MARSHALL DAY Acoustics

PRINCE OF WALES/OMĀRORO RESERVOIR CONSTRUCTION NOISE ASSESSMENT

Rp 001 R05 2016849 | 12 September 2017

Level 2 EMC² House
5 Willeston Street
PO Box 25442
Featherston Street
Wellington 6146 New Zealand
T: +64 4 499 3016 F: +64 4 472 1493
www.marshallday.com

Project:	**PRINCE OF WALES/OMĀRORO RESERVOIR**
Prepared for:	**CH2M Beca** **PO Box 3942** **Wellington 6140**
Attention:	**Mhairi Rademaker**
Report No.:	**Rp 001 R05 2016849W**

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
			26/01/17	B. Wood	S. Arden
	01	Construction programme amendments following Beca review	27/03/17	B. Wood	S. Arden
	02	Construction programme amendments following Beca and WWL review	29/03/17	B. Wood	S. Arden
	03	Final prior to updates	18/04/17	B. Wood	S. Arden
	04	Updated information	01/09/17	B. Wood	S. Arden
	05	Updated traffic data	12/09/17	B. Wood	S. Arden

TABLE OF CONTENTS

1.0 INTRODUCTION

It is proposed to construct a buried concrete reservoir with a capacity of 35,000m^3 in the Town Belt, immediately southwest of the Upper Park of the Prince of Wales Park in Mount Cook, Wellington.

Two construction scenarios are being considered as part of this proposal. These are:

1. All surplus excavated material from the proposed reservoir site, not required for reservoir burial, to be disposed off site; or
2. Surplus excavated materials from the reservoir site, not required for reservoir burial, to be used to raise the finished ground levels of the upper and lower Prince of Wales Park playing fields up to 1.5m, with remaining excess material to be disposed off site.

The acoustic implications of each scenario during construction are discussed in Section 5 of this report.

This document provides an assessment of noise and vibration from the proposed construction activities, and is based on the Beca document "*Hospital Prince of Wales Reservoir – Preliminary Design Report*" (April 2013), its supporting 2017 addendum document, and further updates received by Marshall Day Acoustics on 17 August 2017. Additionally, the CH2M Beca report "*Prince of Wales/Omāroro Reservoir Transport Assessment*" (April 2017) has informed the transportation noise element of this assessment, with supplementary updates received by Marshall Day Acoustics in September 2017.

This assessment does not constitute a full Construction Noise and Vibration Management Plan (CNVMP) but the recommendations within this document should be taken into consideration and incorporated into any management plans.

A glossary of acoustic terminology used within this report can be found in Appendix A.

2.0 SITE DESCRIPTION AND NEIGHBOURING PROPERTIES

The subject site is located within Prince of Wales Park. Construction access to the site would be at the top of Rolleston Street or Hargreaves Street. It is overlooked by properties located on Dorking Road, some 160 metres southwest of the subject site.

The Prince of Wales Park is zoned Open Space C in the Wellington City District Plan. Properties to the east of the subject site are zoned Inner Residential; and properties to the west are zoned Outer Residential.

A site visit was carried out on 22 November 2016 to provide a greater understanding of the topography of the site and to identify the closest potentially affected noise sensitive receivers. The following properties have been identified as our assessment locations:

Adjacent to the upper playing field:

- Rolleston Street: those properties closest to the subject site at the western end of Rolleston Street include numbers 73, and 86 to 102 Rolleston Street. However, all properties fronting on to Rolleston Street are potentially affected as it is proposed that Rolleston Street forms the primary access route for construction vehicles;
- Hargreaves Street: those properties located at the western (top) end of Hargreaves street including numbers 23, 40, 42, 42A, 44 and 46 Hargreaves Street;
- Papawai Terrace: numbers 7 and 8 Papawai Terrace;
- Wright Street: numbers 26, 34A, 40A and 46B Wright Street.

Adjacent to the lower playing field:

- Wright Street: numbers 40A and 46B Wright Street;

- Salisbury Terrace: numbers 9 to 12;
- Salisbury Avenue: even numbers 2 to 10;
- Westland Road: uneven numbers 1 to 7.

Overlooking the subject site:

- Dorking Road: properties on the north side of Dorking Road, including numbers 2 to 18;
- Asquith Terrace: uneven numbers 1 to 17.

Other locations in the area may also be subject to noise and vibration from construction activities. However due to their increased distance from these activities, the noise effects will be lesser when compared with those properties identified above.

Figure 1 presents an aerial view of the site and surrounding closest properties potentially affected by construction noise. Figure 1 shows only those properties closest to the construction site.

Figure 1: View of site and closest surrounding properties. The approximate location of the subject site is shown in red. *(Base Image Source: Wellington City Council GIS)*.

3.0 PERFORMANCE STANDARDS

3.1 Noise

The Wellington City Council District Plan requires that noise from construction activities be assessed in accordance with New Zealand Standard NZS 6803:1999 *'Acoustics-Construction Noise'*.

Because the duration of the construction period is provisionally 2 years, and up to 3 years, the construction noise limits are the "long term duration" limits of NZS 6803, which are the most stringent of this Standard. These are reproduced as follows:

Table 1: Recommended upper limits for construction noise received in residential zones (from New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise" Table 2*)

Time of week	Time of period	Duration of work Long-term duration (dBA)	
		L_{eq}	L_{max}
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and Public Holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

At this stage, the timing of construction activities has not been determined. However, it should be noted that the noise limits for the times identified by the shaded areas of Table 1 may mean that no construction activity can take place.

3.2 Vibration

The Wellington City District Plan does not address vibration resulting from constructions activities. However appropriate guidance can be found in DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"*. The relevant criteria are shown in Table 2 of this report.

Table 2: Vibration Units to avoid Building Damage *(from DIN 4150-3: 1999 Table 3)*

Building Type	Short-term vibration				Long-term vibration
	PPV at the foundation at:			PPV (horizontal plane) of highest floor (mm/s)	PPV (horizontal plane) of highest floor (mm/s)
	1-10Hz (mm/s)	10-50 Hz (mm/s)	50-100 Hz (mm/s)		
Commercial	20	20 – 40	40 – 50	40	10
Dwellings	5	5 – 15	15 – 20	15	5

'Short-term vibration' applies to transient or impulsive vibration sources such as blasting, drop-hammer piling, dynamic consolidation etc. (unlikely to occur at this site). Most other construction activities would be classified as 'long-term'.

Note, the above criteria are the limits to avoid structural damage to buildings. People will be able to 'feel' vibration at lower levels than these criteria. During consultation, this needs to be conveyed to concerned residents.

4.0 PLANNED WORKS AND PREDICTED NOISE LEVELS

Beca advises that two separate approaches are being considered for undertaking works associated with site excavation and development works required for the proposed Prince of Wales/Omāroro reservoir. These are proposed as follows:

- Scenario 1 – Disposal of all surplus excavated material off site: This would involve transportation of all surplus excavated material, not required for backfilling and burying the reservoir, off site for disposal. This is likely to require up to an estimated 5,400 return off-site truck movements (10,800 individual truck movements) over the duration of the project; and
- Scenario 2 – Using surplus excavated materials, not required for backfilling and burying the reservoir, to raise the finished ground levels of the upper and lower playing fields. Excess excavated material would still be disposed off site. This would result in significantly fewer off-site truck movements (approximately 2520 return movements, or 5040 total truck movements). However, it would involve comparatively more site activities on both the upper and lower playing fields associated with field raising, material compaction, material stockpiling, and landscaping.

For each of these scenarios, the proposed construction stages would be similar. The main differences are associated with the storage and use of the excavated materials. This aspect in turn affects the duration of activities on the upper and lower fields.

From discussion with Beca we understand that hourly peak construction traffic movements on Rolleston Street would remain similar for each scenario. However, Scenario 1 would involve the traffic flows extending for a significantly greater duration than for Scenario 2.

For each scenario, the construction is expected to be split into five main stages, and are generally as follows:

4.1 Scenario 1 – Disposal of all surplus excavated material off site

4.1.1 Stage 1 - Site establishment

Includes:

- Site accommodation set-up (site offices, site parking, changes to Rolleston Street parking)

- Site fencing
- Construction of erosion and sediment control measures
- Construction of access tracks
- Clearance of vegetation and top soil (with suitable top soil stockpiled for reuse)
- Service relocation

4.1.2 Stage 2 - Reservoir excavation

Includes:

- Excavation of material from reservoir site
- Stockpiling of excavated material on upper field
- Removal of excess material from the site

4.1.3 Stage 3 - Reservoir construction

Includes:

- Construction of the reservoir and pipe tunnel including in-situ and precast concrete as required
- Connection of services
- Import of required material and components to the site
- Testing

4.1.4 Stage 4 - Backfill

- Burying reservoir using stockpiled material where possible

4.1.5 Stage 5 - Site and upper park restoration

- Reinstatement and landscaping of the reservoir site including planting and reinstatement of tracks and pathways
- Reinstatement of the upper park including reshaping/levelling, installation of surface drainage, topsoiling, grassing, and marking.

4.2 Scenario 2 – Use of surplus excavated material to raise upper and lower playing fields, and stockpiling of excavated material on both fields

4.2.1 Stage 1 - Site establishment

Includes:

- Site accommodation set-up (site offices, site parking, changes to Rolleston Street parking)
- Site fencing
- Construction of erosion and sediment control measures (upper and lower parks)
- Construction of access tracks
- Clearance of vegetation and top soil (with suitable top soil stockpiled for reuse)
- Service relocation

4.2.2 Stage 2 - Reservoir excavation

Includes:

- Excavation of material from reservoir site

- Stockpiling of excavated material on upper and lower fields
- Raising of the upper and lower fields may be done at this time to avoid double handling of material

4.2.3 Stage 3 - Reservoir construction

Includes:

- Construction of the reservoir and pipe tunnel including in-situ and precast concrete as required
- Connection of services
- Import of required material and components to the site
- Testing

4.2.4 Stage 4 - Backfill

- Burying reservoir using stockpiled material where possible

4.2.5 Stage 5 – Site, upper and lower park restoration

- Reinstatement and landscaping of the reservoir site including planting and reinstatement of tracks and pathways
- Raising of the upper and lower fields (may be undertaken earlier in the construction process to reduce double handling of material) including construction of retaining walls and terramesh walls and installation of subsurface drainage where required
- Reinstatement of the upper and lower park including reshaping/levelling, installation of surface drainage, topsoiling, grassing, and marking.

4.3 Noise Sources

The major plant items likely to be used on this project include:

4.3.1 Stage 1 – Site Establishment

- 1 to 2 tracked excavators;
- Wheeled loader;
- Water truck;
- Delivery and haul trucks;
- On-site trucks.

4.3.2 Stage 2 – Reservoir Excavation

- Tracked excavators x3;
- Static roller;
- Vibrating roller;
- Wheeled loader;
- Water cart;
- On-site trucks;
- Delivery and haul trucks;
- Grader;
- Bulldozer.

4.3.3 Stage 3 – Reservoir Construction

- Tracked excavators x2;
- Crane;
- Concrete pump;
- Concrete trucks;
- Concrete vibrators;
- Dump trucks;
- Delivery and haul trucks;
- Wall panel delivery trucks;
- Occasional low-bed semi-trailer type trucks for large machinery deliveries;
- Hiab truck;
- Ramset guns.

4.3.4 Stage 4 – Backfill

- 1 to 2 tracked excavators;
- Static roller;
- Vibrating roller;
- Wheeled loader;
- Delivery and haul trucks;
- Site trucks.

4.3.5 Stage 5 – Site Restoration

- Tracked excavators x3;
- Grader;
- Bulldozer;
- Static roller;
- Vibrating roller;
- Wheeled loader;
- Water cart;
- Delivery and haul trucks;
- Site trucks.

4.4 Sound Power Levels

The equipment noise level data for individual items of plant have been obtained from measurements of similar equipment carried out by Marshall Day Acoustics, and from NZS 6803. These levels are presented in Table 3 below.

Table 3: Equipment sound power levels (All Stages)

Equipment	Sound Power Level (L_w dBA) (per individual item)
Excavator	103
Static roller	100
Vibrating roller	106
Wheeled loader	107
Water Cart	102
Low bed semi-trailer	110(1)
Trucks	106(1)
Grader	101
Dozer	112
Hydraulic jaw crusher	100
Crane	100
Truck-mounted concrete pump	108
Concrete vibrator	92
Air compressor	100
Powder actuated tools	133 (L_{max})

Note: (1): Due to the gradient of the Rolleston St, for the purposes of calculating noise from trucks on Rolleston Street, this tabled sound power is increased by an additional +4 dB.

4.5 Noise Predictions Methodology and Discussion

Noise levels have been predicted at the assessment locations in accordance with the methods described in NZS 6803: 1999.

The site covers a relatively large area and the noise levels received at each assessment location will vary dependent on the location of the works.

We consider this assessment to be a 'typical worst case' scenario for the following reasons:

- We have not taken into consideration any screening which may occur from variations in site topography;
- We have not taken into account any noise reduction due to ground effect;
- We have assumed all machinery will operate simultaneously. In practice this is often not the case, with much of the machinery having 'down time' throughout the day.

For these activities, there is a level of uncertainty in the noise prediction and the impact on affected parties. There are numerous variables and factors affecting the accuracy of the noise predicted. These factors include the variations in the specific models and individual items of equipment, the exact location of each item, the individual operators and the exact location of the various receiving environments. The predictions provided in the following sections are therefore the most reasonable estimates of our typical worst case activity.

4.6 Predicted Noise Levels

Predicted noise levels for each stage of construction are shown in Tables 4 and 5 below.

Table 4: Predicted construction noise levels – Scenario 1 (no mitigation)

Receiver Location	Predicted Noise Levels L_{eq} (dBA)				
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Rolleston St general (construction vehicle noise)	67 to 70	70 to 73	67 to 70	67 to 70	67 to 70
Rolleston St western end	67 to 70	70 to 73	70 to 72	67 to 70	67 to 70
Hargreaves/Papawai/Wright	60 to 70	65 to 72	61 to 67	65 to 70	65 to 72
Salisbury Tce/Salisbury Ave/Westland St	57 to 64	60 to 65	64 to 67	60 to 63	60 to 65
Dorking Road/Asquith Tce	56 to 58	60 to 63	64 to 66	60 to 63	60 to 63

Table 5: Predicted construction noise levels – Scenario 2 (no mitigation)

Receiver Location	Predicted Noise Levels L_{eq} (dBA)				
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Rolleston St general (construction vehicle noise)	67 to 70	70 to 73	67 to 70	67 to 70	67 to 70
Rolleston St western end	67 to 70	70 to 73	70 to 72	67 to 70	67 to 70
Hargreaves/Papawai/Wright	63 to 70	65 to 72	67 to 72	65 to 70	65 to 72
Salisbury Tce/Salisbury Ave/Westland St	66 to 70	68 to 70	64 to 67	67 to 70	66 to 70
Dorking Road/Asquith Tce	56 to 58	61 to 64	64 to 66	61 to 64	60 to 63

5.0 CONSTRUCTION NOISE EFFECTS

Tables 4 and 5 show that for many properties, the construction noise levels are predicted to be similar for the two scenarios. However, the construction activities associated with the Scenario 2 lower playing field proposal would result in comparatively higher construction noise levels received at the closer properties in Wright Street, Salisbury Terrace, Salisbury Avenue, and Westland Road.

The limits provided in NZS 6803 are based on the understanding that noise from construction work is generally limited in duration. As a consequence, the community will usually tolerate higher noise levels than would arise from permanent activities. However, note that there would be an expectation that the noise should be no louder than is necessary.

Tables 4 and 5 show that without mitigation measures implemented, construction noise levels at most assessment points are predicted to be within, or to marginally exceed the NZS 6803 limit for the hours of 0730-1800 (70 dBA L_{eq}). Outside those hours, the exceedance for such activities would be higher, as the relevant noise limits reduce.

We expect the L_{max} noise levels for earthworks to be typically 10 dB above the L_{eq} value. Therefore, the 85 dBA L_{max} noise limit is predicted to be complied with between 0730 and 1800 hours.

At this stage, it is not envisaged that an excavator mounted impact type rock breaker would be used. Should such an item of equipment be deployed on this site, it is likely to control the site noise levels received within the neighbouring community, for the duration of its operation. For that period the exceedances of the Table 2 noise limits could be 5 to 8 dB higher than those of Table 4.

Note that the acceptability of construction noise within a community will typically depend on its potential for interfering with activities. The most important method of reducing annoyance and complaints (and therefore managing the potential adverse effects) associated with the project is adequate communication with noise and vibration sensitive receivers.

5.1 Construction Noise and Vibration Management Plan

For the reasons discussed above, it is essential that a Construction Noise and Vibration Management Plan (CNVMP), prepared by a suitably qualified person, is submitted as part of this project. The overarching criterion of such a CNVMP should be Section 16 of the Resource Management Act (RMA) which, in summary, states that an activity shall adopt the best practicable option to ensure that the emission of noise does not exceed a reasonable level. Section 17 of the RMA also states that there is a duty to avoid, remedy or mitigate any adverse effect on the environment.

The CNVMP should include (but not be limited to) details regarding:

- Community liaison;
- Mitigation measures;
- Monitoring;
- Contingency measures; and
- Staff training.

Some aspects of noise and vibration mitigation to be addressed are as follows:

5.2 Mitigation of Construction Noise

5.2.1 General Mitigation Measures

It is recommended that the following noise mitigation measures are applied to this project, and are considered in the development of a CNVMP.

- Loading of trucks: Marshall Day Acoustics experience has shown that loading rubble onto trucks can provide a significant source of noise. This is particularly the case with the first loads into an empty tray. Careful selection of the location of loader route and loading points is important (away from noise sensitive receivers). Additionally, the material (particularly the first loads) should be carefully placed into the tray, rather than "dumped" from a height above the tray;

- Maintenance of construction equipment to reduce noise resulting from the deterioration of equipment;
- Alternatives to the standard tonal reversing alarms of mobile equipment operating on the construction site should be used. Such alternatives include broadband (white noise) reversing alarms (sound from broadband alarms dissipates more readily over distance than tonal alarms and is subjectively less annoying), and/or flashing warning lights;
- Locating noise barrier screens close to the source can be effective for many potentially affected properties. However, noise barriers will not be effective in all situations, especially for machinery where the dominant noise source is elevated at significant height above ground level (such as the motor of a large excavator).

5.2.2 Construction Traffic

Noise from construction traffic is predicted to control the construction noise levels at most properties on Rolleston Street. The construction traffic calculations have been based on CH2M Beca report "*Prince of Wales/Omāroro Reservoir Transport Assessment*" (April 2017), and in particular the peak HCV/hour information shown in Figure 3-1 of that report. This has been supplemented by updated traffic volume predictions, received by Marshall Day Acoustics in September 2017. We consider use of peak hour traffic flows represents a 'worst case' situation. Lower hourly traffic volumes would reduce the noise levels received at Rolleston Street properties.

Additionally, the manner in which the construction traffic is operated can have a noticeable effect on the resulting noise. Use of engine braking will be prohibited. All drivers should be familiar with the CNVMP and operate the vehicles to reduce the noise on Rolleston Street as much as possible.

6.0 VIBRATION DISCUSSION

The proposed construction does not involve any activities which would typically generate high levels of vibration (such as piling or blasting). From our experience, we would not expect the vibration limits as set out in Section 3.2 to be exceeded, based on the proposed activities.

The Rolleston Street road surface should be maintained in good condition, i.e., no holes or uneven surfaces. This will control vibration received at the houses on Rolleston Street, due to construction traffic using the Rolleston Street site access.

If there is concern regarding vibration damage of buildings closest to the subject site, The CNVMP should address this by a number of means, including (but not limited to):

- Vibration monitoring;
- Consideration of carrying out a pre-construction survey of the closest buildings, with photographic records, etc., for purposes of subsequent comparison, should claims arise regarding building damage due to vibration.

Note that vibration levels which may be subjectively classed as strongly perceptible and even disturbing may be quite safe in terms of building damage risk criteria.

Consultation and communication with residents is of utmost importance.

7.0 CONCLUSION

Marshall Day Acoustics has been engaged by Beca on behalf of Wellington Water Limited to provide an assessment of noise and vibration resulting from the proposed construction of a buried concrete reservoir immediately southwest of the Upper Park of the Prince of Wales Park in Mount Cook, Wellington.

This assessment is based on the Beca document "*Hospital Prince of Wales Reservoir – Preliminary Design Report*" (April 2013), its supporting 2017 addendum document, CH2M Beca report "*Prince of Wales/Omāroro Reservoir Transport Assessment*" (April 2017), and updates received August and September 2017.

The limits set out in NZS6803:1999 have been used to provide guidelines for controlling noise from the proposed works.

Construction noise levels are predicted to be within, or to marginally exceed the NZS 6803 limit for the hours of 0730-1800 (70 dBA L_{eq} and 85 dBA L_{max}) at most assessment points. However, outside those hours, any exceedance for such activities would be higher, as the relevant noise limits reduce.

Regardless of compliance with any Standards, there is a general obligation in terms of Section 16 of the Resource Management Act (RMA) which, in summary, states that an activity shall adopt the best practicable option to ensure that the emission of noise does not exceed a reasonable level. Section 17 of the RMA also states that there is a duty to avoid, remedy or mitigate any adverse effect on the environment.

The most appropriate method of controlling the noise and therefore the potential adverse noise effects resulting from this project is the implementation of a Construction Noise and Vibration Management Plan. This would include (but not be limited to) details regarding:

- Community liaison;
- Mitigation measures;
- Monitoring;
- Contingency measures; and
- Staff training.

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
SPL or L_P	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 µPa RMS) and expressed in decibels.
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 µPa i.e. dB = 20 x log(P/Pr)
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
L_{eq}	The equivalent continuous (time-averaged) sound level. This is commonly referred to as the average noise level.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).