



21 November 2012

CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN 1 – TEMPORARY ROAD

Wellington Inner City Improvements
National War Memorial Park (Pukeahu)

CNVMP1-TR

Rev.	Status	Prepared by	Checked by	Date
0.1	Draft	James Block	Stephen Chiles	26 September 2012
0.2	Draft	James Block	Stephen Chiles	28 September 2012
1.0	Final	James Block	Michelle Brock	25 October 2012
1.1	Final	James Block	Stephen Chiles	8 November 2012
2.0	Final	James Block	Stephen Chiles	21 November 2012

Name	Position	Date	Signature
James Block	Noise and vibration leader	21-Nov-2012	
Ed Breese	Environmental manager	21/11/12	

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GLOSSARY

Acronym	Definition
CNVMP	Construction noise and vibration management plan
CNVMS	Construction noise and vibration management schedule
NZTA	NZ Transport Agency
SH	State highway
TBC	To be confirmed
WCC	Wellington City Council
WICI	Wellington Inner City Improvements

Term	Definition
dB	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa)
L _{A10}	The A-weighted sound level that is exceeded for 10% of the measurement period, measured in units of decibels (dB)
L _{Aeq(t)}	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB)
L _{AFmax}	The maximum A-weighted noise level with a 1/8 second or 'Fast' time constant (indicated by a 'F'), measured in units of decibels (dB)
ppv	Peak particle velocity. This is the instantaneous maximum velocity reached by the vibrating surface as it oscillates about its normal position

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1. INTRODUCTION

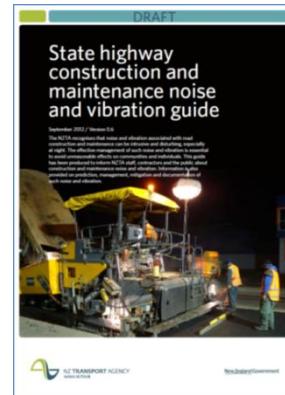
A requirement of the National War Memorial Park (Pukeahu) Empowering Act 2012¹ ('the Act') is the preparation of a Construction Noise and Vibration Management Plan for the temporary road (CNVMP1-TR). This plan has been prepared in accordance with the requirements of the Act. CNVMP1-TR details the noise and vibration criteria, predicted levels, mitigation measures, monitoring requirements, and communication and complaint procedures, for:

State Highway:	SH1
Project:	Wellington Inner City Improvements, National War Memorial Park (Pukeahu), Temporary road
Construction location:	Buckle Street, Wellington
Construction start date:	3 October 2012
Construction finish date:	5 January 2013
NZTA CSVue permit numbers:	TBC

The objective of this plan is to provide a framework for construction noise and vibration management to ensure that noise and vibration levels at neighbouring buildings remain within reasonable limits throughout the works. In addition to meeting the requirements of the Act, this plan follows the guidance set out in the draft NZTA State highway construction and maintenance noise and vibration guide (<http://acoustics.nzta.govt.nz/management/construction>).

CNVMP1-TR addresses the construction of the temporary road only. Other construction work associated with the underpass below the National War Memorial Park will be the subject of future plans, including a Construction Noise and Vibration Management Plan CNVMP2-U.

Items highlighted in yellow will be updated as soon as the information is available/confirmed.



The Act (condition NZTA.22, reproduced in Appendix A) requires CNVMP1-TR to be submitted to Wellington City Council for comments prior to certification. Version 1.0 was sent to the Wellington City Council on 1 October 2012 and comments were received from John Dennison by email on 5 October 2012 and further comments on 6 November 2012. Details of these comments are provided in Appendix B.

Versions 1.0 and 1.1 were provided to the Mark Ashby and Nigel Lloyd (and James Whitlock). A meeting was held on 15 November 2012 to discuss issues raised for certification. These comments are also summarised in Appendix B.

The Act (condition NZTA.27) also requires a draft of this plan to be circulated to named stakeholders and requires issues raised to be set out including how they have been addressed or why they were not incorporated. Version 0.2 of the plan was circulated to the named stakeholders on 28 September 2012 and members of the WICI Alliance offered to meet with all of these parties individually to discuss the plan. Comments are recorded in the Project stakeholder engagement system Darzin.

¹ National War Memorial Park (Pukeahu) Empowering Act. <http://www.legislation.govt.nz/bill/government/2012/0053/latest/DLM4680415.html>

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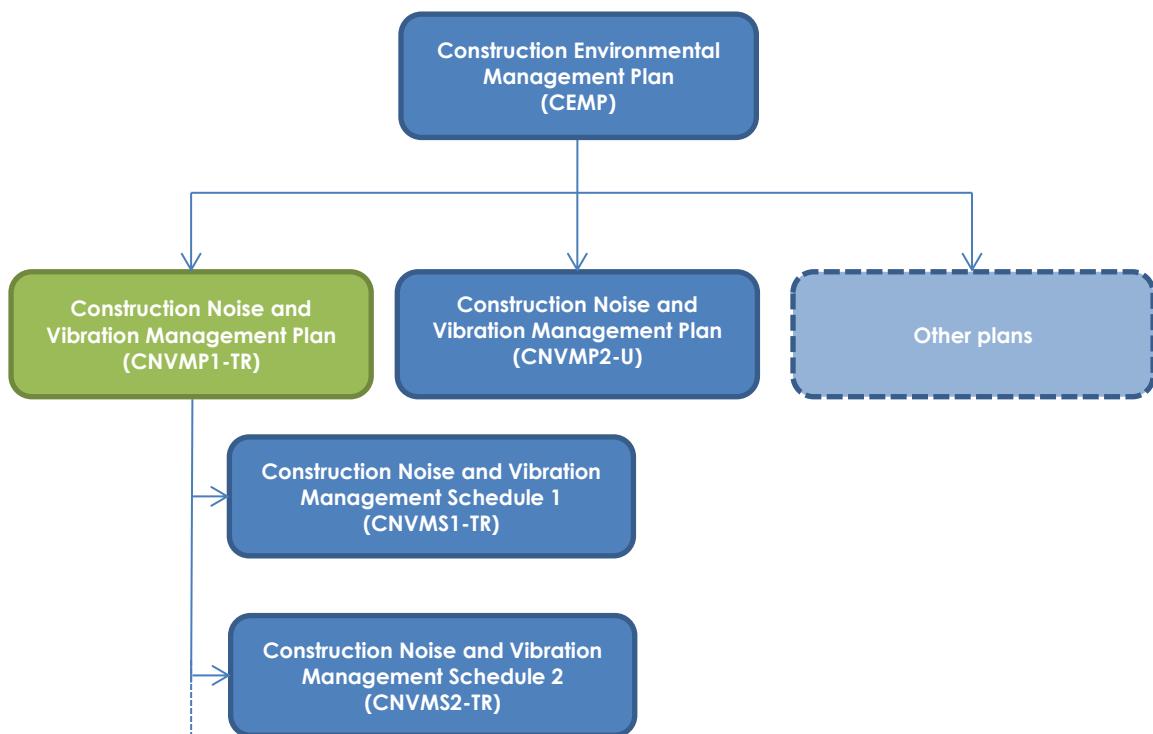
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1.1 Plan and schedules

This document provides the overall framework for management of construction noise and vibration, and broad details of the construction processes, typical noise levels and mitigation. This document will be updated following consultation with stakeholders and as details of the construction methodology are confirmed. Specific detailed information of individual construction activities and specific mitigation and management measures will be contained within separate schedules to this plan. These will be prepared once detailed information is known for each activity as described in Section 10.

The hierarchy of key documents is shown in Figure 1 below.

Figure 1 - Key documents



1.2 Plan author

The Act (condition NZTA.23.a) requires CNVMP1-TR to be prepared by a suitably qualified acoustics specialist. This plan has been prepared by James Block. James has a degree in physics and is a member of the UK Institute of Acoustics. His experience over 20 years' in acoustics has been working predominantly within the railway industry, but also included noise and vibration from roads, industry and construction activities. This experience has involved the prediction, measurement, analysis and assessment of noise and vibration. His particular areas of interest are ground-borne vibration and ground-borne noise in buildings adjacent to vibration sources, such as railway lines or construction activities.

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1.3 Contact details

Table 1 - Contacts

Role	Name	Organisation	Phone	Email
Environmental manager	Ed Breese	WICI Alliance	021 333 726	ebreese@tonkin.co.nz
Construction Manager	Nigel McCreight	WICI Alliance	027 502 7786	nigel.mccreight@downer.co.nz
Stakeholder liaison	Miranda Greer	WICI Alliance	027 270 0593	miranda.greer@downer.co.nz
Noise and vibration leaders	Stephen Chiles	WICI Alliance	03 318 8854	stephen.chiles@urs.com
	James Block	WICI Alliance	021 738 241	james.block@urs.com
Noise and vibration coordinator	Michelle Brock	WICI Alliance	027 475 6982	michelle.brock@downer.co.nz
Noise and vibration monitoring manager	Alan Benton	WICI Alliance	021 537 523	abenton@gotechnics.co.nz
Building survey manager	Greg Szakats	WICI Alliance	021 680 387	greg.szakats@urs.com
Council – Noise Officer	John Dennison	Wellington City Council	021 247 8671	john.dennison@wcc.govt.nz
Council – Compliance Liaison Manager	Amanda Staddon-Smith	Wellington City Council	021 227 8291	Amanda.Staddon-Smith@wcc.govt.nz
Certifying planner	Mark Ashby	Apecx	021 464 654	ashplan@paradise.net.nz
Acoustics advisor to certifying planner	Nigel Lloyd	Acousafe	04 388 3407	nigel@acousafe.co.nz
24 hour public contact number		WICI Alliance	027 270 0593	-

Michelle Brock will be responsible for ensuring that this construction noise and vibration management plan is correctly implemented. Once this plan has been certified she will review all documentation prepared under this plan before it is issued.

Contact details for affected neighbours are given in Section 5.

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2. PROJECT OVERVIEW

As part of the Wellington Inner City Improvements, the alignment of State Highway 1 (SH1) in the vicinity of the Basin Reserve and the National War Memorial Park is being altered. The current SH1 at Buckle Street will be re-aligned through an underpass below the new National War Memorial Park. While the underpass is being constructed, roughly in the position of the current alignment of Buckle Street, SH1 will be diverted to a temporary road. This temporary road will be located to the north of the current alignment as shown approximately in Figure 2. Table 2 provides an outline of the construction of the temporary road.

Table 2 - Outline construction methodology

Activity	Description
1	Archaeological investigations along route of temporary road
2	Construction of noise fence adjacent to Mount Cook School
3	Remove concrete apron at the Wellington Tunnels Alliance site
4	Remove surface of ground on the alignment of the temporary road. Excavation will be required to a depth of between 0.5 and 1.2 m.
5	Lay and compact base course for new road
6	Construct road surface
7	Connect temporary road to existing roads at either end

Table 3 presents the outline programme for the works. This will be updated as the construction methodology is refined.

Table 3 - Outline programme

Activity	Duration	Start date	End date
Archaeological investigations	7 weeks	3 October 2012	18 November 2012
Fence construction	5 weeks	3 October 2012	4 November 2012
Concrete apron removal	2 weeks	3 October 2012	17 October 2012
Existing ground excavation	5 weeks	8 October 2012	11 November 2012
Base course	6 weeks	5 November 2012	16 December 2012
Road surface construction	6 weeks	12 November 2012	23 December 2012
Tie-in to existing roads	3 weeks	3 December 2012	23 December 2012

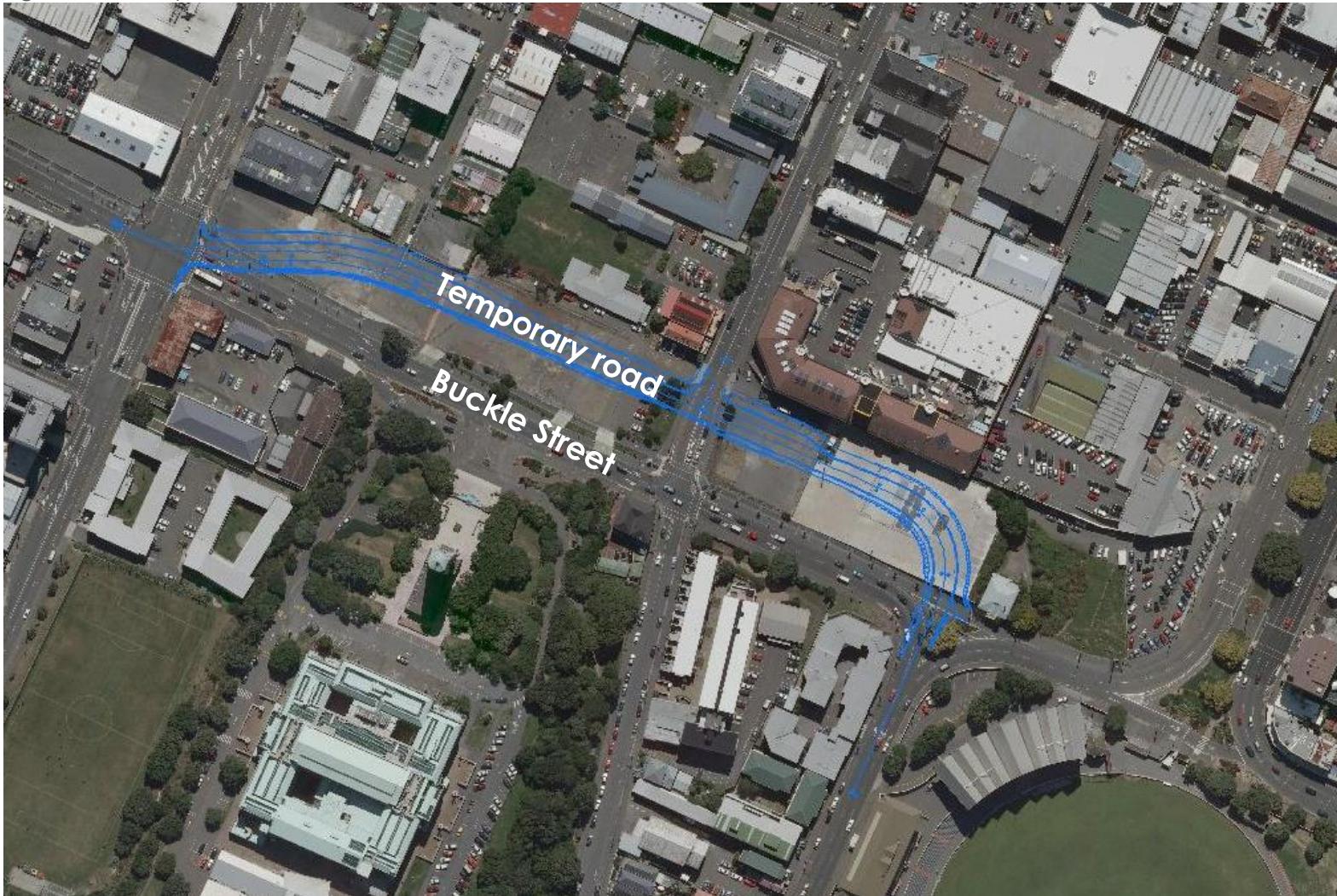
2.1 Hours of operation

The works will generally be carried out seven days a week during morning, day and evening hours (0600h to 2300h overall), although only a few activities are currently planned for Saturdays and no activities are currently planned on Sundays. (A different definition of 'daytime' hours is used for the vibration criteria.) Near commercial buildings such as the Te Papa site and near Mount Cook School, if practicable, any particularly noisy activities will be scheduled for the evening period between 1800h and 2300h so as to minimise disturbance during the day. Night works (2300h to 0600h) will be required to tie-in both ends of the new temporary road with the existing roads. Works would generally not be expected to be continuous over a 24 hour period other than for specific activities such as concrete pours.

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Figure 2 - Site layout



3. CRITERIA

3.1 Conditions

The designation conditions for this Project have been set by the Act in place of normal processes under the Resource Management Act. The designation conditions relating to construction noise and vibration (schedule 3 of the Act, conditions NZTA.22, NZTA.23 & NZTA.27) are reproduced in full in Appendix A. The Act also includes consent conditions relating to construction noise and vibration for the park itself (schedule 2 of the Act). This plan (CNVMP1-TR) only relates to the works authorised by the NZTA designation.

3.2 Noise

Condition NZTA.23 includes criteria for construction noise to be achieved as far as practicable. For morning, day and evening hours (0600h to 2300h overall) it prescribes noise levels directly. For construction noise at night it references the Wellington City District Plan.

The District Plan does not contain a specific rule with noise limits for construction noise but reference is made to NZS 6803P:1984. This provisional standard was revised and published as a full standard in 1999. The noise criteria in the 1984 and 1999 versions of the standard are similar, other than a change in the descriptor used from L_{A10} to $L_{Aeq(t)}$. The key difference is that the 1999 version is expanded to outline significant processes such as the use of management plans.

In summary, in accordance with condition NZTA.23, Table 4 details the actual noise criteria that will be adopted by the Alliance. These will be applied at one metre from the façades of the nearest neighbours.

Table 4 – Noise criteria adopted by the Alliance

Neighbour	Time	$L_{Aeq(15min)}^{(a)}$	L_{AFmax}
Occupied residential and educational buildings (Table 6: R01, R03, R05, R06)	0600h - 0700h	70 dB	85 dB
	0700h - 2000h	75 dB	90 dB
	2000h - 2300h	70 dB	85 dB
	2300h - 0600h	45 dB ^(b)	75 dB ^(b)
Other occupied buildings (Table 6: R02, R04, R07, R08, R10)	0600h - 0730h	80 dB	None
	0730h - 1800h	75 dB	None
	1800h - 2300h	80 dB	None
	2300h - 0600h	75 dB	None

Notes:

(a) NZS 6803 requires a representative time period to be used. For this project the $L_{Aeq(15\ min)}$ has been adopted for all assessments as using a 15 minute period is a conservative approach.

(b) It is noted that these noise levels are lower than those included in the District Plan for general noise (Section 7.6.1.1.1 Noise (emitted and received within Centres)) of 60 dB L_{A10} and 85 dB L_{AFmax} .

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3.3 Vibration

Condition NZTA.23 also includes criteria for construction vibration to be achieved as far as practicable. In summary, the following Project specific criteria will be applied inside the building or on the building foundation of the nearest neighbours.

Table 5 – Vibration criteria and measurement locations adopted by the Alliance

Receiver	Details	Category A	Category B	Location
Occupied dwellings (Table 6: R03, R05, R06)	Daytime 0630h - 2000h	1 mm/s ppv	5 mm/s ppv	Inside the building, on surface supporting occupants
	Night-time 2000h - 0630h	0.3 mm/s ppv	1 mm/s ppv	
Other occupied buildings (Table 6: R01, R02, R04, R07, R08, R10)	Daytime 0630h - 2000h	2 mm/s ppv	10 mm/s ppv	
All buildings	Transient vibration	5 mm/s ppv	BS 5228-2 Table B.2 values	Building foundation
	Continuous vibration		BS 5228-2 50% of Table B.2 values	

These criteria are structured as part of a process whereby construction should be managed to comply with the Category A criteria. If measured or predicted vibration levels exceed the Category A criteria then management measures have to be defined in a schedule to this plan (see Section 10), and if the construction vibration exceeds the Category B criteria then construction activity shall only proceed if there is monitoring of vibration levels and effects, by suitably qualified experts.

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4. RECEIVERS

There is mixed use of the area around the temporary road, with residential and commercial buildings plus a school, Te Papa archive building, and the National War Memorial. Within the District Plan, the area is zoned 'Central', with the memorial is zoned as 'Institutional Precinct'.

The locations in Table 6 will be considered when assessing construction noise and vibration levels, and when preparing schedules to this plan. The approximate distance from the receiver to the nearest significant works is presented, which is typically the distance to the edge of the road or the footpath (whichever is nearer). Minor works may occur at distances less than these.

The receiver locations are shown in Figure 2. If complaints arise from other receivers in the vicinity of the works, they will be assessed on a case-by-case basis.

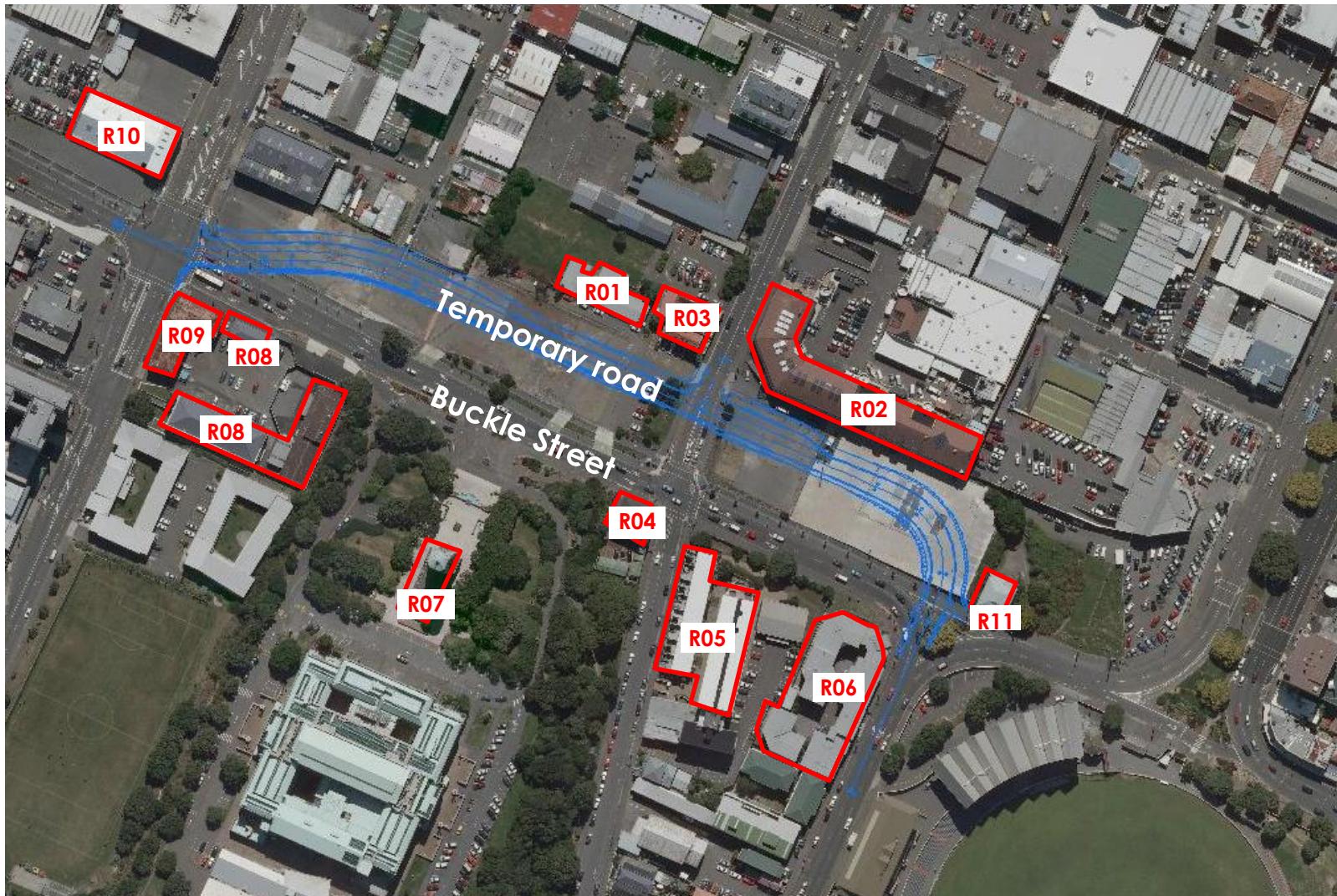
Table 6 – Receivers

Reference	Name, address	Building type/comments	Approximate distance to nearest significant works
R01	Mount Cook School, 160 Tory Street.	School	13 m
R02	Te Papa Archives, 175/179 Tory Street.	Office, archive store, archive restoration	7 m
R03	Apartments, 176 & 178 Tory Street.	Residential	13 m
R04	The former Mount Cook Police Barracks, 13 Buckle Street.	Office	39 m
R05	Tasman Garden Apartments/Townhouses, 1 Tasman Street	Residential	45 m
R06	Apartments, 1 Sussex Street.	Residential	15 m
R07	National War Memorial and the Carillon, 7 Buckle Street	Memorial	87 m
R08	HMNZS Olphert, 213B Taranaki Street.	Office	22 m
R09	Former Army Headquarters Building, 213A Taranaki Street.	Vacant	13 m
R10	Former Francis Holmes building, 208 Taranaki Street.	Office/storage	28 m
R11	Former Home of Compassion Crèche, 18 Buckle Street	Vacant, Category 1 Historic Building	3 m

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Figure 3 - Noise and vibration receivers



5. STAKEHOLDER ENGAGEMENT

A key aspect of this construction noise and vibration management plan is stakeholder engagement. The stakeholders listed in Table 7 are identified in condition NZTA.27, which requires that they be consulted during the preparation of this plan. These stakeholders will also be consulted throughout the works and a record made in the Project stakeholder management system *Darzin*, including actions arising from consultation.

Table 7 – Stakeholders

Stakeholder	Address	Contact name, title	Phone	Email
Mount Cook School	160 Tory Street (R01)	Sandra McCallum, Principal	021 380 924	principal@mtcook.school.nz
Te Papa Archives	175/179 Tory Street (R02)	John Manning, Facilities Manager	029 770 6483	john.manning@tepapa.govt.nz
Owner and occupiers	176 & 178 Tory Street (R03)	Bill Drewitt, Owner	384 3502 or 022 071 9041	bill.drewitt@xtra.co.nz
Owner and occupiers	13 Buckle Street (R04)	Milvia Hannah, Owner	021 224 4007	milvia@germankitchens.co.nz
Owner and occupiers	Tasman Garden Apartments / Townhouses, 1 Tasman Street (R05)	Wendy Booth, Body Corporate Chairperson	021 426 903	Wendyb@actrix.co.nz
Ministry of Defence	HMNZS Olphert, 213 Taranaki Street (R08), Former Army Headquarters Building (R09)	Bob Promeroy, Manager Property Rationalisation	349 7918 or 027 680 7093	bob.promeroy@nzdf.mil.nz

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Communication with these stakeholders and the wider community regarding construction noise and vibration issues will be conducted in accordance with the following framework:

- There will always be a contact person available on site during works, and they will be contactable via the public contact number in Table 1, which will also be prominently displayed at the entrance to the site so that it is clearly visible to the public.
- A draft of this plan will be circulated to the stakeholders in Table 7 and posted on the Project internet site. Schedules to the plan will also be circulated to those stakeholders affected by particular works.
- Individual meetings with the stakeholders listed in Table 7 will be offered at the start of the works and as required during the works.
- Owners and occupiers of properties within 200 metres of works will be notified prior to works (condition NZTA.28). A monthly newsletter will be provided with an update on the progress of the works, and the specific activities (including locations) due to be undertaken next.

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6. NOISE SOURCES

Table 8 lists significant equipment proposed to be used on the site. At this time, the actual makes and models of equipment are unknown. The expected ranges of noise levels have been obtained from library data in NZS 6803. At the start of each activity, site noise monitoring will be conducted to adjust this data where necessary, as specified in schedules (see Section 10). As a mitigation measure, equipment at the lower end of the ranges stated will be targeted (see Section 9).

Table 8 – Machinery/equipment schedule – noise

Machinery/ equipment	Make/Model	Type	Noise level at 10 m	Data reference
Excavator	Hitachi Z-Axis 200	20 tonnes	80 dB	Measured on WICI site
Truck	Various	Various	77-90 dB	NZS 6803, Annex C, Table C.3
Hydraulic concrete breaker	Hitachi Z-Axis 200 with hydraulic breaker	20 tonnes	90 dB	Measured on WICI site
Grader	TBC	TBC	76-84 dB	NZS 6803, Annex C, Table C.3
Vibratory compactor	CAT	8 tonnes	74-78 dB	NZS 6803, Annex C, Table C.3
Paving machine	TBC	TBC	80-86 dB	NZS 6803, Annex C, Table C.8

The following table shows the key activities and construction techniques likely to generate significant noise, and shows the approximate durations of the activity and the equipment that is likely to be used.

Table 9 – Key activities – noise

Activity	Construction techniques	Overall duration of task	Equipment and % use during that activity
Archaeological investigation	Excavation, loading of material into truck, removal of material by truck	4 weeks	Excavator 50% Truck 50%
Concrete apron removal	Concrete breaking, loading of waste in truck, removal of waste by truck	2 weeks	Excavator 50% Concrete breaker 50% Truck 60%
Existing ground excavation	Excavation, loading of material into truck, removal of material by truck	3 weeks	Excavator 90% Truck 60%
Base course	Delivery trucks, grading, vibratory compaction	4 weeks	Truck 70% Excavator 70% Grader 70% Compactor 70%
Road surface construction	Construction of new road surface	4 weeks	Paver 100% Truck 100%

7. VIBRATION SOURCES

The following table shows the key activities and construction techniques likely to generate significant vibration, and shows the approximate duration of the activity.

Table 10 – Key activities – vibration

Activity	Construction techniques	Overall duration of task
Concrete apron removal	Concrete breaking with hydraulic breaker	2 weeks
Existing ground excavation	Excavation with excavator	5 weeks
Base course	Compaction using vibratory roller	6 weeks

As with the noise data, for most activities the actual items of equipment are unknown at this time. Additionally, there is variability in the vibration levels due the ground/soil on which equipment is working. The expected ranges of vibration levels from these activities have been obtained from site measurements and the draft NZTA Guide (see Section 1). During further site vibration monitoring the validity of this data will be confirmed and adjusted where necessary.

Table 11 – Vibration levels

Activity	Machinery/ Equipment	Equipment details	Vibration (ppv at 10 m)
Concrete apron removal	Excavator with hydraulic breaker	Hitachi Z-Axis 200 (20 tonnes) with hydraulic breaker	0.57 mm/s (measured during trial at R01 foundation)
Existing ground excavation	Excavator	Hitachi Z-Axis 200	1.8-5.4 mm/s
Base course	Grader	CAT 20 tonne	0.9 mm/s
	Vibratory compactor	CAT 8 tonne	0.4-12.4 mm/s

8. PREDICTED NOISE AND VIBRATION LEVELS

Using the information in Section 2 regarding the activities, equipment and noise source levels, the noise levels at each of the receivers (Section 4) have been predicted for each of the activities. These indicative calculations have been carried out using the guidance in the draft NZTA State highway construction and maintenance noise and vibration guide. The results are presented in Table 12 in terms of the L_{Aeq} noise level 1 m from the most exposed building façade, for the portion of the activity where the equipment is operating closest to the receiver.

Where the predicted noise exceeds the daytime criteria (Section 3.2), this has been highlighted in the table using red font. Exceedances of the morning and evening criteria are shown using blue font. These highlighted predictions indicate where further specific assessment will be required in the form of schedules (Section 10), over and above the mitigation listed in Section 9.

Table 12 – Noise predictions

Activity	Predicted noise level at receiver $L_{Aeq(t)}$ dB										
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11
Archaeological investigation	78-83	83-86	78-83	69-77	68-76	77-82	63-71	74-80	78-83	72-79	91-93
Concrete apron removal	88	94	88	79	77	87	72	84	88	82	101
Existing ground excavation	81-84	86-88	81-84	72-78	70-77	79-83	65-72	76-81	81-84	74-80	93-95
Base course	76-84	78-86	76-84	71-79	70-78	75-83	65-73	74-82	76-84	73-81	84-92
Road surface construction	82-92	88-98	82-92	73-83	72-81	81-91	66-76	78-88	82-92	76-86	95-105

An initial assessment of vibration has been undertaken using the methodology described in the draft NZTA State highway construction and maintenance noise and vibration guide. For the concrete apron removal activity, data measured during the vibration trial (CNVMS1-TR) has been used. The generic vibration data presented in Table 11 has been used for the remaining activities identified in Table 10. Where the predicted vibration has exceeded the lowest daytime Category A criteria from Table 5, this has been highlighted in the table using red font, and Category B using purple font. These indicate where a schedule is required, over and above the mitigation listed in Section 9.

Table 13 – Vibration predictions

Activity	Predicted vibration level (ppv mm/s)										
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11
Concrete apron removal	0.5	0.6	0.5	0.3	0.3	0.5	0.2	0.4	0.5	0.4	0.8
Existing ground excavation	1.6-5	2-6.1	1.6-5	1-3.5	0.9-3.3	1.5-4.8	0.5-2.5	1.3-4.3	1.6-5	1.2-4	2.5-7.8
Base course	0.4-11.5	0.4-14	0.4-11.5	0.2-8.1	0.2-7.7	0.3-11	0.1-5.7	0.3-9.8	0.4-11.5	0.3-9.1	0.6-18

9. MITIGATION

As detailed in Section 8, indicative calculations have been conducted for the main items of equipment based on the outline construction methodology and minimum distances to the nearest neighbours. The noise and vibration control measures in Table 14 and Table 15 have been identified as good practice, and while these are mostly generic, they are likely to be required to maintain compliance with the construction noise and vibration criteria beyond the immediate neighbours. Any further location specific mitigation for immediate neighbours will be determined when activities are assessed in detail and recorded in schedules (see Section 10).

Where criteria cannot practicably be achieved condition NZTA.23 requires alternative mitigation strategies to be described. In these cases alternative strategies will be detailed in the relevant schedule (see Section 10).

During their induction, all site personnel will be required to read the construction noise and vibration induction form appended to this plan (Appendix C). Site personnel will also be briefed on any relevant schedules during the activity briefing. If required, specific training will be provided for site personnel.

Table 14 – Noise mitigation

Equipment/process	General noise control measures
All	<ul style="list-style-type: none"> Select equipment with noise levels at the lower end of the range quoted in Table 8 Only use required power and size of equipment Fit engine exhausts with silencers Operate equipment in a quiet and efficient manner Do not leave equipment idling unnecessarily Regularly inspect and maintain equipment Use non-tonal reversing alarms Avoid slamming doors Minimise speed and engine revs Turn off stereos Minimise the use of horns Place bedding layer or resilient liner in truck trays Use rubber seals around tailgates Noise barrier/fence to installed adjacent to school before work commences Adjust the time of day and the duration of the activities Use localised screening/enclosure where required
Tracked vehicles	<ul style="list-style-type: none"> Avoid tracked equipment where practicable Grease tracks regularly (keep grease in cab)
Hydraulic breaking	Use low-noise bracket on concrete breaker

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Table 15 – Vibration mitigation

Equipment/process	General vibration control measures
All	Select equipment with vibration levels at the lower end of the range quoted in Table 11
	Only use required power and size of equipment
	Operate equipment in a smooth and efficient manner
Concrete breaker	Only use where concrete cannot be broken up using an excavator

9.1 Reversing alarms

As tonal alarms ('reversing beepers') on construction vehicles are a common cause of noise complaint, broadband alarms will be used. More information on broadband alarms is provided in Appendix D. The Alliance will investigate bulk purchase of broadband alarms.

10. SCHEDULES

Construction noise and vibration management schedules to this plan will be prepared for the construction activities listed in Table 16. The schedules will identify the potentially affected neighbours and confirm the proposed methodology and equipment to be used, along with specific mitigation.

Schedules should be reviewed for any activities where there is a complaint. If there is no schedule for an activity that has caused a complaint then consideration will be given to preparing one for the remainder of that activity.

Within the schedule, predictions of construction noise will be made using the calculator on the NZTA Transport Noise website (www.acoustics.nzta.govt.nz). These calculations will be used to identify where specific mitigation is required and to determine compliance with the Project noise criteria (Section 3.2).

Predictions of vibration will be made using the guidance in the draft NZTA guide.

The schedules will detail any specific monitoring or consultation/communication requirements.

The schedule will be read and signed by all site personnel involved in the work, prior to the activity commencing. This will be incorporated into the activity briefing.

Table 16 – Activities requiring schedules

Activity	Schedule reference	Schedule version/date
Trial of concrete excavation/breaking	CNVMS1-TR	v1.0 16-Oct-12
Concrete apron removal	CNVMS2-TR	v1.0 16-Oct-12
Archaeological investigation*	CNVMS3-TR	-
Existing ground excavation	CNVMS4-TR	v0.1 16-Nov-12
Base course	CNVMS5-TR	v0.1 16-Nov-12
Road surface construction	CNVMS6-TR	In preparation
Night works for tie-ins	CNVMS7-TR	In preparation

Note * - only required if excavation works are immediately next to receivers

11. MONITORING

Monitoring will be conducted by the staff listed in Table 17. Compliance monitoring will typically be carried out at the receivers listed in Table 6.

Table 17 – Trained measurement staff

Name
Alan Benton
James Block
Michael Smith
Stephen Chiles
Tim Haxell
James Green
Matthew Nabney

11.1 Noise

Noise monitoring will be conducted in general accordance with NZS 6801:2008 and NZS 6803:1999, using the NZTA construction monitoring survey sheet and procedures (www.acoustics.nzta.govt.nz).

Noise monitoring will be conducted using the dedicated sound level meter kit owned by the Alliance. This equipment is listed below in Table 18 and will be stored at Alan Benton's office (Geotechnics) for the duration of the Project. The calibrator will be verified by an accredited laboratory annually and the sound level meter and microphone biannually.

Table 18 – Noise monitoring equipment

Equipment	Make	Model	Serial number	Last verification
Sound level meter	01 dB	Solo	TBC	TBC
Microphone	TBC	TBC	TBC	TBC
Calibrator	01 dB	CAL02	TBC	TBC
Software	TBC	TBC	-	-
Wind shield	TBC	TBC	-	-
Tripod	TBC	TBC	-	-

Monitoring will be conducted as follows:

- When an activity commences, the sound levels assumed for each of the major items of equipment will be verified, and to assess the effectiveness of noise control measures and implementation of this plan.
- At regular intervals during the works, at least every two weeks, to check ongoing compliance with the construction noise criteria.
- As required by a construction noise and vibration management schedule.
- If required, in response to construction noise related complaints.

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Following each noise survey, the results will be reported on the NZTA survey report template and any issues discovered will be investigated. Monitoring details will be stored on the Project Orbit website and the results will additionally be recorded on the Project web page www.acoustics.nzta.govt.nz (Section 13).

If noise monitoring indicates that Project noise criteria are being exceeded, and that was not anticipated in the management schedule (Section 10) for the activity/location, then the management schedule will be reviewed by James Block or a delegate within 1 working day.

11.2 Vibration

Vibration monitoring will be conducted in accordance with condition NZTA.23, guided by the NZTA State highway construction and maintenance noise and vibration guide. Vibration measurements will be conducted using the vibration monitoring kit dedicated to this Project, owned by the Alliance. This equipment is listed in Table 19 and will be stored at Alan Benton's office (Geotechnics) for the duration of the Project. The equipment will be verified by an accredited laboratory biannually.

Table 19 – Vibration monitoring equipment

Equipment	Make	Model	Serial number	Last verification
Vibration meter	Instanet	MiniMate Pro 6	TBC	TBC
Geophones	TBC	TBC	TBC	TBC

Vibration Monitoring will be conducted as follows:

- During the trial of the concrete breaking (complete).
- As required by a construction noise and vibration management schedule.
- If required, in response to construction noise related complaints.

Following each vibration survey, the results will be stored on the Project Orbit website (Section 13).

11.3 Building condition surveys

Conditions NZTA.24 and NZTA.25 require building condition surveys for the undergrounding works.

Based on the initial vibration predictions in Section 8, vibration levels may exceed the Category A building damage criteria of 5 mm/s (Table 5) at all of the receivers identified in Table 6. Thus, these buildings will be subject to condition surveys.

Table 20 – Survey programme

Receiver	Survey	Report date
R01- Mount Cook School, 160 Tory Street	Complete	
R02 - Te Papa Archives, 175/179 Tory Street	Complete	2-Nov-12
R03 - Apartments, 176 & 178 Tory Street	Complete	
R04 -The former Mount Cook Police Barracks, 13 Buckle Street.	Complete	5-Nov-12
R05 - Tasman Garden Apartments/Townhouses, 1 Tasman Street	Complete	
R06 - Apartments, 1 Sussex Street.	TBC	

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R07 - National War Memorial and the Carillon, 7 Buckle Street	TBC	
R08 - HMNZS Olphert, 213B Taranaki Street.	Complete	
R09 - Former Army Headquarters Building, 213A Taranaki Street.	Complete	
R10 - Former Francis Holmes building, 208 Taranaki Street.	Complete	
R11- Former Home of Compassion Crèche, 18 Buckle Street	Complete	

12. COMPLAINTS

The following procedure shall be followed for all noise and vibration complaints:

1. All noise and vibration complaints should be immediately directed to Michelle Brock.
2. As soon as the complaint is received it will be recorded on the Project stakeholder management system (Darzin www.darzin.com).
3. An initial response will be made and recorded. Depending on the nature of the complaint the initial response could be to immediately cease the activity pending investigation, or to replace an item of equipment. However, in some cases it might not be practicable to provide immediate relief. The complainant and Council will be informed of actions taken within 5 working days. Contact details for the Council are recorded in Section 1.3 of this plan.
4. Where the initial response does not address the complaint, further investigation, corrective action and follow-up monitoring shall be undertaken as appropriate. The schedule for the activity should be reviewed. The complainant and the Council will be informed of actions taken within 5 working days.
5. All actions will be recorded on the Project web page and the complaint will then be closed.

13. DOCUMENTATION

13.1 File

The construction noise and vibration management file will contain this plan, a number of schedules, monitoring reports and other data. For access by the WICI Project, all electronic files relating to construction noise and vibration will be kept on the Project Orbit website at the following location:

Environmental – Noise and Vibration

The construction noise and vibration management file will contain the following sections:

- Section 1 – Construction noise and vibration management plans
 - This Construction Noise and Vibration Management Plan and any revisions
 - Construction Noise and/or Vibration Management Schedules
 - Signed induction forms and schedules
- Section 2 – Noise and vibration monitoring
 - Site survey sheets and associated aerial photographs
 - Site survey summary sheet
 - Survey reports
 - Survey and equipment operating procedures
 - Current and past equipment kit details and calibration summary
 - Copies of calibration certificates
- Section 3 – Mitigation register

13.2 Web site

For access outside the WICI Project, copies of the following information will also be recorded on the Project construction noise web page on <http://acoustics.nzta.govt.nz/project>:

- This Construction Noise and Vibration Management Plan and any revisions,
- Construction Noise and/or Vibration Management Schedules, and
- Noise and vibration survey results.

The Project area on this web site will be administered by Michelle Brock. It will be made accessible to all the people listed in the contacts table in Section 1.3.

13.3 Information sharing

The designation conditions require certain documents to be provided for information, comment or certification. This applies to the CNVMP1-TR and details of complaints. As part of this management plan, further sharing of information is recommended as good practice. This includes schedules to this plan and survey reports. The following table details both the mandatory submissions and also the recommended information sharing under this plan.

Table 21 – Information

Information	Timeframe	Type
Construction noise and vibration management plan	In accordance with condition NZTA.22 a draft copy of this CNVMP1 TR will be submitted for comment to the Council at least five days before submission for certification.	Required
	In accordance with condition NZTA.27 the draft will also be submitted to stakeholders identified in Section 5 as part of consultation on the plan.	Required
	Following revision of the draft, an updated copy of this CNVMP1-TR will be submitted to the certifying planner and their acoustics advisor together with the comments and clear explanation of where any comments have not been incorporated and the reasons why.	Required
Construction noise and vibration management schedules	Submit to the Council and affected stakeholders before specific works commence.	Good practice
Noise/vibration survey reports	Submit to the Council within one week of monitoring	Good practice
Noise/vibration complaint initial report	Submit to the Council within twenty-four hours	Required
Noise/vibration complaint closed	Submit to the Council within one week of closing complaint	Required

APPENDIX A – DESIGNATION CONDITIONS

Conditions - Construction noise and vibration management

NZTA 22

The Agency shall, at least 5 working days prior to submitting the Construction Noise and Vibration Management Plan—Temporary Road (CNVMP1–TR) to a qualified planner (supported by a suitably qualified acoustician) for certification, and at least 5 working days prior to submitting the Construction Noise and Vibration Management Plan—Undergrounding (CNVMP2–U) to a qualified planner (supported by a suitably qualified acoustician) for certification submit a draft of the relevant plan to the Manager for comment. Any comments received shall be supplied to the certifier when the CNVMP1–TR or CNVMP2–U as relevant is submitted for certification against the requirements set out in condition NZTA 23, along with clear explanation of where any comments have not been incorporated and the reasons why.

NZTA 23

The CNVMP1–TR and CNVMP2–U shall—

- a) be prepared by a suitably qualified acoustics specialist; and
- b) include specific details relating to methods for the control of noise associated with—
 - (i) all relevant construction works associated with the enabling works for the Project including the creation of an at-grade diversion of part of Buckle Street in the case of CNVMP1–TR; and
 - (ii) all other relevant Project construction works in the case of the CNVMP2–U,—which shall be formulated to, as far as practicable, comply with the following criteria when assessed in accordance with NZS 6803:1999:

Time	Noise limits (dB)	
	L _{Aeq}	L _{Max}
Occupied residential and educational buildings		
6:00 am through to 7:00 am	70	85
7:00 am through to 8:00 pm	75	90
8:00 pm through to 11:00 pm	70	85
11:00 pm through to 6:00 am		District Plan construction noise limits
Other occupied buildings		
6:00 am through to 7.30 am	80	
7.30 am through to 6:00 pm	75	
6:00 pm through to 11:00 pm	80	
11:00 pm through to 6:00 am		District Plan construction noise limits

- c) address the following aspects with regard to managing the adverse effects of construction noise:
 - (i) noise sources, including machinery, equipment and construction techniques to be used; and
 - (ii) predicted construction noise levels; and
 - (iii) hours of operation, including times and days when noisy construction work would occur; and
 - (iv) the identification of activities and locations where structural noise mitigation measures such as temporary barriers or enclosures may be used; and
 - (v) the measures that will be undertaken by the NZTA to communicate noise management measures to affected stakeholders; and

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- (vi) mitigation options, including alternative strategies where full compliance with the noise criteria set out in the table above cannot practicably be achieved; and
 - (vii) schedules containing information specific to each area of the site where this is relevant to managing construction noise and vibration effects; and
 - (viii) methods for monitoring and reporting on construction noise.
- (ca) include specific details relating to methods for the control of vibration associated with all relevant Project construction works, which shall be formulated to, as far as practicable, comply with the Category A criteria in the following table when measured in accordance with ISO 4866:2010 and AS 2187-2:2006:

Receiver	Details	Category A	Category B
Occupied dwellings	Night-time 2000h–0630h	0.3 mm/s ppv	1 mm/s ppv
	Daytime 0630h–2000h	1 mm/s ppv	5 mm/s ppv
Other occupied buildings	Daytime 0630h–2000h	2 mm/s ppv	10 mm/s ppv
All buildings	Vibration—transient	5 mm/s ppv	BS 5228-2 ¹ Table B.2
	Vibration—continuous		BS 5228-2 ¹ 50% of B.2

*¹ BS 5228-2–2009 “Code of practice for noise and vibration control on construction and open sites—Part 2: Vibration”.

- (d) describe the measures to be adopted in relation to managing construction vibration including—
- (i) identification of vibration sources, including machinery, equipment and construction techniques to be used; and
 - (ii) procedures for building condition surveys at locations close to activities generating significant vibration, prior to and after completion of the works (including all buildings predicted to experience vibration which exceeds the Category A vibration criteria); and
 - (iii) procedures for management of vibration, if measured or predicted vibration levels exceed the Category A criteria; and
 - (iv) procedures for monitoring of vibration levels and effects by suitably qualified experts if measured or predicted vibration levels exceed the Category B criteria; and
 - (v) the measures that will be undertaken by the Agency to communicate vibration management measures to affected stakeholders.

NZTA 27

Methods to be adopted within the CNVMP1–TR or CNVMP2–U to manage construction noise and vibration shall be formulated following the Agency having first consulted with Mt Cook School, the Ministry of Defence (with regards to HMNZS Olphert and the Former Army Headquarters Building), Te Papa Archives, 176/178 Tory Street, and the owners and occupiers of 13 Buckle Street, and Tasman Garden Apartments/Townhouses, 1 Tasman Street.

The CNVMP1–TR and CNVMP2–U shall set out how any issues raised in consultation with the listed entities have been incorporated, and where they have not, the reasons why.

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APPENDIX B – REVIEW COMMENTS

Comment	Response
John Dennison, WCC – comments on v1.0 received 5 October and 6 November 2012	
Table 1-Amend WCC contacts and details.	Comment actioned.
Table 1- Clarify out of normal office hours contact number.	Comment actioned.
Section 2.2 - Is there any opportunity to allow some respite from 7 day working?	Amend text to clarify that works would generally not be expected to be continuous over 7 days.
Table 4 - relevant part of the District Plan refers to an L ₁₀ rather than an L _{eq} .	It is acknowledged that the district plan is in terms of the L ₁₀ , but for consistency with the Act and NZS 6803:1999 it has been taken as an L _{eq} . It would not be practical to use two different descriptors in routine monitoring. While the L ₁₀ limit would usually be around 3dB more stringent than the L _{eq} , the L _{eq} is a facade level which is 3dB more stringent in the opposite direction. The two are therefore approximately equal. Amend text to explain this.
Table 14 – Consider mitigation through the hours of work (timing and duration) be explicitly proposed.	Comment actioned.
Will monitoring take place at the site identified in Table 6 – Receivers?	Monitoring will be carried out at all the receivers in Table 6, depending on the location of the works at the time. Amend text to clarify this.
Will records be maintained and made available to Wellington City Council Compliance Officers (as per table 20)?	WCC will have access to the monitoring records through the project page on the NZTA Acoustics website (Section 13.2).
James Whitlock (vibration reviewer) – comments on v1.1 received on 13 November 2012	
Correct minor typographic mistakes identified.	Comment actioned.
Change acronym table to a glossary including noise and vibration terms and move to appendix.	Noise and vibration terms have been added (page 3). Table left at start of document for consistency with Alliance template.
Section 1 - Reference CNVMP2-U on page 2 and show in Figure 1.	Comment actioned.
Section 1.1 - Add word 'key' in 2 nd para.	Comment actioned.
Section 1.2 - Clarify status of Michelle Brook reviewing CNVMP1-TR.	Page 6 text reworded to make clear that Michelle is reviewing documents under CNVMP1-TR once it is certified.
Sections 2.2 and 3.2 - Revise hours of operation to align with noise and vibration limits.	Comment actioned.
Section 3.2 - Revise wording of sentence equating different versions of NZS 6803.	Comment actioned, although noise limits have also been altered in response to comments from the certifier.
Section 3.2 - Suggest removing reference to NZS 6803P:1984	Reference retained as this is from the District Plan which is referenced by the conditions.
Table 5 - Delete location column as it is inconsistent with the conditions.	The location column has been retained as it provides the specific advice to carry out an assessment according to the conditions. To be effective CNVMP1-TR needs to contain practical details.
Section 3.3 - Add reference to mitigation in schedules.	Comment actioned.
Section 4 - Add note about other receivers.	Comment actioned.
Section 5 - Reword 2 nd sentence to make clear consultation is a requirement.	Comment actioned.
Section 7 - Note that data has also been obtained from measurements	Comment actioned.
Table 10 – suggest reversing tables 10 and 11 and relabelling	Comment actioned.

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Comment	Response
Section 8 – highlight word 'red'	Comment actioned.
Section 8 – highlight exceedance of Category B in a different colour	Comment actioned.
Section 9 – sentence 2 is confusing	Sentence rephrased
Section 9 – induction form not appended	Comment actioned.
Table 15 – add reference to equipment operation	Comment actioned.
Section 10 – add schedules in response to complaints	Comment actioned.
Section 10 – Add that schedules will be prepared in response to reasonable complaints.	Comment actioned.
Section 10 – Suggests that schedules should be certified.	No change made. The timescales for schedules do not allow for a formal certification process. However, all schedules are provided to WCC.
Table 16 – Delete footnote relating to archaeological investigations.	Footnote has been retained. At this stage it is unknown where detailed archaeological investigations may be required.
Section 11 – Where are other monitoring staff listed?	Table created for other monitoring staff.
Section 11.2 – Monitoring should be in accordance with NZTA.23	Comment actioned.
Section 11.3 – Reorder second para.	Comment actioned.
Table 19 – Update dates.	Comment actioned.
Section 12 – Add timeframes to complaint procedure.	Comment actioned.
Section 12 – Reference CNVMS in complaints procedure.	Comment actioned.
Section 13 – Explain difference between the CNVMP1-TR and the file in 13.1.	Sentence added in Section 13.1 describing the relationship.
Section 13 – Give full URL	Comment actioned.
Section 13 – Is there public access to the project files.	No change made. There is not public access to the files as they contain private information about stakeholders.
Mark Ashby and Nigel Lloyd – comments on v1.1 made at meeting on 15 November 2012	
Section 1 – Add statement of professional qualifications of author.	New Section 1.2 added with author details.
Section 1 – Acknowledge that plan is in accordance with the Act.	Acknowledgement added in first and second paragraphs.
Section 2.2 – Change 'daytime' description to match criteria.	Sentence added in Section 2.1 (new numbering)
Tables 4 & 5 – List buildings for each category	References added to first column
Section 3.2 – Explain use of 15 minute time period	Footnote added to Table 4
Section 5 – Rephrase that a framework is set for communications rather than stating what will occur.	First sentence on page 14 rephrased.
Section 6 – Cross reference Section 10 for measurement of source data.	Note added to end of first paragraph.
Section 6 – Take source data from the old (1997) version of BS 5228	Data source changed in Table 8.
Section 6 – Reference machinery, equipment and construction techniques as in conditions	Tables 8 and 9 headings adjusted. (Also tables 10 and 11)
Section 9 – Add reference to alternative strategies.	New second paragraph inserted.

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Comment	Response
Table 14 – Add mitigation measures	Comment actioned.
Section 11.1 – Add a timeframe and person responsible for reviewing schedules	Comment actioned.
Add review comments received and actions taken	This Appendix has been inserted.

APPENDIX C – CONSTRUCTION NOISE AND VIBRATION INDUCTION

Project: WICI Temporary Road

There are several residential and commercial neighbours in close proximity to the works, where noise and vibration limits apply. To ensure limits are achieved, all staff are responsible for good noise and vibration management.

1. When arriving at work, please drive slowly on site and keep revs to a minimum. Keep stereos off and do not slam doors.
2. No shouting or swearing on site. Either walk over and talk to somebody or use a radio/phone.
3. Be careful with tools and equipment. Place them down and do not drop them.
4. Do not drag materials on the ground. Place them down when you arrive at the work area.
5. Equipment and vehicles should not be left running when not in use.
6. When loading trucks try not to drop material from a height. Load softer material at the bottom.
7. Noise enclosures should always have all doors/hatches closed when the equipment is in use.
8. Stationary equipment such as pumps and generators should be located away from neighbours.
9. All equipment is to be well maintained.
10. No work shall be conducted outside the hours of 0600h to 2300h without specific approval (contact Michelle Brock) and all staff involved in the task have read and signed the Construction Noise Management Schedule for that task.
11. For the following activities, all staff involved in the task will read and sign the Construction Noise Management Schedule for that task:
 - a. Trial of concrete excavation/breaking
 - b. Concrete apron removal
 - c. Archaeological investigation*
 - d. Existing ground excavation
 - e. Base course
 - f. Road surface construction
 - g. Night works for tie-ins
12. Near commercial buildings such as the Te Papa site and near Mount Cook School, if practicable, any particularly noisy activities or those that produce vibration should be carried out for the evening period between 1800h and 2300h so as to minimise disturbance during the day.
13. If you see anything/anyone making unnecessary noise or vibration then stop it/them. If the source cannot be stopped then report it to Michelle Brock.
14. It is essential that good relationships are maintained with the local community. Any queries from members of the public should be responded to politely and referred to Michelle Brock or Miranda Greer. Staff shall assist the public to make contact with this person. Staff shall not enter into debate or argue with members of the public.

APPENDIX D - REVERSING ALARMS

Specifications

All contractors are responsible for ensuring the reversing alarms on their vehicles are of an appropriate specification to ensure a safe working environment. As a guide, the following reversing alarm requirements are likely to be appropriate on most NZTA projects:

- broadband
- directional
- automatic level adjustment over a range of approximately 20dB
- maximum rated level approximately 97dB.

This guideline is appropriate for medium vehicles on typical urban sites. A higher or lower rated level may be appropriate for other vehicles and sites.

Suppliers

For the NZTA Victoria Park Tunnel and Newmarket Viaduct projects, the broadband reversing alarms cost between approximately \$100 and \$400 (2011) and were primarily supplied by:

- Rearsense, www.rearsense.co.nz, model SA-RRA-97
- Capital Instruments, www.capitalinstruments.co.nz, model BBS97SA.

Fitting

Reversing alarms require two wires to be connected. In many cases, they are a standard size, allowing them to be directly swapped with the alarm originally supplied with a vehicle.

As broadband alarms produce a 'beam' with the loudest noise in one particular direction, it is important that the alarms are fitted with an unimpeded view facing backwards from the vehicle.

Alarms should always be fitted by a suitably qualified technician.



A broadband reversing alarm

Further information

NZTA Transport Noise website
www.acoustics.nzta.govt.nz

Dr G Leventhal, *The loudness of broadband alarms and audibility over machine noise*
www.brigade-electronics.com/sites/default/files/Loudness%20of%20Broadband%20Alarms%20Final.pdf

Our contact details

For general enquiries and contact information for the NZ Transport Agency, please check our website www.nzta.govt.nz or email us at info@nzta.govt.nz

NATIONAL OFFICE
Victoria Arcade
44 Victoria Street
Private Bag 6995
Wellington 6141
New Zealand
Telephone: +64 4 894 5400
Fax: +64 4 894 6100

TRANSPORT REGISTRY CENTRE
Private Bag 11777
Palmerston North 4412
New Zealand
Telephone: 0800 108 809
(motor vehicle registrations)
Telephone: 0800 822 422
(driver licensing)
Fax: +64 6 953 6406

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NZ TRANSPORT AGENCY
WAKA KOTAH

New Zealand Government

Construction noise

Reversing alarms

Tonal beeping alarms on reversing construction vehicles are a common cause of noise complaints. All construction vehicles on NZTA projects in urban areas should preferably be fitted with broadband reversing alarms to minimise disturbance to residents.



NZ TRANSPORT AGENCY
WAKA KOTAH

New Zealand Government

Tonal alarms

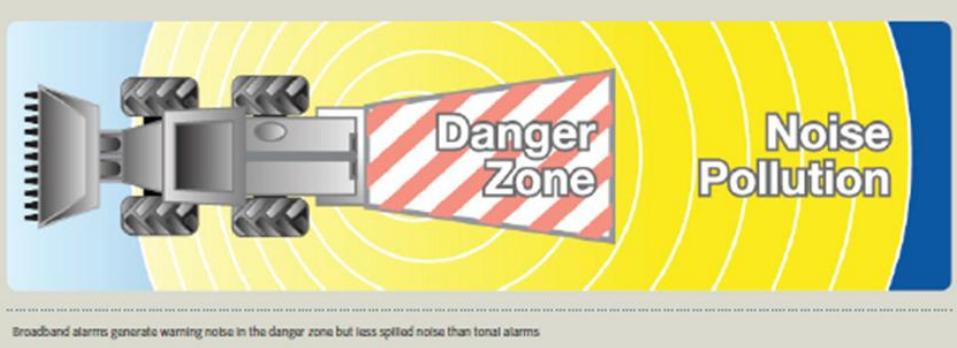
Traditionally, all construction vehicles have been fitted with a tonal alarm that makes a loud beeping noise as the vehicle reverses. The noise from these alarms is distinctive due to the single frequency (tone) of noise being produced. Consequently, as well as achieving the goal of attracting the attention of construction workers behind the vehicle, the alarms can be disturbing for nearby residents.

In many situations such as at ports and quarries, as well as road construction projects, tonal reversing alarms are the most common reason for noise complaints, particularly at night. Other noise sources may last longer and are often louder, but the distinctive characteristics of tonal reversing alarms usually cause greater disturbance.

Broadband alarms

Broadband reversing alarms generate noise across a range of frequencies. The noise level varies and these are sometimes described as 'squawkers' or 'quackers'. Close to a vehicle, these alarms can be as loud as traditional beepers, but at a distance the noise does not have the same distinctive characteristics as a tonal alarm and therefore causes significantly less disturbance.

Broadband alarms generally produce a beam of noise, and are significantly louder in one direction compared with other directions. When correctly fitted with the beam facing backwards, the alarm will be loud behind the vehicle where workers need to be made aware of the vehicle reversing, but less noise will be 'spilled' in other directions towards residents. The noise in neighbouring areas can therefore be reduced while maintaining the safety of workers.



Victoria Park Tunnel, 2009–2012

The Victoria Park Tunnel project in Auckland was the first NZTA project where broadband alarms were made mandatory for all vehicles on site. The project Alliance team procured a bulk order of broadband reversing alarms for contractors to fit to their vehicles. Also, one of the larger contractors separately purchased and fitted broadband alarms to all their vehicles.

No health and safety issues arose from the use of the broadband alarms on this project, and when standing behind vehicles the alarms appeared subjectively to be at least as loud as traditional beepers.

Residents expressed a clear preference for the broadband alarms.

Newmarket Viaduct, 2009–2012

For the Newmarket Viaduct project in Auckland, the use of broadband alarms was also made mandatory at night. In this instance, an information letter was provided to all contractors who were then required to procure and fit alarms to their own vehicles. This again proved to be successful in reducing disturbance to residents, with a stark comparison evident when complaints arose from tonal alarms on the adjacent Greenlane widening project.

For both the Victoria Park Tunnel and Newmarket Viaduct projects the biggest challenge was ensuring that all subcontractors had alarms fitted, including trucks visiting the site on a one-off basis. For future projects, tight controls are recommended to ensure all subcontractors adhere to reversing alarm requirements.

Future NZTA projects

All construction vehicles on NZTA projects in urban areas, or projects involving night works close to houses in other areas, should preferably be fitted with broadband reversing alarms to minimise noise disturbance to residents.