



APPENDIX B3

Construction Noise and Vibration Management Sub Plan *Windsor Bridge Replacement Project*



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Glossary / Abbreviations

CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
dBA	Decibels using the A-weighted scale measured according to the frequency of the human ear.
DECC	Department of Environment and Climate Change (now EPA)
EIS	Environmental Impact Statement
EMS	Environmental management system
Environmental aspect	Defined by AS/NZS ISO 14001:2004 as an element of an organisation's activities, products or services that can interact with the environment.
Environmental impact	Defined by AS/NZS ISO 14001:2004 as any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects.
Environmental objective	Defined by AS/NZS ISO 14001:2004 as an overall environmental goal, consistent with the environmental policy, that an organisation sets itself to achieve.
Environmental target	Defined by AS/NZS ISO 14001:2004 as a detailed performance requirement, applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.
EPA	Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
ER	Environmental Representative
ESR	Environmental Site Representative
ERG	Environmental Review Group
EWMS	Environmental Work Method Statements
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
GMS	Georgiou Management System
ICNG	Interim Construction Noise Guidelines (DEC 2009)
L _{Aeq} (15min)	The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community.
L _A (max)	the A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.

OEH	Office of Environment and Heritage
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
SPIR	Submissions/Preferred Infrastructure Report
SWP	Sound Power Level
SPL	Sound Pressure Level
TfNSW	Transport for New South Wales

1 Introduction

1.1 Context

This Construction Noise and Vibration Management Sub Plan (CNVMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the Windsor Bridge Replacement Project (the Project).

The Windsor Bridge Replacement project team, comprised of the Transport for New South Wales (TfNSW) and Georgiou Group (Georgiou) have partnered together to undertake construction activities for the new road bridge over the Hawkesbury River at Windsor (the Windsor Bridge Replacement Project), on behalf of the New South Wales (NSW) government.

This CNVMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the environmental management measures listed in the Windsor Bridge Replacement Submission / Preferred Infrastructure Report (SPIR) and all applicable legislation.

1.2 Background

The Project has been assessed as State Significant Infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The *Windsor Bridge Replacement Project Environmental Impact Statement* (EIS) was prepared by Sinclair Knight Merz in November 2012 for Roads and Maritime. The EIS was on public exhibition until 17 December 2012. A Submissions Report (and preferred infrastructure report) was finalised in May 2013 which addressed stakeholder submissions received during the EIS exhibition period. Following this, in December 2013, the Project was approved by the Minister for Planning and Infrastructure. The EIS assessed the impacts of construction and operation of the Project from noise and vibration.

As part of EIS development, a detailed noise and vibration assessment was prepared to address the requirements issued by the then Department of Planning. The noise and vibration assessment was included in the EIS as Working Paper 6-1: Noise and Vibration, and concluded that there will some noise and vibration impacts during construction and the extent will vary depending on the type of activity in progress and the proximity to sensitive receivers.

A Modification Report was submitted to DPIE in September 2019 and placed on public exhibition from 23 October 2019 to 7 November 2019. The submissions were addressed by Transport for NSW in the Submissions Report which was lodged with the Director-General in February 2020.

The Minister for Planning and Public Spaces approved the modification on 30 April 2020. The Minister's CoA were updated to incorporate the modification.

The EIS proposed the implementation of the mitigation and management measures. Noise mitigation works have already been undertaken at a number of properties.

1.3 Environmental management systems overview

The overall Environmental Management System for the Project is described in the Construction Environmental Management Plan (CEMP).

The CNVMP is part of the Georgiou environmental management framework for the Project, as described in Section 4.1 of the CEMP. In accordance with D5(c), this Plan has been developed in consultation with the NSW Environment Protection Authority (EPA). Appendix A8 of the CEMP contains a table detailing consultation with relevant agencies to date, including dates, issues raised and how each issue has been addressed within this management plan. Ongoing

consultation with the regulatory authorities will be carried out in accordance with Chapter 1 of the CEMP.

Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS).

EWMS will be developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified requirements and associated mitigation measures.

Used together, the CEMP, strategies, procedures and EWMS form management guides that clearly identify required environmental management actions for reference by Georgiou personnel and contractors.

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how Georgiou proposes to manage potential noise and vibration impacts during construction of the Project. The management of noise and vibration impacts in this Plan is based on the assessment undertaken as part of the EIS.

2.2 Objectives

The key objective of the NVMP is to ensure that impacts to the local community and the built environment from noise and vibration are minimised. Specific objectives include:

- Identifying sensitive receivers and ensure appropriate environmental controls and procedures are implemented during construction activities.
- Minimising potential adverse noise and vibration impacts to the environment and community.
- Managing impacts if they occur through a systematic analysis of mitigation strategies.
- Ensure appropriate measures are implemented to address the relevant CoA outlined in Table 3.1, and the environmental management measures detailed in the SPIR (Table 3.2).
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Section 3.1 of this Plan.

2.3 Targets

Targets have been established for the management of noise and vibration impacts during the Project to ensure:

- Full compliance with the relevant legislative requirements, CoA and environmental management measures.
- Implement feasible and reasonable noise mitigation measures with the aim of achieving the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009).
- Complaints from the community and stakeholders are minimised.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to noise and vibration management includes:

- *Protection of the Environment Operations Act 1997* (POEO Act)
- Protection of the Environment Operations (Noise Control) Regulation 2008.

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the CEMP.

3.1.2 Guidelines

The main guidelines, specifications and policy documents relevant to this Plan include:

- TFNSW QA Specification G36 – Environmental Protection (Management System)
- Environmental Criteria for Road Traffic Noise (ECRTN) (EPA 1999)
- NSW Road Noise Policy (RNP) (DECCW 2011).
- NSW Industrial Noise Policy (EPA 2000)
- Environmental Noise Management Assessing Vibration: A Technical Guideline (DEC, 2006)
- RTA Environmental Noise Management Manual (ENMM) (RTA 2001a)
- TFNSW Construction Noise and Vibration Guideline (2016)
- Interim Construction Noise Guideline (ICNG) (DECCW 2009)
- Assessing Vibration: A Technical Guideline (DEC 2006)
- British Standard 7385: Part 2 “Evaluation and measurement of vibration in buildings”
- German DIN 4150: Part 3 – 1999 Effects of Vibration on Structure (DIN 1999)
- Australian Standard AS2187.2-2006: “Explosives – Storage, Transport and Use”
- NSW Road Noise Policy (DECCW, 2011).

3.2 Minister's Conditions of Approval

The CoA relevant to this Plan are listed Table 3-1 below. A cross reference is also included to indicate where the condition is addressed in this Plan or other project management documents.

Table 3-1 Conditions of Approval relevant to noise and vibration

CoA No.	Condition Requirements	Document Reference
NOISE AND VIBRATION		
CoA C13	Construction activities associated with the SSI shall be undertaken during the following standard construction hours: (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; and (b) 8:00am to 1:00pm Saturdays; and (c) at no time on Sundays or public holidays.	Table 8-1
CoA C14	Construction works outside of the standard construction hours identified in condition C13 may be undertaken in the following circumstances: (a) construction works that generate noise that is: (i) no more than 5 dB(A) above rating background level at any residence in accordance with the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009); and (ii) no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers; or (b) for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; or (c) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or (d) works as approved through the out-of-hours work protocol outlined in the CEMP.	Table 8-1 Appendix B: Out of Hours Works Protocol
CoA C15	Activities resulting in impulsive or tonal noise emission (such as rock breaking, rock hammering, pile driving) shall only be undertaken: (a) between the hours of 8:00 am to 5:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. For the purposes of this condition 'continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.	Table 8-1

CoA No.	Condition Requirements	Document Reference
CoA C16	Wherever feasible and reasonable, piling activities shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.	Table 8-1
CoA C17	Where feasible and reasonable, operational noise mitigation measures shall be implemented at the start of construction (or at other times during construction) to minimise construction noise impacts	Table 8-1
CoA C18	All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the CEMP. Note: The Interim Construction Noise Guideline identifies 'particularly annoying' activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML.	Table 8-1
CoA C19	The SSI shall be constructed with the aim of achieving the following construction vibration goals: (a) for structural damage, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration – effects of vibration on structures; and (b) for damage to other buildings and/or structures, the vibration limits set out in the British Standard BS 7385-1:1990 — Evaluation and measurement for vibration in buildings. Guide for measurement of vibration and evaluation of their effects on buildings; and (c) for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).	Section 5.4 Section 9.3.2
CoA C20	Unless otherwise agreed by the Director-General, within 6 months of commencing construction, the Applicant shall, in consultation with the EPA, prepare and submit for the approval of the Director-General, a review of the operational noise mitigation measures proposed to be implemented for the project. The review shall: (a) confirm the operational noise predictions of the project based on detailed design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes); (b) review the suitability of the operational noise mitigation measures identified in the documents listed under condition A2 to achieve the criteria outlined in condition C14 based on the operational noise performance of the project predicted under (a) above; and (c) where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the Road Noise Policy (DECCW, 2011).	Section 9.7.1
CoA C21	During construction, affected educational institutions shall be consulted and reasonable steps taken to ensure that noise generating construction works in the vicinity of affected buildings are not timetabled during examination periods where practicable, unless other reasonable arrangements to the affected institutions are made at no cost to the affected institution.	Table 8-1

CoA No.	Condition Requirements	Document Reference
CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)		
D5	As part of the CEMP for the project, the Applicant shall prepare and implement the following sub plan(s):	This plan
D5(c)	A Construction Noise and Vibration Management Sub-plan to detail how construction noise and vibration impacts will be minimised and managed. The sub-plan shall be developed in consultation with the EPA and include, but not necessarily be limited to:	This plan
D5(c)(i)	Identification of nearest sensitive receptors and relevant construction noise and vibration goals applicable to the project;	Section 4.1 & 7.1
D5(c)(ii)	Identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to impact on surrounding sensitive receivers including expected noise/ vibration levels;	Section 5.2 Section 7
D5(c)(iii)	Identification of feasible and reasonable measures proposed to be implemented to minimise construction noise and vibration impacts (including construction traffic noise impacts);	Table 8-1
D5(c)(iv)	Procedures for dealing with out-of-hours works in accordance with condition C14, including procedures for notifying the Director-General concerning complaints received in relation to the extended hours approved under condition C14;	Appendix B: Out of Hours Works Protocol
D5(c)(v)	Procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program, applicable buffer distances for vibration intensive works, use of low-vibration generating equipment/ vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and/ or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria);	Table 8-1 Appendix B: Out of Hours Works Protocol
D5(c)(vi)	Procedures for notifying sensitive receivers of construction activities that are likely to affect their noise and vibration amenity, as well as procedures for dealing with and responding to noise complaints; and	Table 8-1 Appendix B Section 9.5
D5(c)(vii)	A program for construction noise and vibration monitoring clearly indicating monitoring frequency, location, how the results of this monitoring would be recorded and, procedures to be followed where significant exceedances of relevant noise and vibration goals are detected.	Section 9.3

4 Existing environment

4.1 Sensitive receivers

Sensitive receivers for potential noise and vibration issues include low density residential properties, and commercial properties such as motels located to the east of Bridge Street. To the west of Bridge Street, sensitive receivers are largely local businesses such as hotels and eateries. Sensitive receivers on Freemans Reach Road and Wilberforce Road include rural residential properties and a turf farm. Some of the receivers are sensitive to vibration only (H1 heritage wall) and noise only (T1, T2 passive recreational land).

Residential receivers beyond the first row of houses have the benefit of noise shielding from the intervening rows of buildings and are additionally affected by other roads in the area. Therefore, only the properties immediately adjacent to the alignment are considered on a quantitative basis in the EIS noise assessment. The sensitive receivers identified in Table 4-1 include residential receivers and non-residential receivers potentially affected by noise and vibration. The locations of these receivers are mapped in Appendix A.

Table 4-1 Sensitive receivers

ID	Receiver Location	Details	Distance from existing road
Residential Receivers			
R1 ¹	27 Wilberforce Road	Single storey residential dwelling	17 metres
R2	4 Bridge Street	Single storey residential dwelling. Lightweight brick and weatherboard construction.	27 metres
R3	10 Bridge Street	Double storey mixed residential upper floor and commercial lower floor, heritage building. Masonry construction	10 metres
R4	53 George Street	Double storey residential building. Masonry construction	40 metres
R5	12 The Terrace	Single storey residential dwelling. Masonry construction	145 metres
R6	14 The Terrace	Single storey residential dwelling. Masonry construction	160 metres
R7	16 The Terrace	Single storey residential dwelling. Masonry construction	172 metres
R8	18 The Terrace	Single storey residential dwelling. Masonry construction	190 metres
R9	20 The Terrace	Single storey residential dwelling. Masonry construction	205 metres
R10	22 The Terrace	Single storey residential dwelling. Masonry construction	223 metres
R11	45 George Street	Single storey residential dwelling. Masonry construction	120 metres
R12	43 George Street	Single storey residential dwelling. Masonry construction	133 metres
R13	41 George Street	Single storey residential dwelling. Masonry construction	150 metres
R14	39 George Street	Single storey residential dwelling. Masonry construction	178 metres
R15	29 George Street	Single storey residential dwelling. Construction unknown	250 metres
R16	3 Thompson Square	Double storey residential dwelling. Heritage building. Masonry construction	10 metres

ID	Receiver Location	Details	Distance from existing road
U1 ²	51 George Street	Double storey residential dwelling. Masonry construction	40 metres
U2	50 George Street	Single storey residential dwelling. Masonry construction	90 metres
U3	48 George Street	Single storey residential dwelling Masonry construction	100 metres
U4	3/52 George Street	Single storey residential dwelling. Masonry construction	10 metres
U5	20 Bridge Street	Single storey residential dwelling. Masonry construction	35 metres
U6	2/52 George Street	Single storey residential dwelling. Masonry construction	40 metres

Non – Residential Receivers

H1 ³	4 Bridge Street	Heritage listed brick wall to rear of 4 Bridge Street. Masonry and mortar construction	30 metres
H2	6 Bridge Street	Single storey commercial building. Medium weight brick construction	15 metres
H3	99 George Street	Double storey commercial, heritage building. Masonry construction	45 metres
H4	7 Thompson Square	Double storey commercial, heritage building. Masonry construction	30 metres
H5	5 Thompson Square	Single storey commercial, heritage building. Masonry construction	25 metres
H7	70 George Street	Single storey commercial, heritage building, Masonry construction	45 metres
H8	74 George Street	Double storey commercial, heritage building. Masonry construction	40 metres
H9	68 George Street	Double storey commercial, heritage building. Masonry construction	35 metres
H10	62 George Street	Single storey commercial, heritage building. Masonry construction	6 metres
H11	17 Bridge Street	Single storey commercial, heritage building. Timber construction	5 metres
C1 ⁴	Windsor Terrace Motel, 47 George Street	Double storey commercial building. Masonry construction	80 metres
C2	Reserve Road	Underground services channel/pipe running along Bridge Street	8 metres
C3	Windsor Motel	Double storey commercial building. Masonry construction	15 metres
C4	14 Bridge Street	Single storey commercial, heritage building. Masonry construction	7 metres
T1 ⁵	Thompson Square 1	Passive recreational land	5 metres
T2	Thompson Square 2	Passive recreational land	25 metres

¹R – Residential receivers identified in the EIS

²U – Unidentified residential receivers (not identified in EIS but have been included as properties have been identified in OOHV Noise Assessments)

³H – Heritage building

⁴C – Commercial building

⁵T – Thompson square

4.2 Ambient noise

Noise monitoring was conducted as part of the EIS (section 3.2.1 of the Noise and Vibration working paper) to quantify the existing noise environment. Locations were selected to be representative of receivers that would experience potential noise impacts from the existing alignment (Bridge Street, Wilberforce Road and Freemans Reach Road).

The monitoring data was processed to provide information on background noise levels including existing traffic noise. This data has been used to establish appropriate construction noise assessment criteria for the project. The primary noise source at the monitoring locations was traffic noise from Bridge Street, Wilberforce Road, and Freemans Reach Road. There were no industrial noise influences noted at any of the monitoring sites.

A summary of the background noise monitoring results is provided in Table 4-2.

Table 4-2 Summary of Rating Background Level (RBL), dB (A)

ID	Receiver locations	Rating Background Level dB(A)		
		Day 7am-6pm	Eve 6pm-12pm	Night 10pm-7am
R1	27 Wilberforce Road	57.7	50.3	38.8
R3	10 Bridge Street	61.7	56.1	41.1
R4	53 George Street	45.1	42.1	27.2

5 Noise and vibration criteria for NSW

The EPA recommends the development of management levels and goals when assessing construction noise and vibration. These are outlined in:

- TFNSW Construction Noise and Vibration Guideline (2016)
- Interim Construction Noise Guideline (ICNG) (DECCW 2009)
- British Standard 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (BSI 1993)
- German DIN 4150: Part 3 – 1999 Effects of Vibration on Structure (DIN 1999).
- The ANZECC, Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.

Relevant elements of these documents are summarised and discussed in this section.

5.1 Construction noise and assessment objectives

The DECC Interim Construction Noise Guideline (ICNG, July 2009) provides guidelines for the assessment and management of construction noise. The ICNG focuses on applying a range of work practices to minimise construction noise impacts rather than focusing on achieving numeric noise levels.

The main objectives of the ICNG are to:

- Identify and minimise noise from construction works.
- Focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts.
- Encourage construction during the recommended standard hours only, unless approval is given for works that cannot be undertaken during these hours.
- Reduce time spent dealing with complaints at the project implementation stage.
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts.

5.2 Quantitative noise assessment criteria

Construction noise assessment goals presented in the ICNG are referenced to noise management levels for residential, sensitive land uses and commercial/ industrial premises.

Residential Premises

Table 5-1 sets out management levels for noise at residences and how they are to be applied.

In Table 5-1 the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the Interim Construction Noise Guideline (ICNG) (DECCW 2009). As a guide, the difference between the internal noise level and the external noise level is typically 10dB with windows open for adequate ventilation.

Table 5-1 Noise at residents using quantitative assessment

Time of day	Management Level $L_{Aeq} (15 \text{ min})^*$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or 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 $L_{Aeq} (15 \text{ min})$ 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: <ul 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

Time of day	Management Level L_{Aeq} (15 min) *	How to apply
		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.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m 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.

Other land uses sensitive to noise

Other noise sensitive land uses, such as schools, typically find noise from construction to be disruptive when the properties are being used (such as during school times). Table 5-2 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. Consultation should be undertaken with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.

Internal noise levels are assessed at the centre of the occupied room. External noise levels are assessed at the most affected point within 50 metres of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10dB for buildings other than residences. Some buildings may achieve greater performance, such as where windows are fixed (that is, cannot be opened). The management levels in Table 5-2 are 5dB above the corresponding road traffic noise levels in the Environmental Criteria for Road Traffic Noise (EPA 1999) (and the 'maximum' levels in the NSW Industrial Noise Policy (EPA 2000) for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

Table 5-2 Noise at sensitive land uses (non-residents) using quantitative assessment

Land use	Noise assessment location	Noise management level ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Hospitals and operating theatres		
Places of worship		
Active recreation areas ¹	External	65
Passive recreation areas ²	External	60

Land use	Noise assessment location	Noise management level ($L_{Aeq,15min}$)
Community centres	Dependent on intended use	Maximum internal levels recommended in AS2107 for specific use
Industrial premises	External	75
Office, retail outlets	External	70

Notes:

1. Active recreation areas are characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
2. Passive recreation areas are characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg. reading, meditation).

5.3 Adopted project noise management levels

Section 4.2.3 of the EIS noise and vibration working paper developed project-specific construction noise management levels for each representative monitoring location and are presented in Table 5-3 below. The RBLs from Table 4-2 were applied to the ICNG guidelines to calculate the noise management levels. The noise management levels relate to the background monitoring locations but may also be applied to other areas that experience similar existing noise impacts. For example the noise management level (NML) for receiver R4 is representative of other receivers in the same area (receivers R5 –R15). The location of all noise sensitive receivers is detailed in table 4-1 and in the map provided in Appendix A.

Considering the possibility of works outside standard construction hours additional management levels for these times are also included in the construction noise objectives.

In addition to the NMLs identified below, where receivers are exposed to construction noise above 75dB(A), they would be classed as being 'highly noise affected' in line with the ICNG criteria, and therefore would be prioritised for mitigation.

Table 5-3 Project-specific construction noise objectives (NMLs)

Receiver			*Noise Management Level / dB(A)		
			Daytime (7am–6pm)	Evening (6pm–10pm)	Night-time (10pm–7am)
			NML	NML	NML
R1	27 Wilberforce Road		68	55	44
R2 & U4-U6	4 Bridge Street		72	61	46
R3	10 Bridge Street	Ground Floor	70	70	70
		First Floor	72	61	46
R4	53 George Street		55	47	32
R5-15** & U1-U3	See Table 4-1 for ID		55	47	32
R16***	16 Bridge Street		72	61	46
C1, C3	See Table 4-1 for ID		60	60	60
H2-H12	See Table 4-1 for ID		70	70	70
C2	Services Channel		N/A	N/A	N/A

*Daytime NML = RBL +10dB(A), Evening RBL = RBL +5dB(A), Night-time NML = RBL +5dB(A), or absolute levels for commercial receivers.

**In the absence of measured background noise levels at these specific locations, monitoring data at R4 assumed to be representative of noise at receivers R5-R15.

*** In the absence of measured background noise levels at R16, monitoring data at R3 (first floor) assumed to be representative of noise at this receiver.

5.4 Vibration criteria

Effects of ground vibration on buildings resulting from construction may be segregated into the following three categories:

- Human exposure – disturbance to building occupants: vibration in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Effects on building contents – vibration where the building contents may be affected.
- Effects on building structures – vibration in which the integrity of the building or structure itself may be prejudiced.

Vibration criteria relating to human comfort that are applicable to this project are taken from the DEC (2006) document Assessing Vibration – A Technical Guideline and include the following.

- Continuous vibration – from uninterrupted sources (Table 5-4).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (Table 5-5).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (Table 5-6).

Continuous and impulsive vibration criteria have not been included as criteria for this CNVMP as they are unlikely to occur given the proposed methodologies for the project. Where vibration is classed as intermittent, OEH uses a vibration dose value (VDV) to assess levels of vibration. Table 5-6 details the criteria for intermittent vibration. VDV is calculated using the acceleration rate of the vibration event and the time duration over which it occurs. This method is more sensitive to the level of vibration than its duration, and is a measure of the total quantity of vibration perceived. The VDV method is the most suitable for assessing human comfort from intermittent vibration sources.

Two standards by which building damage from construction-induced vibration are commonly assessed include:

- British Standard 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (BSI 1993)
- German DIN 4150: Part 3 – 1999 Effects of Vibration on Structure (DIN 1999).

The German standard provides the most stringent criteria and will be used in this CNVMP. The DIN guideline values for peak particle velocity (mm/s) measured at the foundation of the building are summarised in Table 5-7. The criteria are frequency dependent and specific to particular categories of structure.

Table 5-4 Continuous vibration acceleration criteria - Human Comfort (m/s²) 1-80Hz (DEC 2006)

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 5-5 Impulsive vibration acceleration criteria – Human Comfort (m/s²) 1-80Hz (DEC 2006)

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 5-6 Acceptable Vibration Dose Values (VDV's) for Intermittent Vibration ($\text{ms}^{-1.75}$) 1- 80 Hz (DECC 2006)

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 5-7 DIN Guideline values of vibration velocity for building structures

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order or heritage listed)	3	3 to 8	8 to 10	8

* For frequencies above 100Hz, at least the values specified in this column shall be applied.

5.4.1 Project specific criteria

Project Specific Vibration Criteria has been adopted from section 4.3.2 of the EIS noise and vibration working paper. The EIS has not detailed project specific Human comfort criteria and these will be based on the maximum levels presented in Table 5-6, as taken from Assessing Vibration: A Technical Guideline. The building damage criteria are summarised from the German DIN standard.

Safe vibration working limits for working near the brick barrel heritage drain will be established during test pile operations. Appendix D details the methodology and monitoring requirements for the test piling. The test piling will determine the vibration generated by the pile rig within

the geology. Test piling will trial different various rotation speeds and torque with the aim of determining how to install the piles without causing any damage to the brick barrel drain.

Table 5-8 Project specific building damage vibration criteria

Building Type	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Residential Properties / Lightweight Commercial	5	5	15	15
Heritage Buildings (including receiver H1)	3	3	8	-
Underground services	15	15	15	-

6 Environmental aspects and impacts

6.1 Environmental aspects

The Project will involve a range of activities incorporating various heavy machinery, plant and equipment that will operate in a number of locations across the Project. In order to assess the level of potential impact on noise and vibration sensitive receivers, the broad categories of construction activity likely to interact with these receivers are identified below.

- Site establishment/early works
 - Archaeological investigations
 - Clearing and grubbing
 - Utility adjustments on northern approach
 - Earthworks on northern bridge approach
 - Erection of tower crane
 - Minor utility relocations on southern approach
- Bridge pier and northern abutment construction
 - Non-terrestrial impact piling (riverbed) up to 9 piles per pier (4 piers)
 - Concrete pumping from northern approach
 - Terrestrial bored piling at northern abutments
- Incrementally launched bridge construction (including casting yard)
 - Bridge casting in northern casting yard
 - Bridge form and steel work
 - Incrementally launched bridge
 - Concrete pumping on bridge
 - Concrete pours and surface construction
- Southern approach road construction
 - Terrestrial bored piling at southern bridge abutment
 - Construction of land bridge or concrete panel fill southern approach road
 - Paving and asphaltting
- Removal of casting yard and northern road construction
 - Earthworks and clearing for new round about and northern approach road
 - Paving and asphaltting
- Southern end of Bridge Street tie-in and junction construction
 - Standard road construction including earthworks
 - Paving and asphaltting
 - Fill of existing southern cutting
- Existing bridge demolition
 - Superstructure removal – road saws, grinders, cranes
 - Substructure removal – oxy cutters and cranes

- Use of laydown/construction compound
 - Use of area adjacent to Wilberforce Road (Lot 21 DP1196661) as a laydown area (plant storage and potential materials stockpile) and construction compound (ancillary facility). To be used throughout each construction phase.

6.1.1 Timeframe of works

The works in total would take about 18 months to complete with the bridge construction works taking between 9 and 14 months to complete. With the exception of the construction of the southern approach road, all other phases would be undertaken consecutively. The phases containing the construction of the southern approach road would be undertaken during the bridge pier construction phase and the incremental bridge launching phase. The impact of these simultaneous works has been assessed.

6.2 Impacts

The potential for noise and vibration impacts on sensitive receivers or structures will depend on a number of factors. Typically these might include:

- The type of equipment in use.
- The number of equipment simultaneously in use.
- Ground condition.
- Topography and other physical barriers.
- Proximity to sensitive receivers.
- The condition of sensitive receivers.
- Hours/duration of construction works.
- The prevailing background noise level.

Relevant aspects and the potential for related impacts have been considered in a risk assessment at Appendix A2 of the CEMP.

Noise and vibration impacts attributable to the Project are anticipated. Chapter 8 provides a suite of mitigation measures that will be implemented to avoid or minimise impacts on the receiving community and/or built environment.

7 Construction noise and vibration assessment

A range of plant and equipment will be required to undertake activities associated with the Project. A summary of anticipated construction scenarios and predicted noise levels are provided below. This information will be used to determine potential impacts on the receiving community. An adaptive management approach will be applied to the implementation of mitigation measures to minimise impacts on the community.

7.1 Construction activities

Table 7-1 provides a summary of construction scenarios, and associated plant and equipment required for the works. Plant and equipment may be used in isolation or simultaneously. Table 7-1 also provides a correlating sound pressure level for the relevant equipment.

Table 7-1 Construction scenarios and associated plant and equipment and sound power levels (dB(A))

Construction scenario	Activity	Out of hours works proposed	Plant	LAeq Sound power level dB(A)	Indicative total project duration
A - Site establishment and early works	Archaeological investigations	No	8 tonne excavator	103	3-4 weeks
			5 tonne vibratory roller	107	
			Spoil truck	103	
	Clearing and grubbing	No	30T excavator	108	2 weeks
			Truck	103	
			Tub grinder	109	
	Northern approach utility adjustments	No	Backhoe	108	2 weeks
	Northern approach site clearing / casting yard construction	No	30 tonne excavator	103	3 months
			Spoil truck	103	
			Backhoe	108	
	Erection of tower crane / concrete pad footing	No	30 tonne excavator	103	1 week
			Concrete truck and pump	111	
			Poker vibrator	112	
			Mobile 45 tonne crane	105	
	Southern approach utility adjustments	No	Backhoe	108	2 weeks
B - Bridge pier and northern abutment construction	Non-terrestrial impact piling (riverbed)	No	Impact piling rig	121	3 months
			Construction river barge	95	
			Tower crane	103	
			Barge crane	103	
			Truck	103	

Construction scenario	Activity	Out of hours works proposed	Plant	LAeq Sound power level dB(A)	Indicative total project duration
C - Incrementally launched bridge (from north to south)	Northern bridge abutment piling	No	Bored piling rig	110	1-2 months
			Mobile 45 tonne crane	105	
			Truck	103	
	Bridge casting	Yes	Truck	103	9 months
			Concrete truck and pump	111	
		No	Poker vibrator	112	
			Grinders/saws	117	
	Bridge form and steel work	Yes	Mobile 45 tonne crane	105	9 months
			Tower crane	103	
			Barge crane	103	
			Hand tools (ratchet gun, grinder etc.)	115	
	Incrementally launch bridge	Yes	Tower crane	103	9 months
			Hydraulic rams	85	
			Barge crane	103	
	Concrete pours and surface construction	Yes	Concrete truck and pump	111	9 months
			Poker vibrator	112	
	Paving and asphaltting	Yes	Paver	111	2 weeks
			18 tonne smooth barrel roller	108	
			Road saw	117	1-2 weeks
D - Southern approach road construction	Terrestrial bored piling – southern bridge abutment	No	Bored piling rig	110	1-2 months
			Mobile 45 tonne crane	105	
			Truck	103	
	Land Bridge (precast)*	No	Bored piling rig	110	3 months
			Mobile 45 tonne crane	105	
			Truck	103	
			30 T excavator	103	
			Mobile 45 tonne crane	103	
	Concrete panel fill*	No	Truck	103	3 months
			30 T excavator	103	
			Concrete pump and truck	111	
			Poker vibrator	112	
			20 tonne mobile crane	103	
	Paving and asphaltting	Yes	Paver	111	1 week
			18 tonne smooth barrel roller	108	
			Grinders/saws	117	1-2 weeks
E - Northern approach road construction	Earthworks	No	30 tonne excavator	103	1 month
			Spoil trucks	103	

Construction scenario	Activity	Out of hours works proposed	Plant	LAeq Sound power level dB(A)	Indicative total project duration
	Paving and asphaltting	Yes	15 tonne roller	108	
			Bobcat	103	
			Dump truck	105	
			Paver	111	1 week
			18 tonne smooth roller	108	
			Grinders/saws	107	1-2 weeks
F - Southern Bridge Street tie-in and junction construction	Existing road removal	Yes	Backhoe	108	1-2 weeks
			Road saw	115	
			30 tonne excavator	103	
			Road miller	113	
			Truck	103	
	Paving and asphaltting	Yes	Paver	111	1 week
			18 tonne smooth roller	108	
			Grinders/saws	107	1-2 weeks
G - Existing bridge demolition	Superstructure removal	No	Barge crane	103	2 months
			Road saw	117	
			Grinders	117	
			Truck	103	
			30 tonne crane	103	
	Substructure removal	No	Barge crane	103	2 months
			Road saw	117	
			Grinders	117	
			Truck	103	
			Oxy cutters	105	
			30 tonne crane	103	
H - Laydown area/compound use	Plant removal	Yes	Truck idling	103	Up to 18 months
			Excavator idling	103	

7.2 Construction noise impacts

7.2.1 General construction

Table 7-2 provides a summary of predicted noise impacts from each related construction scenario, this information has been sourced from the EIS noise and vibration working paper. Noise management level thresholds for each key sensitive receiver location have also been provided. Predicted noise levels for each construction scenario have been derived by calculating the combined noise output from the sound power levels of each piece of equipment listed in Table 7-1. Appendix A includes a map for the sensitive noise receiver locations.

Table 7-2 Noise impact on representative sensitive receivers

Sensitive receiver location	Scenario reference no.	Daytime NML (dB(A))	Evening NML*	Night NML*	Predicted LAeq (15minute) (dB(A))	Exceedance of NML		
						Day (dB(A))	Evening (dB(A))	Night (dB(A))
R1	A	68	55	44	63	0	-	-
	B	68	55	44	64	0	-	-
	C	68	55	44	63	0	8	19
	D	68	55	44	57	0	2	13
	E	68	55	44	69	1	14	25
	F	68	55	44	54	0	0	10
	G	68	55	44	58	0	-	-
	H	68	55	44	44	0	0	0
R2 & U4-U5	A	72	61	46	67	0	-	-
	B	72	61	46	69	0	-	-
	C	72	61	46	61	0	0	15
	D	72	61	46	77	5	16	31
	E	72	61	46	51	0	0	5
	F	72	61	46	69	0	8	23
	G	72	61	46	65	0	-	-
	H	72	61	46	43	0	0	0
R3	A	72	61	46	54	0	-	-
	B	72	61	46	62	0	-	-
	C	72	61	46	50	0	0	4
	D	72	61	46	65	0	4	19
	E	72	61	46	46	0	0	0
	F	72	61	46	84	12	23	38
	G	72	61	46	60	0	-	-
	H	72	61	46	31	0	0	0
R4	A	55	47	32	64	9	-	-
	B	55	47	32	72	17	-	-
	C	55	47	32	65	10	18	33
	D	55	47	32	74	19	27	42
	E	55	47	32	55	0	8	23
	F	55	47	32	49	0	2	17
	G	55	47	32	66	11	-	-
	H	55	47	32	63	8	16	31
R5-R15* & U1-U3	A	55	47	32	53	0	-	-
	B	55	47	32	66	11	-	-
	C	55	47	32	60	5	13	28
	D	55	47	32	60	5	13	28
	E	55	47	32	54	0	7	22
	F	55	47	32	56	1	9	24
	G	55	47	32	65	10	-	-
	H	55	47	32	51	0	4	19
R16	A	72	61	46	37	0	-	-
	B	72	61	46	47	0	-	-
	C	72	61	46	40	0	0	0
	D	72	61	46	49	0	0	3
	E	72	61	46	41	0	0	0
	F	72	61	46	75	3	14	29
	G	72	61	46	52	0	-	-
	H	72	61	46	30	0	0	0
C1-C3*	A	60	-	-	53	0	-	-
	B	60	-	-	68	8	-	-
	C	60	-	-	62	2	-	-
	D	60	-	-	61	1	-	-
	E	60	-	-	55	0	-	-
	F	60	-	-	76	16	-	-
	G	60	-	-	64	4	-	-

Sensitive receiver location	Scenario reference no.	Daytime NML (dB(A))	Evening NML*	Night NML*	Predicted LAeq (15minute) (dB(A))	Exceedance of NML		
						Day (dB(A))	Evening (dB(A))	Night (dB(A))
	H	60	-	-	55	0	-	-
H2-H12*	A	70	-	-	62	0	-	-
	B	70	-	-	72	2	-	-
	C	70	-	-	64	0	-	-
	D	70	-	-	74	4	-	-
	E	70	-	-	54	0	-	-
	F	70	-	-	85	15	-	-
	G	70	-	-	68	0	-	-
	H	70	-	-	55	0	-	-
T1-T2*	A	60	-	-	54	0	-	-
	B	60	-	-	64	4	-	-
	C	60	-	-	57	0	-	-
	D	60	-	-	65	5	-	-
	E	60	-	-	50	0	-	-
	F	60	-	-	84	24	-	-
	G	60	-	-	60	0	-	-
	H	60	-	-	49	0	-	-

*Highest predicted noise level taken for all receivers within this area. NMLs are the same for all these receivers

Table 7-2 shows that during the site establishment phase of works (scenario A), all of which are proposed to be undertaken during standard construction hours, the daytime NML is only predicted to be exceeded at one sensitive receiver.

During non-terrestrial impact piling (scenario B), which will only occur during standard construction hours, the daytime NML/criteria is predicted to be exceeded at receivers along the southern riverbank and within Thompson Square. The highly noise affected criteria of 75dB(A) is not predicted to be exceeded at any receiver.

7.2.2 Out of hours works

Standard Construction activity hours are 7:00am to 6:00pm Mondays to Fridays, inclusive, 8:00am to 1:00pm Saturdays, and at no time on Sundays or public holidays. A number of activities will need to be undertaken outside of standard construction hours. Generally works outside of standard construction hours are considered reasonable where the works are below the relevant NML.

The C, H and T receivers in Table 7-2 are non-residential and will not likely be affected by works outside of standard construction hours. H and C receivers are retail properties unlikely to be affected by out-of-hours work and T is the Thompson Square parkland which is unlikely to be used for recreational purposes outside of standard hours as it has no lighting and the majority of this area will be within the construction zone. The NMLs for these retail outlets and passive recreation areas have been sourced from the ICNG criteria, see Table 5-2.

The scenarios that will occur outside of standard hours are associated with roadworks at the northern and southern tie-ins where a ROL is not possible during standard construction hours. There is also a possibility that bridge work will occur out of hours to allow for accurate timing of concrete pours. The associated activities and plant and equipment are detailed in table 7-1 during scenarios C, D, E, F and H. The predicted noise levels in Table 7-2 show the cumulative noise predictions from all activities within each scenario.

The majority of the receivers for the southern bridge road tie-in (Scenario F) are commercial and the impacts during night time and evening periods would be restricted to residential dwellings on Bridge Street including R2, R3 and R16. Depending on the plant being used

during out of hours periods, the highly noise affected criteria of 75dB(A) still would have the potential to be exceeded as a result of close proximity working areas.

Where paving is proposed to be undertaken during out of hours works for the northern approach road (Scenario E), up to 12 sensitive receivers may be exposed to noise levels above evening and night time NMLs. These works are likely to be short term and therefore the impact is reduced. However, where these works are required out of hours, an assessment and approval would be sought in accordance with the out-of-hours work protocol (Appendix B) prior to works. This would identify specific impacts and mitigation measures.

Certain activities associated with the southern approach road construction phase may be required outside of standard construction hours including paving and asphaltting works. If paving is undertaken in close proximity to receivers on the lower end of Bridge Street, noise levels are predicted to exceed both evening and night time NMLs by up to 30dB(A). Therefore there is potential for sleep disturbance at the closest receivers and they will need to be offered alternative accommodation options.

Georgiou will apply standard mitigation measures for all proposed out of hours works in an attempt to reduce predicted noise levels below the NMLs. These measures will include; noise shielding, scheduling of works, behavioural practices, use and selection of plant. Equipment selection and the use of non-tonal reversing alarms.

After standard noise mitigation measures have been applied and where predicted noise levels may still exceed NMLs, additional mitigation measures will be applied where relevant. These additional mitigation measures include; respite periods, duration respite, and alternative accommodation. Table 8-1 provides further detail on the standard and additional mitigation measures for works undertaken outside of standard construction hours for the Project.

Any proposed out of hours works must follow the out-of-hours work protocol (Appendix B), this protocol includes individual assessment and approval for all proposed out of hours works.

7.2.3 Construction Road Traffic Noise

Section 4.2.3 of the EIS noise and vibration paper assessed the potential noise impacts associated with construction road traffic and considered the increase in traffic numbers due to construction would be sufficiently small that they would be absorbed into general traffic numbers. Construction traffic numbers would be up to a peak of 40 truck/wagon/plant movements in any daytime assessment period and up to five movements during any out of hour's works. This equates to an increase in heavy vehicle movements during daytime periods along Bridge Street of 2 per cent, and 1 per cent during out of hours periods. The EIS noise and vibration paper determined that an increase in traffic numbers of at least 25 per cent, or decrease in 20 per cent would be required to have change in noise of 1dB(A). Using this general methodology, noise levels associated with project construction traffic would increase noise levels on existing roads by a maximum of 0.15 dB(A) during either daytime or night time periods. The EIS noise and vibration paper did not quantitatively assess these impacts because it determined that a level change of this magnitude would not be perceivable and therefore the risk of impacts from construction traffic would be low.

7.2.4 Compound and stockpile operation (including access)

The Project will require a main site compound, and a number ancillary facilities and stockpile sites. These compound and ancillary facilities will accommodate a range of activities, plant and equipment including, but not limited to:

- Office accommodation.

- Staff amenities.
- Light vehicle parking and access.
- A plant and equipment maintenance workshop.
- Material and chemical storage.
- Equipment storage.
- Material storage.
- Concrete casting areas.

Not all sites will serve the same purpose and may include only one, or many combinations of the activities listed above. Table 7-3 summarises the likely combination of activities, plant and equipment anticipated at facilities for the Project. The Ancillary Facility Assessment provides further detail on the location, activities and timing associated with the main ancillary facility on the northern side of the river.

Table 7-3 Likely construction facilities and associated attributes

Facility reference no.	Facility type	Activities	Typical plant and equipment required
A	Main Ancillary Facility (Northern side of River)	<ul style="list-style-type: none"> • Staff and worker parking. • Office accommodation. • Toilet facilities • Equipment maintenance and storage. • Material handling and storage. • Concrete casting bed for bridge 	<ul style="list-style-type: none"> • Light Vehicles • Front end loader • Excavator • Road truck • Welding equipment • Light vehicles • Generator • Truck and dogs. • Light vehicles. • Concrete trucks.
B	Minor Ancillary facility (Southern side of River)	<ul style="list-style-type: none"> • Light vehicle parking. • Small site office. • Toilet facilities. • Material storage. 	<ul style="list-style-type: none"> • Light Vehicles • Excavator • Light vehicles • Generator

Table 7-4 provides the predicted noise levels at the nearest residential receiver from each facility type. The noise predictions the establishment and operation of facility C has been adopted from table 6 of the EIS noise and vibration working paper. The noise predictions for the establishment and operation of the facility A has been calculated using TfNSW Services Noise Estimator Tool. The Residential Receiver R1 is the nearest to facility A at 45m distance and the Residential Receiver R2 is the nearest to facility B at 60m.

Table 7-4 Predicted noise levels from facility type (L_{Aeq} (15min))

Facility	Nearest Residential Receiver	Daytime NML (dB(A))	Predicted L_{Aeq} (15minute) (dB(A))	Exceedance of NML Day (dB(A))
A	R1	68	65	0
B	R2	72	43	0

Table 7-4 shows that the establishment and operation of the ancillary facilities throughout construction will remain within the noise management levels. However, in the instance that unplanned deliveries, concrete pours or other are required outside of standard construction hours they will likely exceed the evening and night time NMLs for R1 and R2 as the evening and night time RBLs are very low (see table 7-1). For any out of hour's works the out-of-hours work protocol (Appendix B) must be followed.

Vibration impacts from the operation of compound and ancillary facilities are not anticipated, as there are no activities considered vibration intensive.

7.3 Construction vibration assessment

The highest vibration emitting plant would be used during pier construction. The bridge piers are to be constructed by driving permanent steel liners into the rock, followed by augering out and filling with concrete. Other activities resulting in vibration are bored piling, vibratory rollers and rock breakers. Impact piling only occurs during the installation of the new bridge piers which is a minimum of 50 metres distant from the nearest residential or non-residential building. Other piling within the project would comprise of bored piling. Rock hammering and breaking will occur during the road removal during tie in works to the south of Bridge Street and on the northern side of the bridge. No blasting will occur during the project.

Table 7-5 has been sourced from the EIS noise and vibration working paper and it shows predictions of the wave propagation associated with impact driven piles, the activities of rock hammering and compaction. It identifies the vibration level prediction in terms of velocity (PPV) and the associated VDV. The VDV was calculated from the acceleration (converted from PPV using assumed frequency character) and was based on an assumed total duration of any one vibration causing activity (time for which the vibration is actually produced). The total duration of vibration was set at 2 hours in any working day.

Table 7-5: Typical activities and maximum vibration levels

<i>PPV vibration level (mm/s) at distance (metres)</i>						
<i>Distance from activity (metres)</i>	<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>50</i>
Heavy rock hammer (1.5 t)	4.5	3	1.5	0.4	0.35	0.3
Medium rock hammer (0.6 t)	0.2	0.06	0.02	0.01	-	-
Impact piling rig	21	9	3	2	1	0.2
Compactor / Roller (10t) at 70Hz vibrating frequency	4	3	2	0.5	0.1	0
<i>Estimated Vibration Dose Value (ms^{-1.75})</i>						
Heavy rock hammer (1.5 t)	2.9	1.9	1.0	0.3	0.2	0.2
Medium rock hammer (0.6 t)	0.1	0.0	0.0	0.0	-	-
Impact piling rig	3.2	2.1	1.1	0.35	0.26	0.18
Compactor / Roller (10t)	2.0	1.2	0.8	0.2	0.1	<0.1

The highest vibration emitting plant would be used during pier construction. The bridge piers are to be constructed by driving permanent steel liners into the rock. Impact piling only occurs during the installation of the new bridge piers which is a minimum of 50 metres distant from the nearest residential or non-residential structure and it not predicted to cause any vibration impacts.

Other activities resulting in vibration are the use of vibratory rollers and rock breakers. Vibratory rolling and potentially rock hammering will occur during the road removal during tie in works to the south of Bridge Street and on the northern side of the bridge and at these locations they will be within 20m of existing buildings. The actual distances to each of the existing buildings was considered when determining predicted maximum vibration levels as shown in table 7-6 below.

The EIS noise and vibration working paper has modelled maximum vibration predictions for the nearest sensitive receivers and compared these predictions against vibration criteria for cosmetic damage and human comfort, see table 7-6 below.

Table 7-6 Maximum Vibration predictions

1 expected to exceed the maximum vibration criteria

ID	Receiver	Criteria		Impact Piling		Rock Breaking		Vibratory Roller	
		Structural Damage (PPV)	Human Comfort (VDV)	PPV	VDV	PPV	VDV	PPV	VDV
R1	27 Freemans Reach Road	5	0.4	<0.2	<0.25	0.4	0.3	2.5	1
R2	4 Bridge Street	5	0.4	<0.2	<0.25	3	1.9	2.5	1
R3	10 Bridge Street	3	0.8	<0.2	<0.25	1.8	0.2	2.5	1
R16	16 Bridge Street	5	0.4	-	-	1.8	0.2	2.5	1
H1	4 Bridge Street (wall)	3	-	<0.2	-	-	-	2.5	n/a
H2	6 Bridge Street	3	0.4	<0.2	<0.25	-	-	2.5	1
H6	3 Thompson Square	3	0.4	<0.2	<0.25	0.4	0.3	2.5	1
H7	70 George Street	-	0.4	-	-	0.4	0.3	2.5	1
H8	74 George Street	3	0.4	-	-	0.4	0.3	2.5	1
H9	68 George Street	3	0.4	-	-	0.4	0.3	2.5	1
H10	62 George Street	3	0.4	-	-	0.4	0.3	2.5	1
H11	17 Bridge Street	3	0.4	-	-	0.4	0.3	2.5	1
H12	14 Bridge Street	3	0.4	-	-	0.4	0.3	2.5	1
C2	Utilities Channel	3	0.4	-	-	3	-	2.5	n/a

The EIS assessment in Table 7-6 above shows that it is unlikely any cosmetic damage (PPV) will occur. However, they may impact human comfort (VDV) within the residences.

The DIN vibration criteria for cosmetic damage must be complied with at all times and as such continuous vibration monitoring will be undertaken when vibration intensive works are within safe working distances for cosmetic damage. Table 7-5 indicates estimated safe working distances for the plant that is proposed to be used onsite. Georgiou proposes to use the smallest plant practical to perform the works, this would include the preference to select small or medium rock hammers and vibratory rollers for the works.

As such, when rock hammering or vibratory rolling occurs within 10m of any building; Georgiou will undertake continuous vibration monitoring to confirm compliance with the project specific vibration criteria detailed in table 5-8. This commitment by Georgiou is more conservative than the EIS noise and vibration working paper, section 7.4, where vibration monitoring is only required when heavy plant is used within 7m of a heritage structure. Vibration monitoring will occur in accordance with section 9.3.2 of this plan and vibration mitigation measures detailed in section 8 of this plan will be implemented to minimise potential impacts. Appendix C shows vibration monitoring locations for heritage buildings directly adjacent to the project boundary. Safe vibration working limits for working near the brick barrel heritage drain will be established during test pile operations as detailed in Appendix D.

8 Environmental control measures

A range of environmental requirements and control measures are identified in the various environmental documents, including the EIS mitigation measures, Conditions of Approval and TfNSW documents. Specific measures and requirements to address impacts from noise and vibration are outlined in Table 8-1.

Table 8-1 Noise and vibration management and mitigation measures

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
CONSTRUCTION NOISE AND VIBRATION					
NV1	A Construction Noise and Vibration Management Plan (CNVMP) will be prepared as part of the CEMP		Pre-construction, construction	Environmental Site Representative	G36 Section 4.6 CoA D5(c)
NV2	<p>Construction activities associated shall be undertaken during the following standard construction hours:</p> <ul style="list-style-type: none"> • 7:00am to 6:00pm Mondays to Fridays, inclusive; and • 8:00am to 1:00pm Saturdays; and • at no time on Sundays or public holidays. <p>Unless in the following circumstances;</p> <ul style="list-style-type: none"> • no more than 5 dB(A) above RBL at any residence in accordance with the ICNG, and • no more than the NMLs specified in Table 3 of the ICNG at other sensitive receivers; or • for the delivery of materials required outside these hours by the NSW Police or other authorities for safety reasons; or • an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or • works as approved through the out-of-hours work protocol 	Interim Construction Noise Guideline (ICNG) (DECCW 2009)	Construction	Project Manager Environmental Site Representative	CoA C13 CoA C14
NV3	Further detailed noise impact assessments will be undertaken for any works outside standard construction hours to ensure that they comply with CoA 14.		Pre-construction, construction	Project Manager	EIS table 10-1 NV 1 CoA D5(c) G36 Section 4.6(a)
NV4	<p>High impact noise activities such as rock breaking, rock hammering, pile driving shall only be undertaken:</p> <ul style="list-style-type: none"> • between the hours of 8:00 am to 5:00 pm Monday to Friday; • between the hours of 8:00 am to 1:00 pm Saturday 		Construction	Superintendent	CoA C15

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
NV5	<p>High impact noise activities that exceed the NML (section 7.2) like impact piling and activities such as rock breaking, rock hammering will not occur in continuous blocks exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.</p> <p>'Continuous' includes any period during which there is less than a one-hour respite between ceasing and recommencing any of the work subject to this condition.</p>		Construction	Superintendent	CoA C15
NV6	<p>The Interim Construction Noise Guideline identifies 'particularly annoying' activities that will require the addition of 5dB(A) to the predicted level before comparing to the construction NML. These include;</p> <ul style="list-style-type: none"> • use of 'beeper' style reversing or movement alarms, particularly at night-time • use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work • grinding metal, concrete or masonry • vibratory rolling • bitumen milling or profiling • jackhammering, rock hammering or rock breaking • Impact piling. <p>This has been included in the EIS noise assessment and any future noise modelling would need to include the addition of 5dB(A) for 'particularly annoying' activities as defined in the Interim Construction Noise Guideline.</p>	Interim Construction Noise Guideline (ICNG) (DECCW 2009)	Construction	Superintendent	CoA C18
NV7	<p>The nearest noise and vibration sensitive receivers will be notified of future works and expected levels of noise and vibration well in advance of the works occurring. Notifications will be in accordance with the Community Communications Strategy.</p>		Pre-construction, construction	Communications Manager	EIS table 10-1 NV 1 CoA D5(c)(vi) G36 Section 4.6(b)

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
NV8	Construction programming will be developed to minimise noise impacts - this may include time and duration restrictions and respite periods, and will be developed after consultation with affected receivers.	Construction Program	Pre-construction, construction	Project Manager	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(c)
NV9	During construction, affected educational institutions shall be consulted and reasonable steps taken to ensure that noise generating construction works in the vicinity of affected buildings are not timetabled during examination periods where practicable, unless other reasonable arrangements to the affected institutions are made at no cost to the affected institution. The nearest educational institutions are St Matthew's Primary School (approximately 850m away in Little Church Street, Windsor) and Windsor Public school (approximately 1km away in Dight Street, Windsor). These institutions will not be impacted by noise or vibration.	Construction Program	Pre-construction, construction	Project Manager	CoA C21
NV10	Any proposed work outside normal construction hours will need to be approved through the out-of-hours work protocol outlined in Appendix B of this plan. One option as stated in G36 is to obtain negotiated agreements with affected sensitive receivers.	Out of Hours work protocol (Appendix B)	Pre-construction, construction	Communications Manager	EIS table 10-1 NV 1 CoA D5(c)(iv) CoA C14 G36 Section 4.6(e)
NV11	No Out of hours works are to be undertaken on a Saturday or Sunday between 5 pm and 7 am or on a public holiday with the exception of 1 weekend road closure required for the traffic switch from the old to the new bridge.		Construction	Project Manager, Environmental Site Representative	Good Practice. CoA C14
NV12	In planning for Out of hour's works, alternative accommodation options will be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels throughout the night between 10.00pm – 7am. Highly intrusive noise levels are >25dB(A) above the NML.	TFNSW Construction Noise and Vibration Guideline – August 2016 Version 1.0	Construction	Communications Manager, Project Manager, Environmental Site Representative	Good practice Georgiou commitment
NV13	Evening works between the hours 6pm – 10pm with noise levels exceeding the NML at the same sensitive receivers will be limited to (except for where there is a	TFNSW Construction Noise and Vibration	Construction	Project Manager, Environmental	Good practice, Georgiou commitment

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	Duration Respite negotiated with the sensitive receivers): <ul style="list-style-type: none"> three consecutive nights per week, separated by a minimum of one week; and a maximum of six nights per month. 	Guideline – August 2016 Version 1.0		Site Representative	
NV14	Night works between the hours 10pm – 7am with noise levels exceeding the NML at the same sensitive receivers will be limited to (except for where there is a Duration Respite negotiated with the sensitive receivers): <ul style="list-style-type: none"> two consecutive nights per week, separated by a minimum of one week; and a maximum of six nights per month. Where possible, high noise generating works shall be completed before 11pm.	TFNSW Construction Noise and Vibration Guideline – August 2016 Version 1.0	Construction	Project Manager, Environmental Site Representative	Good practice, Georgiou commitment
NV15	A Duration Respite may occur where it is beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly. For this to occur, an agreement must be reached with the potentially affected residents to demonstrate support for Duration Respite.	TFNSW Construction Noise and Vibration Guideline – August 2016 Version 1.0	Construction	Communications Manager, Project Manager, Environmental Site Representative	Good practice, Georgiou commitment
NV16	Where practical, noise attenuation at the source will be applied during evening and night works. This includes the use of noise blankets to reduce the noise levels by approximately 10dB (A).	TFNSW Construction Noise and Vibration Guideline – August 2016 Version 1.0	Construction	Project Manager, Environmental Site Representative	Good practice, Georgiou commitment
NV17	Where possible, the use of noisy plant simultaneously and/or close together will be avoided.	Construction Program	Construction	Superintendent	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(f) CoA C17
NV18	Equipment and excavation work sites will be orientated away from sensitive receivers where possible to reduce noise emissions.	Sensitive Area Plans	Construction	Superintendent	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(g)

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
					CoA C17
NV19	Equipment will be maintained in efficient working order.	Pre start equipment checklists	Construction	Foreman	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(h) CoA C17
NV20	Quieter construction methods will be used where feasible and reasonable. This may include grinding, rock splitting or terrain levelling instead of rock breaking where it is feasible and reasonable.		Construction	Project Manager	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(i) CoA C17
NV21	Where acceptable from a work health and safety perspective, quieter alternatives to reversing alarms (such as spotters, closed circuit television monitors and 'smart' reversing alarms) will be used particularly during out of hours activities.		Construction	Superintendent	EIS table 10-1 NV 1 CoA D5(c)(iii) G36 Section 4.6(j) CoA C17
NV22	All noise complaints will be investigated and appropriate mitigation measures implemented where practicable to minimise further impacts.	Complaints Handling Procedure	Construction	Environmental Site Representative / Communications Manager	EIS table 10-1 NV 1 CoA D5(c)(iv) G36 Section 4.6(k)
NV23	Noise monitoring will be undertaken to assess compliance with NMLs and assess the effectiveness of noise mitigation. The use of temporary noise shielding will be considered at locations along Bridge Street where substantial exceedances of noise criteria are predicted. In addition where work is undertaken in close proximity to Thompson Square or along Freemans Reach Road, temporary noise barriers will be considered.		Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(vii) G36 Section 4.6(l)
NV24	Dilapidation surveys will be undertaken prior to and following construction works at buildings within 50 metres of the construction footprint, this includes the heritage retaining wall at 4 Bridge Street. In the event that a complaint relating to property damage is received and is verified by a monitored vibration exceedance, an inspection of the property	Dilapidation Survey Reports	Pre-construction, construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D1 G36 Section 4.7

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	would be undertaken and an interim building condition survey prepared.				
NV25	No impact piling works will be undertaken within 20 metres of any heritage structure, unless additional assessment and monitoring confirm that vibration levels will be below project specific criteria.	Construction Heritage Management Sub Plan	Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA C16 G36 Section 4.7(a) CoA C17
NV26	Wherever feasible and reasonable, piling activities shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.		Construction	Project Manager Superintendent	CoA C16 CoA C17
NV27	Rock breaking/hammering will not be undertaken within seven metres of any heritage item or building unless additional assessment and monitoring confirm that vibration levels will be below project specific criteria.	Construction Heritage Management Sub Plan	Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(v) G36 Section 4.7(b)
NV28	Rock breaking/hammering will not be undertaken within five metres of any non-heritage building unless additional assessment and monitoring confirm that vibration levels will be below project specific criteria.		Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(iii) CoA D5(c)(v) G36 Section 4.7(c)
NV29	Where rock breaking/hammering is planned within 10 metres of any occupied dwelling, the occupants will be notified of the works and the duration of the activity will be restricted, unless otherwise agreed with affected residents.	Community Communications Strategy	Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(iii) CoA D5(c)(v) G36 Section 4.7(d)
NV30	Where heavy plant is used within seven metres of a heritage structure, attended vibration monitoring will be undertaken to assess compliance with project specific vibration criteria.	Construction Heritage Management Sub Plan	Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(vii) G36 Section 4.7(e)
NV31	Where an exceedance of project specific vibration criteria for structural damage is recorded during monitoring, work will cease immediately and alternative construction methods will be used. See section 9.3.2 for management of exceedances		Construction	Environmental Site Representative	EIS table 10-1 NV 1 CoA D5(c)(vii) G36 Section 4.7(f)

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
CONSULTATION					
NV32	Early and ongoing consultation and communication with residents and local businesses will be undertaken to provide information on construction activities, including timing, duration and likely impacts.	Community Communications Strategy	Construction	Communications Manager	Good practice CoA D5 (c) vi
NV33	Affected local business owners will be consulted prior to construction to identify appropriate measures to manage potential impacts.	Community Communications Strategy	Construction	Communications Manager	G36 Section 4.6(f) CoA D5 (c) vi
NV34	Consult with receivers identified as being subject to levels that exceed the Highly Noise Affected criteria with the objective of determining appropriate hours of respite unless an agreement is reached with those receivers.	Interim Construction Noise Guideline (ICNG) (DECCW 2009)	Construction	Communications Manager	Good practice CoA D5 (c) vi
NV35	Information will be provided to the affected community before and during construction through media such as letterbox drops, meetings or individual contact. A website will also be established for the project to provide information.	Community Communications Strategy	Pre-Construction Construction	Communications Manager	G36 Section 3.7.2 CoA D5 (c) vi
NV36	A toll-free 24hour project hotline will be provided for enquiries and complaints during the works	Community Communications Strategy	Construction	Communications Manager	G36 Section 3.7.2 CoA D5 (c) vi
NV37	A regular newsletter will be provided to the community with site news, significant project events and timing of different activities.	Community Communications Strategy	Construction	Communications Manager	G36 Section 3.7.2 CoA D5 (c) vi

9 Compliance management

9.1 Roles and responsibilities

Georgiou's Project Team's organisational structure and overall roles and responsibilities are outlined in Section 4.2 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Chapter 8 of this Plan.

9.2 Training

All employees, contractors and utility staff working on site will undergo site induction training that includes construction noise and vibration management issues. The induction training will address elements related to noise and vibration management including:

- Existence and requirements of this Sub Plan.
- Normal construction hours, including the need to seek approval for out of hours works
- Location of noise sensitive areas.
- Complaints reporting.
- General noise and vibration management measures.
- Specific responsibilities to minimise impacts on the community and built environment from noise and vibration associated with the works.
- Minimisation of noise impacts at ancillary sites during Out of Hours Work, particularly at the beginning, end and during meal breaks (e.g. arrival and exit of vehicles and personnel).

Further details regarding staff induction and training are outlined in Section 5 of the CEMP.

9.3 Inspections and monitoring

Weekly and other routine inspections by the Environment Site Representative, TfNSW and ER will occur throughout construction. Detail on the nature and frequency of these inspections are documented in Section 8.1 of the CEMP.

Noise and vibration monitoring will also occur routinely for the duration of the Project. Monitoring will be undertaken quarterly by an Acoustic Consultant or the Environment Site Representative during the construction phase of the Project.

9.3.1 Noise monitoring

The following noise monitoring will be undertaken:

- Noise monitoring against NMLs during each construction stage at the nearest sensitive receiver locations relevant to the works. Table 7-2 of this plan details the relevant NML for the activity phase. Monitoring will occur against the NML for the nearest sensitive receiver to determine the effectiveness of mitigation measures against predicted impacts. This attended noise monitoring is to occur on a minimum monthly basis.
- Where noise complaints are received, additional noise monitoring will be undertaken at sensitive receivers to determine if the actual construction noise generated exceeds the predicted 'worst case' construction noise levels identified in Section 7.2 of this Plan.
- Attended noise monitoring will occur for all out of hour's works at the nearest noise sensitive receiver to confirm the predictions in the noise assessment were accurate.

- Noise monitoring may be carried out for the purpose of refining construction methods or techniques to minimise noise.
- Ongoing spot checks of noise intensive plant and equipment will be undertaken throughout construction to ensure compliance with manufactures specifications.

Where actual noise levels are found to exceed the predicted worst case levels, the works will stop immediately. The source of excessive noise generations will be identified, and any additional feasible and reasonable measures available will be implemented to either reduce noise emissions or reduce the impacts on receivers before recommencing work. In addition, where significant exceedances of relevant noise goals are detected a non-conformance report will be raised and reported to TfNSW Services (section 9.4).

Details of site activity and equipment usage will be noted during construction noise monitoring. The Environmental Site Representative will maintain accurate records substantiating all noise monitoring associated with the project. Results of the monitoring will be provided in the monthly environmental report and records will be made available to the DP&E upon request, within the timeframe nominated in the request.

Acoustic instrumentation employed in the noise monitoring surveys will comply with the requirements of AS1259.2-1990 Acoustics – Sound Level Meters, Part 2: Integrating – Averaging and carry appropriate NATA (or manufacturer) calibration certificates.

9.3.2 Vibration monitoring

Attended vibration monitoring will be undertaken when checking the safe working distances from construction plant (e.g. compaction plant) or in response to a complaint. This method will be used when carrying out the test pile for the brick barrel drain to ensure the safe working distance for method of piling is acceptable prior to commencing the actual piling near this heritage item. The testing method includes:

- Monitoring to be conducted for at least three distances from the plant, including a representative distance for the nearest sensitive structures and/or receivers.
- The testing will be conducted at each location to obtain a suitable representation of the range of vibration levels that would occur from the tested plant.
- The plant will be tested in the settings in which it is expected to operate. For vibratory rollers this may include both “High” and “Low” settings. For the brick barrel drain test pile this will be with the rig operating in “low” to “medium” thrust.

In addition, Continuous vibration monitoring will occur when rock hammering or vibratory rolling occurs within 10m of any building. This commitment by Georgiou is more conservative than the EIS noise and vibration working paper, section 7.4, where vibration monitoring is only required when heavy plant is used within 7m of a heritage structure. Georgiou’s vibration monitoring commitment will extend to all heritage buildings directly adjacent to project boundary as shown Appendix C and in the sensitive area maps (CEMP Appendix A4). The testing method includes;

- Vibration logger to continuously measure vibration while relevant works are occurring within the safe working distance for cosmetic damage to confirm compliance with the project specific vibration criteria detailed in Table 5-8 (this includes heritage structure criteria).
- Measurement to be conducted as close as possible to the sensitive structure.
- A warning system will be implemented including one or both of an audible and/or visual warning alarm, and/or SMS and/or email alerts to site staff. As a minimum this alert will be directed to the operator, site supervisor and the environmental site representative.

During continuous vibration monitoring where the operator, site supervisor and the Environmental site representative receive an alert, the work is to stop immediately. The recorded data is to be assessed by the environmental site representative to determine the level of exceedance of the cosmetic damage criteria.

Where exceedances of cosmetic damage criteria are detected the works will stop and a non-conformance report will be raised and reported to TfNSW Services (Section 9.4). Works will not recommence until a change is made to reduce vibration impact through either work method, equipment selection or building protection measures. In this case, works will not recommence until TfNSW Services and the Independent Environmental Representative (ER) are satisfied that all deficiencies have been addressed and there is no risk of further significant exceedances of the cosmetic damage criteria.

In the event that a complaint relating to property damage is received, an inspection of the property would be undertaken and an interim building condition survey prepared.

Vibration monitoring for construction works near the heritage brick barrel drain will be conducted by a NATA accredited consultant in accordance with the Brick Barrel Drain vibration management protocol (Appendix D).

9.4 Non-conformances

A non-conformance is the failure or refusal to comply with the requirements of project system documentation, including this CNVMP. Any member of Project team may raise a non-conformance or improvement opportunity. Where a non-conformance is detected or monitoring results directly attributable to the Project exceed the targets set in this CNVMP, the process described in Section 8.6 of the CEMP will be implemented.

9.5 Complaints

Complaints will be recorded in accordance with the Community Communications Strategy (CCS). Information to be recorded will include location of complainant, time/s of occurrence of alleged noise or vibration impacts (including nature of impact particularly with respect to vibration), perceived source, prevailing weather conditions and similar details that could be utilised to assist in the investigation of the complaint. All resident complaints will be responded to in a timely manner and action taken recorded in accordance with the CCS.

For community complaints during out of hours works the ER and DP&E must be notified of the complaint. In accordance with Appendix B, the notification must be provided prior to 12.00pm the day following the out of hour's works.

9.6 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this Sub Plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 8.3 of the CEMP.

9.7 Reporting

Reporting requirements and responsibilities are documented in Section 8.5 of the CEMP.

Specific reports prepared in response to noise and vibration monitoring will capture detail including, but not limited, to:

- The locations and description of monitoring undertaken.

- A tabulation of noise and vibration results together with notes identifying the principle sources and operations.
- Summary of any measurements exceeding the nominated criteria, and descriptions of the plant or operations causing these exceedances.
- Detail of any corrective actions and confirmation of their successful implementation.

9.7.1 Operational noise mitigation measures

Within six months of commencing construction, TfNSW in consultation with the EPA, are to prepare and submit for the approval of the Secretary-General, a review of the operational noise mitigation measures proposed to be implemented for the project, as per CoA C20.

The report shall:

- (a) Confirm the operational noise predictions of the project based on detailed design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes);
- (b) review the suitability of the operational noise mitigation measures identified in the documents listed under condition A2 to achieve the criteria outlined in condition of approval C14 based on the operational noise performance of the project predicted under (a) above; and
- (c) Where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the Road Noise Policy (DECCW, 2011).

Georgiou is to provide the necessary information to Roads and Maritime, through the reporting requirements in Section 8.5 of the CEMP, to meet the necessary criteria of the report.

10 Review and improvement

10.1 Continuous improvement

Continuous improvement of this Plan will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance.
- Determine the cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies.
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement.
- Make comparisons with objectives and targets.

10.2 Update and amendment

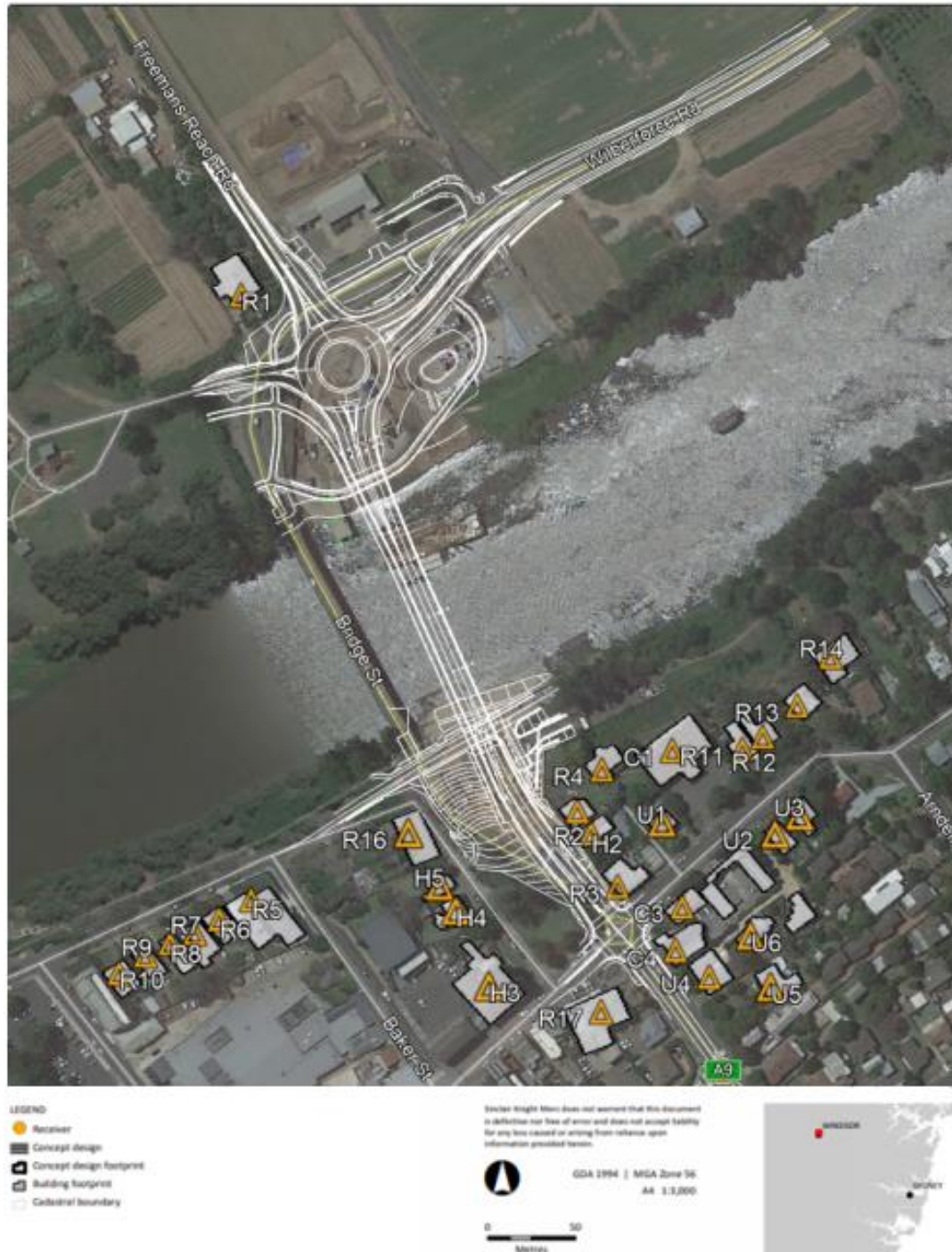
The processes described in Section 8 and Section 9 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

Only the Environmental Manager, or Environmental Site Representative, has the authority to change any of the environmental management documentation.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 10.2 of the CEMP.

Appendix A

Noise Sensitive Receivers



Noise and Vibration Management Plan

Appendix B

Out of hours works protocol

Revision history

Revision	Date	Description	Approval
1	23/10/19	Annual review	
0	31/08/18	For construction	
D	24/08/18	DP&E Review	
C	31/07/18	DP&E & ER review	
B	21/06/18	RMS Review	
A	28/05/18	For review	

Distribution of controlled copies

Copy no.	Issued to	Version
1	RMS	A
2	RMS	B
3	RMS	C
4	RMS	D
5	RMS	0

1. Purpose

The purpose of this protocol is to ensure all out of hours work (OOHW) activities are undertaken on a case by case basis in accordance with the requirements of;

- TFNSW Specification G36 Clause 3.6 and 3.7;
- The Windsor Bridge Replacement Project CoA C14.
- The Interim Construction Noise Guideline (DECC, 2009).

2. Scope

This protocol applies to out-of-hours work that may be undertaken by Georgiou or its subcontractors where a justifiable and demonstrable need has been shown for works to be undertaken outside normal operating times or where the works will shorten the length of the project and are supported by the community. Works may also be required out of hours due to safety restrictions when working on live roads and some utilities.

Normal working hours are 07:00 to 18:00 Monday to Friday and 08:00 to 13:00 Saturday and at no time on Sundays or public holidays.

The Project CoA C14 states that construction works outside of the standard construction hours may be undertaken in the following circumstances;

- a) construction works that generate noise that is:
 - (i) no more than 5 dB(A) above rating background level at any residence in accordance with the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009); and
 - (ii) no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers; or
- b) For the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; or
- c) Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or
- d) Works as approved through the out-of-hours work protocol outlined in the CEMP.

3. Potential Out of Hours Work

Out of hours works is possible when the Transport Management Centre (TMC) refuses to issue a ROL for the works or activities during standard construction hours due to requirements to maintain network capacity. Examples of construction activities that could require out of hours works include;

- traffic control, signage, line marking and associated works for traffic switches
- asphaltting
- Utility/service relocations across and in the verge of existing roads
- Concrete pours for bridge work, girder and pile construction (enabling unloading and return by haulage vehicles) to achieve the required strength and quality product.
- Minor works (e.g. site surveillance/security operations)

4. Procedure

To enable the works to occur outside of standard construction hours the following process will be implemented:

1. Engineers to consult with the Georgiou Environmental Site Representative (ESR) and Georgiou Community Manger at least a month in advance of proposed out of hours works.
2. The engineer is to submit an out of hours works (OOHW) request form (refer to Appendix A) which will allow the Georgiou Environmental Site Representative (ESR) to determine the predicted noise level and compliance with CoA C14.
3. The Georgiou Environmental Site Representative (ESR) will assess the out-of-hours work request and determine:
 - a. That the proposed works are no more than 5 dB (A) above rating background level at any residence in accordance with the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009).
 - b. No more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers.
 - c. if the works are for the delivery of materials required outside of standard hours by the NSW Police Force or other authorities for safety reasons; or
 - d. where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm;
 - e. If an agreement can be negotiated with the potentially affected residents in accordance with TFNSW G36 cl 4.6 (d)
4. If the Georgiou Environmental Site Representative (ESR) determines, based on initial noise assessment, that the works will generate LAeq(15 minutes) noise levels that will be less than RBL + 5 dB(A) and meet the requirements of CoA C14(a)(i), (ii), or comply with CoA C14(b) or (c) or if an agreement can negotiated with the affected residents the works will be approved by the ESR. Specific noise management measures, in accordance with the CNVMP will be included in the out-of-hours work approval and noise monitoring undertaken.
5. If proposed out-of-hours work do not comply with CoA C14 (a) – (c) an assessment will be undertaken and the ESR will not be able to approve the works (refer Section 5).

5. Noise and Vibration Impact Assessment

Where the proposed out-of-hours work do not comply with CoA C14 (a) – (c) a noise and vibration impact assessment for the works will be undertaken and include the following:

- A justification for the out-of-hours work
- A table showing for each activity and work in each noise catchment showing;
 - The location of each of the most affected noise sensitive receiver;
 - The background noise level and noise management level for each of the noise sensitive receivers listed in the table;
 - the predicted LAeq (15 min) noise level, and the potential exceedance of the NML;
 - an assessment of sleep disturbance as set out in Section 4.3 of the ICNG (DECC, 2009), where works are planned to extend over more than two consecutive nights
- details of any standard and additional noise mitigation measures to be adopted in respect of any activity or work predicted to generate noise levels at any noise sensitive receiver exceeding the noise affected LAeq(15minute) level of background plus 5 dB outside the standard hours.
- a diagram showing the location of noise and vibration monitoring locations in relation to each of the most affected noise sensitive receivers for each activity and work in each noise catchment.

The Georgiou Environmental Site Representative (ESR) will document the assessment in a report and provide to the Independent Environmental Representative (ER) for review and approval.

6. Out-of-hours work approval

The Independent Environmental Representative (ER) must approve all out-of-hours work that do not comply with CoA C14 (a) – (c). However, any out-of-hours work with a high risk category must be supported by a construction noise impact statement before being provided to the Independent Environmental Representative (ER) and DPIE for approval. The risk categories have been adopted from the TfNSW Construction Noise Strategy.

Low Risk Category

- No sleep disturbance risk
- 1800 – 2200 weekdays
- 1300 – 2200 Saturday
- 0800 – 1800 Sunday and public holidays

Medium Risk

- sleep disturbance risk
- 2200 - 0700 weekdays
- 2200 - 0800 Saturday
- 1800 – 0700 Sunday and public holidays

High Risk

- Prolonged work (i.e. >1 week)
- Sleep disturbance possible
- Impulsive noise and vibration after 12.00pm (e.g. vibratory rolling or rock breaking)

OOHW flow chart

7. Negotiated agreements

If the predicted noise levels are higher than 5dBA above the RBL then an agreement with the substantial majority of potentially affected noise sensitive receivers may be reached. A substantial majority is at least 85% of receivers impacted above the NML. Any agreement(s) between Georgiou and the potentially affected noise sensitive receivers must be recorded in writing and a copy of the agreement(s) kept on the premises for the duration of the project. These agreements will be made available to the Independent Environmental Representative (ER), Roads and Maritime, DPIE and EPA on request.

If an agreement cannot be reached with the potentially affected noise sensitive receivers where predicted noise levels are higher than 5dBA above the RBL, the works cannot proceed without prior approval by the Independent Environmental Representative (ER) on behalf of the DPIE.

8. Community Consultation

Georgiou will notify the community in accordance with the Community Communication Strategy. This notification will;

- Be made by targeted letterbox drop or doorknock to noise sensitive receivers
- Be made not less than 5 days and not more than 14 days before commencement of any out of hour's works or activities.

The notification will include;

- A diagram that clearly shows the location of the proposed out-of-hours work;
- The timing, nature, scope and duration of the proposed works and activities;
- Detail of why the proposed works and activities are being undertaken outside of standard construction hours;
- The potential noise and vibration impacts;
- Proposed mitigation measures, including respite periods and scheduling;
- Types of plant and equipment that will be used to undertake the work;
- How complaints may be made and additional information obtained about the work.

9. Complaints

Any complaints received as a result of the out-of-hours work are to be managed in accordance with the Community Communication Strategy. On receipt of any complaints the works will cease and noise monitoring undertaken to confirm compliance with the predicted noise levels. If compliant, the works will recommence. If the noise monitoring determines noise levels greater than predicted, the construction process will be reviewed and additional noise mitigation measures will be implemented where reasonable and feasible.

In addition to notifying the TfNSW Environmental Manager /or delegate the Independent Environmental Representative (ER) and DPIE must be notified of the complaint. The notification must be provided prior to 12.00pm the day following the out of hour's works. The report must include details on the location of complainant, time/s of occurrence of alleged noise or vibration impacts (including nature of impact particularly with respect to vibration), perceived source, prevailing weather conditions and initial response made to the complainant.

10. Monitoring

Attended monitoring will occur during all out-of-hours work to confirm the predictions in the noise assessment were accurate. Monitoring will also occur if a complaint is received during any works including out-of-hours work.

11. Document management

Record keeping all out-of-hours works applications and requests are recorded within Georgiou's online document management system. All monitoring records relating to approved Out of Hours works will be recorded monitoring record form. In addition to recording the relevant data will include at least;

- The date on which the sample was taken;
- The time at which the sample was collected;
- The point at which the sample was taken; and
- The name of the person who collected the sample.

The records will be kept on site at the Project office and will be available for review upon request by the Roads and Maritime, DPIE and EPA on request.

Appendix A - Out-of-hours work request form

OOH Request No:

Requested by:

Request Date:

Proposed Date/s:

Reason for proposed out-of-hours work:

Example: Transport Management Centre (TMC) refuses to issue a ROL for the works or activities during standard construction hours.

Request Information		
ID	Criteria	Information/comments
1	Supervisor:	
2	Sub-contractor:	
3	Description of work:	
4	Location:	
5	Start and finish time:	
6	Plant and equipment:	
7	Activities undertaken:	
8	Mitigation measures:	
9	Traffic control required:	

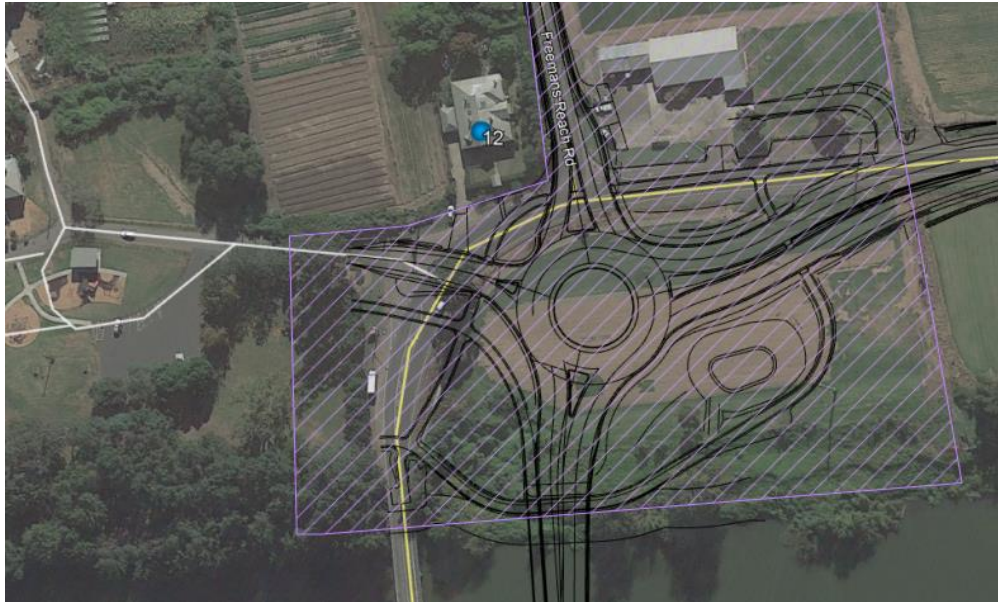
10	traffic control supervisor:	
11	lighting required:	
Emergency Planning		
17	Who in the work team is currently senior first aid qualified?	
18	Where will the first aid kit be located?	
19	Communication to contact assistance in an emergency?	
Assessment		
Acoustic assessment completed by the ESR to determine if works are above RBL +5dB(A) at closest receiver		<input type="checkbox"/> Less than RBL +5dB(A) <input type="checkbox"/> Above RBL +5dB(A)

If the predicted noise is above RBL +5dB (A) external approval is required by the Independent Environmental Representative (ER) and for high risk works the DPIE. Refer to the Out of Hours Works protocol in the CNVMP.

Approvals		
Position	Signature	Date
Georgiou Environmental Site Representative		
Georgiou Safety Site Representative		
Georgiou Community Liaison Representative		

Appendix C

Potential vibration monitoring locations for heritage buildings



Northside of River



Southside of river

Noise and Vibration Management Plan

Appendix D

Brick Barrel Drain vibration management protocol

Revision history

Revision	Date	Description	Approval
1	19/09/18	Following DP&E approval	
0	30/08/18	For construction	

Distribution of controlled copies

Copy no.	Issued to	Version
1	RMS	0
2	RMS	1
3		
4		
5		

1. Purpose

The purpose of this protocol is to ensure that there is no damage to the brick barrel drain during construction. The construction works around the brick barrel drain must occur in accordance with this protocol. This protocol has been developed in accordance with the requirements detailed in:

- TFNSW Specification G1.
- Thompson Square Brick Drain Heritage Mitigation and Options Report (AAJV 23 May 2018).
- The Design Compliance Report under condition B8
- Memorandum titled 'Barrel Drain – Potential Piling Vibration Impacts' dated 9 March 2018, prepared by a Jacobs Vibration Specialist.
- Jacobs Design Drawing – Cast In Place Pile Details and General Arrangement.

2. Scope

The 1814 brick barrel drain was found during salvage works within Area 1 of the archaeological salvage zones (refer Figure 2). Feeding into it are three surface box drains. The bridge design has been modified to allow the barrel drain to be retained in situ, underneath the new bridge structure. However, the three surface box drains will be salvaged during pre-construction salvage works in Area 1. This is detailed in the Barrel Drain Mitigation and Options Report, as is further detail of the significance and history of the item (refer Appendix H of the CHMP).

Within the scope of the approved bridge replacement project, the management of brick barrel drain involves implementing the approved bridge design, and the alternate abutment footing design, which will enclose the drain within the new footing design.

A key management measure detailed in section 9.1 of The Thompson Square Brick Drain, Windsor NSW Heritage Mitigation and Options Report (Appendix H of the CHMP) is to complete trial piling to refine the piling procedure to ensure the brick barrel drain is not damaged. During the trial the vibrations will be monitored and the piling procedure will be adjusted to reduce vibrations should there be a possibility of harm to the brick barrel drain.

3. Redesign to preserve Brick Barrel Drain

Jacobs on behalf of TfNSW has redesigned the western retaining wall to preserve the circa 1814 brick barrel drain in-situ. The proposed design includes a redesigned foundation for the retaining wall which has piles either side of the barrel drain and a pile cap (a structural slab positioned atop the piles) to straddle the brick barrel drain (Refer Figure 1). The main objective of the design changes was to alter the footing system of these structural elements to retain the brick barrel drain in its original location while preserving and protecting its integrity during the construction and operation phases of the proposed works.

The first step of the re-design was to develop options for an alternative structural footing system that would be sufficiently clear from the barrel drain, withstand the intended design loads and eliminate the need to amend above-surface elements previously designed. Technical specialists were consulted and provided input to the redesign including; the project team, archaeologists, a material conservator (ICS) and a vibration specialist.

The AAJV has reviewed these design changes and are supportive of measures which will avoid or reduce heritage impacts.. The AAJV has prepared a Heritage Mitigation and Options Review Report which documents the proposed measures to protect the brick barrel drain in-situ.

4. Location of Brick Barrel Drain

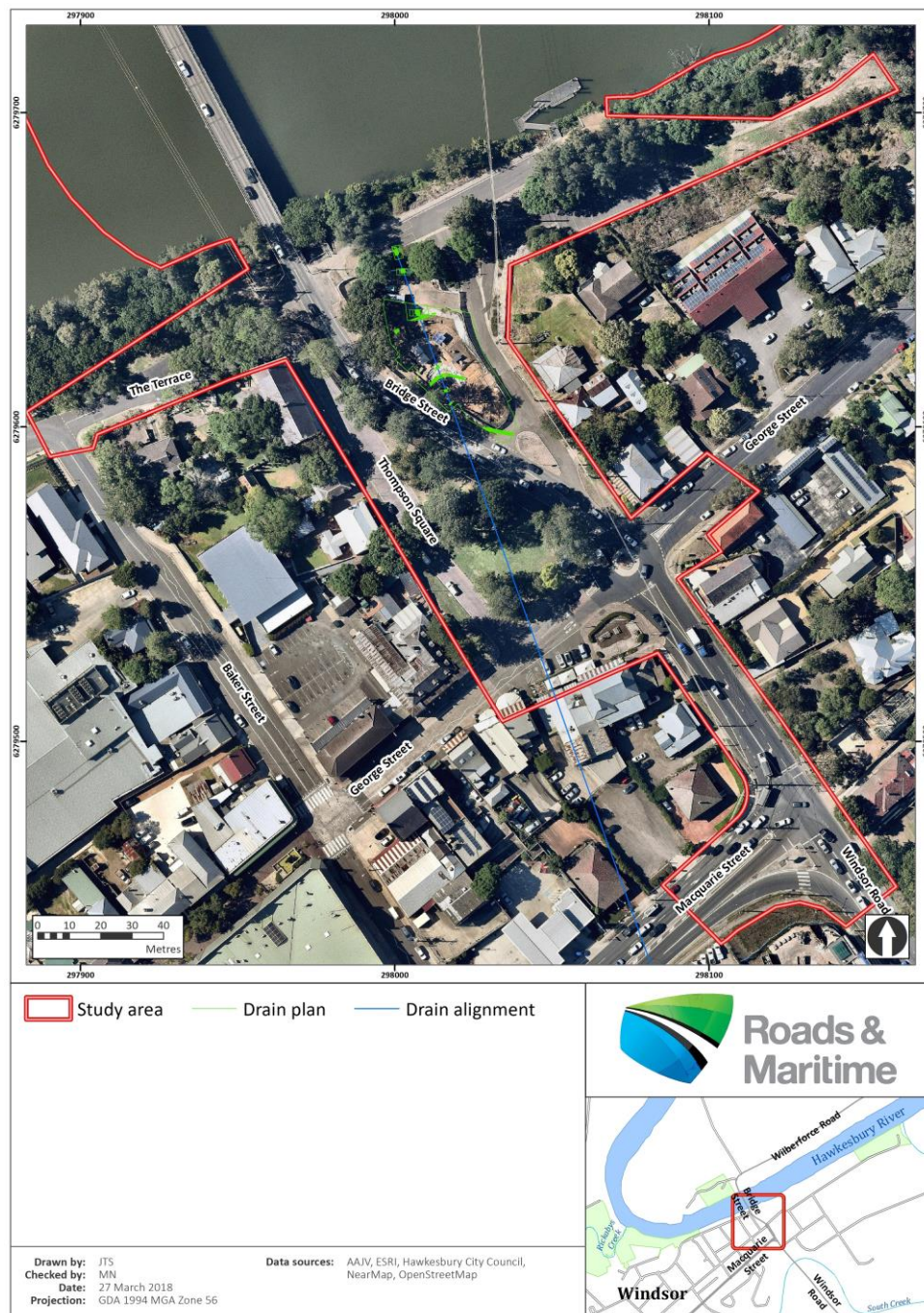


Figure 2 - Location of the Brick Barrel Drain

5. Vibration Impact Assessment

The Design Compliance Report under condition B8 includes a Memorandum titled 'Barrel Drain – Potential Piling Vibration Impacts' dated 9 March 2018, prepared by a Jacobs Vibration Specialist. The vibration specialist has assessed that the prediction of construction vibration levels is unreliable at short source-receiver distances and it is not possible to quantify the expected vibration levels on the drain with good accuracy. Applicable vibration standards and vibration limits for the drain are similarly imprecise, making it difficult to eliminate risks.

The vibration specialist made both design and construction recommendations to minimise the risk of vibration related damage to the brick barrel drain. They are as follows;

1. The foundation of the retaining wall be designed such that the piles are spaced as far from the drain as is practically possible.
2. Specify the use of vibration minimising techniques for boring the piles (e.g. use of a small piling rig with low thrust load and reduced piling rig rotational speed, particularly when boring through rock).
3. Vibration monitoring to be carried out during piling in representative soil conditions elsewhere on site to assist in identifying the lowest vibration-inducing piling techniques and maintaining control over vibrations to the greatest possible extent.
4. The first pile be bored at a location where the adjoining roof of the brick barrel drain is exposed and can be monitored by visual inspection by an archaeologist with vibration monitoring being in place.
5. The piling trial would then confirm the construction methodology to be employed for the remainder of the piling.
6. The use of vibratory compaction techniques over and adjacent to the barrel drain should be avoided.
7. The retaining wall foundation should not bear directly on the top of the barrel drain.

Georgiou has reviewed all of the construction related recommendations and included them within this protocol.

6. Piling Trial

A key management measure recommended by the Jacobs Vibration Specialist is to complete test piling to refine the piling procedure to ensure the brick barrel drain is not damaged. This management measure has been included in section 9.1 of The Thompson Square Brick Drain, Windsor NSW Heritage Mitigation and Options Report. During the piling trial the vibrations will be monitored and the piling method will be adjusted to reduce vibrations should there be a possibility of harm to the brick barrel drain.

The piling trial will include installing a pile remote from the barrel drain, monitor vibrations and adjust the piling method to minimise vibrations. Following this a pile will be excavated, in accordance with the piling methodology, adjacent to an exposed section of the brick barrel drain roof. The vibrations and the barrel drain will be monitored and piling methodology adjusted if required. The trial will be monitored by an archaeologist.

6.1 Piling Trial Methodology

The sequence for the proposed Piling Trial is as follow

Stage 1 - Test Piles away from brick barrel drain

1. There will be 2 test piles on the abutment a minimum of 10m away from the brick barrel drain in soil/rock conditions similar to that adjacent to the brick barrel drain.
2. Survey and set out the location of the brick barrel drain and the location of the test piles.
3. Selection of a small piling rig with low thrust load and reduced piling rig rotational speed.
4. Use a NATA accredited vibration consultant to conduct continuous vibration monitoring during the piling of this test hole to determine the vibration levels emitted from the piling method.
5. Whilst monitoring vibration, adjust the piling method to reduce vibration. This will include low thrust load and reduced piling rig rotational speed. The piling method will need to be adjusted until there is validation from the vibration monitoring that the method proposed will emit the lowest vibration possible at the distance of 1500mm (pile design adjacent to the brick barrel drain) whilst still being able to screw the pile casing in to the ground.
6. The NATA accredited vibration consultant is to compile vibration monitoring report from the Stage 1 test piling and this is to be submitted to TfNSW Services and the approved Heritage Manager for review.
7. TfNSW Services and the approved Heritage Manager are to review the findings in the vibration monitoring report and determine whether the Georgiou can progress to stage 2 test piling or whether further refinement of the piling method is required under Stage 1 test piling.
8. The vibration monitoring report will be endorsed by the approved Heritage Manager and a copy of the approved report will be provided to the DPIE prior to proceeding to Stage 2 test piling.

Stage 2 - Test Pile directly adjacent to the Brick Barrel Drain

1. Survey and set out the location of a test pile directly adjacent to the brick barrel drain. This test pile should be in a location where the brick barrel drain was previously exposed during archaeological investigation work.
2. Set up the piling rig on this test pile location. Note that the piling rig or other machinery cannot operate on top of the drain at any time, unless the potential compression impacts have been reviewed by an engineer and any necessary mitigation measures implemented.
3. Expose the adjacent roof of the brick barrel drain so that it can be monitored by visual inspection by the approved Heritage Manager. The excavation will occur over a section of the drain that was previously excavated during Archaeological investigation work. The Excavation will occur with a toothless bucket under the guidance and supervision of the approved Heritage Manager.
4. Use a NATA accredited vibration consultant to conduct continuous vibration monitoring directly over the exposed brick barrel drain.
5. Use the piling method validated during the stage 1 test piling to minimise the vibration levels during piling. The vibration monitor should be set with an alarm at the acceptable vibration levels that were determined by the NATA accredited vibration consultant during the stage 1 test piling.

6. The approved Heritage Manager is to be present at all times during this test pile to visually observe the exposed drain.
7. This test pile is to occur slowly and intermittently to allow the approved Heritage Manager to closely inspect the drain for any damage. A photo log should be taken by the approved Heritage Manager throughout this process.
8. Work must STOP IMMEDIATELY if the approved Heritage Manager notices any movement around the drain that could potentially cause damage or if the vibration monitor alarm sounds. TfNSW Services will be notified immediately and Georgiou will not recommence piling until given approval by TfNSW Services.
9. At all times during this test pile the approved Heritage Manager has the authority to STOP work.
10. Only once the test pile has confirmed that actual vibration levels will pose no risk to the brick barrel drain will piling operations commence.
11. Following Stage 2 test piling, provide TfNSW Services and the approved Heritage Manager a vibration monitoring report with input from the approved Heritage Manager.
12. TfNSW Services and the approved Heritage Manager is to review the findings in the Stage 2 test piling monitoring report and determine whether the Georgiou can progress to excavate the remaining Abutment A piles P27, P28, P32 and P33 and the Western Retaining Wall piles.
13. The vibration monitoring report will be endorsed by the approved Heritage Manager and a copy of the approved report will be provided to the DPIE prior to proceeding to Stage 3 piling.

Stage 3 – Piling at all other locations adjacent to the Brick barrel drain

Once Stage 1 and 2 trial piling has confirmed that there is no risk of damage to the brick barrel drain, and the TfNSW Services and the approved Heritage Manager have reviewed and approved the monitoring reports, piling for the retaining wall foundation will continue. The piles that are adjacent to the Brick Barrel Drain are Abutment A piles P27, P28, P32 and P33 and the Western Retaining Wall piles. The management measures for excavation of these piles will include;

1. No exposure by excavation of any other sections of the brick barrel drain
2. No machinery is to operate on top of the drain at any time, unless the potential compression impacts have been reviewed by an engineer and any necessary mitigation measures implemented.
3. Continuous vibration monitoring will occur during all piling adjacent to the brick barrel drain and the monitor will be located on the surface directly above the brick barrel drain alignment.
4. Vibration monitor alarm will be set to ensure vibration levels stay within the acceptable vibration levels that were determined by the NATA accredited vibration consultant during the stage 1 test piling.
5. Work must STOP IMMEDIATELY the vibration monitor alarm sounds and TfNSW Services will be notified immediately. Georgiou will not recommence piling until given approval by TfNSW Services.