF WATERLOO CONGREGATIONAL CHURCH	25
	APPENDIX D - HERITAGE SPECIALIST ADVICE ON MONITORING METHODS AND LOCATIONS	26

Report Revision History				
Rev no.	Date	Description	Prepared by	Reviewed by
A	26/01/2017	Initial Draft	Mark Della Sabina	Rauf Osterman
B	21/02/2017	General update and revision following review by Delta and Project AA	Mark Della Sabina	Rauf Osterman
C	09/08/2017	Updated to incorporate comments from Project AA dated 21/03/2017	Mark Della Sabina	Rauf Osterman
D	15/08/2017	Updated to incorporate comments from Alternate Project ER dated 14/08/2017	Mark Della Sabina	Rauf Osterman
E	20/08/2017	Updated to incorporate comments from Project ER dated 16/08/2017	Mark Della Sabina	Rauf Osterman

This document is and will remain the property of Osterman Consulting. No portion of this document, in part or whole, shall be duplicated, imitated or otherwise, in any form without prior written permission of Osterman Consulting. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of Engagement for the commission. This document is subject to copyright laws and is the intellectual property of Osterman Consulting.

1. Introduction

1.1 Context

This Construction Noise and Vibration Impact Statement (CNVIS) has been developed for Delta Pty Ltd (Delta) to assess the noise and vibration impacts associated with demolition and retention works at the Waterloo site (the site) on the Sydney Metro City & Southwest Project (the project). This CNVIS exists as a sub-plan to the Construction Noise and Vibration Management Plan 0116-041-01 (CNVMP) for the project.

The principal issues addressed within this CNVIS include:

- Identification of noise sensitive receivers near to the site;
- Prediction of the level of noise and vibration impact on these sensitive receivers from construction activities including assessment of predicted compliance with project-imposed Noise and Vibration Management Levels;
- Details of the plant and equipment to be used on site including details of sound mitigation measures to be employed to reduce noise impacts on adjacent noise sensitive receivers.

1.2 Site Overview

The Waterloo site is located between Botany Road and Cope Street, Raglan Street and Wellington Street. Works on the site involve demolition of a number of low-rise commercial, industrial and residential buildings. The Waterloo Congregational Church on 103 Botany Road is not part of the demolition package and will be conducting service on Sundays.



Figure 1: Waterloo Site Overview

1.3 Site Layout and Access

Site layout and access is illustrated in Figure 2.



Figure 2: Waterloo Site Layout and Access

2. Applicable Criteria

2.1 Airborne Noise Management Levels

Noise Management Level's (NML's) on this site are assessed under the broader requirements of the approval conditions which are consistent with the EIS and CNVS and based on the Interim Construction Noise Guideline (ICNG). The NML's applicable to Delta's scope of works are outlined in Table 1.

Table 1. ICNG Noise Criteria		
Time of Day	Management Level $L_{Aeq(15\ min)}^*$	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays / Public Holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ol style="list-style-type: none"> times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	<ul style="list-style-type: none"> A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 (of the Interim Construction Noise Guidelines).

*Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

For the purpose of establishing construction Noise Management Levels in accordance with Table 1, RBL's have been based on noise monitoring conducted by Osterman Consulting during August 2017.

Unattended noise monitors were placed at three sensitive receiver locations around the Site for a minimum period of one week. These locations are shown on the respective site plans in Appendix B. The results of the unattended noise survey are summarised in Table 2.

Table 2. Rating Background Levels				
Location	Monday to Friday (7am - 6pm)		Saturday (8am - 1pm)	
	RBL	NML L_{Aeq} (15 min)	RBL	NML L_{Aeq} (15 min)
45 Botany Rd	62	72	62	72
123 Botany Rd	60	70	59	69
100 Botany Rd	63	70 ¹	62	70 ¹

¹Noise Management Levels at this location are independent of RBL and are set at 70dB(A) for commercial premises

Other Sensitive Land Uses

The project specific L_{Aeq(15minute)} NMLs for other non-residential noise sensitive receivers from the ICNG are provided in Table 3.

Table 3. ICNG Noise Criteria for 'Other' Sensitive Receivers	
Land Use	Management Level L_{Aeq} (15 min) (Applied when the land is in use)
Classrooms at schools and other education institutions	Internal noise level of 45dB(A)
Hospital wards and operating theatres	Internal noise level of 45dB(A)
Places of worship	Internal noise level of 45dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level of 65dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. reading, meditation)	External noise level of 60dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in Australian Standard 2107 – Acoustics – Recommended design sound levels and reverberation times for building interiors for specific uses.

Other noise-sensitive businesses require separate project specific noise goals. The Interim Construction Noise Guideline recommends that the internal construction noise levels at these premises are determined based on the 'maximum' internal levels presented in AS 2107. These recommended 'maximum' internal noise levels are provided in Table 4.

Table 4. AS2107 Noise Criteria for 'Other' Sensitive Receivers			
Description	Time Period	AS2107 Classification	Recommended 'Maximum' Internal LAeq (15 min)
Hotel	Daytime and evening	Bars and lounges	50
	Night-time	Sleeping areas (hotels near major roads)	40
Cafe	When in use	Coffee bar	50
Bar/Restaurant	When in use	Bars and lounges / Restaurant	50
Library	When in use	Reading areas	45
Recording studio	When in use	Music recording studios	25
Theatre / Auditorium	When in use	Drama theatres	30

Commercial and industrial premises

NMLs for commercial and industrial premises have been set based on the Interim Construction Noise Guidelines. For commercial premises, including offices, retail outlets and small commercial premises an external NML of LA_{eq(15 minute)} 70 dBA has been adopted. An external NML of LA_{eq(15 minute)} 75 dBA has been adopted for industrial premises. For both land use types, the external noise levels should be assessed at the most affected occupied point on the premises.

Notwithstanding the above, at no time can noise generated by construction exceed the National Standard for exposure to noise in the occupational environment of an eight-hour equivalent continuous A-weighted sound pressure level of LA_{eq,(8h)}, of 85dB(A) for any employee working at a location near the CSSI.

2.2 Ground-borne Noise Management Levels

Ground-borne Noise Management Levels for residential receivers are provided in Table 5.

Table 5. ICNG NML's for Ground-borne Noise

Land Use	Noise Management Level L_{Aeq} (15 min)
Daytime 7am - 6pm	Internal noise level of 45dB(A)
Evening 6pm - 10pm	Internal noise level of 40dB(A)
Night-time 10pm - 7am	Internal noise level of 35dB(A)

2.3 Construction Vibration

Condition E28 of the Conditions of Approval for the project stipulate that vibration from construction activities shall not exceed 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.

British Standard 7385: Part 2 1993 suggests levels of vibration at which 'cosmetic', 'minor' and 'major' damage may occur. This standard is based on data collated from a wide range of national and international sources which collectively saw relatively few cases of damage caused by vibration. BS7385 suggests that vibration levels up to the cosmetic damage level are considered 'safe' and have produced no observable damage for particular building types.

For the purposes of this standard, damage includes minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

BS7385 is based on peak particle velocity and specifies damage criteria for transient vibration within the range of frequencies usually encountered in buildings, being 4Hz to 250Hz. This criteria is reproduced in Table 6.

Table 6. BS7385: Part 2 Structural Damage Criteria

Group	Type of Structure	Damage Level	Peak component particle velocity, mm/s		
			4 Hz - 15 Hz	15 Hz - 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50 (all frequencies)		
		Minor	100 (all frequencies)		
		Major	200 (all frequencies)		
2	Unreinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor	30 to 40	40 to 100	100
		Major	60 to 80	80 to 200	200

Where dynamic loading caused by continuous vibration may result in magnification of vibration through a building structure the guideline values may need to be reduced by up to 50 per cent. Rock breaking, rock hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences).

For construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, and consistent with the guidance from BS 7385, the following conservative vibration damage screening level per receiver type have been adopted for the project:

- Reinforced or framed structures: **25.0 mm/s**
- Unreinforced or light framed structures: **7.5 mm/s**
- Heritage structures: **7.5mm/s**

Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.

With regards to the heritage-listed Waterloo Congregational Church, an assessment of the condition of the structure has been undertaken by a structural engineer and is provided in Appendix C. The assessment identified that the church is in sound structural condition and therefore the vibration criterion for heritage structures is suitable.

2.3.1 Warning Levels

The INFRA Monitoring System used on this project features a number of real time alerts and alarms that enable instant notification where limits are approached or exceeded. Where vibration-intensive works are planned to occur in close proximity to sensitive receivers, and works are expected to approach the limits for cosmetic damage, monitoring equipment shall be equipped with visual and/or audible alarms that are triggered when the levels of vibration exceed the control criteria presented in Table 7.

Table 7. Operator Warning and Halt Levels

Structure	Site Control Criteria (PPV in any Orthogonal Direction)	
	Operator Warning Level	Operator Halt Level
Reinforced or framed structures	20 mm/s	25 mm/s
Unreinforced or light framed structures	5 mm/s	7.5 mm/s
Heritage structures	5 mm/s	7.5 mm/s

3. Noise and Vibration Assessment

3.1 Sensitive Receivers

A full list of sensitive receivers surrounding the site are listed in Appendix A. A subjective classification of the noise & vibration impact has been evaluated for each sensitive receiver and documented as:

- Low Impact
- Moderate Impact
- High Impact

The classifications were determined on a case-by-case basis using the metrics defined in the CNVS, including:

- The location of the works in relation to the NSR's with consideration of the noise attenuation features such as distance to NSR's, noise barriers, attenuation factor of NSR's windows and elements, Topographical features etc.
- The type and sensitivity of the NSR's:
 - Lower impact: e.g. commercial buildings/scattered residential (low density)
 - Moderate impact: eg standard residential (typical density)
 - High impact: e.g residential home for elderly/high density unit blocks/persistent complainers/residents deemed to have "construction noise fatigue", highly sensitive commercial (jewellers, etc.) or health applications e.g. operating theatres, MRI's, Psychotherapy units, Audio & video production studios etc. and schools/childcare centres.
- Predicted noise and vibration levels and extent of noise exceedance above Noise Management Level
- The type of and intensity of noise emitted from works (ie tonal or impulsive):
 - Lower Impact: No high noise and/or vibration intensive activities
 - Moderate Impact: Short/intermittent high noise and/or vibration intensive activities
 - High Impact: Prolonged high noise and/or vibration intensive activities.
- The duration of any OOHW required.

Site plans illustrating the location of, and degree of impact to, sensitive receivers can be found in Appendix B.

3.2 Construction Activities and Sources of Noise

The degree of noise impact on adjacent sensitive receivers from demolition activities is highly dependent on the type and size of machinery used. In consultation with Delta Group, a list of the activities to be undertaken and the associated machinery is provided in Table 8.

Table 8. Construction Activities and Equipment Noise

Equipment	Number	Construction Activity	Assumed Sound Power* Level dB(A)
5T Excavators	2	Strip Out	89
20T Excavator w/pulveriser	2	Structural Demolition	104
47T Excavators w/hammer	3	Low Level Structural Demolition	119
Mustang Bobcats	2	Strip out	110
Powered Hand Tools		Strip Out	100
Trucks	3	Haulage	105

* Sound power levels provided in the table above should be verified against specifications of actual equipment used onsite.

3.3 Airborne Noise Predictions

Due to the significant number of sensitive receivers across the project, and for the purposes of reducing the required number of monitors, sensitive receivers with like characteristics have been grouped into ‘noise catchment areas’ (NCAs) that can be represented by a single monitor. For the purpose of simplicity, NCA’s have been defined according to their general direction relative to the site.

Using the sound power levels stated in Section 3.2, predicted noise levels have been calculated for each NCA based on the distance between noise-emitting activities and the closest sensitive receivers for that location. These predictions assume that equipment is operating at the nearest point of works to the sensitive receiver and therefore represent worst-case scenarios. The predictions do not take into account any mitigation measures. Due to the staging of construction works and the expected spread of equipment across the full area of the site, cumulative noise impacts are expected to be minimal. Predicted noise levels are provided in Table 9 and are highlighted according to the following:

Exceeds Noise Affected Management Level

Exceeds Highly Noise Affected Management Level

Table 9. Predicted External Noise Levels				
Equipment	Noise Prediction $L_{eq}(15 \text{ minute})$			
	North - Opp. Raglan St	East - Opp. Cope St	South - Opp. Wellington St	West - Botany Rd
5T Excavators	56	53	55	53
20T Excavator w/pulveriser	71	68	70	68
47T Excavators w/hammer	86	83	85	83
Mustang Bobcats	77	74	76	74
Powered Hand Tools	67	64	66	64
Trucks	72	69	71	69

A heritage listed church is located at 103 Botany Rd and is surrounded on three sides by the demolition site. Noise criteria for this sensitive receiver is based on internal noise levels therefore it is necessary to make an assessment of the degree of noise reduction between the outdoor and indoor environment. This assessment is made according to noise reduction values listed in Table 10.

Table 10. Typical Noise Reduction Values	
Building Environment	Noise Reduction
Most building types - with windows open	10dB
Most building types - with windows closed	20dB
Commercial buildings - non-opening double-glazed windows, etc.	30dB

Based on these reduction values, predicted internal noise levels are provided in Table 11 and are highlighted according to the following:

Exceeds Internal NML for Places of Worship

N.B. Predicted noise levels are provided for reference only. The Waterloo Congregational Church is only utilised and therefore noise sensitive on Sundays, outside project working hours when no equipment will be operational.

Table 11. Predicted Internal Noise Levels	
Equipment	Noise Prediction $L_{eq}(15 \text{ minute})$ (20dB Noise Reduction)
	103 Botany Rd - Heritage Listed Church
5T Excavators	49
20T Excavator w/pulveriser	64
47T Excavators w/hammer	79
Mustang Bobcats	70
Powered Hand Tools	60
Trucks	65

3.4 Ground-borne Noise

As demolition and retention works do not involve ground excavation, ground-borne noise is expected to be an issue only where sensitive receivers are directly coupled to the works (structure-borne noise). On the Waterloo site, this applies to the heritage listed church at 103 Botany Road where the rear wall abuts the adjacent structure to be demolished.

This properties is expected to experience exceedance of internal Noise Management Levels of 10dBA to 20dBA where works occur directly adjacent to these premises.

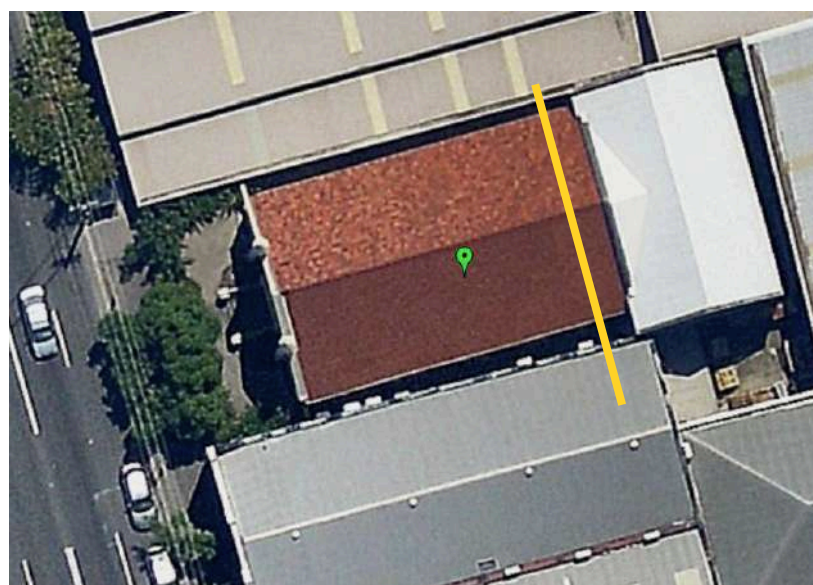


Figure 3: Waterloo Congregational Church

3.5 Vibration Predictions

Vibration at the nearest sensitive receivers (adjacent to the building foundation) has been estimated using the formula from the FTA's Guideline "Transit Noise and Vibration Impact Assessment".

$$PPV_{Receiver} = PPV_{Ref} \times \left(\frac{d_{ref}}{d} \right)^{1.5}$$

Where: $PPV_{Receiver}$ = peak particle velocity at the receiver in mm/s

PPV_{Ref} = peak particle velocity of the source, measured at the reference distance (7.6 m)

d_{ref} = reference distance for the vibration source (7.6 m)

d = horizontal distance from the source to the receiver (m)

The values of PPV_{Ref} are based on a review of current literature and are provided in Table 12 for reference.

Table 12. Reference PPV's	
Equipment	PPV @ 7.6m (mm/s)
5T Excavators	2.5
20T Excavator w/pulveriser	2.5
47T Excavators w/hammer	7.6
Mustang Bobcats	0.3
Powered Hand Tools	0.2
Trucks	1.9

The levels of predicted vibration at the nearest sensitive receivers are provided in Table 13.

Table 13. Predicted Ground Vibration					
Equipment	Predicted PPV (mm/s)				
	North (Opp. Raglan St)	East (Opp. Cope St)	South (Opp. Wellington St)	West (Opp. Botany Rd)	Church (103 Botany Rd)
5T Excavators	0.7	0.5	0.6	0.4	6.7
20T Excavator w/ pulveriser	1.4	0.9	1.2	0.9	6.7
47T Excavators w/ hammer	2.1	1.4	1.8	1.3	20.0 ¹
Mustang Bobcats	0.1	0.0	0.1	0.0	0.7
Powered Hand Tools	0.0	0.0	0.0	0.0	0.5
Trucks	0.5	0.3	0.5	0.3	5.1

¹Vibration levels for the 47T Excavator adjacent to the Waterloo Congregational Church on Botany Rd are provided for reference purposes only. Hammering shall not occur in close proximity to the church, rather hydraulic shears/pulverisers shall be employed instead.

The German Standard DIN 4150 Part 2 - 1975 presents information on the degree of human perception of various levels of motion. The threshold for 'noticeable' vibration is stated as 1mm/s, with 'easily noticeable' at 2.2mm/s. In light of this, and with reference to Table 13, it is evident that vibration impacts from demolition works are mainly associated with excavator activities in close proximity to the Waterloo Congregational Church. During consultation with this receiver, it was identified that the church only operates on Sundays and is therefore not considered vibration sensitive from a human comfort perspective Monday through Saturday during normal project working hours.

4. Noise and Vibration Management

4.1 Environmental Monitoring

Noise and vibration monitoring shall be undertaken using permanent installations at the nearest representative sensitive receivers around the site. Results from these monitors shall be reviewed on a weekly basis to ensure ongoing compliance. Where complaints are received, additional monitoring may be conducted at the specific location of complaint.

Monitor locations are detailed in Table 14 and illustrated in Appendix B.

Property	Monitor Category	Installation Type	Location	Notes
45 Botany Rd	Noise & Vibration	Permanent	Awning	Representative monitor for compliance
123 Botany Rd	Noise & Vibration	Permanent	Awning	Representative monitor for compliance
103 Botany Rd	Vibration	Permanent	Exterior wall	Representative monitor for compliance
100 Botany Rd	Noise & Vibration	Permanent	Level 1 Awning	Representative monitor for compliance

As there is no permanent monitor installation that completely represents the Noise Catchment Area to the East of the Site, attended noise monitoring shall be conducted in this area at stages of the work that are representative of the highest impacts in that catchment.

The number and location of monitoring points shall be reviewed after an initial period of 2 - 3 months. Where noise and vibration levels are negligible and, in consideration of the works still to be completed, those levels are not expected to increase for the remainder of the project, consideration shall be given to the removal of redundant monitoring points.

For further detail on environmental monitoring, refer to Section 6.3 of the CNVMP.

4.1.1 Heritage-listed Structures

CoA E31 stipulates that a heritage specialist shall provide advice regarding noise and vibration monitoring of heritage-listed structures. Such advice is provided in Appendix D.

4.2 Mitigation Measures

4.2.1 Standard Measures

A range of standard noise and vibration mitigation measures shall be adopted on the site so as to minimise the impact of works on neighbouring sensitive receivers. These are outlined in Table 15. Where it is predicted that

NML's will be exceeded even with the implementation of standard mitigation measures, additional mitigation measures shall be put in place (See Section 4.2.2).

Note that CoA E33 states that specific mitigation measures must be identified through consultation with affected sensitive receivers. On this site, the nearest noise sensitive receivers are predominantly commercial with residential receivers to the East. Consultation with sensitive receivers did not identify any specific "sensitive periods" where provision for respite is required therefore standard hours are appropriate. Evidence of consultation is contained in the Business Management Plan - Early Works as referenced in Section 6.

N.B. While standard hours are generally appropriate, it has been identified that the Waterloo Congregational Church occasionally operates outside Sunday Hours. NVMWA2 in Table 15 has been implemented to address this.

Table 15. Noise and Vibration Mitigation Measures			
No.	Control	Anticipated Noise Reduction	Timing
Administration			
NVM1	Conduct a site induction addressing the requirements of this CNVMP for all new personnel undertaking site activities	N/A	Prior to starting works
NVM2	Educate staff on noise and the impacts of workers activities on the noise environment	N/A	Prior to starting works / following noise complaints
NVM3	Develop a complaints handling procedure and respond to complaints	N/A	Prior to starting works / as required
NVM4	Conduct regular toolbox talks to reiterate the appropriate noise and vibration management methodologies	N/A	Periodically
Procedural			
NVM5	Turn off machinery when not in use	Up to 10 dB	Daily
NVM6	Conduct regular noise measurements in the vicinity of the site to assess compliance with noise criteria	N/A	As needed / following changes in activities
NVM7	The coincidence of noisy plant working simultaneously close together would be avoided	Up to 10 dB	Daily
NVM8	Operate and maintain equipment according to manufacturers' specifications.	Up to 3 dB	Daily
NVM9	Do not use crane whistles, amplified external telephone ringers/ horns or alarms (excluding emergencies)	N/A	Daily
NVM10	Preference the use of the following in lieu of hydraulic hammers: <ul style="list-style-type: none"> • hydraulic concrete shears • hydraulic concrete pulverisers • saw cutting and lifting 	Up to 15 dB	At all times so far as is practicable
NVM11	Maximise offset of noisy plant to sensitive receivers as much as possible.	N/A	Where practicable

Table 15. Noise and Vibration Mitigation Measures

No.	Control	Anticipated Noise Reduction	Timing
NVM12	Sequencing of demolition work to retain noise shields (walls, etc.) as long as possible ie floor by floor leaving the perimeter wall	5 to 15 dB	Where practicable
NVM13	Positioning of load out areas and dump chutes away from neighbouring walls and enclosing dump chutes	N/A	Where practicable
NVM14	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.		Ongoing
Engineering			
NVM15	Use site offices, sheds as noise barriers during demolition works	5 to 15 dB	Prior to starting works
NVM16	Use equipment appropriately sized for each task.	Up to 2 dB	Daily
NVM17	Use smart broadband reversing alarm on mobile equipment where possible.	2 to 5 dB	When selecting equipment
NVM18	Removal of any points of contact between the buildings	Up to 15 dB	Where practicable
Hours of Work			
NVM19	Operate during standard work hours wherever possible	N/A	Daily
NVM20	Introduce respite periods and/or take smoke and lunch breaks when noisy equipment is operating close to the site boundaries.	N/A	Daily
NVM21	Works outside recommended standard hours shall be conducted in accordance with OOHW Protocol	N/A	Ongoing
NVMWA1	All site access via Botany Rd as soon as possible.	N/A	Daily
NVMWA2	Place Manager to undertake ongoing consultation with Waterloo Congregational Church to ensure that works are timetabled outside of sensitive periods.	N/A	Weekly

4.2.2 Additional Measures

The Sydney Metro Construction Noise and Vibration Strategy (CNVS) outlines additional mitigation measures that shall be adopted where exceedance of imposed limits is expected, with the level of measure commensurate with the degree of exceedance.

The latest version of the strategy, as referenced in Section 6, outlines the following additional measures for works within standard construction hours:

Noise

- Letterbox Drops - Information to neighbours on expected duration of noise-intrusive activities
- Monitoring - Monitoring at the nearest affected sensitive receiver (may include attended monitoring where permanent monitors do not reflect the nearest affected sensitive receiver)

It is anticipated that these measures will be required where hammering activity approaches the boundaries of the site.

Vibration

None required providing works do not occur on a Sunday adjacent to the Waterloo Congregational Church

5. Conclusion

Airborne noise will generally be the key environmental impact arising from demolition works on the Waterloo site. This applies to sensitive receivers around the site where demolition works approach the adjacent site boundaries. It is anticipated that much of the impact will be mitigated by A class hoarding erected around the site. The church on Botany Rd has lower NML's due to the category of receiver however given that the church only operates on a Sunday, outside normal project hours, this receiver is deemed to be of low impact. Nonetheless, it will be essential to restrict hammering activities in the vicinity of the church for the purpose of maintaining compliance with the vibration criterion for structural damage. Vibration and structure-borne noise is not predicted to be of high impact to other sensitive receivers surrounding the site.

Appendices

Appendix A - List of Sensitive Receivers

Property Numbers	Address	Business	Business Category	Distance	Impact		Sensitive Equipment
					Noise	Vibration	
1	103 Botany Road	Waterloo Congregational Church	Place of Worship	0m	Low Impact	High Impact	Heritage. No receivers Mon to Sat
Preliminary discussion with the church identified no sensitive receivers from Monday to Saturday. Church service is only conducted on Sundays (OOH).							
2	123 Wellington Street	Public Housing	Residential Buildings	25m	Moderate Impact	Low Impact	
3	219 Cope Street,	Public Housing	Residential Buildings	24m	Moderate Impact	Low Impact	
4	217 Cope Street,	Public Housing	Residential Buildings	40m	Moderate Impact	Low Impact	
5	215 Cope Street,	Public Housing	Residential Buildings	32m	Moderate Impact	Low Impact	
6	213 Cope Street,	Public Housing	Residential Buildings	24m	Moderate Impact	Low Impact	
7	209 Cope Street,	Public Housing	Residential Buildings	25m	Moderate Impact	Low Impact	
8	104 Raglan Street,	Public Housing	Residential Buildings	25m	Moderate Impact	Low Impact	
9	149 Cope Street.	Public Housing	Residential Buildings	47m	Moderate Impact	Low Impact	
10	125 Raglan Street,	Mixed Business	Shop Buildings	17m	Low Impact	Low Impact	
11	129 Raglan Street,	The Rag Land Cafe	Public Buildings	17m	Low Impact	Low Impact	
12	131 Raglan Street,	Waterloo Tobacconist	Public Buildings	17m	Low Impact	Low Impact	
13	45-47 Botany Road,	Abbots Hotel	Public Buildings	18m	Moderate Impact	Low Impact	
14	56 Botany Road,	12 Apartments	Residential Buildings	43m	Moderate Impact	Low Impact	
15	60 Botany Road,	Grill King	Shop Buildings	19m	Low Impact	Low Impact	
16	62 - 72 Botany Road	Sydney Toner Supply	Shop Buildings	25m	Moderate Impact	Low Impact	
16	62 - 72 Botany Road	Yum Yai Thai	Shop Buildings	25m	Moderate Impact	Low Impact	

Property Numbers	Address	Business	Business Category	Distance	Impact		Sensitive Equipment
					Noise	Vibration	
16	62 - 72 Botany Road	Residential	Residential Buildings	25m	Moderate Impact	Low Impact	
17	76 - 82 Botany Road	Southroom Pty Ltd (Future Development Site)	Industrial Buildings	24m	Low Impact	Low Impact	
18	88 Botany Road	Vision Panels	Shop Buildings	24m	Low Impact	Low Impact	
19	100 Botany Road	The Aurora Project	Office Buildings	24m	Low Impact	Low Impact	
19	100 Botany Road	No Quarter Boxing & Martial Arts	Indoor Sports Buildings	24m	Low Impact	Low Impact	
20	108 Botany Road	Allan's Billy Hyde	Shop Buildings	24m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Boka's Shoes	Shop Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Sunbeam Factory Outlet	Shop Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Bettina Child Model Management	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Evolve Corporate Technology	Industrial Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Executive Media	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Evolve Constructions	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	P.L. Stonewall & Co Pty Ltd	Industrial Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Dyer Agencies	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Drawable & Hand Of Law	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Mesh Networks	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Pacific Institute Of Technology	Educational Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Aser	Office Buildings	25m	Low Impact	Low Impact	

Property Numbers	Address	Business	Business Category	Distance	Impact		Sensitive Equipment
					Noise	Vibration	
21	110 - 120 Botany Road	Out Sourcing	Office Buildings	25m	Low Impact	Low Impact	
21	110 - 120 Botany Road	Cosmopolitan Protection Security	Office Buildings	25m	Low Impact	Low Impact	
22	128 Botany Road,		Commercial	22m	Low Impact	Low Impact	
23	130 Botany Road,	Red Rose	Commercial	19m	Low Impact	Low Impact	
24	132 Botany Road,	The Toast Bar Café	Public Buildings	20m	Low Impact	Low Impact	
25	134 Botany Road,	Vacant	Residential/ Commercial Buildings	28m	Low Impact	Low Impact	
26	123 Botany Road,	The Cauliflower Hotel	Public Buildings	19m	Moderate Impact	Low Impact	
27	122 to 136 Wellington Street	Residential	Residential Buildings	19m	Moderate Impact	Low Impact	
28	221 Cope Street,	Community Services Ethnic Communities Council of Aus	Office Buildings	32m	Low Impact	Negligible	
29	142 Botany Road	Dental Surgery	Residential/ Commercial Buildings	43m	Low Impact	Negligible	
29	142 Botany Road	Veterinary clinic	Residential/ Commercial Buildings	43m	Low Impact	Negligible	
29	142 Botany Road	Residential/ Commercial	Residential/ Commercial Buildings	43m	Low Impact	Negligible	
30	44 - 54 Botany Road	FBI Radio	Studio Buildings	49m	Low Impact	Negligible	
30	44 - 54 Botany Road	Residential	Residential Buildings	49m	Low Impact	Negligible	
31	92 - 110 Cope Street	Residential	Residential Buildings	39m	Moderate Impact	Negligible	

Appendix B - Monitoring Locations and Sensitive Receivers

This page intentionally left blank



Impact Category

- Low Impact
- Moderate Impact
- High Impact
- Demolition Zone

Monitoring Category

- Noise
- Regenerated Noise
- Vibration
- Noise & Vibration

Sensitive Receiver Category

- Commercial
- Residential
- Educat/Childcare
- Industrial
- Heritage
- Place of worship
- 5 Property no.
- Monitored RBL



www.ostermanconsult.com

Sydney Metro Demolition - Waterloo
Noise and Vibration Receivers & Land Uses

Date: 15/08/2017
Created by: RO
Report No: 0116 041 06



The contents within this document are based on third party data. The accuracy of the information can not be guaranteed

Appendix C - Structural Engineer's Assessment of Waterloo Congregational Church

This page intentionally left blank

From: James Taylor <jtaylor@jamestaylorassociates.com.au>

Sent: [Thursday, August 3, 2017 4:52:41 PM](#)

To: Elliot Nuberg

Subject: Waterloo Congregational Chapel, Botany Road

Elliot

As you are aware I attended site [yesterday morning](#) in company with Brendan Jolliffe from Delta Group and several other parties.

I inspected the general condition of the church building.

There are several very minor brick cracks in brickwork which are certainly not new.

One, internal, lies over the lintel leading to the kitchen at the rear of the church.

Upstairs in the rear of the church there is cracking evident around some of the windows.

There is evidence of other very minor cracks over some of the windows in the external skin.

These have been repaired at some stage in the past.

However, the cracking described above represents very minor distress in the building fabric.

Generally the building is in sound condition and obviously adequately founded. Demolition works alongside, as planned, would not need to have any extra conditions placed upon them other than the standard care applied to building or demolition works abutting heritage buildings.

Should you require any further information please contact me

James

--

James Taylor

James Taylor and Associates

Civil and Structural Consulting Engineers

T [+61 2 9969 1999](tel:+61299691999)

M [+61 413 996931](tel:+61413996931)

www.jamestaylorassociates.com.au

Limits of Liability and Disclaimer: James Taylor & Associates is not liable for any loss, damage, claims, cost demand or expense whatsoever and howsoever arising in connection with or out of the use of information supplied in this email transmission. Virus-scanning software is utilised by James Taylor & Associates, however no responsibility is taken for any virus or related damage that may originate from this transmission and the receiver is urged to scan this transmission and any attachments for malicious code. This message and any attached files may contain information that is confidential and/or the subject of legal privilege for use only by the intended recipient. If you are not the intended recipient or the person responsible for delivering the message to the intended recipient, be advised that you have received this message in error and that any dissemination, copying or use of this message or attachment is strictly forbidden, as is the disclosure of the information therein. If you received this message in error please notify the sender immediately on [+61 2 9969 1999](tel:+61299691999) and then delete the message.

Appendix D - Heritage Specialist Advice on Monitoring Methods and Locations

This page intentionally left blank

MEMO



DATE: 5 May 2017

AMBS Ref: 16278 VM

TO: Rauf Osterman, Director Osterman Consulting

FROM: Jennie Lindbergh, Director Historic Heritage, AMBS Ecology & Heritage

SUBJECT: **Sydney Metro Demolitions – Vibration Monitoring, Congregational Church, Waterloo**

Background

The Sydney Metro City & Southwest Chatswood to Sydenham Metro was approved as a State Significant Development (SSD) on 7 January 2017. The Minister's Conditions of Approval (CoA) that are relevant to vibration monitoring on heritage structures are:

E30 The Proponent must conduct vibration testing before and during vibration generating activities that have the potential to impact on heritage items to identify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent must review the construction methodology and, if necessary, implement additional mitigation measures.

E31 The Proponent must seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring of heritage-listed structures.

The standard equipment and methodology to be used for monitoring heritage structures adjacent to buildings to be demolished is described below.

Equipment

The noise and vibration monitoring equipment consists of:

- a logger for data storage, communication and power supply;
- a vibration sensor – Geophone;
- a Noise sensor – Microphone; and,
- associated data cables

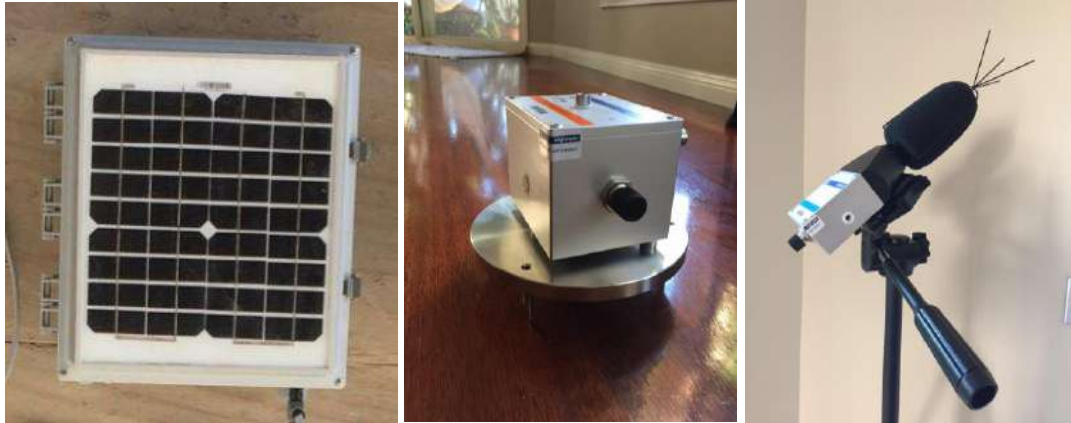


Figure 1 The components of the vibration monitoring; the logger (left), geophone set on comfort plate (centre) and microphone (left).

The *logger* can be installed on a wall or a pole or at ground level.

The preferred installation of the *geophone* is on the foundation of the structure being monitored. The best level of coupling is achieved when the geophone is coupled using a bolt positioned through the centre of the geophone. The process requires an 8mm masonry brass expander to be inserted into an 8mm drill hole and the geophone fastened using a 6mm stainless bolt through the centre of the geophone. In rare cases when drilling into the foundation is not permitted, the geophone may be installed on nearby structures. There is also the option of fastening a plate to the foundation using a two part epoxy putty. The geophone is then screwed onto the plate. The least preferred option is the use of a comfort plate. A comfort plate is generally for internal use when measuring for human comfort and is not ideal for vibration monitoring for cosmetic/structural damage.

The *microphone* can be installed on a pole or wall using the bolt hole in the centre of the sensor or it can be zip tied to an object. There is also the possibility to install the microphone on a tripod when in a secure environment. The preferred height of installation is 1.5 metres but for practical reasons (to prevent theft or damage) the monitor can be positioned at a height of 2.5 to 3 metres.

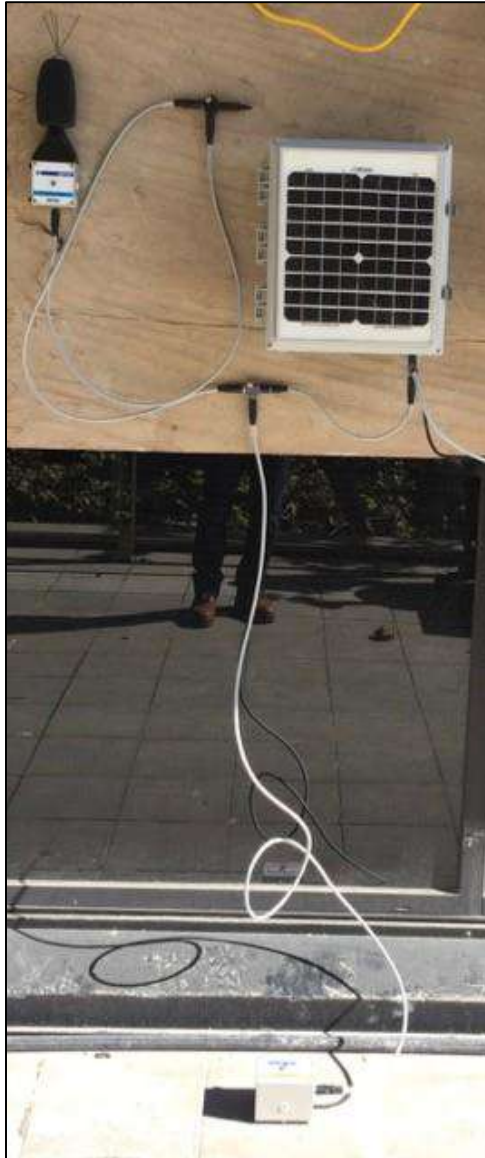


Figure 2 Typical layout of the vibration monitoring equipment.

Congregational Church

The following describes the methodology proposed to be used at the Congregational Church, 103 Botany Road, Waterloo. The Congregational Church, built 1883, is a rendered and painted Victorian Gothic style church with a symmetrical plan and elevation. The Congregational Church including interior is Item 2069 on the heritage schedule of the Sydney Local Environmental Plan 2012, having historical, aesthetic, social and representative significance with good integrity. The Statement of Significance is:

The Gothic church of rendered brick construction was constructed in 1883 to replace the congregation chapel built in 1865. The symmetrical design of the façade demonstrates high quality architectural traits of the building. It is one of the earliest worship venues in Waterloo.



Figure 3 The entrance to the Congregational Church.

Vibration Monitoring

The preferred location for the monitoring equipment is the northern side wall behind a gate. In addition:

- Fixings are not to be made through any flashings or damp proof courses. The fixing should be either entirely above or entirely below the damp proof course. The damp proofing is likely to comprise re-used roofing slates.
- Care is to be taken to avoid damage during fixing and removal of the equipment and any damage is to be made good.
- Following removal of the monitoring equipment, any damage is to be made good based on the principle of like-for-like.



Figure 4 View along the passage on the north side (left), and the damp proof course will be immediately above the wall vent (right).

Conclusion

Installation of the vibration monitoring would have a negligible effect on the fabric of the Congregational Church and is mitigated by monitoring the building, in its entirety, against damage from vibration. There would not be an adverse effect on the local heritage significance of the building and as such, the work complies with the requirements of Conditions E30 and E31 of the Minister's Conditions of Approval.