

21 December 2012



# CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN 2 – UNDERGROUNDING

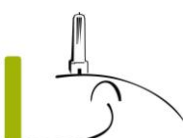
Wellington Inner City Improvements

National War Memorial Park (Pukeahu)

CNVMP2-U

Rev.	Status	Prepared by	Checked by	Date
1.0	Draft	James Block	Michael Smith	14 December 2012
1.1	Final	James Block	Michael Smith	21 December 2012

Name	Position	Date	Signature
James Block	Noise and vibration leader	21-Dec-12	
Ed Breese	Environmental manager	21-Dec-12	





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## GLOSSARY

Acronym	Definition
CNVMP	Construction noise and vibration management plan
CNVMS	Construction noise and vibration management schedule
MPA	Memorial Park Alliance
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 <sub>A10</sub>	The A-weighted sound level that is exceeded for 10% of the measurement period, measured in units of decibels (dB)
L <sub>Aeq(t)</sub>	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB)
L <sub>AFmax</sub>	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



### 1. INTRODUCTION

A requirement of the National War Memorial Park (Pukeahu) Empowering Act 2012<sup>1</sup> ('the Act') is the preparation of a Construction Noise and Vibration Management Plan for the underpass (CNVMP2-U). This plan has been prepared in accordance with the requirements of the Act. CNVMP2-U 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), Undergrounding
Construction location:	Buckle Street, Wellington
Construction start date:	7 February 2013
Construction finish date:	February 2015
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>).

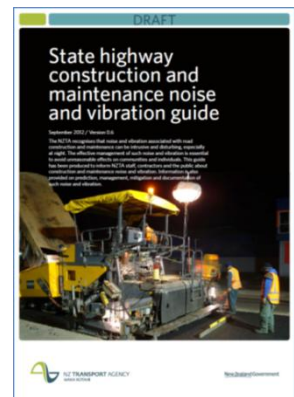
CNVMP2-U addresses the construction of the underpass only. Earlier construction work associated with the interim road (referred to initially in the project as 'temporary road') around the site of the underpass was the subject of Construction Noise and Vibration Management Plan CNVMP1-TR.

Following comments from stakeholders, CNVMP1-TR has been certified as required by Condition NZTA.22 of the Act (reproduced in Appendix A). This current plan has been prepared to be consistent with the certified CNVMP1-TR. The processes described in CNVMP1-TR have also been incorporated into this plan.

The certification process for CNVMP2-U has been as follows:

1. Version 1.0 of CNVMP2-U was submitted for comment to the Wellington City Council and the other stakeholders on 14 December 2012. A copy of this version was also sent to the certifier.
2. Comments received from these parties are presented in Appendix B, together with the responses. The Act (condition NZTA.27) requires issues raised to be set out including how they have been addressed or why they were not incorporated
3. Version 1.1 of CNVMP2-U was submitted for certification on 21 December 2012.

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



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

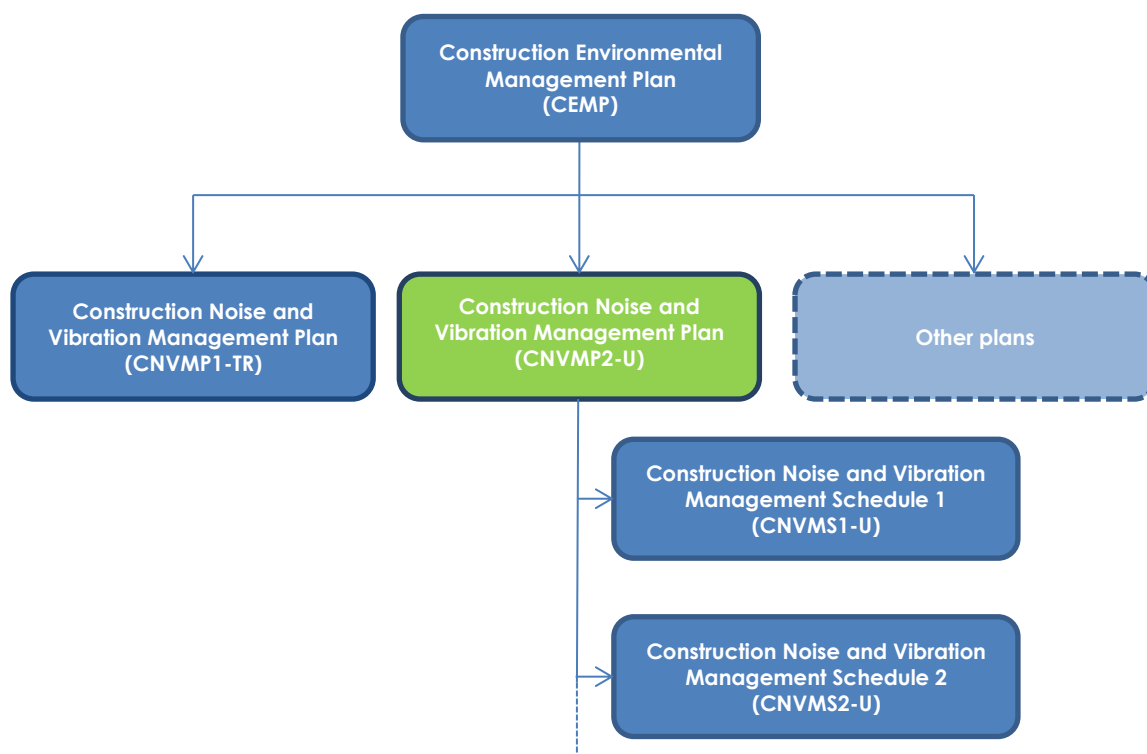


### 1.1 Plan and schedules

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 0.

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 CNVMP2-U to be prepared by a suitably qualified acoustical 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.



### 1.3 Contact details

Table 1 - Contacts

Role	Name	Organisation	Phone	Email
Environmental manager	Ed Breese	Memorial Park Alliance	021 333 726	ebreese@tonkin.co.nz
Construction Manager	Nigel McCreight		027 502 7786	nigel.mccreight@downer.co.nz
Stakeholder liaison	Miranda Greer		027 270 0593	miranda.greer@downer.co.nz
Noise and vibration leaders	Stephen Chiles		03 318 8854	stephen.chiles@urs.com
	James Block		021 738 241	james.block@urs.com
Noise and vibration coordinator	Michelle Brock		027 475 6982	michelle.brock@downer.co.nz
Noise and vibration monitoring manager	Alan Benton		021 537 523	abenton@goetechnics.co.nz
Building survey manager	Greg Szakats		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		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		Memorial Park Alliance	0800 020 086	memorial.park@nzta.govt.nz

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.



## **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 (Figure 2). The traffic on Buckle Street between Tory/Tasman Streets and Taranaki Streets will be diverted onto the interim road prior to construction commencing.

In broad terms, the construction is as follows:

1. Construct retaining walls to the north and south of the underpass, including ground anchors.
2. Excavate between the retaining walls, starting at the west end.
3. Cast concrete floor slab.
4. Cast concrete walls.
5. Cast concrete roof slab.
6. Remove retaining wall and backfill between retaining walls and underpass walls.

Table 2 provides further details of the construction activities and a programme for the underpass. Schematic diagrams of these activities are shown in Appendix C. These details will be updated as the construction methodology is refined.

Excavation is anticipated to start at the western end and progress towards the Basin Reserve. Subsequent activities, eg installing ground anchors, casting floor, walls and roof, etc., will follow the excavation along the tunnel. These subsequent activities will commence before excavation has been completed along the entire length of the underpass.

### **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, or during school holidays (for the school), so as to minimise disturbance during the day. This will need to be balanced against the impact on any nearby residential receivers.

Night works (2300h to 0600h) will be required to tie-in both ends of the new underpass 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.

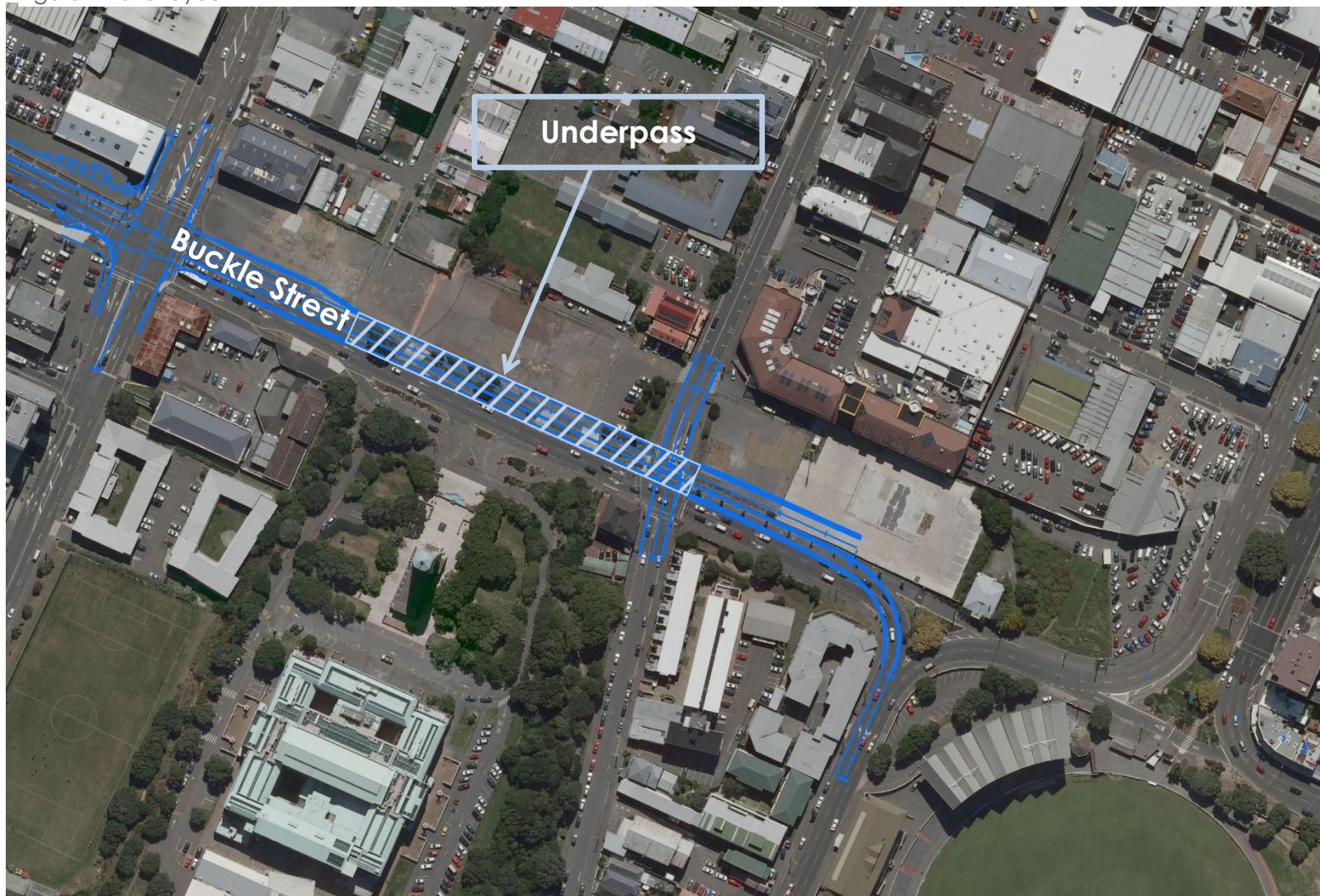


Table 2 - Outline construction phases and programme

Phase	Description	Duration	Start date	End date
1	Site set-up and early preparatory works	4 weeks	7 February 2013	6 March 2013
2	Construct haul road and install north retention wall posts	12 weeks	7 February 2013	2 May 2013
3	Install south retention wall posts and sheetpiles	9 weeks	25 March 2013	30 May 2013
4	Excavate to 1st bench and install ground anchors to retention walls	18 weeks	3 May 2013	6 September 2013
5	Excavate to 2nd bench and install ground anchors to retention walls	13 weeks	24 May 2013	23 August 2013
6	Excavate to founding level and install medium-term dewatering sump	7 weeks	8 July 2013	23 August 2013
7	Cast concrete floor slab	42 weeks	12 August 2013	5 June 2014
8	Fix wall rebar, form and cast wall concrete	37 weeks	10 October 2013	26 June 2014
9	Cast concrete roof slab	21 weeks	31 January 2014	26 June 2014
10	Backfill behind walls, tunnel fit-out	39 weeks	February 2014	November 2014
11	Surface underpass, connect both ends and open 2 lanes	4 weeks	November 2014	November 2014
12	Complete NW corner pavement and retaining walls	22 weeks	October 2014	February 2015
13	Open under pass to traffic, remove interim road	3 weeks	December 2014	December 2014



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 (CNVMP2-U) 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 3 – 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, R12)	0600h - 0700h	70 dB	85 dB
	0700h - 2000h	75 dB	90 dB
	2000h - 2300h	70 dB	85 dB
	2300h - 0600h	45 dB <sup>(b)</sup>	75 dB <sup>(b)</sup>
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  $L_{AFmax}$ .



### 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. Note that, as per the conditions, the time periods differ from those used in the noise conditions.

Table 4 – Vibration criteria and measurement locations adopted by the Alliance

Receiver	Details	Category A	Category B	Location
Occupied dwellings (Table 6: R03, R05, R06, R12)	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.



## 4. RECEIVERS

There is mixed use of the area around the underpass, 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 5 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 5 – 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 and restoration	7 m
R03	Apartments, 176 & 178 Tory Street.	Residential	13 m
R04	The former Mount Cook Police Barracks, 13 Buckle Street.	Office	5 m
R05	Tasman Garden Apartments/Townhouses, 1 Tasman Street.	Residential	8 m
R06	Apartments, 1 Sussex Street.	Residential	10 m
R07	National War Memorial and the Carillon, 7 Buckle Street.	Memorial	40 m
R08	HMNZS Olphert, 213B Taranaki Street.	Office	3 m
R09	Former Army Headquarters Building, 213A Taranaki Street.	Vacant	3 m
R10	Former Francis Holmes building, 208 Taranaki Street.	Office/storage	50 m
R11	Former Home of Compassion Crèche, 18 Buckle Street.	Vacant, Category 1 Historic Building	30 m
R12	Grandstand Apartments, Cambridge Terrace.	Residential	40 m



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 6 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 6 – 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@extra.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



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 6 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 6 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.



## 6. NOISE SOURCES

Table 7 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 7 – 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	77-82 dB	Measured on WICI site
Pipe jack	TBC	TBC	TBC	
Directional drilling rig	TBC	TBC	86 dB	Measured on previous project
Grader	Mitsubishi MG300	-	76 dB	Measured on WICI site
Vibratory compactor	CAT	8 tonnes	74 dB	Measured on WICI site
Sheet piling – driven	TBC	TBC	65-78 dB	NZS 6803, Annex C, Table C.4
King posts - augured	TBC	TBC	79-90 dB	NZS 6803, Annex C, Table C.4
Crane	TBC	TBC	71-82 dB	NZS 6803, Annex C, Table C.7
Percussion drill for ground anchors	TBC	TBC	86 dB	URS database
Concrete truck	TBC	TBC	68-72 dB	NZS 6803, Annex C, Table C.6
Concrete pump	TBC	TBC	78-79 dB	NZS 6803, Annex C, Table C.6
Paving machine	TBC	TBC	80-86 dB	NZS 6803, Annex C, Table C.8
Road miller	TBC	TBC	83 dB	NZS 6803, Annex C, Table C.8
Road roller	TBC	TBC	83 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 equipment that is likely to be used.



Table 8 – Key activities – noise

Ref	Construction activity	Equipment and % use during that activity
N1	Reduce overburden/archaeological investigation	Excavator 80% Truck 50%
N2	Pipe jack 900mm sewer	Pipe jacking machine 90% 50T crawler crane 50% Truck 50% Pump 100%
N3	Thrust stormwater line from Cambridge Terrace	Directional drill rig 100%
N4	Construct haul road	Grader 75% Vibratory compacter 75% Truck 75%
N5	Install retaining wall King-posts	Auger piling rig 90% Crane 90% Truck 50%
N6	Install south retaining wall sheetpiles	Sheet piling rig 90% Crane 90% Truck 50%
N7	Excavate	Excavators (3) 90% Truck 50%
N8	Install lagging to King-Posts with crane	Crane 75% Truck 50%
N9	Install ground anchors	Percussion drill 90% Crane 25%
N10	Cast underpass floor slab, walls and roof	Concrete truck 100% Concrete pump 100%
N11	Backfill behind walls and cover roof	Excavator 90% Truck 50%
N12	Pave the road surface of the underpass	Paving machine 100% Truck 100% Roller 100%
N13	Connect both ends	Road miller 20% Excavator 20% Grader 20% Vibratory compacter 20% Truck 20% Paving machine 20% Road roller 20%
N14	Construct NW corner pre-cast retaining walls	Crane 80% Truck 50%



Ref	Construction activity	Equipment and % use during that activity
N15	Remove retaining wall – north side	TBC
N16	Remove interim road	Road miller 70% Excavator 60% Grader 60%

## 7. VIBRATION SOURCES

The following table shows the key construction activities likely to generate significant vibration.

Table 9 – Key activities – vibration

Ref	Construction activity	Equipment
V1	Pipe jack 900mm sewer	Pipe jack Sheet piling rig
V2	Thrust stormwater line from Cambridge Terrace	Directional drill rig
V3	Construct haul road	Vibratory compacter
V4	Install retaining wall King-posts	Auger piling rig
V5	Install south retaining wall sheetpiles	Sheet piling rig
V6	Install ground anchors	Percussion drill
V7	Remove retaining wall – north side	TBC

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 10 – Vibration levels

Ref	Machinery/ Equipment	Equipment details	Vibration (ppv at 10 m)
V1	Pipe jack	TBC	TBC
V2	Directional drill rig	TBC	TBC
V3	Vibratory compacter	Dynapac CA151D	2.8 mm/s
V4	Auger piling rig – King posts	TBC	0.4 mm/s
V5	Driven piling rig – sheet piles	TBC	TBC
V6	Percussion drill	TBC	TBC
V7	TBC	TBC	TBC



## 8. PREDICTED NOISE AND VIBRATION LEVELS

Using the information in Section 2 regarding the activities, equipment and noise source levels, the noise levels at the nearest receivers (Section 4) have been predicted for each of the activities likely to produce significant noise. These indicative calculations have been carried out using the guidance in the draft NZTA *State highway construction and maintenance noise and vibration guide*. The noise results are presented in **Error! Reference source not found.** 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. Any screening of noise from the equipment by the earthworks has not been included.

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.

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* and the predicted vibration levels are in Table 12 for the activities likely to generate significant vibration.

The generic vibration data presented in Table 10 has been used for the activities identified in Table 9. Where the predicted vibration has exceeded the lowest daytime Category A criteria from Table 4, 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.



## CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN 2 – UNDERGROUNDING

Wellington Inner City Improvements

Table 11 - Noise predictions

Ref	Predicted noise level $L_{Aeq}(15min)$ dB											
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12
N1	79	79	79	82-83	82-83	82-83	68-69	85-86	85-86	70-71	74	59
N2	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
N3	62	70	63	63	65	68	60	59	57	56	74	75
N4	71-73	68-70	71-73	65-67	66-69	66-69	57-60	68-71	68-71	59-62	66-69	51-54
N5	73-84	73-84	73-84	70-81	73-84	76-87	67-78	88-99	88-99	70-81	72-83	62-73
N6	62-73	62-73	62-73	76-86	70-80	63-74	59-70	53-64	52-63	50-60	57-68	52-63
N7	80	80	80	88	82	82	75-76	94	94	76	77-78	68
N8	66-76	66-76	66-76	62-72	65-75	68-78	59-69	80-90	80-90	62-72	64-74	54-64
N9	81	81	81	89	83	83	76-77	95	95	77	78-79	69
N10	73-75	73-75	73-75	81-83	75-77	75-77	69-70	87-89	87-89	69-71	71-72	61-63
N11	76-77	76-77	76-77	84-85	78-79	78-79	71-73	90-91	90-91	72-73	73-75	64-65
N12	59-64	69-74	62-67	68-73	71-76	71-76	56-62	83-88	83-88	65-70	67-72	57-62
N13	55-56	64-65	56-57	57-59	62-63	73-74	54-56	67-69	74-75	68-69	70-72	55-56
N14	53-63	49-59	51-61	50-60	48-58	46-56	52-62	66-76	66-76	61-71	44-54	42-52
N15	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
N16	88	85	80	70	69	79	63	75	80	73	88	60



## CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN 2 – UNDERGROUNDING

Wellington Inner City Improvements

Table 12 - Vibration predictions

Ref	Predicted vibration level ppv mm/s											
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12
V1	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
V2	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
V3	2.4-2.5	2.1-2.3	2.4-2.5	1.7-2	1.9-2.1	1.9-2.1	0.9-1.4	2.1-2.3	2.1-2.3	1.2-1.6	1.9-2.1	0.4-1
V4	0.3-0.4	0.3	0.3-0.4	0.2-0.3	0.3	0.3	0.1-0.2	0.3	0.3	0.2	0.3	0.1
V5	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
V6	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
V7	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC



## 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 13 and Table 14 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 D). 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 13 – Noise mitigation

Equipment/process	General noise control measures
All	Select equipment with noise levels at the lower end of the range quoted in Table 7
	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. 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, or during school holidays (for the school), so as to minimise disturbance during the day. This will need to be balanced against the impact on any nearby residential receivers.
	Use localised screening/enclosure where required
Tracked vehicles	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 14 – Vibration mitigation

Equipment/process	General vibration control measures
All	Select equipment with vibration levels at the lower end of the range quoted in Table 10
	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 E. 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 15, and where complaints have been received and investigations indicate that actions are required to achieve reasonable noise and vibration levels. 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](http://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 15 – Activities requiring schedules

Ref	Construction activity	Schedule reference	Schedule version/date
N1	Reduce overburden/archaeological investigation	CNVMS01-U	
N2, V1	Pipejack 900mm sewer	CNVMS02-U	
N3, V2	Thrust stormwater line from Cambridge Terrace	CNVMS03-U	
N4, V3	Construct haul road	CNVMS04-U	
N5, V4	Install retaining wall King-posts - north side	CNVMS05-U	
	Install retaining wall King-posts - south side	CNVMS06-U	
N6, V5	Install south retaining wall sheetpiles	CNVMS07-U	
N7	Excavate	CNVMS08-U	
N8	Install lagging to King-Posts with crane	CNVMS09-U	
N9, V6	Install ground anchors	CNVMS10-U	
N10	Cast underpass floor slab, walls and roof	CNVMS11-U	
N11	Backfill behind walls and cover roof	CNVMS12-U	
N12	Pave the road surface of the underpass	CNVMS13-U	
N14	Construct NW corner retaining walls	CNVMS14-U	
N15, V7	Remove retaining wall – north side	CNVMS15-U	
N16	Remove interim road	CNVMS16-U	



## 11. MONITORING

Monitoring will be conducted by the staff listed in Table 16. Compliance monitoring will typically be carried out at the receivers listed in Table 5.

Table 16 – Trained measurement staff

Name	Organisation	Contact details
Alan Benton	Memorial Park Alliance	See Table 1
James Block		
Michael Smith		Contact via James Block
Stephen Chiles		See Table 1
Tim Haxell		Contact via Alan Benton
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](http://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 17 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 17 – 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.



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](http://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 18 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 18 – Vibration monitoring equipment

Equipment	Make	Model	Serial number	Last verification
Vibration meter	Instantel	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 before and after the undergrounding works. Additional settlement inspections will be carried out during the course of the works:

- On completion of significant or deep foundation works adjacent to each building
- When notified by building owners or others that cracking or serviceability issues are present

Based on the initial vibration predictions in Section 8, vibration levels may exceed the Category A building damage criteria of 5 mm/s (Table 4) at all of the receivers identified in Table 5. Thus, these buildings will be subject to condition surveys.



Table 19 – Survey programme

Receiver	Survey	Report date
R01- Mount Cook School, 160 Tory Street	Complete	In progress
R02 - Te Papa Archives, 175/179 Tory Street	Complete	2-Nov-12
R03 - Apartments, 176 Tory Street	Complete	29-Oct-12
R03 - Apartments, 178 Tory Street	Complete	2-Nov-12
R04 -The former Mount Cook Police Barracks, 13 Buckle Street.	Complete	5-Nov-12
R05 - Tasman Garden Apartments/Townhouses, 1 Tasman Street	Complete	In progress
R06 - Apartments, 1 Sussex Street.	In progress	In progress
R07 - National War Memorial and the Carillon, 7 Buckle Street	Complete	In progress
R08 - HMNZS Olphert, 213B Taranaki Street.	Complete	13-Nov-12
R09 - Former Army Headquarters Building, 213A Taranaki Street.	Complete	9-Nov-12
R10 - Former Francis Holmes building, 208 Taranaki Street.	Complete	In progress
R11- Former Home of Compassion Crèche, 18 Buckle Street	Complete	In progress
R12 – Grandstand apartments	In progress	In progress



## **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](http://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. This will be documented in a CNVMS. 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 CNVMP2-U 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 20 – Information

Information	Timeframe	Type
Construction noise and vibration management plan	In accordance with condition NZTA.22 a draft copy of this CNVMP2-U 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 CNVMP2-U 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 <sub>Aeq</sub>	L <sub>Amax</sub>
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



- (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 <sup>*1</sup> Table B.2
	Vibration—continuous		BS 5228-2 <sup>*1</sup> 50% of B.2

<sup>\*1</sup> 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.



## APPENDIX B – REVIEW COMMENTS

Comment	Response
<b>Received from John Dennison, WCC , 19 December 2012 on CNVMP2-U v1.0</b>	
I note that the Appendix A levels provided are predicted to be significantly exceeded. In particular at the HMNZS Olphert site. Given the nature of this project I assume that the contractor is able secure a reasonable understanding with NZ Defence Force personnel for this work to proceed.	Agreed. The buildings of HMNZS Olphert are the typically the closest receiver to the majority of the activities and therefore appears frequently in Table 11. Note that noise and/or vibration levels above the criteria may also occur at other receivers which are further away from the construction activity. In response to comments from the certifying planner and their acoustics advisor (see below), v1.1 will include predictions of noise and vibration at all receivers for all activities.  Liaison with all affected stakeholders will be undertaken (Section 5). They have been consulted during the preparation of this plan and will also be consulted throughout the works
Some data for equipment is not available and consequently predictions of SPL's are not available in Table 11. In particular no data is available for the Grandstand Apartments which is classified as "noise sensitive" in the Council's District plan. I cannot see any information relating to stakeholder engagement with that site. I would encourage an approach to those householders be made (if not already done). I should also be grateful for any noise measurements you are able to provide for this site, once they are available.	Agreed. Not all of the equipment for the construction works has been identified at this stage or noise data is not available for some of the less-common items. The plan will be updated when this information becomes available, including from measurements when equipment first arrives on-site.  The Grandstand Apartments are an additional receiver to those included in CNVMP1-TR and has been added due to its proximity to the stormwater drilling in Cambridge Terrace. These apartments are not specifically listed in Condition NZTA 27 but are included in the plan as an affected receiver. Hence liaison will be undertaken with these occupants.  Any noise measurements undertaken on this project will be recorded on the project web page (Section 13.2) to which WCC has access.
I note that hours of operation are intended to be between 6.00hrs to 23.00hrs with evening work scheduled near commercial buildings and the school wherever practicable.	Agreed. This is included in Section 2.1 and Table 12.
Where practicable I would encourage as much work near the school to be carried out during school vacations in preference to term time	Agreed. Additions made to Section 2.1 and Table 12 to accentuate this.
<b>Received from Nigel Lloyd, Acoustic Advisor to Certifying Planner, 19 December 2012 on CNVMP2-U v1.0</b>	
The predictions in Table 11 have only been done for the nearest receivers.  In Plan 1 the equivalent Table 12 predicted all of the activities for all of the receivers and I believe the conditions require this. The reason for this Plan is to identify which areas the schedules are required and therefore it needs to be determined where the non-compliances may occur.	Only the results for the nearest receivers were included as these could be used to indicate which activities required schedules. At the schedule stage then the impact on the all the receivers would be assessed.  Nevertheless, predictions for all the receivers for all of the activities will be included in v1.1
<b>Received from James Whitlock, Vibration Advisor to Certifying Planner, 20 December 2012 on CNVMP2-U v1.0</b>	
Section 1.2 - Plan Author – I understand the reason for including this, but it is very odd for a CNVMP to include (what's essentially) a resume for the Author. The requirement for engaging a suitably qualified specialist was on the consent holder, so	No change made. This section was inserted at the request of the Certifier.

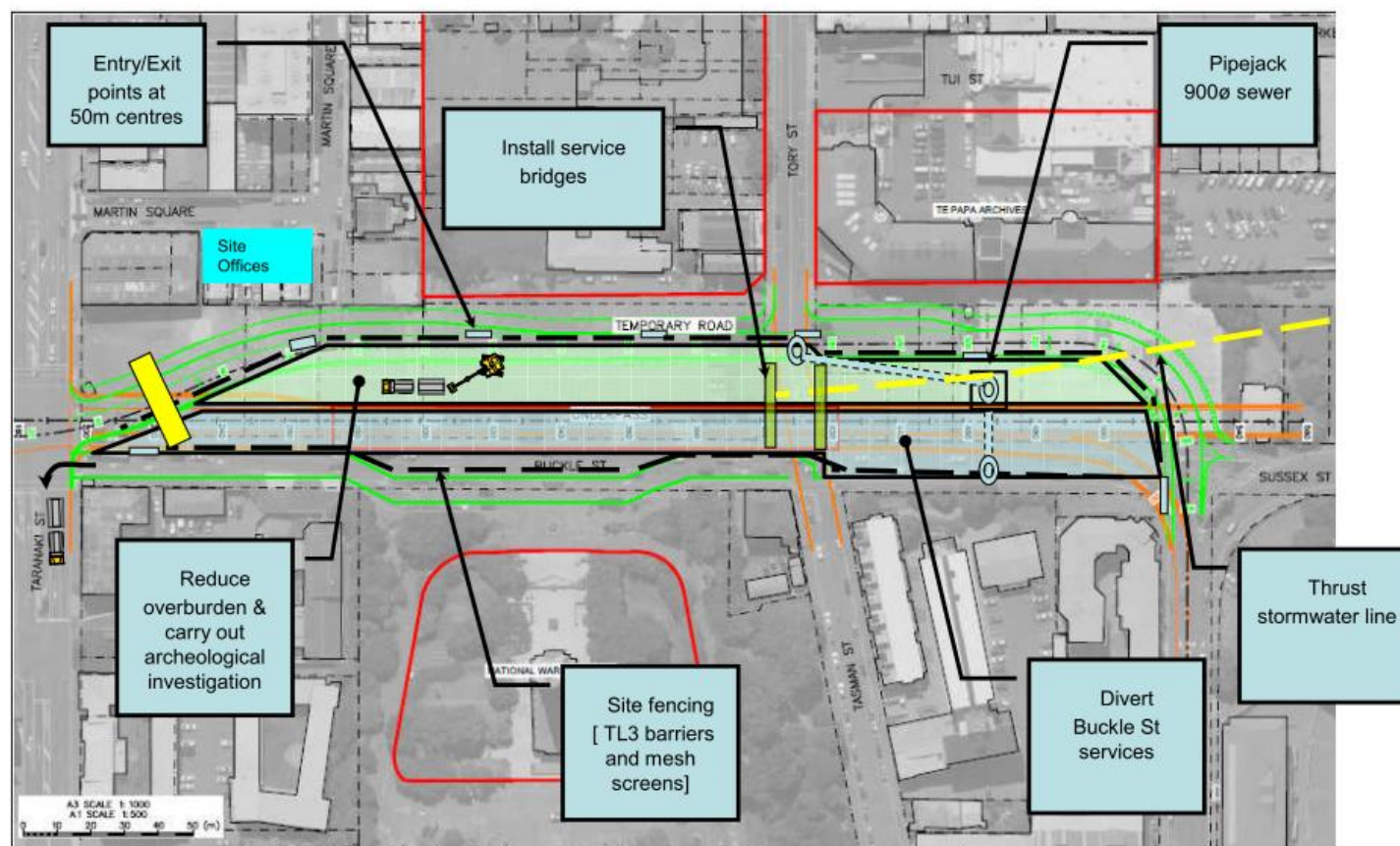


Comment	Response
it's not up to James to defend. Suggest removing.	
The word acoustics, when used as an adjective should not be pluralised. So 'acoustics specialist' is grammatically incorrect. Suggest 'acoustic' or 'acoustical' in its place.	Comment actioned.
Section 3.3 - Vibration – As in CNVMP1-TR, the hours of operation in Table 4 don't match up to those mentioned previously in the document. If this can't be altered, then perhaps a statement to this fact (and why it doesn't matter) should be made.	These time periods originate from the conditions. Note added in Section 3.3 to the effect that the time periods differ between the noise and vibration criteria.
Section 7 - Vibration sources – I'm not sure pipejacking would be counted as a significant vibration generator, but I don't have a great deal of experience with these.	No change made. Information on the levels of vibration from pipe jacking is not available, therefore to be conservative, the activity has been included as a potential source of vibration.
Section 10 - Schedules – Suggest wording: "Construction noise and vibration management schedules (CNVMSs) to this plan will be prepared for the construction activities listed in Table 14, and in response to reasonable complaints."	Comment actioned.
Section 10 - Schedules – Last sentence – does Council have to certify each CNVMS? In my opinion, "all site personnel involved in the work" does not provide adequate objectivity. The CNVMSs are important documents in relation to managing effects and 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.
Section 10 - Schedules – These comments are the same as those made in CNVMP1-TR, and I feel they should be addressed.	As above.
Section 11 - Monitoring – Table 15 – suggest having affiliation and perhaps contact details for each member of staff.	Comment actioned.
Section 11 - Monitoring – Last paragraph contains a reference to Section 0. Update.	Comment actioned.
Section 11 - Monitoring – Table 18 – they are some completed surveys without report dates.	This is correct; some surveys have been completed but not yet reported. Note to this effect has been included.
Section 12 – Complaints – It should also refer to the CNVMS framework, as complaints may lead to a CNVMS being developed.	Comment actioned.



## APPENDIX C – SCHEMATIC DIAGRAMS OF CONSTRUCTION

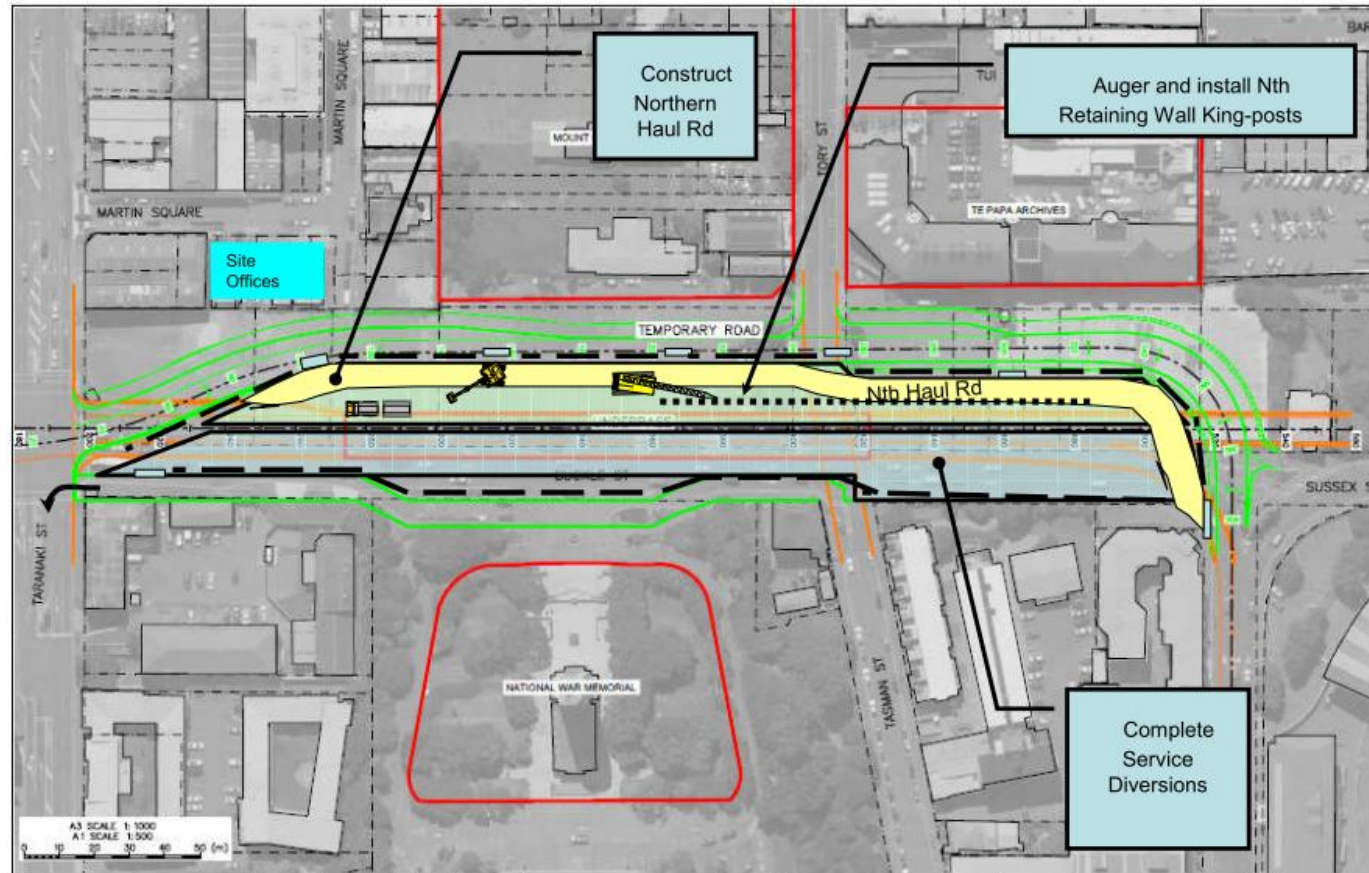
7<sup>th</sup> Feb 2013 to 6 March 2013 (Haul Rd & Overburden)



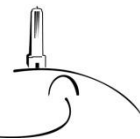
Site Set-up & Early Prep. Works



7<sup>th</sup> Feb 2013 to 2 May 2013

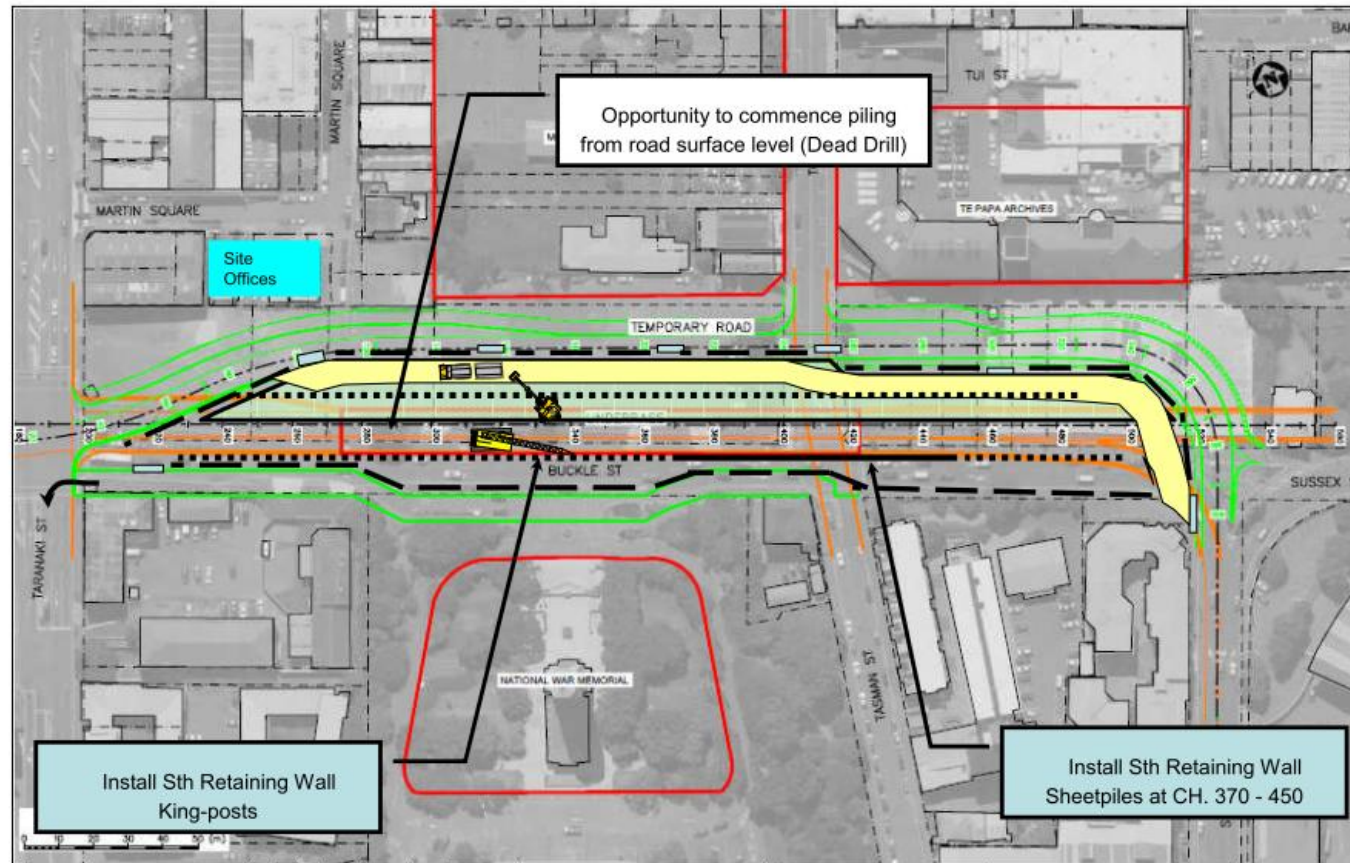


Construct Haul Rd & Install Nth Retention Wall Posts





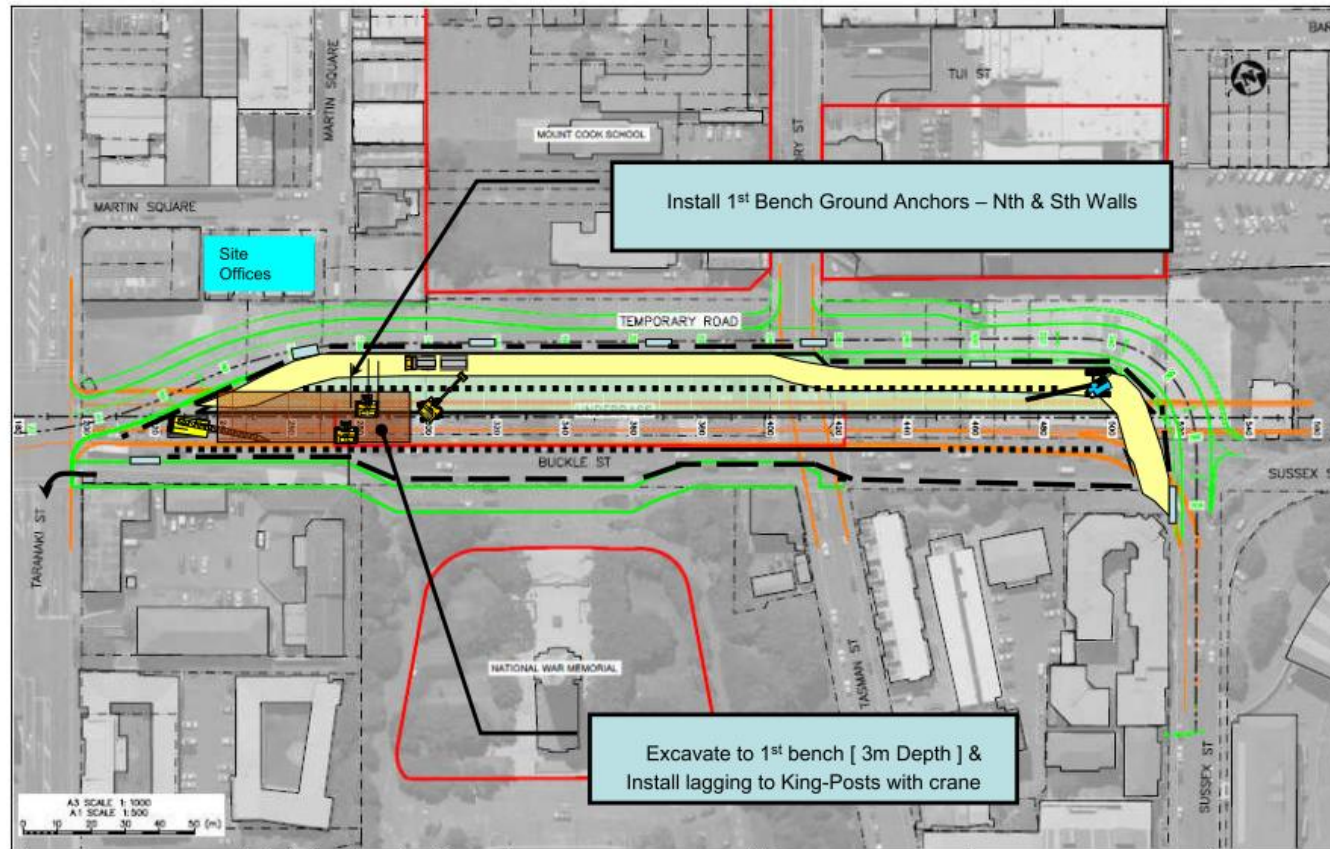
25th March 2013 to 30 May 2013



Install Sth Retention Wall Posts & Sheetpiles



3 May 2013 to 6 September 2013

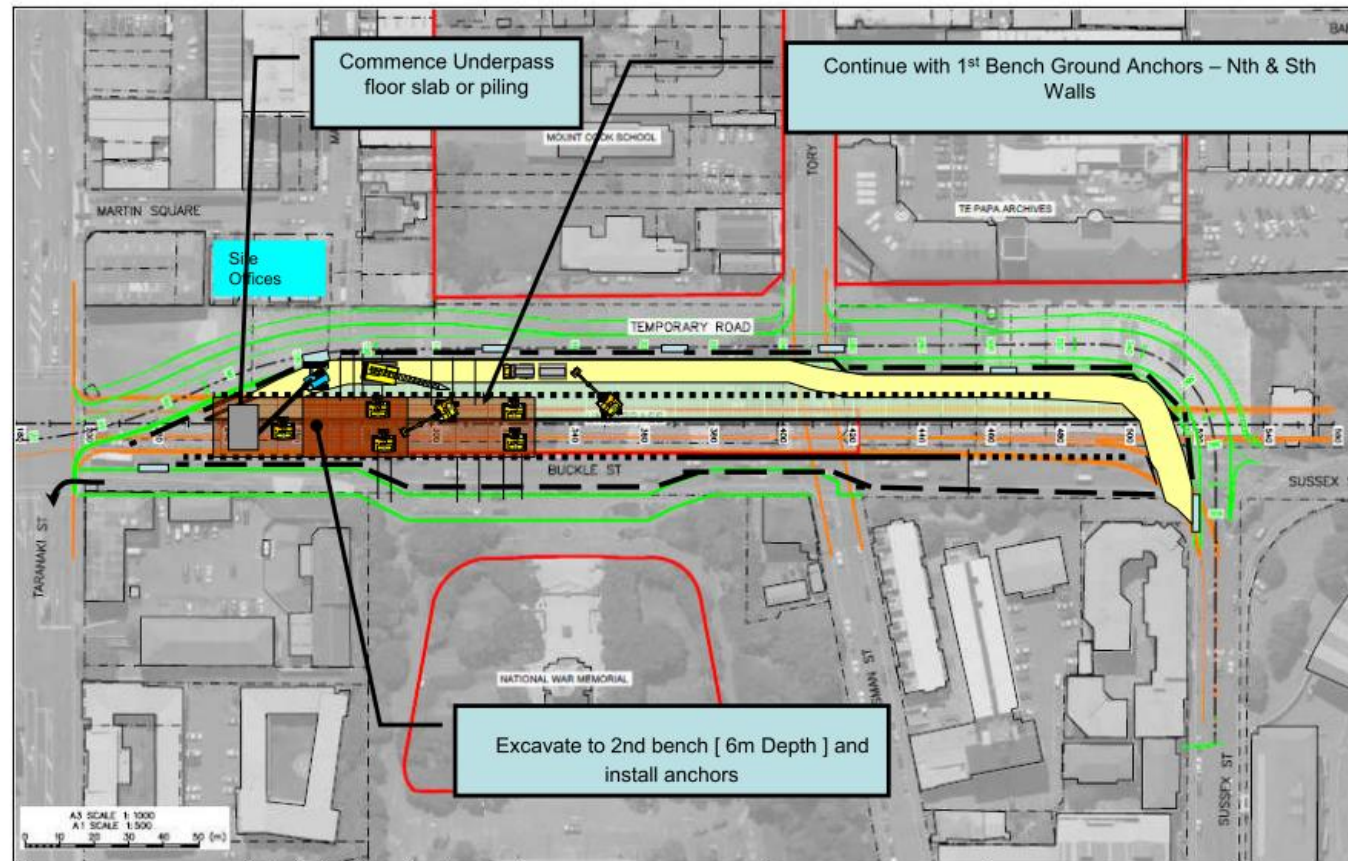


Excavate to 1<sup>st</sup> Bench & Install Ground Anchors to Retention Walls





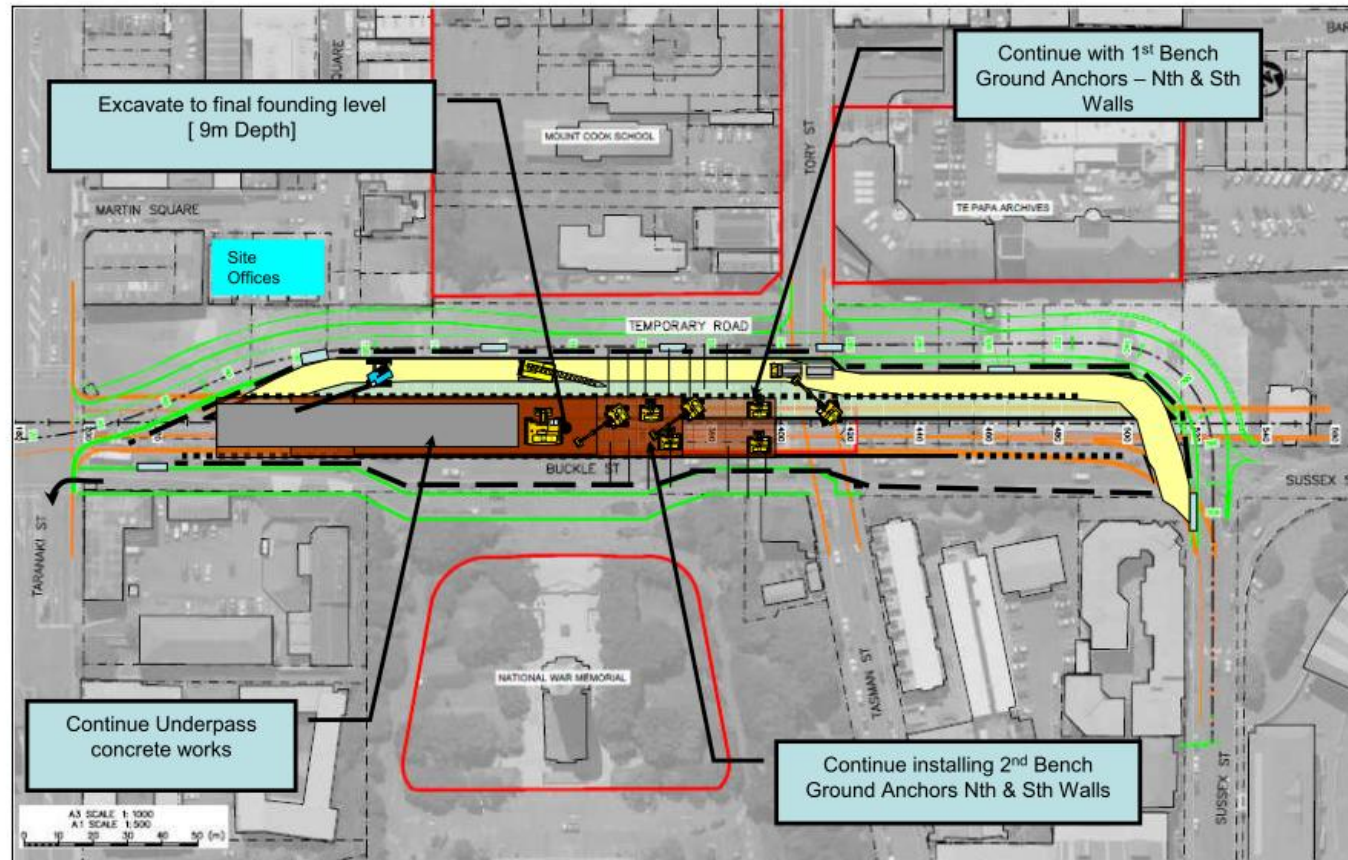
24 May 2013 to 23 August 2013



Excavate to 2nd Bench & Install Ground Anchors to Retention Walls



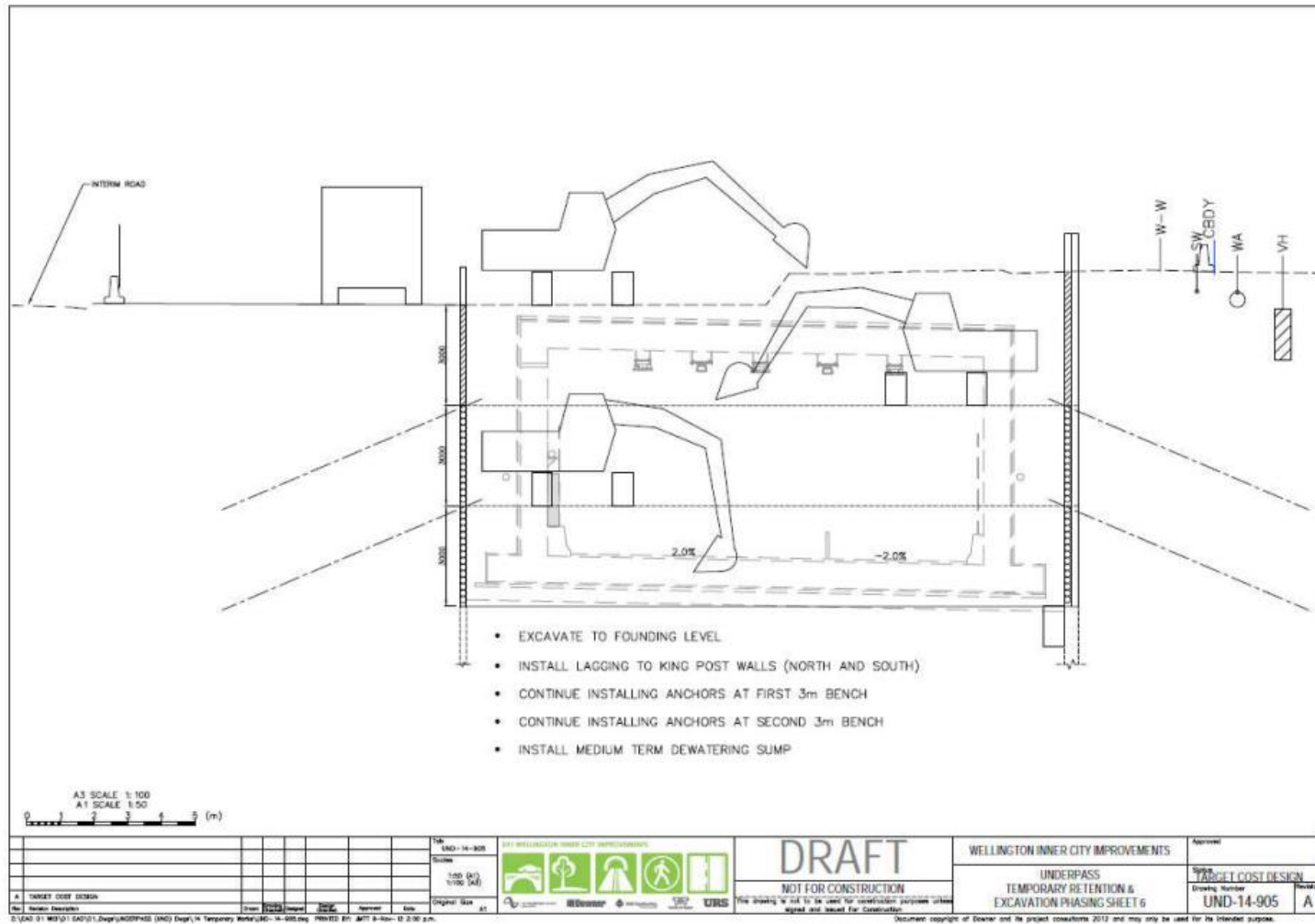
8 July 2013 to 23 August 2013



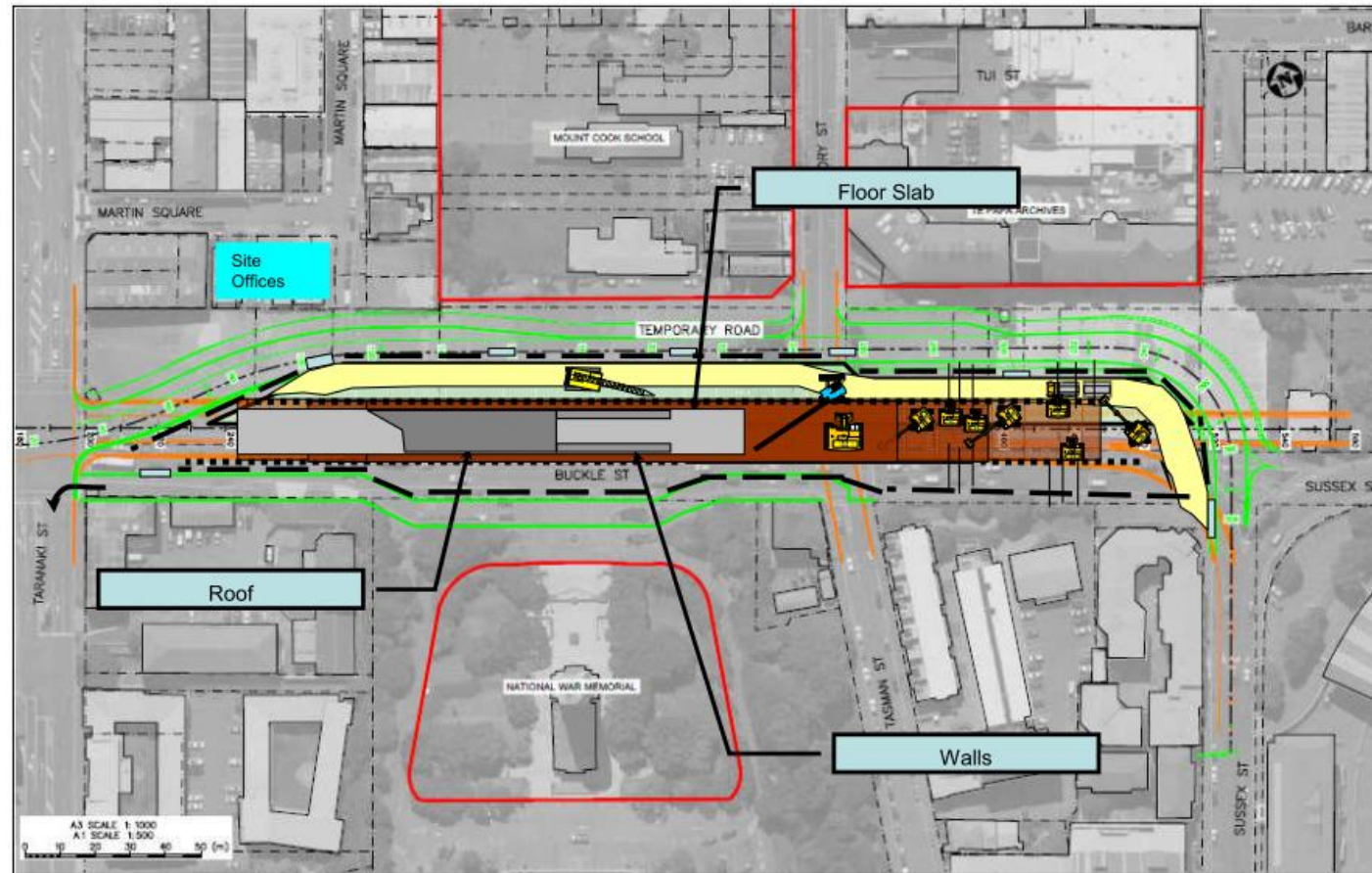
Excavate to Founding Level & Install Medium Term Dewatering Sump



# Wellington Inner City Improvements



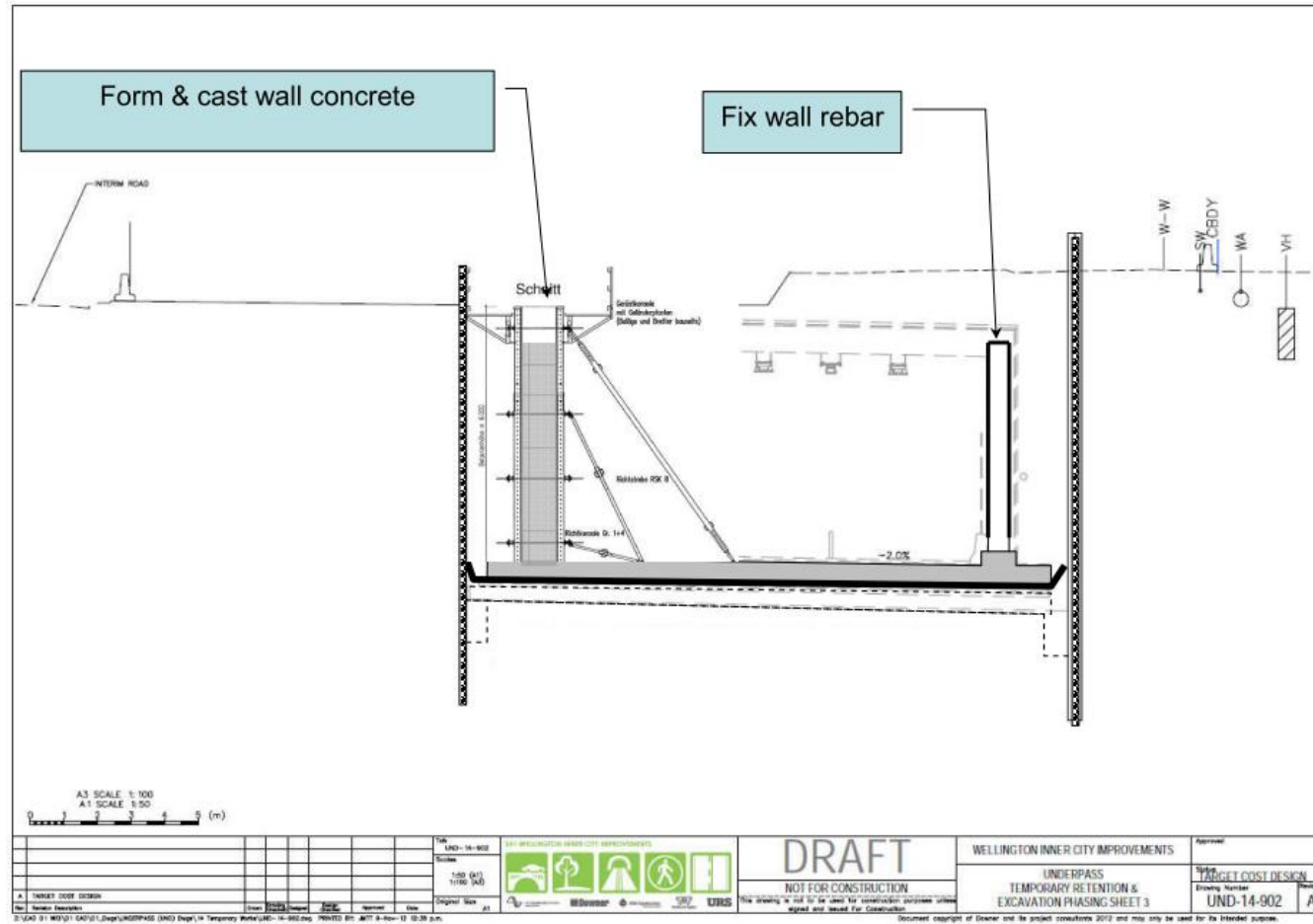




Progress Underpass Construction

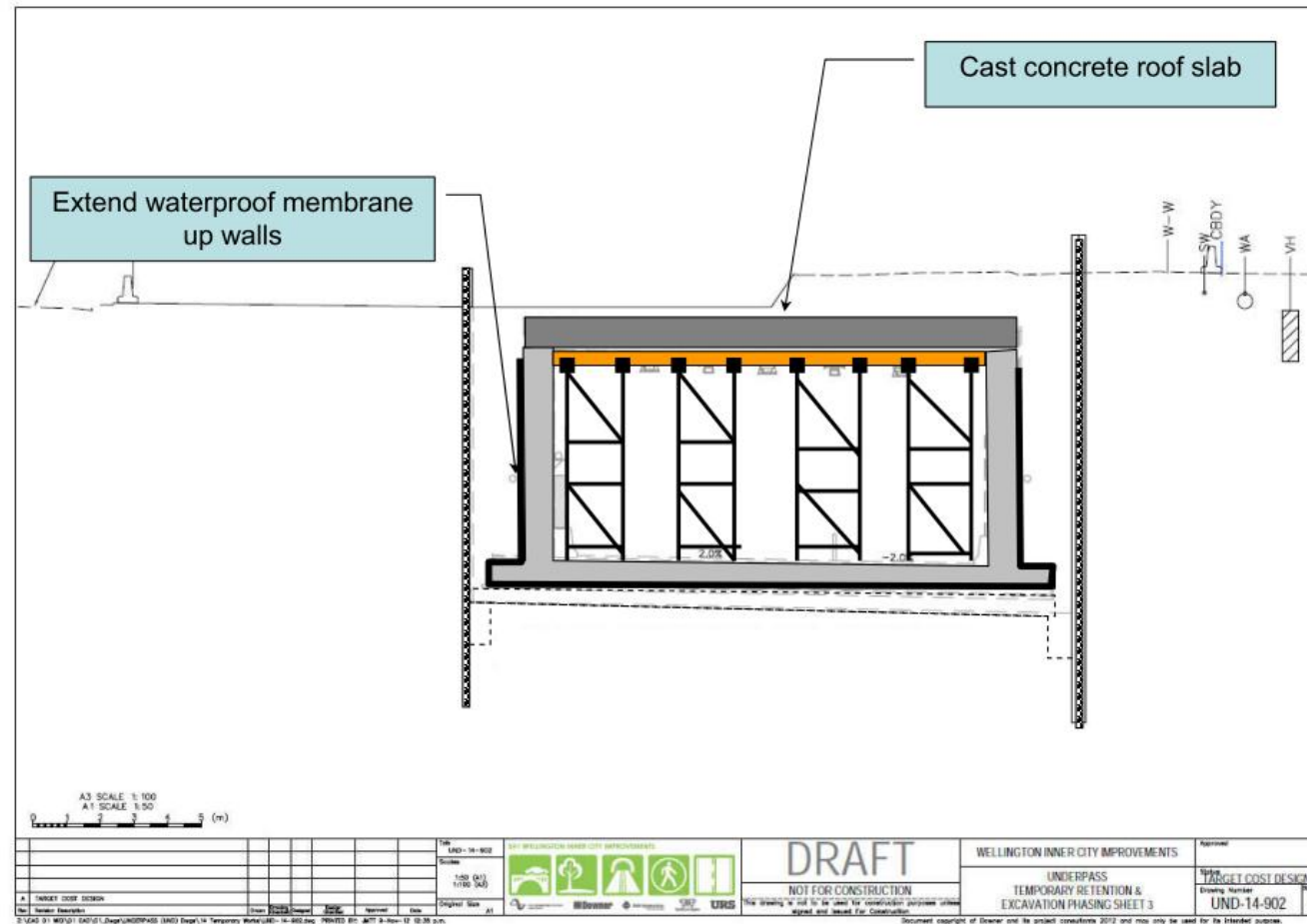


10 October 2013 to 26 June 2014





31 January 2014 to 5 June 2014





## **APPENDIX D – CONSTRUCTION NOISE AND VIBRATION INDUCTION**

Project: WICI Underpass

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 E - 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](http://www.rearsense.co.nz), model SA-RRA-97
- Capital Instruments, [www.capitalinstruments.co.nz](http://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](http://www.acoustics.nzta.govt.nz)

Dr G Leventhall, *The loudness of broadband alarms and audibility over machine noise*

[www.brigade-electronics.com/sites/default/files/Loudness%20of%20Broadband%20Alarms%20Final.pdf](http://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](http://www.nzta.govt.nz) or email us at [enquiries@nzta.govt.nz](mailto:enquiries@nzta.govt.nz)

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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 KOTAHU

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.



Broadband alarms generate warning noise in the danger zone but less spilled noise than tonal alarms.

### 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.

