SINCLAIR KNIGHT MERZ

SKM

Hunter Economic Zone

ROAD INFRASTRUCTURE: CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

- Final
- 8 April 2008

Hunter Economic Zone

ROAD INFRASTRUCTURE: CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

- Final
- 8 April 2008

Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

Contents

SKM

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
1	12/12/07	J Hutchison	M Davies	12/12/07	Draft
2	8/04/08	A Savage			Final

Distribution of copies

Revision	Copy no	Quantity	Issued to

Printed:	8 April 2008
Last saved:	8 April 2008 01:59 PM
File name:	D:\Documents and Settings\asavage\My
Author:	Anthony Savage
Project manager:	John Hutchison
Name of organisation:	HEZ
Name of project:	Hunter Economic Zone
Name of document:	Road Infrastructure: Construction Noise and Vibration Assessment
Document version:	Final
Project number:	EN02213

1. Introduction

1.1 General introduction

The Hunter Economic Zone (HEZ) is a large industrial and business area zoned for development by the Cessnock City Council (CCC) located to the south of Kurri Kurri in the Hunter Valley, NSW. Since much of the HEZ is 'greenfield' development, infrastructure including roads must be constructed to provide access to the proposed industrial and commercial facilities.

The Pelaw Main Bypass will provide access to the HEZ from the East, including traffic from the F3 Freeway between Sydney and Newcastle. The proposed Bypass will connect John Renshaw Drive to the north of the HEZ with Leggetts Drive and requires construction of a two lane road in conjunction with connecting intersections at either end (see **Figure 1-1**).

The Station St extension will provide access to the HEZ from Weston in the north. The extension of Station St will incorporate the construction of a two lane road and an at-grade railway crossing.

This report provides an assessment of noise and vibration impacts associated with the construction of the proposed Pelaw Main Bypass and Station Street extension and consists of the following.

- A discussion of the existing acoustic environment including identification of sensitive receivers.
- Description of relevant legislation and appropriate noise and vibration objectives.
- An assessment of predicted noise and vibration impacts at identified sensitive receivers against the identified criteria.
- Recommendations for mitigation of impacts as necessary.

- **Figure 1-1 HEZ locality and proposed residential receivers**

SKM

2. Existing environment

2.1 Sensitive receivers

As seen in**Figure 1-1,** the Pelaw Main Bypass and Station Street extension construction zones are predominantly located in undeveloped areas with limited sensitive receivers. However, where these proposed roads intersect with existing roads, the density of sensitive receivers greatly increases.

Sensitive receivers that have the potential to be impacted upon by construction noise were identified via aerial photographs and confirmed during site inspection. The identified sensitive receivers were categorised as predominantly residential dwellings. For the purposes of the impact assessment, a representative dwelling was selected for each potentially affected area. These are summarised in **Table 2-1**, with the shortest distance to construction activities.

- **Table 2-1 Summary of nominated representative sensitive receivers.**

Receiver number	Location	Distance from proposed road construction corridor (m)
1	Station Street (north)	50
2	Station Street (east)	250
3	Pelaw Main Bypass (west)	550
4	Pelaw Main Bypass (north)	220

An additional dwelling was identified in close proximity to the proposed construction corridor, adjacent to the unattended monitoring location. This dwelling is the property of HEZ Pty Ltd and is not considered to be a sensitive receiver.

2.2 Background noise levels

Background noise levels for the project have been established through both attended and unattended monitoring. Noise monitoring locations are provided in **Figure 1-1**.

Attended noise monitoring was undertaken on 5/12/07 using a Brüel and Kjær 2260 type 1 sound level meter (SLM) over two 15-minute durations at each location. Results from the attended noise monitoring are provided in **Table 2-2**.

Unattended noise monitoring was undertaken by SKM during a previous assessment at the northern extent of the proposed Station St extension, as shown on **Figure 1-1**. Noise in this location is not representative of the identified sensitive receivers; however it is used in this report to demonstrate the current noise characteristics of the proposed construction corridor. Unattended monitoring was undertaken with an Acoustic Research Laboratories – Type 1 Environmental Noise Logger over a thirteen day period between 07/12/2006 and 19/12/2006. A summary of the unattended noise monitoring is provided in **Table 2-3**.

It is noted that the L_{90} noise levels measured during attended monitoring at Station Street are significantly higher than those measured during unattended monitoring in December 2006. This is most likely due to unattended noise measurements being undertaken in a more remote location, away from the influence of typical urban noise sources such as existing road traffic.

- **Table 2-2 Attended noise monitoring results.**

Monitoring Location	Monitoring Time	Results (dBA)					Comments
		L_{A1}	L_{A10}	L_{A90}	L_{AMAX}	L_{Aeq}	
1. Date Avenue	10:05 – 10:20	55.2	51	42	63.2	48.6	Traffic, cicadas, birds, Children playing
	13:30 – 13:45	49	46	38.4	56.4	43.3	Birds, traffic, wind
	Average	**52.1**	**48.5**	**40.2**	**59.8**	**46.0**	
2. Station Street	11:05 – 11:20	61.4	55	45.4	66	52.1	Traffic (cars)
	13:50 – 14:05	59.4	53.6	46.2	67.4	51.3	Minibikes, commercial noise
	Average	**60.4**	**54.3**	**45.8**	**66.7**	**51.7**	
3. Smith Street	10:35 – 10:50	55.6	54.2	50.2	65.7	52.6	Birds, wind, cicadas, car horn
	14:10 – 14:25	52.8	48	40.2	63.3	45.4	Birds, wind, traffic, trail bikes
	Average	**54.2**	**51.1**	**45.2**	**64.5**	**49.0**	
4. Wallsend Street	11:30 – 11:45	52.4	49	42.8	57	46.5	Birds, building noise, traffic
	14:35 – 14:50	56.8	50.4	41.6	73.6	50	Traffic, wind
	Average	**54.6**	**49.7**	**42.2**	**65.3**	**48.3**	
5. Standford Street	12:00 – 12:15	48.8	45	40	57.5	43	Birds, traffic, cicadas, kids playing
	15:00 – 15:15	59.6	51.4	42.2	71.3	49.6	Welding, dogs, delivery truck
	Average	**54.2**	**48.2**	**41.1**	**64.4**	**46.3**	

SKM

Table 2-3 Unattended noise monitoring results, Station Street

Date	L_{A10}	L_{Aeq}	L_{A90}
7:00 am to 6 pm			
Thursday 7December 2006	48	46	36
Friday 8December 2006	50	47	39
Saturday 9December 2006	44	41	35
Sunday 10December 2006	47	46	38
Monday 11December 2006	45	43	37
Tuesday 12December 2006	50	51	36
Wednesday 13December 2006	44	42	35
Thursday 14December 2006	47	46	41
Friday 15December 2006	43	42	37
Saturday 16December 2006	43	41	36
Sunday 17December 2006	44	42	37
Monday 18December 2006	45	43	39
Tuesday 19December 2006	46	43	37
Median	**45**	**43**	**37**
6 pm to 10 pm			
Thursday 7December 2006	44	41	38
Friday 8December 2006	45	44	38
Saturday 9December 2006	44	41	37
Sunday 10December 2006	44	42	39
Monday 11December 2006	47	46	38
Tuesday 12December 2006	39	39	30
Wednesday 13December 2006	44	42	38
Thursday 14December 2006	46	44	41
Friday 15December 2006	41	38	32
Saturday 16December 2006	42	40	35
Sunday 17December 2006	45	44	39
Monday 18December 2006	45	43	39
Median	**44**	**42**	**38**
10 pm to 7 am			
Thursday 7December 2006	39	37	30
Friday 8December 2006	42	39	36
Saturday 9December 2006	42	40	37
Sunday 10December 2006	41	40	37
Monday 11December 2006	45	48	34
Tuesday 12December 2006	36	35	29
Wednesday 13December 2006	43	41	38
Thursday 14December 2006	45	42	36
Friday 15December 2006	41	39	35
Saturday 16December 2006	42	40	36
Sunday 17December 2006	43	41	38
Monday 18December 2006	42	40	38
Median	**42**	**40**	**36**

3. Legislative and other requirements

3.1 Noise

The Department of Environment and Climate Change (DECC 2000) document *NSW Industrial Noise Policy* specifically excludes construction noise sources. For this project, noise objectives documented in the DECC's *Environmental Noise Control Manual* (DECC 1994), *Chapter 171 Construction Site Noise*, are used for assessing potential impacts. The noise criteria are dependent on the existing background noise levels and the expected duration of the works. The conditions of operation (for construction activity) are expressed in terms of L_{A10} noise levels above the nominated background L_{A90} level and are detailed in **Table 3-1**.

Table 3-1 Construction noise criteria

No.	Duration Of Works	DEC L_{A10} Guidelines
1	Construction period of 4 weeks and under	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).
2	Construction period greater than 4 weeks and not exceeding 26 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).
3	Construction period greater than 26 weeks	The EPA does not provide noise control guidelines for construction periods greater than 26 weeks duration, however, it is generally accepted that provided L_{A10} noise levels from the construction area do not exceed a level of 5 dB(A) above background, then adverse (intrusive) noise impacts are not likely to be experienced at nearest sensitive receptor locations.

Restrictions are placed on the hours of construction to ensure that the amenity of the closest residences is protected. Hours of operation for construction works are listed below.

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- No construction work will take place on Sundays or Public Holidays

SKM

3.1.1 Project specific noise criteria

Construction is anticipated to exceed 26 weeks. As such, condition 3 in **Table 3-1** are expected to apply. Based on attended background noise monitoring results at representative locations adjacent to the proposed road alignments, the $L_{A10,\ 15\ minute}$ noise limit during construction activities should be defined as follows:

L_{A90} background noise level, plus 5 dB(A) = $L_{10,\ 15\ minute}$ Criteria dB(A).

It is noted that work should be carried out during day time hours only. **Table 3-2** provides a summary of project specific noise criteria that should not be exceeded at sensitive receiver locations.

- **Table 3-2 Project specific noise criteria**

Receiver Number	L_{90} dBA (Background Noise Level)	L_{10} dBA (Noise Criteria)
1	46	51
2	45	50
3	42	47
4	42	47

3.2 Vibration

The effects of vibration in buildings can be divided into three main categories:

- where occupants or users of the building are disturbed or inconvenienced (human comfort);
- those in which the building contents may be affected; and
- circumstances in which the integrity of the building or the structure itself may be prejudiced.

3.2.1 Human comfort

Vibration from a source has three components, the vertical, longitudinal and transverse components. Vibration criteria for the comfort of residences (measured at the centre of the affected room within a residence) differ depending on the mode of transmission and are also frequency dependent. Vibration from construction activities with regard to human comfort within a building envelope should comply with the British Standard BS 6472: - 1992 *Evaluation of Human Exposure to Vibration in Building* (BSI 1992).

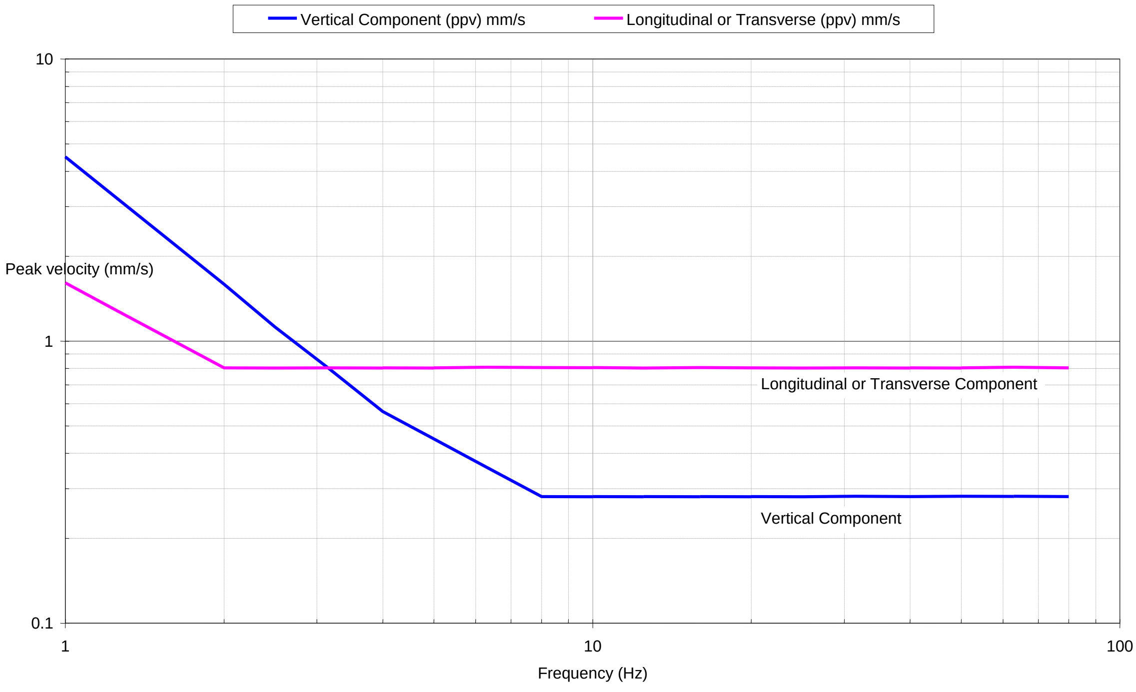
Assuming vibration occurs sufficiently frequently to be classified as "continuous" and vibration levels measured in the ground near the building foundations are lower than those shown in **Figure 3-1,** there should be no adverse comments, sensations or complaints from nearby receivers. The curves in **Figure 3-1** have been reproduced from base curves for vertical and longitudinal – transverse vibration as shown in BS6472.

For vibration levels from activities that are not considered continuous, such as pile driving, the British Standard BS6472 identifies less stringent set of criteria in recognition of the reduced frequency of impulsive vibration events. The standard also qualifies this in Note 9 of *Table 5* stating that:

"When short term works such as piling, demolition and construction give rise to impulsive vibrations it should be borne in mind that undue restriction on vibration levels can significantly prolong these operations and result in greater annoyance. In certain circumstances higher magnitudes can be used."

Since this assessment can be considered short-term, human comfort vibration limits are not considered necessary and compliance with these limits may unduly prolong the works.

- **Figure 3-1 Daytime vibration criterion for human comfort BS6472**



SKM

3.2.2 Building structures

Two standards by which vibration impacts with regard to building damage from construction activities are commonly assessed include the British Standard 7385: Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration* (BSI 1993) and the German DIN 4150: Part 3 – 1999 *Effects of Vibration on Structure* (DIN 1999).

The German standard provides the most stringent criteria and will be used in this assessment. The DIN guideline values for peak particle velocity (mm/s) measured at the foundation of the building are summarised in **Table 3-3**. It may be seen from the table that these values are also frequency dependent and are specific for particular categories of structure.

In this project, structures are likely to be residential or of similar design, and vibration from an impact roller is likely to be at a frequency of approximately 10 – 12 Hz (Landpac 2005). Hence the corresponding guideline value for evaluation of short term vibration is approximately 5 mm/s.

- **Table 3-3 Guideline values of vibration velocity, for evaluating the effects of short term vibration DIN 4150**

Line	Type of Structure	Guideline values for velocity, v_i , in mm/s			
		Vibration at the foundation at a frequency of			Vibration at horizontal Plane of highest floor at all frequencies
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	8 to 10	8 to 10	8
* For frequencies above 100Hz, at least the values specified in this column shall be applied					

3.2.3 Regenerated noise

Vibration can be transmitted into the ground by some construction operations. This vibration can cause a low-frequency rumbling sound to be generated within rooms of a building. This sound is termed “regenerated noise”. Regenerated noise cannot occur outside a building envelope. There is no specific DEC policy for regenerated noise criteria. However, recommendations for internal noise levels in AS2107 for residential living areas (near major roads) indicate that L_{Aeq} 35 dB(A) is appropriate. Based on the construction duration of the project, the maximum objective of L_{Aeq} 45 dB(A) for residential premises would most likely be applicable.

The level of regenerated noise cannot be accurately predicted for any given situation. While vibration levels can be estimated at a building foundation, a large component of this type of impact is based on the transfer of vibration into the building (known as the transfer function of the foundations) and will be building specific. Noise mitigation for this type of impact would be restricted to the use of alternative construction methods to complete the works at the affected location.

4. Noise and vibration impact assessment

4.1 Noise

Noise levels from construction activities vary with distance from the source, the type of equipment in operation, meteorological conditions and structural and topographical shielding. During each stage of works, at the Station Street extension and Pelaw Main Bypass construction sites, it is anticipated that the equipment listed in **Table 4-1** would be utilised.

Although the construction schedule has not yet been made available, it is envisaged that each stage of construction would continue for in excess of two months and would be undertaken during daylight hours in accordance with DECC (1994) guidelines (refer **Section 3.1**).

- **Table 4-1 Road construction schedule.**

Construction Stage	Construction Activity	Equipment	Estimated Duration
Stage 1	Clearing/Stripping	▪ Chainsaws, ▪ tub grinder, ▪ dozer, ▪ haul trucks	Greater than 2 months
Stage 2	Earthworks	▪ Scrapers, ▪ graders, ▪ haul trucks, ▪ excavators, ▪ water carts, ▪ compactors dozers, ▪ loaders	Greater than 2 months
Stage 3	Paving	▪ Pavers, ▪ pneumatic roller, ▪ concrete truck, ▪ concrete vibrator, ▪ concrete saw, ▪ compressors, ▪ generators.	Greater than 2 months

It is anticipated that each construction stage would be undertaken sequentially in each construction corridor, i.e. clearing will be complete prior to earthworks commencing. The estimated noise levels associated with this equipment are assumed to be similar to those provided by AS 2436-1981 *Guide to noise control on construction, maintenance and demolition sites* (Standards Australia 1981). These are summarised in **Table 4-2**.

SKM

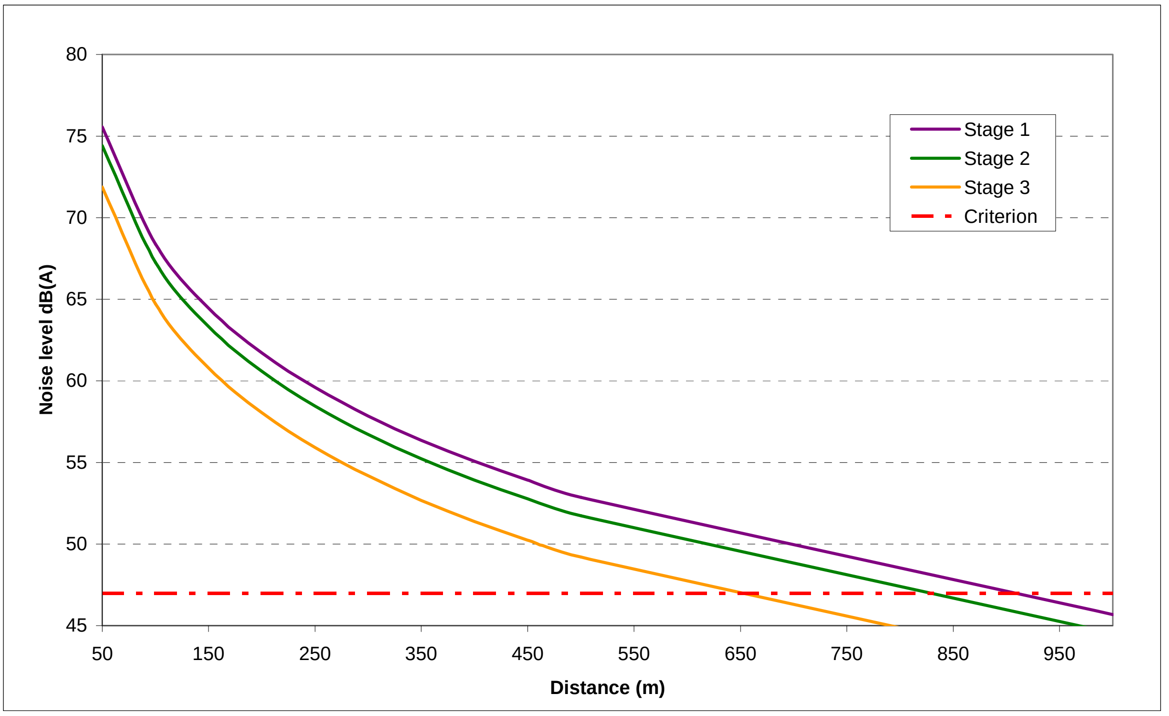
- **Table 4-2 Construction equipment sound power level (AS 1981).**

Works stage	Equipment used		A-weighted sound power level dB ref 10^{-12}W
	Type	Quantity	
Stage 1	Chain Saw	2	114
	Tub Grinder	1	109
	Dozer	1	114
	Haul Trucks	2	110
Stage 2	Scraper	2	108
	Grader	3	111
	Haul Truck	1 / 6 mins	110
	Excavator	3	112
	Water Cart	2	107
	Compressor	3	105
	Dozer	2	114
	Loader	2	115
Stage 3	Concrete Paver	1	111
	Asphalt Paver	1	111
	Roller	1	111
	Concrete Truck	1 / 15 mins	110
	Concrete Vibrator	1	105
	Concrete Saw	1	114
	Compressor	3	114
	Generator	1	111

Considering geometric divergence, atmospheric and ground absorption, the noise levels likely to be experienced at various distances from the construction activities are illustrated in **Figure 4-1**. These levels do not consider any topographical or structure screening and assume all equipment is operating concurrently in the same location. Hence these levels are the maximum expected values and are likely to be less in practice.

It can be seen in **Figure 4-1** that the project specific noise criteria are likely to be exceeded when each stage of construction activity is within 600 m – 800 m of a sensitive receiver.

- **Figure 4-1Predicted Noise reduction with distance from construction activity**



Predicted noise levels at the nominated representative sensitive receivers are summarised in **Table 4-3.** It can be seen that when construction is at its minimum distance from sensitive receivers, the assessment criteria are likely to be exceeded and the risk of adverse impacts is likely to be high.

These impacts are likely to be transient, however, and the risk will decrease as construction progresses along the corridor and further from receivers.

- **Table 4-3 Predicted Noise Levels from Construction Equipment at Receivers**

Receiver	Distance from construction activity (m)	Stage 1	Stage 2	Stage 3	Assessment criteria (dB(A))
Receiver 1	50	76	74	72	51
Receiver 2	250	60	58	56	50
Receiver 3	550	52	51	48	47
Receiver 4	220	61	60	57	47

SKM

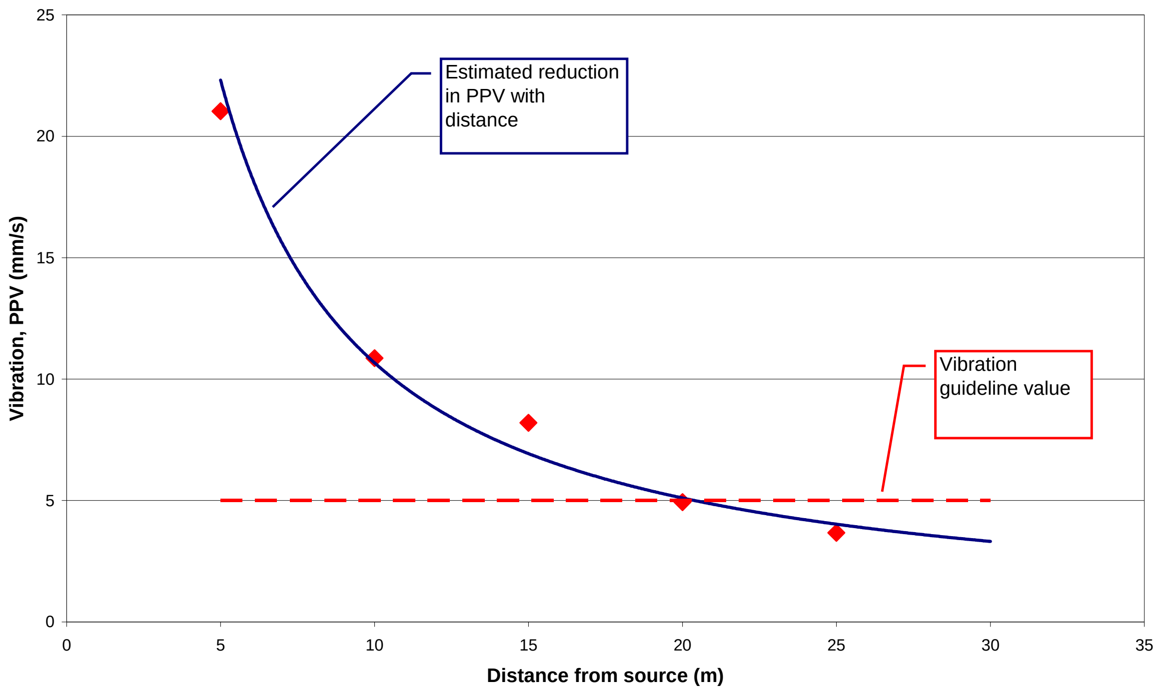
4.2 Vibration

Of the construction activities, vibration generated by roller compaction is likely to present the greatest risk of adverse impacts on sensitive receivers. It is unlikely that other activities will present any significant risk, therefore only compaction will be assessed in this section.

Vibration monitoring has been undertaken (RHA 2004) at a range of distances from an operational impact roller compactor, similar to that which could be used for this project. Results of monitoring are summarised in **Figure 4-2.** It can be seen that sensitive receivers within 20 m of compacting activities may experience vibration in excess of the 5 mm/s limit recommended by DIN 4150 for residential structures.

Given that there are no sensitive receivers identified within 20 m of the proposed construction activities, the impact of vibration is expected to be negligible.

- **Figure 4-2 Measured vibration (mm/s) with distance (m) from impact roller compactor (RHA 2004).**



5. Noise and Vibration Management

5.1 Overview

The nature of the proposed construction activities is such that noise and vibration sources would be mobile, resulting in temporary exceedances of noise and vibration limits at sensitive receivers. To ensure noise and vibration levels are maintained at a practical minimum, recommendations for management of these impacts are provided in this section.

5.2 Noise Mitigation

Exceedances of noise criteria will be mitigated where possible through careful management of the proposed construction works. This would involve the forward planning of potential noise generating activities and the implementation of reasonable and feasible measures to control noise emissions. Specific measures for the overall work site are addressed in the mitigation measures listed in **Table 5-1**.

Table 5-1 Noise Mitigation Measures

Mitigation measure	Description
Plant and equipment noise levels	▪ Selection of plant and equipment should consider noise levels and all construction equipment should be fitted with residential class mufflers where practical or other noise suppression devices unless equipment noise is shown not to exceed noise limits. ▪ Ensure equipment is operated in the correct manner including replacement of engine covers, repair of defective silencing equipment, tightening of rattling components, repair of leakages in compressed air lines and shutting down equipment not in use. ▪ Alternatives to monotonal reversing alarms adopted where possible, such as white noise beepers, spotters, closed circuit television monitors, etc. ▪ Undertake monitoring of noise levels from fixed and mobile plant every six months and ensure that levels are not degraded by lack of maintenance and comply with respective Australian Standards (Refer AS 2436 -1981). ▪ Undertake regular monitoring of overall noise and vibration levels at sensitive receivers to check for compliance.
Construction processes	▪ Ensure strict compliance with construction hours: 7 am –6 pm (M-F) 8 am-1 pm (Sat) and at no time Sundays and public holidays (unless otherwise approved). This requirement to be communicated to all construction staff through inductions and toolbox meetings. ▪ Prepare a construction noise and vibration management plan (CNVMP) and ensure strict adherence. The plan should include, as a minimum, the mitigation measures included in this table and provide procedures whereby additional measures may be identified and implemented during construction.

Mitigation measure	Description
	▪ Provide an induction to site personnel (including s/c) addressing the requirements of this CNVMP and their responsibilities with regard to noise and vibration management. ▪ Implement a community liaison program to ensure that the public is kept informed and that any concerns regarding noise and vibration are promptly addressed. ▪ A protocol will be developed for handling noise complaints that includes recording, reporting and acting on complaints.
Screening	▪ Any stationary plant would be placed inside or behind semi-complete structures or noise screens (with respect to receiver locations) and as close as practical to the operating areas of mobile site equipment ▪ Acoustic screens should be placed as close as possible to the construction works whilst maintaining sufficient practical work space and should be tall enough to block line of site between sensitive places and the noise sources. Screens should be made from solid materials such as plywood, cement sheeting or galvanised steel and should have no gaps between adjacent panels (refer below). ▪ Operations using hand tools that are assessed as being noisy or within line-of-site to sensitive receivers will be undertaken behind a suitable acoustic screen.
Offset distance	▪ Maximise the distance between noisy plant items and sensitive receivers; including loading and unloading of equipment and materials, selecting site access points and storing stationary equipment as far from sensitive receivers as possible. ▪ Equipment with very directional noise characteristics should be oriented away from sensitive receivers. ▪ Topsoil will be stockpiled, where practicable within the width of easement, in noise sensitive areas to provide shielding to residences.
Community concerns	▪ Affected residents should be notified in advance of any construction activities likely to generate high noise levels and the most practical approach for minimising adverse impacts discussed with them. ▪ The construction contractor would be required to monitor construction noise at affected residences upon receiving complaints or if noise levels at sensitive receivers are considered by the contractor to exceed assessment criteria.

SKM

5.3 Vibration Mitigation

To ensure vibration levels at sensitive receivers are at a practical minimum and recommended vibration limits are not exceeded recommendations for impact roller compaction work is provided in **Table 5-2**.

- **Table 5-2 Vibration Mitigation Measures**

Mitigation measure	Description
Safe working levels	Assessment of ground borne vibration should be conducted on site at the commencement of works to determine safe working levels (site law).
Construction processes	To minimise the duration of vibration impacts, construction activities would be completed in the shortest possible timeframe.
Community concerns	Affected residents should be notified in advance of any construction activities likely to generate high vibration levels and the most practical approach for minimising adverse impacts discussed with them. The construction contractor would be required to monitor construction vibration at affected residences upon receiving complaints or if vibration levels at sensitive receivers are considered by the contractor to exceed assessment criteria.

SKM

6. Conclusions

Development of the HEZ will require construction of new infrastructure, including roads, to facilitate access and operations. This report provides and assessment of construction noise and vibration associated with the Station St extension and the construction of Pelaw Main Bypass. Both these roads will provide access to the HEZ, Station St from the north and Pelaw Main Bypass from the east, as well as helping to relieve congestion on existing local roads from through traffic.

Background noise was monitored in selected locations and the background L_{A90} noise level found to range between 42 and 46 dB(A). Derived from the background L_{A90} noise level, the construction noise assessment criteria was determined based on the most representative background monitoring results for each identified receiver. The assessment, criteria were determined to be 52, 51, 47 and 47 dB(A) for receivers 1,2,3 and 4 respectively. These criteria apply to daytime construction noise emissions. According to DECC (1994) construction should only occur during daytime hours, Monday through Saturday.

Based on proposed construction activities and typical equipment noise and vibration emissions, it was found that, where construction is less than 600 m from a sensitive receiver, noise will likely exceed the construction noise assessment criteria.

Relevant vibration limits are unlikely to exceed criteria at receivers located at a distance greater than 20 metres from the construction activity. Since there are no sensitive receivers identified within this distance, construction is unlikely to present a high risk of adverse impact.

Although any adverse impacts from construction noise and vibration will be of short duration and of a mobile nature, recommendations for ensuring the practical minimum impact is maintained have been provided.

7. References

BSI 1992, British Standard BS 6472: - 1992 Evaluation of Human Exposure to Vibration in Building, BSI, London, England

BSI 1993, British Standard 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration, BSI, London, England.

DIN 1999, DIN 4150: Part 3 – 1999 Effects of Vibration on Structure, Deutsches Institut für Normung e. V., Berlin, Germany.

DECC 1994, Environmental Noise Control Manual, Environment Protection Authority, Sydney, NSW.

DECC 2000, NSW Industrial Noise Policy, Environment Protection Authority, Sydney, NSW.

RHA 2004, Impact roller vibration assessment, Kellyville netball courts, Richard Heggie Associates Pty Ltd, lane Cove, NSW.

Standards Australia 1981, AS 2436-1981 Guide to noise control on construction, maintenance and demolition sites, Standards Australia, Sydney, Australia.