6.2 Noise and vibration

A Noise and Vibration Impact Assessment (SLR Consulting Australia, 2012) was undertaken to assess the construction and operational noise and vibration impacts of the proposal. The full report is provided in Appendix E and a summary of the report is provided below.

6.2.1 Methodology and policy setting

The study area for the noise and vibration assessment is defined as the area within 500 metres of the proposal.

To assess the potential noise and vibration impacts arising from construction and operation of the project, an assessment has been undertaken with consideration to the following:

- NSW Interim Construction Noise Guidelines (DECC 2009b).
- NSW Road Noise Policy (DECCW 2011).
- Environmental Noise Management Manual (RTA 2001).
- Assessing Vibration: A Technical Guideline (DEC 2006).
- NSW Industrial Noise Policy (EPA 2000).

For the purpose of this assessment, construction noise has been assessed for day, evening and night periods. Hours of work are described in Section 3.3.2.

Noise

Monitoring and noise source emissions

Background noise monitoring for the noise and vibration assessment was undertaken in accordance with the NSW Industrial Noise Policy (EPA 2000). Monitoring was undertaken at three residences in the study area to determine the existing noise levels occurring at these properties. Residences 1, 2 and 3 are located about 85, 260 and 75 metres respectively from the proposal. The location of these residences is shown in Figure 1.2. The remaining receptors (residences in the Kapooka Military area, shown in Figure 1.2) are located over 400 metres away from the proposal.

Monitoring was undertaken using unattended noise loggers adjacent to the three residences mentioned above. A detailed methodology for the noise monitoring is located in Section 3 of the noise assessment in Appendix E.

For the construction assessment, six generic construction scenarios were developed to assess the impacts of construction equipment that would potentially be used simultaneously during works. Table 6.5 outlines the six construction scenarios used in the assessment, including the time of the day each would be occurring. Equipment to be used during each scenario is also included along with sound power levels.

Table 6.5: Construction scenarios and typical equipment involved

Scenario	Activity	Equipment used	Sound power level (dBA)	
			LAeq	LAmax
1	Site preparations, including surface preparation, cut and fill earthwork transportation, etc. Construction of roadside batters, gutters and berms. To occur during the daytime period, but potentially also the evening and night time periods.	Excavator 30 t	109	115
		Truck (delivery / removal)	93	97
		Concrete truck	109	113
		Mobile crane	105	113
		Vibratory roller	106	114
		Grader	106	-
		Rockbreaker	117	124
		Compressor	106	107
		Generator	100	103
2	Re-surfacing asphalt works. To occur during the daytime period, but potentially also the evening and night time periods.	Asphalt paver	104	112
		Vibratory roller	109	114
		Tip trucks	93	97
3	Traffic management, set-up and line marking. To occur during the daytime period, but potentially also the evening and night time periods.	Truck (delivery / removal)	93	97
		Generator	100	103
		Lighting tower	87	88
4	Bridgeworks. To occur during the daytime period - bored piling, abutments and piers, deck and finishing.	Piling rig (bored)	107	110
		Rockbreaker	117	124
		Excavator 30 t	109	115
		Backhoe	106	111
		Truck (delivery / removal)	93	97
		Generator	100	103
		Compressor	106	107
		Crane (up to 70 t)	109	113
		Concrete pump	108	112
		Vibratory roller	106	114
5	Bridgeworks. To occur during the evening and night time periods.	Generator	100	103
		Compressor	106	107
		Concrete truck	109	113
		Concrete pump	108	112
		Truck (delivery / removal)	93	97
		Mobile crane	105	113
6	Major cut (located at chainage 68900 to 69200). To occur during the daytime period, but potentially also the evening and night time periods.	Excavator 30 t	109	115
		Truck (delivery / removal)	93	97
		Rockbreaker	117	124
		Loader	104	109
		Crusher	118	123

Noise modelling was undertaken for a number of operational scenarios to determine the noise levels with and without the proposal at opening and ten years after

opening. The scenarios modelled are:

- 2014 (year of opening) without the construction of the proposal.
- 2014 (year of opening) with the construction of the proposal.
- 2024 without the construction of the proposal.
- 2024 with the construction of the proposal.

Construction noise criteria

The Interim Construction Noise Guideline (DECC, 2009b) provides guidance for assessment of construction noise. OEH's standard construction hours are as follows:

- 7 am to 6 pm Monday to Friday.
- 8 am to 1 pm Saturday.
- No work Sundays or public holidays.

Construction noise management levels are identified for noise in the guideline for affected residential receivers and are shown in Table 6.6. The highly noise affected level (75 dB (A)) represents the level above which strong community reaction to noise is likely.

Table 6.6: Construction noise management levels

Time of day	Management level $L_{Aeq(15\ min)}$
Recommended standard hours:	Noise affected RBL + 10dB
Monday to Friday 7am to 6pm, Saturday 8am to 1pm, and no work on Sunday or public holidays	Highly noise affected 75 dB(A)
Outside recommended standard hours	Noise affected RBL + 5dB

Note – RBL: rating background level

Table 6.7 provides the construction noise management levels having regard to the measured background noise levels for the study area shown in Table 6.14 below.

Table 6.7: Construction noise management levels at residential receivers, dB(A)

Residence	Noise management level, dBA $L_{eq,\ 15mins}$		
	During standard hours		Outside standard hours
	Noise affected	Highly noise affected	Noise affected
1	52	75	42
2	46	75	36
3	51	75	38

For construction activities proposed outside of standard hours (out of hours), strong justification for the works is required and all feasible and reasonable measures must be implemented.

Construction sleep disturbance

The current approach to assessing potential sleep disturbance during construction is to apply an initial screening criterion of background noise levels plus 15 dBA (as described in the Application Notes to the Industrial Noise Policy), and to undertake further analysis if the screening criterion cannot be achieved.

Where the screening criterion cannot be met, the additional analysis should consider the level of exceedance as well as factors such as:

- How often high noise events would occur.
- The time of day (normally between 10 pm and 7 am).
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Other guidelines that contain additional advice relating to potential sleep disturbance impacts should also be considered, including the *NSW Road Noise Policy 2011 (RNP)* (DECCW 2011).

It is generally accepted that internal noise levels in a dwelling with the windows open are 10 dBA lower than external noise levels. Based on a worst case minimum attenuation of 10 dBA with windows open, the RNP evaluation suggests that short term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions. The RNP evaluation suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to affect health and wellbeing significantly.

Operational noise criteria

The RNP provides non-mandatory traffic noise assessment criteria for residential receivers near new roads and redevelopment of existing roads. The target levels should aim to be achieved at project opening and 10 years after project opening. For the purpose of this noise assessment these years are 2014 and 2024 respectively.

The operational noise criteria under the RNP are summarised in Table 6.8.

Table 6.8 also includes the relative increase criteria for the proposal.

Table 6.8: Noise criteria

Road category	Type of project/land use	Criteria external dBA	
		Daytime (7am to 10pm)	Night time (10pm to 7am)
Noise criteria for residential land uses for new road			
Freeway/ arterial/sub arterial roads	Existing residences affected by noise from new freeway/ arterial/sub arterial road corridors	LAeq(15hour) 55	LAeq(9hour) 50
Relative increase criteria for residential land uses for new or redevelopment of existing road			
Freeway/arterial/sub arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	$L_{Aeq(15hour)}$[1]+12dB Residence 1 – 70.4 Residence 2 – 59.5 Residence 3 – 63.2	$L_{Aeq(9hour)}$[1]+12dB Residence 1 – 58.5 Residence 2 – 67.1 Residence 3 – 61.2

Note:

1: From Table 5 in Appendix E

Acute noise is defined as an exceedance of day Leq 15 hr 65 dBA and night 60 dBA. In cases where the predicted future existing noise level is deemed acute investigation into feasible and reasonable noise mitigation is required.

Operational sleep disturbance

Guidance for the assessment of sleep disturbance given in the RNP is as follows:

> *"Triggers for, and effects of sleep disturbance from, exposure to intermittent noise such as noise from road traffic are still being studied. There appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The NSW Roads and Traffic Authority's Practice Note 3 (NSW Roads and Traffic Authority 2008d) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance."*

Practice Note 3 (RTA 2008d) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance and is reproduced in part below:

> *"an evaluation of maximum noise levels may prove beneficial in managing the concerns of surrounding residents if interruptions to traffic flows are proposed (such as would occur with the installation of roundabouts or traffic lights)."*

To assess the potential for sleep disturbance, the difference between LAFmax and LAeq(1hr) is calculated for each night time pass by event. The number of night-time pass by events where the difference is greater than 15 dBA is to be noted.

With regard to reaction to potential sleep disturbance events, the RNP gives the following guidance:

> *From the research on sleep disturbance to date it can be concluded that:*
>
> - *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep.*
> - *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

Vibration

Construction vibration criteria for human comfort

Human comfort vibration criteria have been set with consideration to *Assessing Vibration: A Technical Guideline* (DEC, 2006). British Standard BS 6472 – 1992 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by OEH as the preferred standard for assessing 'human comfort'.

Table 6.9, Table 6.10 and Table 6.11 outline the vibration goals for continuous, intermittent and impulsive vibration sources.

Table 6.9: Preferred and maximum vibration levels for continuous vibration

Building type	Preferred vibration level RMS velocity (mm/s)	Maximum vibration level RMS velocity (mm/s)
Critical working areas (eg Hospital operating theatres, precision laboratories)	0.10	0.20
Residential daytime	0.20	0.40
Residential night time	0.14	0.28

Building type	Preferred vibration level RMS velocity (mm/s)	Maximum vibration level RMS velocity (mm/s)
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Table 6.10: Preferred and maximum vibration levels for intermittent vibration (vibration dose values)

Building type	Preferred vibration level RMS velocity (mm/s)	Maximum vibration level RMS velocity (mm/s)
Critical working areas (eg Hospital operating theatres, precision laboratories)	0.10	0.20
Residential daytime	0.20	0.40
Residential night time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Table 6.11: Preferred and maximum vibration levels for impulsive vibration

Building type	Preferred vibration level RMS velocity (mm/s)	Maximum vibration level RMS velocity (mm/s)
Critical working areas (eg. Hospital operating theatres, precision laboratories)	0.10	0.20
Residential daytime	6	12
Residential night time	2	4
Offices, schools, educational institutions and places of worship	13	26
Workshops	13	26

Construction vibration criteria for structural damage

Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* as they 'are applicable to Australian conditions'.

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are shown in Table 6.12.

Table 6.12: Transient vibration guide values - minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Blasting

The ground vibration and air blast levels which cause concern or discomfort to residents are generally lower than the relevant building damage limits.

The EPA advocates the use of the Australian and New Zealand Environment Conservation Council (ANZECC) guideline *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* for assessing potential residential disturbance arising from blast emissions. The ANZECC guidelines for control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear. The level of 115 dB Linear may be exceeded on up to five per cent of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is five mm/s, peak vector sum (PVS) vibration velocity. It is recommended however, that two mm/s PVS be considered as the long term regulatory goal for the control of ground vibration. The PVS level of two mm/s may be exceeded on up to five per cent of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 9am to 5pm Monday to Friday and 9am to 1pm Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

The Australian Standard 2187.2-2006 *Explosives - Storage, and Use: Use of Explosives* does not present human comfort criteria for ground vibration from blasting. It does however make mention of human comfort level for airblast in saying 'a limit of 120 dB for human comfort is commonly used'. This is consistent with the ANZECC guidelines.

AS 2187.2-1993 nominates building damage assessment criteria as presented in Table 6.13.

Table 6.13: Blast emission building damage assessment criteria (AS 2187)

Building type	Vibration level	Airblast level (dB re 20 µPa)
Sensitive (and heritage)	PVS 5 mm/s	133 dB(linear) peak
Residential	PVS 10 mm/s	133 dB(linear) peak
Commercial/industrial	PVS 25 mm/s	133 dB(linear) peak

Note: PVS: Peak vector sum

6.2.2 Existing environment

Sensitive receivers

Sensitive receivers in the study area are shown in Figure 1.2 and include:

- Kapooka residential area, located west of the proposal.
- Two residences at the northern end of the proposal (residences 1 and 2).
- One residence at the southern end of the proposal (residence 3).

The proposed realignment of the Olympic Highway would bring the road closer to these three residences than the existing highway, and it is anticipated that operational traffic noise levels would increase at these receivers.

Background noise monitoring at these three residences was undertaken, with the results summarised in Table 6.14. As discussed in Section 6.2.1 background monitoring was not undertaken at the Kapooka residential area due to its distance from the proposal, meaning impacts are unlikely.

Table 6.14: Existing noise levels at nearby residences

	RBL (dBA)			Road traffic noise indices (dBA)	
Residence	Daytime[1]	Evening[2]	Night time[3]	$LA_{eq(15hour)}$	$LA_{eq(9hour)}$
1	52	42	37	58.4	46.5
2	46	34	31	47.5	55.1
3	51	37	33	51.2	49.2

Note 1: OEH's standard hours discussed in Section 6.2.1.
Note 2: Evening hours: 6pm to 10pm.
Note 3: Night time hours: 10pm to 7am Sunday to Friday, 10pm Saturday to 8am Sunday.
Note 4: RBL: rating background level.

Observations during noise monitoring indicated that noise levels at residence 1 were influenced by high noise activities such as truck engine brakes and trucks ascending and descending the road prior to crossing the existing bridge.

Sleep disturbance

Monitoring was undertaken in 2011 at residence 1 to determine the maximum noise levels at this location. Monitoring at the other two residences (residences 2 and 3) was not undertaken due to greater setbacks from the road than residence 1. These have been included in Table 6.15.

Table 6.15: Night-time vehicle pass by ($L_{Aeq} - L_{aeq}$)

Date		Time of night								
		12am to 1am	1am to 2am	2am to 3am	3am to 4am	4am to 5am	5am to 6am	6am to 7am	10pm to 11pm	11pm to 12am
23/11										
	Number of events per hr	-	-	-	-	-	-	-	3	6
	Estimated internal L_{AFmax}	-	-	-	-	-	-	-	65.7	62.7
24/11										
	Number of events per hr	6	14	16	14	12	1	0	-	-
	Estimated internal L_{AFmax}	62.2	63.5	63	61.8	62.1	59.4	-	-	-
28/11										
	Number of events per hr	-	-	-	-	-	-	-	1	10
	Estimated internal L_{AFmax}	-	-	-	-	-	-	-	61.4	60.8
29/11										
	Number of events per hr	10	9	16	14	13	1	0	-	-
	Estimated internal L_{AFmax}	65.8	58.9	63.2	59.5	60.9	62.8	-	-	-

As shown in Table 6.15, there are up to 16 maximum noise level events per hour during the evening. Estimated internal noise levels are typically between 60 dBA and 65 dBA, with only a few events over 65 dBA.

6.2.3 Potential impacts

Construction

Noise

The predicted noise levels during the daytime, evening and night-time periods are outlined in Table 6.16, Table 6.17 and Table 6.18 respectively. Each table outlines the noise impacts for each of the key construction scenarios (a description of these scenarios is found in Table 20 of the noise and vibration assessment in Appendix E).

Table 6.16: Construction noise predictions – daytime

Residence	Rating Background Level (dBA)	Daytime NML (dBA) (RBL +10 dBA)	Maximum Predicted LAeq(15 minute) Noise Level for each Scenario (dBA)				
			1 Site Preparation	2 Resurfacing	3 Traffic Management	4 Bridge works	6 Major cut
1	40	50	**66**	51	52	52	22
2	36	46	**47**	32	33	32	15
3	41	51	**53**	**56**	50	34	45
Kapooka residential area (R4-R12)[1]	36	46	42	35	28	28	30

Note 1 No background monitoring was conducted at Kapooka residential area, therefore the lowest measured rating background noise level (RBL) (residence 2) has been used to calculate NMLs.

BOLD Represents exceedances of the NML

Table 6.17: Construction noise predictions – evening

Residence	Rating Background Level (dBA)	Evening NML (dBA) (RBL +5 dBA)	Maximum Predicted LAeq(15 minute) Noise Level for each Scenario (dBA)				
			1 Site Preparation	2 Resurfacing	3 Traffic Management	5 Bridge works	6 Major cut
1	40	45	**66**	**51**	**52**	43	22
2	34	39	**47**	32	33	21	15
3	38	43	**53**	**56**	**50**	24	**45**
Kapooka residential area (R4-R12)[1]	34	39	**42**	35	28	18	30

Note 1 No background monitoring was conducted at Kapooka residential area, therefore the lowest measured RBL (residence 2) has been used to calculate NMLs.

BOLD Represents exceedances of the NML

Table 6.18: Construction noise predictions – night time

Residence	Rating Background Level (dBA)	Night NML (dBA) (RBL +5 dBA)	Maximum Predicted LAeq(15 minute) Noise Level for each Scenario (dBA)				
			1 Site Preparation	2 Resurfacing	3 Traffic Management	5 Bridge works	6 Major cut
1	36	42	**66**	**51**	**52**	**43**	22
2	28	33	**47**	32	**33**	21	15
3	33	38	**53**	**56**	**50**	24	**45**
Kapooka residential area (R4 to R12)[1]	28	33	**42**	**35**	28	18	30

Note 1 No background monitoring was conducted at Kapooka residential area, therefore the lowest measured RBL (residence 2) has been used to calculate NMLs.

BOLD Represents exceedances of the NML

The majority of construction activities would occur during standard construction hours

however some works may be required outside these hours as described in Section 3.3.2. For this reason the noise predictions for works occurring outside of the standard construction hours have been included in the assessment below.

Construction noise is predicted to be the least intrusive during the daytime period, although exceedances of the daytime noise management levels are predicted for residences 1 and 3. Generally, the higher exceedances are related to the use of rock breakers, concrete pumps and jackhammers. The predicted noise levels do not fall into the highly noise affected category and such activities would be undertaken for relatively short periods of time during individual construction stages. Mitigation measures in Section 6.2.4 would be implemented to minimise these impacts. Noise and vibration impacts from blasting activities during construction are discussed below.

Exceedances of the night-time noise management levels are predicted to occur for most activities at the predicted receptor locations. If any construction works are to occur during the night and evening periods, then noise management would be considered at locations predicted to exceed the criteria.

Where noise management levels are likely to be exceeded (especially during the more sensitive evening and night-time periods), mitigation measures would be implemented to minimise impacts.

Sleep disturbance

Sleep disturbance would only occur if construction works were proposed to be undertaken during the evening and night-time periods. The predicted LA_{max} levels during the night time period are outlined in Table 6.19.

Table 6.19: Predicted internal L_{max} noise levels

Residence	Sleep Disturbance Screening Criterion (dBA) (RBL +15 dBA)	Predicted Lmax (external) dBA	Predicted Lmax (internal) dBA
1	51	**73**	**63**
2	43	**54**	**44**
3	48	**60**	**50**
Kapooka residential area (R4-R12)	43	**48**	38

BOLD Represents exceedances of the NML

The largest exceedances are predicted at residences 1 and 3. The higher exceedances generally relate to the use of rockbreakers and jackhammers.

In the event of construction occurring during the night time period, particularly in close proximity to residences 1 and 3, mitigation measures would be required. These are described in Section 6.2.4.

Construction compound

The main site compound activities that are considered to be potentially noise generating would typically be truck movements around the site and may also include some lighting/generator associated noise. A prediction of the noise at the nearest

residence is shown in Table 6.20. This result is six dB below the maximum noise level due to the small number of truck movements expected on site.

Table 6.20: Construction compound noise

Residence	Daytime NML (dBA) (RBL +10 dBA)	Evening NML (dBA) (RBL +5 dBA)	Night NML (dBA) (RBL +5 dBA)	Predicted LAeq(15minute) Noise Level (dBA)1
3	51	39	36	**50**

As outlined in Table 6.20, the criteria would potentially be exceeded during the evening and night-time periods. Any work proposed during these periods would require the implementation of mitigation measures.

Vibration

Impacts resulting from vibration are not considered likely as works likely to generate vibration impacts would be remote from the identified receivers and beyond the safe working distances for structural damage described in Table 6.21.

Table 6.21: Indicative working distances for vibration intensive plant

Plant Item	Rating/Description	Indicative Safe Working Distance	
		Structural Damage	Human Response[1]
Vibratory roller	< 50 kN (typically 1-2 tonnes)	10 m	15 m
	< 100 kN (typically 2-4 tonnes)	15 m	20 m
	< 200 kN (typically 4-6 tonnes)	25 m	40 m
	< 300 kN (typically 7-13 tonnes)	30 m	60 m
	> 300 kN (typically 13-18 tonnes)	40 m	90 m
	> 300 kN (> 18 tonnes)	50 m	120 m
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	5 m	10 m
Medium hydraulic hammer	(900 kg - 12 to 18t excavator)	15 m	25 m
Large hydraulic hammer	(1600 kg - 18 to 34t excavator)	40 m	75 m
Vibratory pile driver	Sheet piles	8 m	20 m
Pile boring	≤ 800 mm	4 m	8 m
Jackhammer	Hand held	2 m	Avoid contact with structure

Note 1: The working distances for Human Response assume that the source of the vibration is continuous throughout the daytime period. Higher levels of vibration are acceptable when the vibration levels are intermittent or impulsive. The safe working distances are therefore considered to be conservative and it is likely that the safe working distances corresponding to a "low probability of adverse comment" would be lower than indicated.

Vibration-intensive works and plant would potentially occur within safe working

distances for human response (see Table 6.21) and may occur at residences 1 and 3. Vibration from most equipment however is unlikely to be detected at residential locations.

Blasting

Impacts on residences
Blasting would potentially be required as part of the proposal. This would occur approximately 400 metres from the nearest residence. At this distance, the airblast overpressure would be below the acceptable level of 115 dB linear. This vibration level is expected to be 1.77 mm/s, which is well within the recommended maximum level of five mm/s in the ANZECC Guidelines.

It is evident that the anticipated blasting is likely to easily meet all human comfort limits and building damage criteria. All other sources of vibration would be less than for blasting.

Impacts on pipelines
The closest anticipated distance between the blasting and the pipeline would be approximately 100 metres. A nominated vibration limit for the pipeline has not been provided, although AS 2187.2-1993 nominates building damage assessment criteria of between five mm/s PVS for sensitive and heritage buildings to 25 mm/s PVS for commercial and industrial buildings. Based on the representative site law and a minimum offset distance of 100 metres, a predicted vibration level for a range of maximum instantaneous charge is provided below:

- A maximum instantaneous charge of four kilograms would result in a vibration level PVS of five mm/s.
- A maximum instantaneous charge of six kilograms would result in a vibration level PVS of 10 mm/s.
- A maximum instantaneous charge of 16 kilograms would result in a vibration level PVS of 25 mm/s.

Operation

Noise

Table 6.22 outlines the results of the noise modelling undertaken for the four operational scenarios considered.

Noise levels at residence 1 are predicted to result in exceedances of the day and night base criteria. Existing noise levels currently exceed the criteria. Due to these exceedances, mitigation needs to be considered (see Section 6.2.4).

Noise levels at residence 2 are predicted to comply with the day and night criteria. Due to no exceedances, mitigation is not considered further at this property.

Noise levels at residence 3 are predicted to result in exceedances of the day and night base criteria. Due to these exceedances, mitigation needs to be considered (see Section 6.2.4).

Modelling was also undertaken for Kapooka residential area receivers (R4 to R12). No exceedances were predicted at any of the receivers. One receiver did have an increase in noise however levels were below the criteria.

Table 6.22: Predicted noise levels without mitigation

Noise receivers	Address	2014 With proposal noise levels, LAeq, dBA		2014 Without proposal noise levels, LAeq, dBA		2024 With proposal noise levels, LAeq, dBA		2024 Without proposal noise levels, LAeq, dBA		RNP Criteria LAeq, dBA		Are the RNP criteria exceeded by the proposal?		Change in noise level LAeq, dBA[2] 2014		Change in noise level LAeq, dBA[2] 2024		Acute level of noise		Consider further additional noise mitigation[3]
		15h	9h	15h	9h	15h	9h	15h	9h	Day	Night	15h	9h	15h	9h	15h	9h	15h	9h	
R 1	7007 Olympic Hwy	**60.9**	**57.9**	**58.4**	**55.4**	**62.1**	**59.1**	**59.6**	**56.6**	55	50	Yes	Yes	2.5	2.5	2.5	2.5	No	No	Yes
R 2	7015 Olympic Hwy	51.6	48.6	50.4	47.4	52.8	49.8	51.6	48.6	55	50	No	No	1.2	1.2	1.2	1.2	No	No	No
R 3	6852 Olympic Hwy	**59.5**	**56.5**	54.9	**51.9**	**60.7**	**57.7**	**56**	**53**	55	50	Yes	Yes	4.6	4.6	4.7	4.7	No	No	Yes
R 4	1 Sturt Ave	47.6	44.6	52.9	49.9	48.7	45.7	54.0	**51.0**	55	50	No	No	-5.3	-5.3	-5.3	-5.3	No	No	No
R 5	2 Sturt Ave	47.9	44.9	52.8	49.8	49.2	46.2	53.9	**50.9**	55	50	No	No	-4.9	-4.9	-4.7	-4.7	No	No	No
R 6	3 Sturt Ave	48.3	45.3	53.1	50.1	49.6	46.6	54.2	**51.2**	55	50	No	No	-4.8	-4.8	-4.6	-4.6	No	No	No
R 7	4 Sturt Ave	48.4	45.4	53.1	50.1	49.6	46.6	54.2	**51.2**	55	50	No	No	-4.7	-4.7	-4.6	-4.6	No	No	No
R 8	5 Sturt Ave	48.0	45.0	52.6	49.6	49.2	46.2	53.7	**50.7**	55	50	No	No	-4.6	-4.6	-4.5	-4.5	No	No	No
R 9	12 (Side St of Sturt Ave)	46.1	43.1	50.7	47.7	47.4	44.4	51.8	48.8	55	50	No	No	-4.6	-4.6	-4.4	-4.4	No	No	No
R 10	13 (Side St of Sturt Ave)	47.5	44.5	52.6	49.6	48.7	45.7	53.7	**50.7**	55	50	No	No	-5.1	-5.1	-5	-5	No	No	No
R 11	14 (Side St of Sturt Ave)	47.5	44.5	52.6	49.6	48.7	45.7	53.7	**50.7**	55	50	No	No	-5.1	-5.1	-5	-5	No	No	No
R 12	Lot DP 1116883 Wiradjun Walking	42.5	39.5	41.2	38.2	43.7	40.7	42.4	39.4	55	50	No	No	1.3	1.3	1.3	1.3	No	No	No

1. **Bold** = exceeds RNP Criteria
2. Change in noise level between 'with proposal' and 'without proposal' scenarios for year opening and design year
3. Where either change in noise levels exceed two dB or predicted design year levels are acute, consideration of additional mitigation is required.

Relative increase assessment

In addition to the base assessment criteria outlined in the RNP, any increase in total traffic noise levels at a location due to a traffic generating development must be considered. Residences experiencing increases in total traffic noise levels above the relative increase criteria should be considered for mitigation. The relative increase criterion is primarily intended to protect existing quiet areas from excessive changes in amenity due to noise from a road project.

Residences surrounding the Olympic Highway at Kapooka are already exposed to noise from traffic, which is evident in the background noise monitoring. An assessment of the four residential locations that experience an increase in predicted noise levels is provided in Table 6.22.

It is predicted that traffic growth on the Olympic Highway over a 10 year period would account for an increase of 1 dB. The new alignment would increase noise levels at some residential dwellings due to a change in offset distance between the receiver and the road.

From the results presented in Table 6.22, while residences 1 and 3 would experience increases in predicted noise levels, none would experience an increase in predicted noise levels greater than 12 dB (relative increase criteria). Mitigation still needs to be considered for these residences (see Section 6.2.4).

The predicted relative increases shown in Table 6.22 are lower than the criteria for both scenarios therefore the relative increases do not trigger the requirement for noise mitigation.

Sleep disturbance

This stretch of the road currently experiences short-term high noise level events from heavy vehicles. The proposal is anticipated to reduce the number of high noise level events as it would eliminate sharp changes in vertical alignment and the use of engine brakes. The proposal would result in the alignment moving closer to residences 1 and 3. This would result in higher maximum noise events at residence 1, while impacts to be experienced at residence 3 would be similar to the existing environment at residence 1.

Table 6.22 indicates that the maximum noise levels at residence 1 and potentially residence 3 could exceed the nominated 65 dBA criteria. As mentioned above the RNP base criteria are exceeded at these locations and therefore mitigation is to be considered. It is considered that the treatments outlined in Section 6.2.4, would result in a reduction to the maximum noise level events.

6.2.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration - construction and operation	• Where practicable, architectural treatments to mitigate noise impacts to the identified sensitive receivers residence 1 and residence 3 will be completed before construction.	Project manager	Pre-construction
Noise and	• A noise barrier to minimise noise impacts	Project	Pre-

Impact	Environmental safeguards	Responsibility	Timing
vibration - construction	on residence 3 during construction will be implemented where feasible. • A construction noise and vibration management plan will be prepared.	manager and contractor	construction
Noise impacts during construction - general	• Noise impacts will be minimised in accordance with Roads and Maritime's *Environmental Noise Management Manual* (RTA 2001) and Roads and Maritime's *Environmental Fact Sheet No. 2 - Noise management and Night Works*.	Project manager and contractor	Construction
Noise and vibration – out of hours construction work	• Works will generally be carried out during standard working hours (ie 7am to 6pm Monday to Friday; 8am to 1pm Saturdays). Any work that is performed outside normal work hours or on Sundays or public holidays will be undertaken in accordance with Practice Note 7 of Roads and Maritime's Environmental Noise Management Manual.	Project manager and contractor	Construction
Noise and vibration - construction	• Maintenance work on all construction plant will be carried out away from noise sensitive receivers and confined to standard construction hours and work compound where feasible. • The use of noisy plant or equipment (eg rockbreakers and jackhammers) will be limited to the daytime. • Regular compliance checks will be carried out on noise emissions from plant and machinery. All plant and machinery will be regularly maintained to minimise noise emissions. • Noise monitoring will be carried out during construction at three-monthly intervals.	Project manager and contractor	Construction
Noise and vibration – construction (reversing alarms)	• Reversing movements in work vehicles and plant will be minimised where practicable. • Workers will be made aware during driver training and site induction sessions of the potential adverse impact of reversing alarms and the need to minimise their use. • To reduce the annoyance associated with reversing alarms, use of broadband reversing alarms (audible movement alarms) will be considered where this will not compromise safety.	Project manager and contractor	Construction
Noise and vibration – construction (consultation)	• The community will be kept informed of the nature, timing and duration of impending works. • The contractor will nominate a contact person in the construction noise and vibration management plan to directly address any noise and/or vibration	Project manager and contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	complaints that the community may have during the construction phase of the project.		
Noise and vibration – construction (management response strategy)	• All noise complaints will be investigated and mitigation measure implemented where feasible. Consideration of noise mitigation measures will follow the receipt of a noise complaint.	Project manager and contractor	Construction
Noise and vibration - vibration	• Measures, including allowing adequate distance between rollers and adjacent buildings and/or using non vibrating rollers, will be used to minimise or prevent vibration impacts. • The potential for damage to pipelines and other infrastructure would be monitored during blasting.	Project manager and contractor	Construction