16. Noise and Vibration

The Noise and Vibration Assessment examined the existing ambient noise environment and the potential impacts that the Project could have on sensitive receivers (in this case, mostly dwellings).

The assessment found that the construction of the Project has the potential to create adverse effects from noise and vibration at some sensitive receivers. Construction during the day is considered to be of negligible risk as generally receivers are not as sensitive to noise during the day and management techniques including noise reduction technology on machinery would be implemented.

Construction is considered to be of higher impact during the evenings, at night and at weekends, although evening, night time and weekend construction is only expected to occur in exceptional circumstances. Evening, night time and weekend construction noise impacts would be managed by consulting with potentially impacted residents and implementing a noise mitigation strategy.

Energy from construction activities can also be transformed into vibration. No significant vibration effects on human comfort are predicted; however vibration may be just perceptible at residences within approximately 50m of construction activities involving equipment such as rolling and compacting machinery. The vibration from rolling and compacting activities would be considered intermittent and short-term and likely to be tolerated if prior warning is given to the resident.

Fourteen sensitive receivers are located within 50m of the proposed alignment and may experience vibration impacts during construction. While vibration levels during construction could be noticeable at these dwellings, the vibration levels are not expected to be sufficient to cause damage to the structural integrity of the buildings and infrastructure.

Noise modelling was also undertaken to predict the operational impact of the Project on the surrounding area, by considering predicted traffic volumes at completion (estimated as 2016), and in 2026. Results were compared with predicted traffic noise levels from the existing Western Highway in 2026.

The model predicts operational noise levels would increase when compared to the present, predominately due to increases in traffic which are anticipated regardless of whether or not the project proceeds. In some areas, the proposed alignment would be closer to sensitive receivers than the existing Western Highway and therefore the potential for impact is greater. In other cases the proposed alignment would be further away from sensitive receivers, reducing noise levels.

Based on a comparison of predicted traffic noise levels from the existing Western Highway in 2026 and the predicted traffic noise levels from the proposed alignment for the same year, the Project is expected to result in slightly more dwellings experiencing a clearly noticeable reduction in traffic noise (decrease of 5dB(A) or more) than a clearly noticeable increase in traffic noise (increase of 5dB(A) or more).

The impact assessment identified that there are sensitive receptors, particularly north-east of Great Western, that would require further investigation to confirm if noise mitigation measures would be required.

Further acoustic assessment following completion of the detailed alignment design would be required to clarify areas and the extent to which noise attenuation may be required. Noise attenuation would be considered for the affected properties however, normal road wear and tear is expected to reduce these levels to within policy guidelines.

16.1 EES Objectives

The EES objectives relevant to 'Noise and Vibration' specified in the EES Scoping Requirements include:

'*To minimise air emissions, noise, visual, landscape and other adverse amenity effects during the construction and operation of the proposed duplicated highway to the extent practicable.'*

'To avoid or minimise disruption and other adverse effects on infrastructure, land use (including agriculture) and households, as well as road users resulting from the construction and operation of the highway duplication.'

This chapter discusses the noise environment of the study area, the potential noise and vibration impacts of the Project, and management measures recommended for implementation to minimise these impacts. More specifically, this chapter addressing the EES Scoping Requirements by:

- Characterising the ambient noise environment and identifying sensitive receivers in the study area.
- Identifying and assessing the potential for the Project to increase noise and vibration levels during construction and operation at sensitive receivers.

- Identifying possible design and management measures to avoid, mitigate and manage any potential noise or vibration effects on sensitive receivers during construction and subsequently, to ensure the project will comply with applicable policy.

This chapter is based on a Noise and Vibration Impact Assessment Report completed by GHD Pty Ltd (2012g), and is included in Technical Appendix M.

16.2 Study Area

The noise and vibration assessment study area is the same as the Project area, which is approximately 24 kilometres (km) long, commencing at Pollard Lane, Ararat and finishing at Gilchrist Road, Stawell. The study area encompasses a corridor extending up to 1500m to the east and west of the existing Western Highway, except around Great Western where it extends to 1800m either side to encompass the extent of the alignment options (see Figure 16-1).

16.3 Methodology

An assessment existing of conditions was undertaken and involved the deployment of six noise loggers at various points along the study area (see Figure 16-1).

Four of the loggers were placed at residential dwelling locations, as close as possible to the existing Western Highway, in order to capture current traffic noise for model calibration purposes. Two additional locations were chosen based on their amenity value. Amenity value with regard to this noise assessment was defined as sites that were a significant distance from the existing highway, but may be affected by the proposed duplication running close to the property. Amenity site data describes more closely the true background noise of the study area, excluding or minimising traffic noise.

Attended and unattended measurements were taken from six locations along the alignment with consideration given to AS2702:1984 - Acoustics (Methods for the Measurement of Road Traffic Noise). Seven days of unattended noise logging was carried out, and a subset of three days (28 June 2011 to 30 June 2011) was selected for analysis based on meterological conditions. A set of 15 minute attended noise measurements were carried out at each site during deployment of the logger instruments. The LA10 (18hr), LA10 (12hr), LAeq (15hr), LAeq (16hr), LAeq (8hr), LAeq (9hr) noise level descriptors (see glossary in Technical Appendix M) were processed for each hourly time interval over the logging period.

Construction vibration assessment was based on a review of commonly used guidelines such as British Standard – BS 6472 – 2008 (Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration sources other than blasting), British Standard – BS 5528.2:2009 (Code of Practice for noise and vibration control on construction and open sites: Part 2 Vibration) and German Standard DIN 415-3:1999 (Structural Vibration – Part 3: Effects of vibration on structures). These guidelines were used for establishing base vibration criteria for use in the assessment of building damage caused by vibration and also human discomfort due to vibrations occurring inside dwellings.

Modelling was undertaken to predict construction noise at varying distances from an indicative 2km section of the Project around Briggs Lane. This location was selected because it was relatively flat and the construction zone would contain both an east and west carriageway and accompanying service road either side of the alignment. Receiver locations in the model were evenly spaced at 100m intervals both east and west of the 2km sub- section of the Project, radiating from the central point of the model. Receiver locations were positioned up to 1km to the east and west of the construction activity (see Figure 16-2).

Two scenarios were run, one (Time Weighted) where a selection of different types of machinery were modelled to mimic a typical day construction with machinery stopping and starting throughout the day. A second scenario (Full Load) was run where a selection of different types of machinery was in use at all times throughout the construction day, which would describe a worst case scenario.

A further construction noise assessment was undertaken using construction equipment sound power levels found in the Australian Standard AS2436:2010 ‘Guide to Noise and Vibration Control on Construction Demolition and Maintenance Sites’ and a distance to noise attenuation relationship.

Noise modelling was also undertaken to predict the operational impact of the Project on the surrounding area, by considering predicted traffic volumes at completion (estimated as 2016), and in 2026. The United Kingdom Department of Transport Calculation of Road Traffic Noise (CoRTN) algorithm was used as it is accepted and approved by both VicRoads and EPA as a suitable method for predicting road traffic noise levels.

The accuracy of the model outputs were validated by modelling the existing highway and comparing the results to the existing conditions data collected by VicRoads between Harvey Lane and Panrock Reservoir Road during May 2012. The difference was less than +/- 2dB(A), which is considered acceptable.

A comparison of predicted noise levels for the existing Western Highway in 2026 due to natural increase in traffic volumes, and the predicted 2026 noise levels due to the proposed new alignment was undertaken.

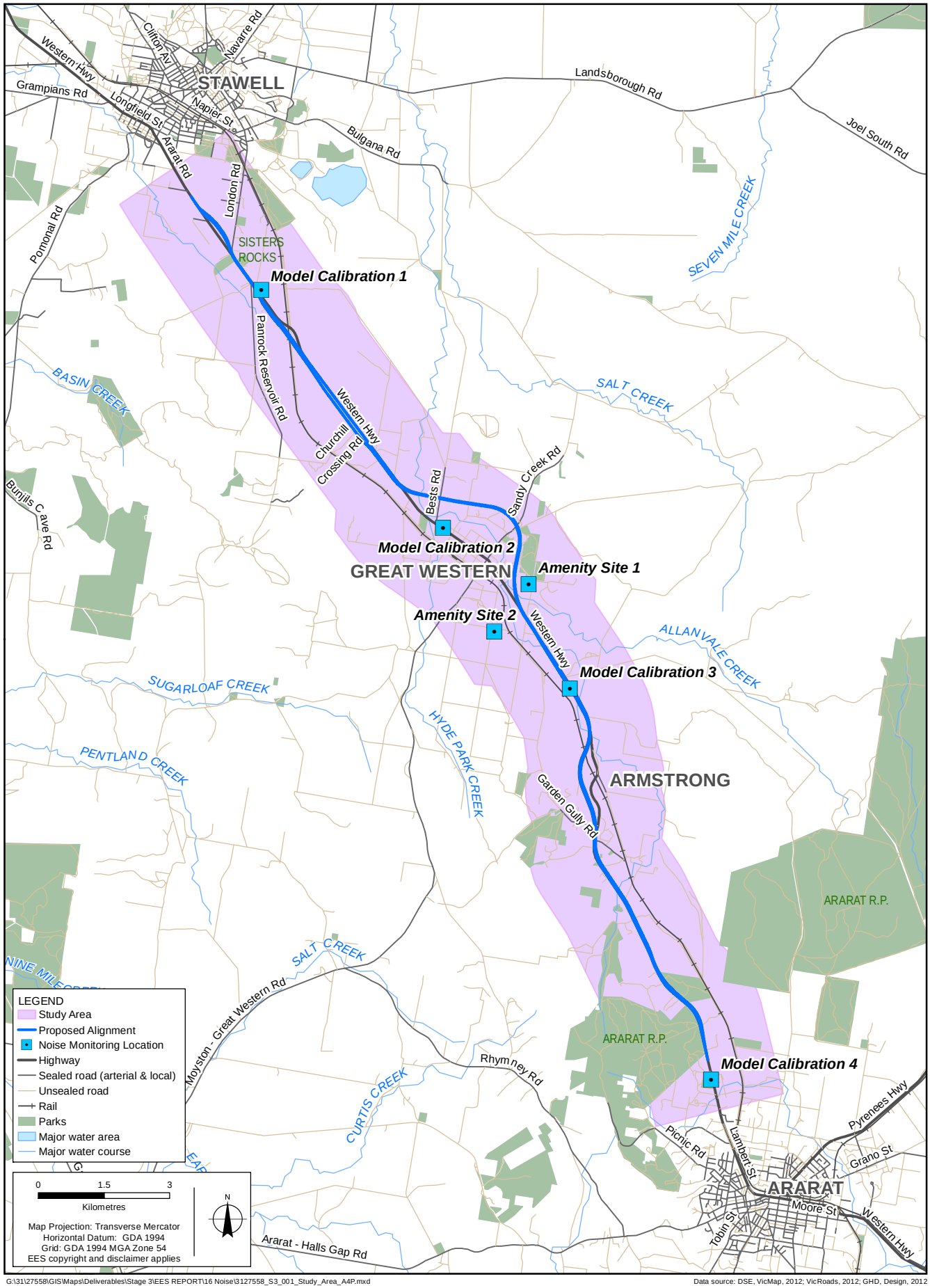

Figure 16-1 Noise and Vibration Assessment Study Area and Noise Monitoring Locations

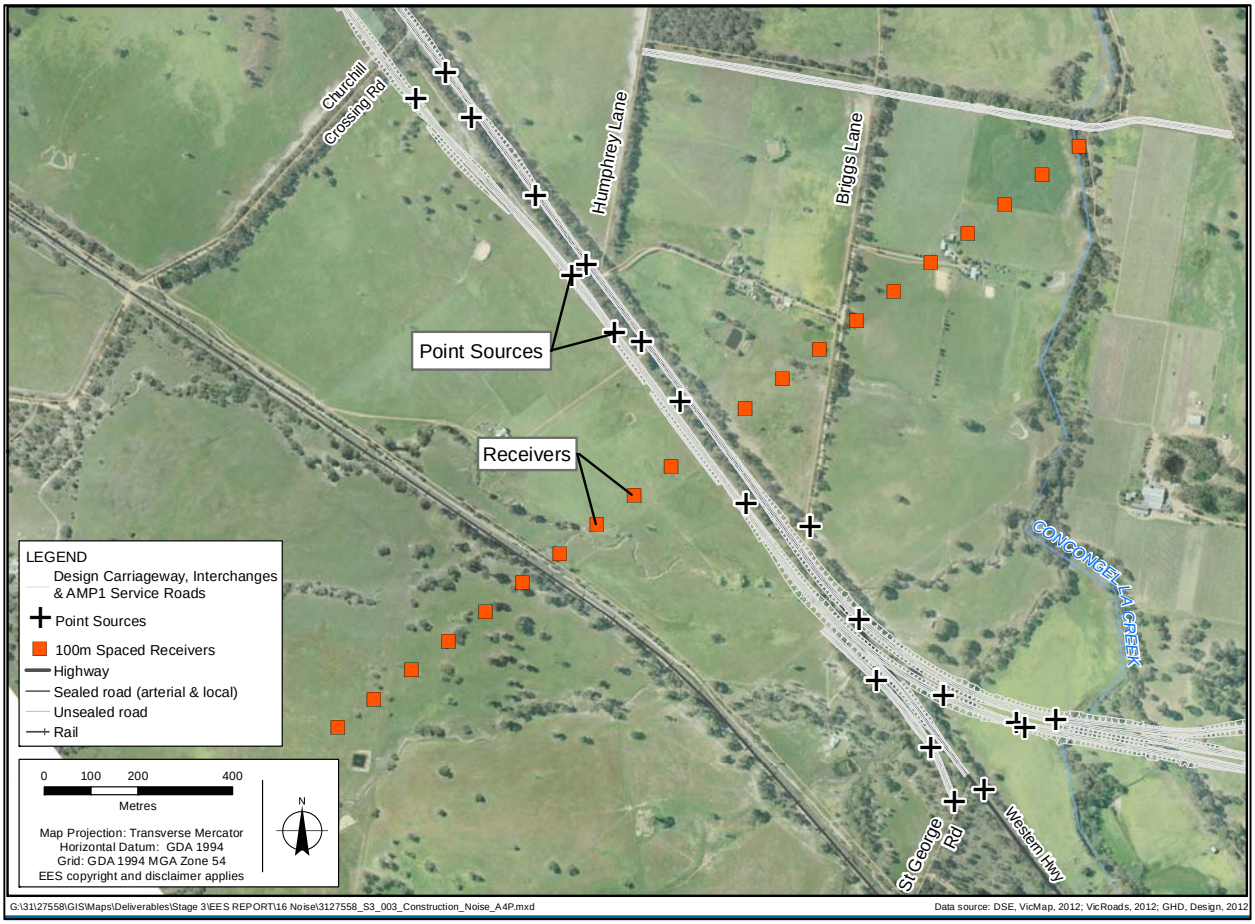

Figure 16-2 Indicative construction noise model locations showing a 2km section of the Project (1km either side of Briggs Lane) and the placement of receivers in the model

16.4 Legislation, Policy and Guidelines

The relevant legislation, government policies and guidelines for the noise and vibration assessment are shown in Table 16-1.

Table 16-1 Relevant Noise and Vibration Legislation, Policies and Guidelines

Legislation / Policy	Description
State	
Transport Integration Act 2010	The *Transport Integration Act 2010* sets out a vision, objectives and principles for transport in Victoria. It makes clear that the transport system needs to be integrated and sustainable - in economic, environmental and social terms. Part 2, Division 2, Section 10 of the Act outlines the transport objectives with regard to environmental sustainability, these are: *"The transport system should actively contribute to environmental sustainability by—* *(a) protecting, conserving and improving the natural environment;* *(b) avoiding, minimising and offsetting harm to the local and global environment, including through transport-related emissions and pollutants and the loss of biodiversity;* *(c) promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment;* *(d) improving the environmental performance of all forms of transport and the forms of energy used in transport."*

Legislation / Policy	Description
Traffic Noise Reduction Policy (VicRoads, February 2005)	There is currently no State Environment Protection Policy (SEPP) for road traffic noise along State-controlled roads. Instead, traffic noise along these roads is controlled using the *VicRoads – Traffic Noise Reduction Policy 2005*. The policy seeks to regulate noise levels where a new alignment is built. New alignment refers to those areas where a new carriageway is constructed outside the current (i.e. pre-existing) road reserve boundary. **Existing Road Corridor Works (Retrofitting)** The Traffic Noise Reduction Policy seeks to mitigate noise where arterial roads and freeways a exceed a 68dB(A) $L_{10\ (18hr)}$ trigger level. Mitigation is achieved by retrofitting barriers, bridge parapets, crash barriers, and upgrading of road surfaces in order to attenuate the noise levels to a level below 68dB(A) $L_{10\ (18hr).}$ This Project would be exempt from the retrofitting program as the existing road was built prior to 1979. **New Alignment and Corridor Expansion Works** The Traffic Noise Reduction Policy seeks to limit noise at sites where arterial roads and freeways are built on new alignments or existing networks are widened as follows: Category A – For residential dwellings, aged person homes, hospitals, motels , caravan parks and other buildings of a residential nature, the noise level objective will be 63dB(A) $L_{10\ (18hr).}$ measured between 6 am and midnight; Category B – For schools, kindergartens, libraries and other noise sensitive community buildings, the noise level objective will be 63dB(A) $L_{10\ (12hr)}$ measured between 6 am and 6 pm; and Where the noise level adjacent to Category A or B buildings prior to road improvements is less than 50dB(A) $L_{10\ (18hr)}$, consideration will be given to limiting the noise level increase to 12dB(A).
Australian Standard (AS) 2702-1984: Acoustics-Methods for the Measurement of Road Traffic Noise	This Standard sets out methods for the measurements of the noise emitted by road traffic. The Standard describes minimum instrument requirements, preferred scales of measurements, and the location of measurement sites and non-acoustic data which are to be recorded in conjunction with the acoustic measurements.
Traffic Noise Measurement Requirements for Acoustic Consultants (VicRoads, November 2005)	The Traffic Noise Measurement Requirements are based on AS 2702 and have been developed to ensure that all measurements are of high quality and consistent over time.
EPA 1254-2008: Noise Control Guidelines	This guideline provides a schedule of working hours and noise limits for construction sites. These are broken up into normal working hours, weekend/evening work hours and the night period and are presented in Table 16-5. This guideline makes an allowance for unavoidable construction works through the night provided that residents are notified of the intended work, its duration and times of occurrence and provides mitigation measures that need to be considered.
EPA 480-1996: Environmental Guidelines for Major Construction Sites	This document is designed to provide developers and contractors with guidelines on how to implement sound practices that minimise environmental impacts and eliminate health risks and nuisance to residents near a construction site

16.5 Existing Conditions

16.5.1 Meteorology

The following meteorological conditions will have an effect on noise propagation and absorption:

- Temperature: The higher the temperature the higher the noise absorption.
- Temperature Inversions: Temperature inversions can cause noise to refract ground-ward. An inversion is a thin air layer which experiences increasing temperature with height, rather than the typical decreasing trend.
- Relative humidity: The higher the humidity the lower the noise absorption.
- Wind direction and speed: Sound refracts or bends across a wind pressure gradient, bending ground-ward downwind, and skyward upwind of the noise source.

Climate data downloaded from the Bureau of Meteorology website indicates that the entire study area from Ararat to Stawell has a 'temperate' climate with 'no dry season (warm summer)'. Extreme values in temperature occur, with hot days more frequent at the north-western end and frosty mornings occurring more often at the south-eastern end. The wettest months to occur in the spring with greater rainfall expected at the south-eastern end of the study area.

Annual average winds for the project area are predominately from the south, with a seasonal switch to the north during winter.

Atmospheric stability in the study area is predominately 'neutral' for well over half the time with 'stable' conditions for about a third of the time. These stable and low wind speed conditions are suitable for the formation of inversion layers.

Local meteorology is discussed in detail in the Air Quality Impact Assessment Report (GHD, 2012f) prepared for the Project (see Appendix L).

16.5.2 Noise Levels

A summary of unattended measured noise levels is presented in

Table 16-2 and their locations mapped in Figure 16-1. A summary of daily unattended measured noise levels for each site is presented in Tables 17 through 22 in the Noise and Vibration Assessment Report (GHD 2012g) prepared for the Project (see Appendix M).

Attended noise measurements were undertaken in order to monitor noise sources at different times of the day at the different sites. A summary of the results of attended noise monitoring is provided in Table 16-3.

The sensitivity of the human ear to noise depends on any number of contextual factors which typically include distance from source, wind, humidity, traffic density, etc. Perception of sound will vary from person to person but generally, the human ear can pick up sounds from 0dB(A) through to the pain threshold of 130dB(A). Daytime noise levels of around 55dB(A) are generally classed as acceptable in residential areas for planning purposes, while industrial zones have higher values. During sleep, it is generally accepted that an internal noise level below 50 to 55dB(A) is unlikely to cause a person to wake up, whereas a level of 65dB(A) or above is likely to cause some sleep disturbance.

Future traffic noise levels can be predicted from the existing and future traffic volumes, as well as the changes in the road alignment due to the Project. A 100% increase (or doubling) in traffic volume translates to an increase of 3dB(A) in traffic noise levels. Note, noise levels in dB(A) are measured on a logarithmic scale. Therefore, a small change in traffic volume, say 20%, would result in a traffic noise increase of less than 1dB(A).

It is important to note that the residential dwellings along the highway already experience noise from the existing road. A 3dB(A) increase in noise levels would only just be perceptible to the normal human ear (Bies, 2003).

Results from unattended measurements show:

- As would be expected, the amenity sites which were situated further away from the existing Western Highway had a lower overall LA10 (18hr) than the model calibration sites - with 54dB(A) and 49dB(A) for Amenity Sites 1 and 2 respectively.
- Amenity Site 2 is currently below the noise level of 50dB(A) LA10 (18hr) described in the VicRoads – Traffic Noise Reduction Policy, February 2005 for both Category A & B buildings as the level in which 'consideration will be given to limiting the noise increase to 12dB(A) LA10 (18hr)'.
- Model calibration Sites 2 and 3 demonstrated similar traffic noise levels with 72 and 71dB(A) LA10 (18hr) respectively. These sites were relatively close to the existing highway at 13m and 34m and hence, give a good representation of the traffic noise at these locations. Model calibration Site 1, which was just outside Stawell, was significantly quieter, at 62dB(A) LA10 (18hr), as it is set back from the highway approximately 85m.
- Model Calibration Site 4 was also 65dB(A) LA10 (18hr), however, this site was much closer to the existing highway at 17m and had more traffic and a higher percentage of heavy traffic at 25 percent.

Table 16-2 Noise Monitoring Locations and Summary of Measured Road Traffic Noise Levels (dB)

Site ID	Location	Date Start	Date End	$L_{A10, 18hr}$	$L_{Aeq, 16hr}$	$L_{Aeq, 15hr}$	$L_{Aeq, 9hr}$	$L_{Aeq, 8hr}$
Model Calibration Site 1	2460 Western Highway, Stawell,	28/06/11	01/07/11	62	58	58	58	58
Model Calibration Site 2	9-11 Main Street, Great Western	28/06/11	01/07/11	72	68	68	66	66
Model Calibration Site 3	1301 Western Highway, Ararat	28/06/11	01/07/11	71	67	67	66	66
Model Calibration Site 4	309 Western Highway, Ararat	28/06/11	01/07/11	65*	62*	62*	60*	60*
Amenity Site 1	134 Wattle Gully Road, Great Western	28/06/11	01/07/11	54	55	54	55	56
Amenity Site 2	588 Garden Valley Road, Ararat	28/06/11	01/07/11	49	47	48	47	47

* Values have been adjusted in order to remove erroneous data found on Thursday 30 June 2011 from 12:00 to 13:30 hours due to two spikes of unknown origin

Table 16-3 Summary of Attended Noise Measurements (dB)

Site ID	Date	Time	Traffic	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}	L_{Amin}
Model Calibration Site 1	28/06/11	9:30	Heavy 15 Light 77 Total 92	15 min	58	47	62	69	40
Model Calibration Site 2	28/06/11	10:00	Heavy 30 Light 81 Total 111	15 min	66	47	71	82	38
Model Calibration Site 3	28/06/11	11:30	Heavy 15 Light 66 Total 81	15 min	64	42	68	79	33
Model Calibration Site 4	28/06/11	12:00	Heavy 25 Light 76 Total 101	15 min	62	49	65	79	41
Amenity Site 1	28/06/11	11.00	Heavy 30 Light 73 Total 103	15 min	54	43	53	79	33
Amenity Site 2	28/06/11	10.30	Heavy – Light - Total -	14 Min	43	34	45	64	30

16.6 Impact Assessment

16.6.1 Key Issues

The Project has the potential to improve (reduce) noise levels at Great Western township, and some houses around Harvey Lane and on Robson Road, as the proposed alignment is further away from sensitive receivers than the existing highway. However, there are some dwellings that may potentially be impacted more, such as those situated on the north-eastern outskirts of Great Western township and some houses east of London Road. This is discussed further in Section 16.6.4

16.6.2 Construction Noise

Plant and equipment needed for the Project would be determined during the construction planning phase, however an estimation has been made to predict the likely construction noise levels.

The magnitude of off-site noise impact associated with construction would be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.
- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would move about the study area, altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction.

As described in Section 16.3, construction noise was modelled to predict construction noise levels at varying distances from an indicative 2km section of the Project around Briggs Lane using a combination of different types of construction equipment. Results of the construction modelling for two scenarios (Time Weighted and Full Load) are presented in Table 16-4. Sensitive receivers at a distance of approximately 100m from the centre of the construction activities were predicted to experience construction noise levels between 51 and 55dB(A) LAeq east and west of the construction activities respectively for Time Weighted scenario one and between 56 and 60dB(A) LAeq east and west of the construction activities for the Full Load scenario.

Table 16-4 Predicted Construction Noise Emissions of an Indicative Section of Highway

Distance away from centreline (m)	Construction Noise from Time Weighted Equipment Usage L_{Aeq} dB(A)	Construction Noise from Using Equipment All Day (100%) L_{Aeq} dB(A)	Construction Noise from Time Weighted Equipment Usage L_{Aeq} dB(A)	Construction Noise from Using Equipment All Day (100%) L_{Aeq} dB(A)
	East of Alignment		West of Alignment	
100	51	56	55	60
200	50	54	54	59
300	49	54	49	53
400	47	52	51	55
500	45	50	48	54
600	42	47	48	53
700	40	45	47	52
800	39	44	46	51
900	40	45	44	49
1000	37	42	42	47

Sensitive receivers at a distance of approximately 200m from the centre of construction activities are likely to experience construction noise levels between 50 and 54dB(A) LAeq east and west of the construction activities respectively for Time Weighted scenario and between 54 and 59dB(A) LAeq east and west of the construction activities respectively for the Full Load scenario.

The EPA Noise Control Guidelines 2008 provide noise criteria for evening (6pm to 10pm), night (10pm-7am) and weekend works (see Table 16-5).

Based on overall measured evening and night time noise levels at Amenity Sites 1 and 2, construction values during the evening and night-time periods should not exceed an external noise level of 47dB(A) and 34dB(A) for the first 18 months and 42 and 34dB(A) after this period for evening and night-time construction respectively. Therefore, should evening construction be required, it is predicted that the 47dB(A) criteria would be exceeded if construction was carried out 400m from a residence to the east and 700m from a residence to the west of the construction area (Time Weighted scenario) and the night-time criteria would be exceeded in all cases.

Further construction noise assessment, as described in Section 16.3, was undertaken using a distance to noise attenuation relationship and construction equipment sound power levels.

Predicted noise levels were determined for anticipated plant and equipment at various receiver distances. Noise level data has been obtained from Australian Standard AS2436 and the VicRoads Technical Noise Guidelines – Construction and Maintenance Works (VicRoads, 2007).

The construction noise assessment indicates that some activities such as concrete saws, pneumatic hand tools, piling, jackhammering may exceed the evening criteria up to a distance of over 1km away. However, construction outside of the standard hours is likely to be minimal and would be subject to approval by VicRoads and notification of affected members of the community.

Table 16-5 Construction Work Hours (Environment Protection Authority (EPA), 2008)

Time	Work Hours	Noise Limit
Normal Working Hours	7 am to 6 pm Monday to Friday 7 am to 1 pm Saturdays	There are no limiting construction noise criteria for the daytime period, however there is still a duty to minimise noise impacts on the surrounding environment.
Weekend Work Hours and Evening Work Hours	6 pm to 10 pm Monday to Friday 1 pm to 10 pm Saturdays 7 am to 10 pm Sundays and Public Holidays	Noise level at any residential premises not to exceed background noise by: 10dB(A) or more for up to 18 months after Project construction commencement; and 5dB(A) or more after 18 months.
Night Period	10 pm to 7 am Monday to Sunday	Noise inaudible within a habitable room of any residential premises.

16.6.3 Construction Vibration

Energy from construction equipment is transmitted into the ground and transformed into vibration, which weakens with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive, reciprocating, rolling or rotating equipment);
- The frequency content;
- The impact medium stiffness;
- The type of wave (surface or body); and
- The ground type and topography.

Due to these factors, there is inherent variability in ground vibration predictions without site-specific measurement data. The NSW RTA Environmental Noise Management Manual (ENMM) 2001 provides typical construction equipment ground vibration levels at 10m (Roads and Traffic Authority of New South Wales, 2001). These levels are suitable in the absence of Victorian specific guidelines.

The predicted ground vibrations at various distances are shown in Table 16-6 for typical equipment that may be used based on data from the ENMM.

No significant vibration effects on human comfort are predicted; however vibration may be just perceptible at residences within approximately 50m of the construction activities involving equipment such as rolling and compacting machinery. The vibration from rolling and compacting activities would be considered intermittent and short-term and likely to be tolerated if prior warning is given to the resident.

Fourteen sensitive receivers are located within 50m of the proposed alignment and due to their proximity they may notice vibration impacts during construction. Of these, one residential dwelling is proposed to be acquired by VicRoads.

While vibration levels during construction could be noticeable at these dwellings, the vibration levels are not expected to be sufficient to cause damage to the structural integrity of the buildings and infrastructure.

As a precaution, the construction contractor should undertake a property inspection for any buildings, structures or utilities located within 50m of construction works.

Blasting is unlikely to be required during construction. However if any blasting events are required, it would be expected to be short term, minor events at distances far enough away from the sensitive receivers as to cause no more than minor transitory impacts.

Table 16-6 Typical Vibration Levels at Distances (Peak mm/s)

Plant Item	Peak Vibration (mm/s), Distance from Source			
	10m	20m	50m	100m
15t roller	7.0 to 8.0	3.8	1.5	0.8
7t compactor	5.0 to 7.0	3.0	1.2	0.6
Dozer	2.5 to 4.0	1.6	0.7	0.3
Backhoe	1.0	0.5	0.2	0.1
Pavement breaker	4.5 to 6.0	2.6	1.1	0.5

16.6.4 Operational Noise

The noise assessment for operational impacts is based on noise modelling of future traffic volumes along the proposed alignment, as described in Section 16.3.

The model predicts noise levels would increase when compared to the present, predominately due to increases in traffic which are anticipated, regardless of whether or not the project proceeds. In some areas, the proposed alignment would be closer to sensitive receivers than the existing and therefore the potential for impact is greater, and in other cases it would be further away, reducing noise levels.

An increase in the sound level by up to 3dB(A) would only just be perceptible to the normal human ear (Bies, 2003). A change in sound level of approximately 5dB(A) would be clearly noticeable, and a change of 10dB(A) would seem twice as loud.

A comparison of predicted noise level differences due to traffic, road surface and relative location of receivers between the existing Western Highway (2026) and the proposed alignment (2026) for all sensitive receivers is presented in Table 32 and Figure 9 Technical Appendix M and Figure 9 of this report. The predicted change in noise levels at sensitive receptors is illustrated in Figure 16-3. The predicted changed in noise levels shown in Figure 16-3 have been considered in the following three ranges and are illustrated with colours:

- An increase in sound level by up to 3 dB(A) which and would ‘only just be perceptible’ to the normal human ear at a sensitive receiver location (Green);

- A change of between 3 dB (A) and 4 dB(A) which would be 'perceptible' to the human ear at a sensitive receiver location (Orange); and
- A change of 5 dB(A) or more which would be 'clearly noticeable' to the human ear at a sensitive receiver location (Bies, 2003) (Red).

The new alignment noise models also have a +2dB(A) adjustment for a 14mm spray seal road surface. Typically +4dB(A) would be used for 14mm spray seal, however only +2dB(A) was used in this assessment to account for future road wear closer to 2026. It should be noted that by assessing the road project for future road wear closer to 2026 (10 year horizon), predicted 2016 noise levels are understated by 2dB(A), however it is expected that over time these higher initial noise levels will reduce under normal road wear.

Based on the operational noise impact assessment, the following is a summary of anticipated outcomes:

- 67 houses are predicted experience decreased noise levels in 2026 if the proposed alignment is built compared to what the noise levels would be from the existing highway in 2026:
- Of the 67 houses with a decreased noise level, 30 houses are predicted to have noise level decreases of 5dB(A) or more;
- The noise levels at 21 houses are predicted to remain the same if the proposed alignment is built compared to what the noise levels would be from the existing highway in 2026;
- 153 houses are predicted to experience increased noise levels if the proposed alignment is built compared to what the noise levels would be from the existing highway in 2026;
- Of the 153 houses, 28 houses are predicted to experience noise level increases of 5dB(A) or more; and
- Of these 28 houses, 9 houses are predicted to experience a noise level increase of 10dB(A) if the proposed alignment was built compared to what the noise levels would be from the existing highway in 2026.

An investigation into the predicted 2016 and 2026 traffic noise levels at Great Western Primary School was carried out. The predicted noise level at the most exposed façade to the proposed alignment was 51dB(A) LA10(12hr) in 2016 increasing slightly to 52dB(A) LA10(12hr) in 2026.

Intersection of Western Highway and Humphrey Lane

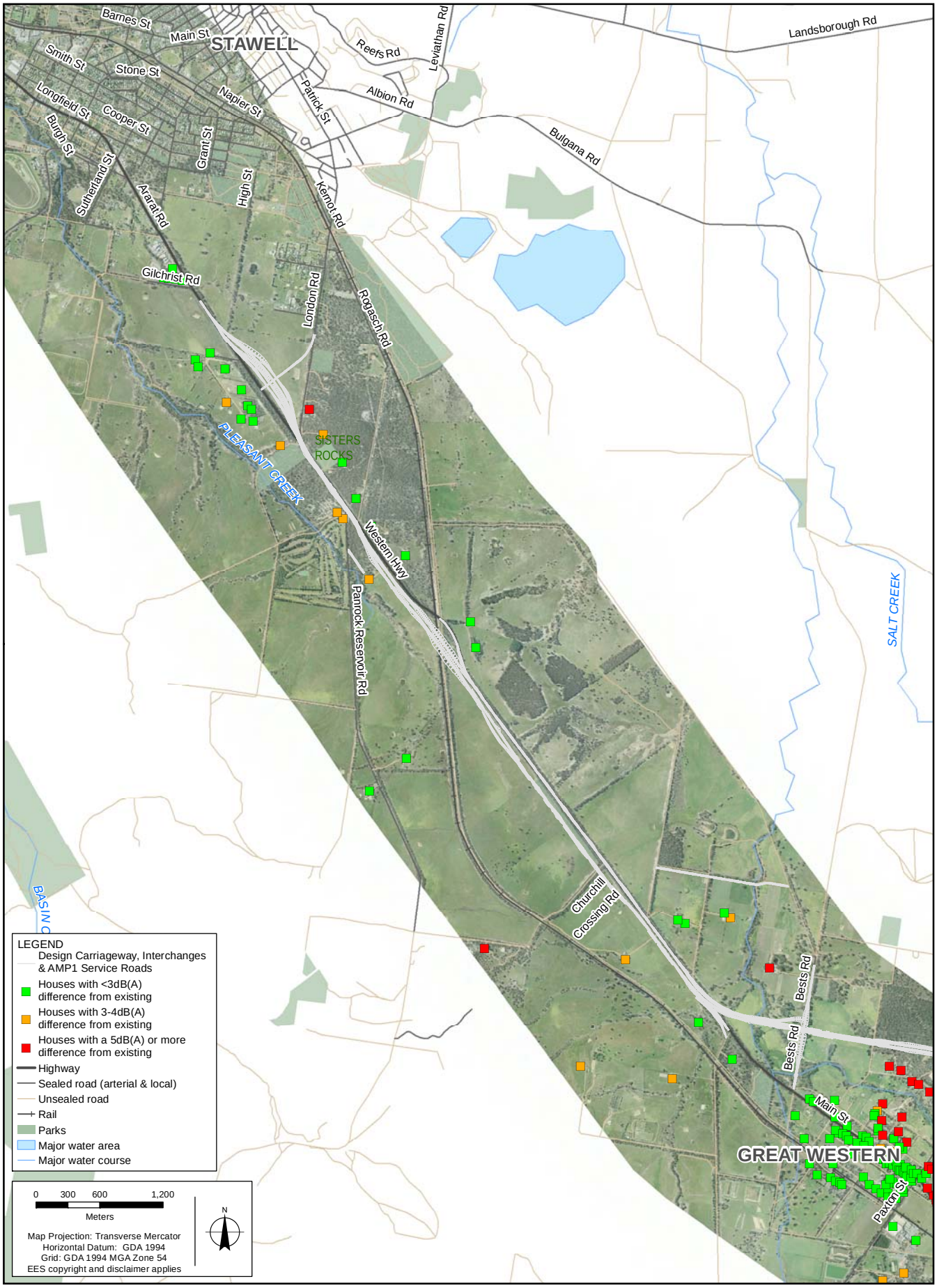

Figure 16-3a Predicted change in noise levels and noise contours

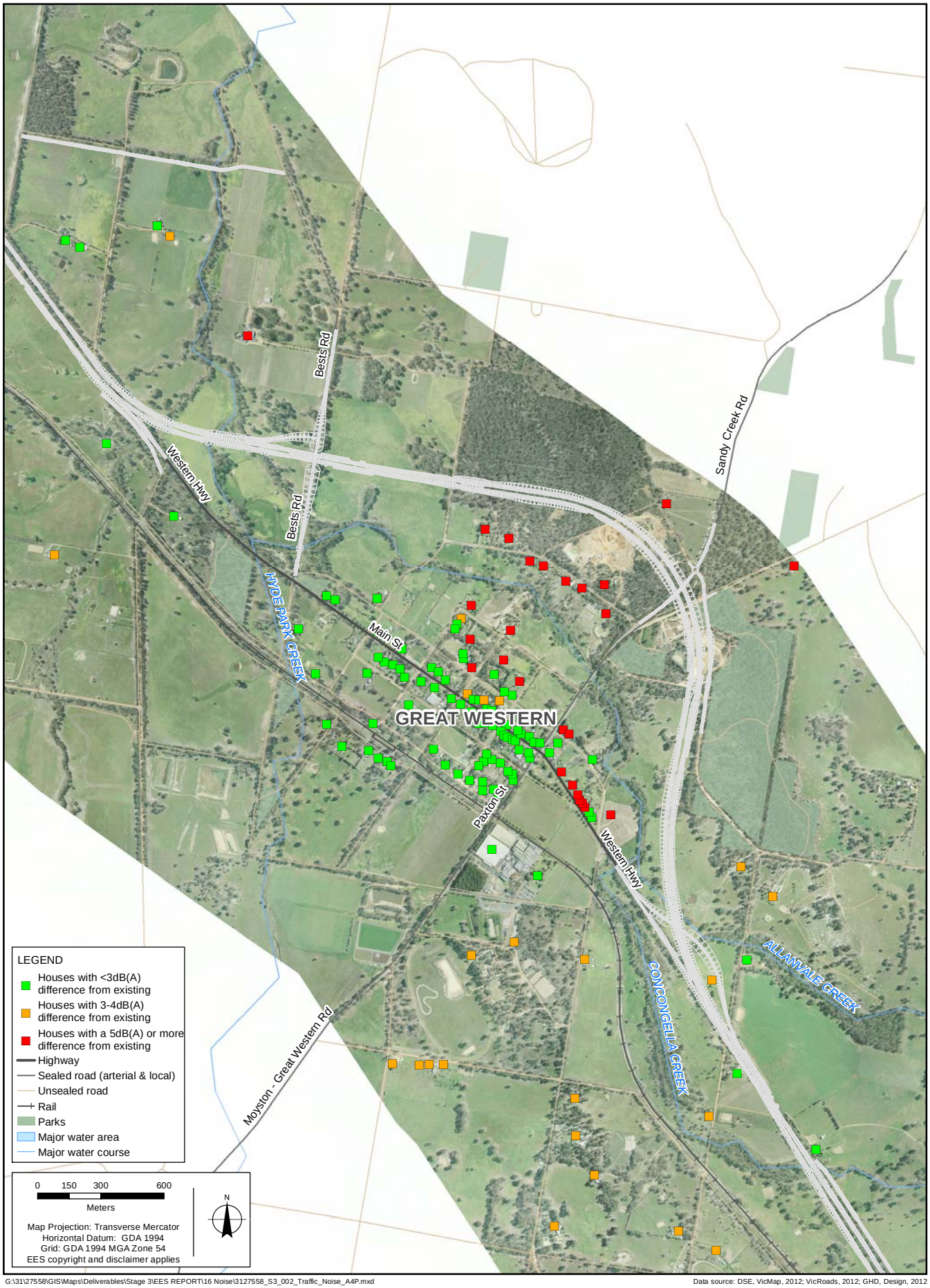

Figure 16-3b Predicted change in noise levels and noise contours

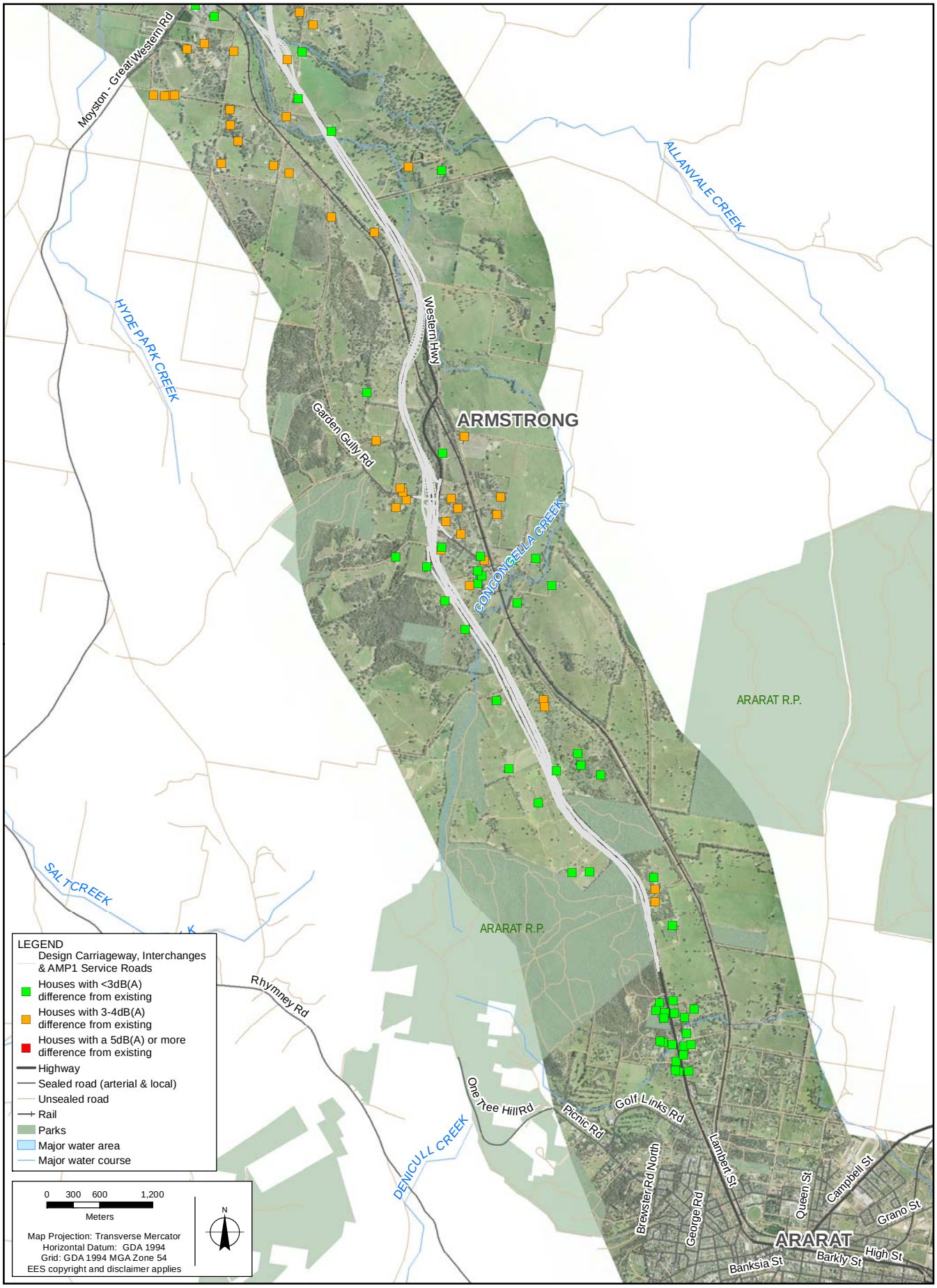

Figure 16-3c Predicted change in noise levels and noise contours

16.6.5 Application of the Traffic Noise Reduction Policy

The VicRoads – Traffic Noise Reduction Policy 2005 would apply to two sections of the proposed alignment. This is because these areas are considered as 'new' carriageway under the policy. These sections are:

- Ch. 11,700 to 16,200: Bypass of Great Western township from 400m northwest of Delahoy Road through to 45m northwest of Robinsons Creek near St George Road; and
- Ch. 23,100 to 23,900: 160m northwest of London Road through to adjacent Robson Road.

In accordance with Section 2.4 of the VicRoads' Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005 (RDN06-01), *"if the additional noise level from the new alignment section of the road at a residence is above 63 dB(A) or the level that would have prevailed if the 'new alignment' had not been built, then the VicRoads Policy applies and the noise attenuation should be considered for this property."*

Results of the modelling show no house locations are predicted to exceed the VicRoads Traffic Noise Reduction Policy 2005 criteria of 63dB(A)LA10(18hr) for the new alignment sections of the project north-east of Great Western. Where the proposed alignment is a duplication along the existing highway, some house locations either currently exceed or are predicted to exceed the 63dB(A) LA10(18hr) noise policy criteria.

A comparison of predicted noise levels for the existing Western Highway in 2026 due to natural increase in traffic volumes, and the predicted 2026 noise levels due to the proposed new alignment in areas where the policy applies, demonstrated that 58 out of 242 receiver locations (24 percent) would have a noise level greater than the level that would have prevailed if the new alignment had not been built. Of those, 25 would have a clearly noticeable change in noise level of 5dB(A) or more.

The VicRoads – Traffic Noise Reduction Policy 2005 states that *"Where the noise level adjacent to Category A or B buildings prior to road improvements is less than 50dB(A)LA10(18hr), consideration would be given to limiting the noise level increase to 12dB(A)".*

Predicted existing Western Highway noise levels in 2026 due to natural increase in traffic volumes demonstrated that 38 out of 242 receivers (16 percent) would have an existing noise level less than 50dB(A)LA10(18hr). However, none of these receivers in 2026 had a predicted noise level increase of more than 12dB(A)LA10(18hr).

For the EES it was assumed that the proposed road surface would be a 14 mm spray seal. This surface generates additional noise until it wears downs over time. It has been assumed that this could create up to +4dB(A) increase in noise when compared to dense graded asphalt (DGA). This surface correction has been adjusted downward to +2dB(A) for comparing noise levels in 2026 due to the expected road wear and tear which over time will reduce the tyre noise generated from this type of road surfacing.

However, if a +4dB(A) road surface correction is used for the year 2016 (proposed opening year of the new alignment) where no wear and tear has occurred, seven houses that are predicted to have an existing a noise level below 50 dB(A) in 2016 would exceed the 12 dB(A) criterion if the proposed alignment was constructed. Overtime however, it was predicted that road noise levels at these seven locations will reduce to a level at or below the criterion of 12 dB(A) through normal road wear.

16.6.5.1 Noise Mitigation

The impact assessment identified that there are sensitive receptors, particularly north-east of Great Western, that would require further investigation to confirm if noise mitigation measures would be required.

Through the detailed design process, further assessment of noise levels would be undertaken for sensitive receptors. The assessment would involve the placement of noise loggers and carrying out of attended noise measurements at those dwellings predicted to be most affected.

An overall assessment of the existing noise levels, mitigation options for affected dwellings, at source mitigation strategies and costing estimates would need to be carried out. From this assessment, the most appropriate mitigation measures would be selected based on their location and/or merit.

Following construction of the proposed alignment, noise monitoring would also be undertaken at identified sensitive receptors. The road design note Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005 states that "*Post construction monitoring should also be undertaken 6 months following opening of the new or upgraded road to verify that Project Objective Noise Level (PONL) targets have been met*." (VicRoads, 2010)

16.6.6 Operational Vibrations

No significant vibration effects from operation of the new road on human comfort or the structural integrity of buildings and infrastructure are predicted due to the operation of the proposed alignment.

16.7 Risk Assessment

An environmental risk assessment was undertaken to identify key environmental issues associated with the construction and operation of the Project. The methodology for this risk assessment has been described in Chapter 4.2 (EES Assessment Framework). A Risk Assessment report that explains the process in detail and contains the complete project risk register has also been included in Technical Appendix Q.

The risk assessment was conducted on the proposed alignment only.

Table 16-7 provides a summary for noise and vibration of:

- The impact pathways identified; and
- A description of the consequence.

Table 16-7 Noise and Vibration Risks

Risk No.	Impact Pathway	Consequence Descriptor
N1	Daytime construction of Western Highway at an individual sensitive receptor. Normal working hours under EPA Publication 1254 - Guidelines for Noise Control (2008) are: ▪ 7 am -6 pm Monday to Friday ▪ 7 am -1 pm Saturdays	▪ Noise disturbance at a dwelling or other sensitive receptor. ▪ There are no limiting noise criteria for the daytime period, however there is still a duty to minimise noise impacts on the surrounding environment.
N2	Daytime construction of Western Highway near sensitive receptors (i.e. more than one receptor) in a local area (community) such as: ▪ Gilchrist Road - Commercial Properties, Stawell (Ch. 24,800) ▪ Robson Road Community, Stawell (Ch. 23,200 - 24,200) ▪ Stawell Park Caravan Park, Monaghan Road, Stawell (Ch. 22,200) ▪ Great Western Community, Great Western (Ch. 11,000 - 16,600) ▪ Garden Gully Road Community, Armstrong (Ch. 4,200 – 8,200) ▪ Morella/Kennel Road Community, Ararat (Ch. 0 - Ararat Township)	▪ Noise disturbance within the local community, dwellings or other sensitive receptors. ▪ There are no limiting noise criteria for the daytime period, however there is still a duty to minimise noise impacts on the surrounding environment.
N3	Evening construction of Western Highway Evening hours in the EPA Publication 1254 are as follows: ▪ 6 pm -10 pm Monday to Friday ▪ 1 pm -10 pm Saturdays ▪ 7 am - 10 pm Sundays and public holidays	▪ Noise disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ If evening works are required EPA Publication 1254 - Guidelines for Noise Control (2008) will apply.
N4	Night time construction of Western Highway The night period as laid out in the EPA Publication 1254 is as follows: 10 pm -7 am Monday to Sunday	▪ Noise disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ If night time works are required EPA Publication 1254 - Guidelines for Noise Control (2008) will apply.
N5	Site compounds and laydown areas during construction	▪ Noise disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ There are no limiting noise criteria for the daytime period, however there is still a duty to minimise noise impacts on the surrounding environment. If evening, weekend or night time works are required EPA Publication 1254 - Guidelines for Noise Control (2008) will apply.

Risk No.	Impact Pathway	Consequence Descriptor
N6	Vibration caused by construction of Western Highway	▪ Vibration disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ The magnitude of ground vibrations is not expected to be sufficient to cause structural damage, as defined by the DIN 4150-3 criteria. ▪ No significant vibration impacts are expected, however vibration may be just perceptible at residences within 50m for construction activities involving rolling and compacting. The vibration from rolling and compacting activities would be considered intermittent and short-term. ▪ Potentially affected residences include: o ID_021 (VR_2527) Ch. 850; ID_023 (VR_2545) Ch. 2,600; ID_026 (VR_1672) Ch. 4,500; ID_027 (VR_2676) Ch. 4,900; ID_028 (VR_2684) Ch. 5,300; ID_029 (VR_2616) Ch. 5,800; ID_030 (VR_2776) Ch. 9,400; ID_040 Ch. 22,050; ID_041 (VR_3024) Ch. 22,150; ID_159 (VR_2746) Ch. 10,550; ID_061 (VR_2806) Ch. 11,100; ID_084 (VR_2966) Ch. 21,850; ID_102 (VR_2613) Ch. 5,450; ID_103 (VR_22613) Ch. 5,500
N7	Operation of the Western Highway generates noise emissions from vehicular traffic Areas where the VicRoads Traffic Noise Reduction Policy 2005 **Applies**	▪ Noise disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ **Locations Where Policy Applies:** ▪ Sections where both alignments are located outside the existing road reserve include: ▪ Ch. 11,700 to 16,200 (400m northwest of Delahoy Road through to 45m northwest of Robinsons Creek near St George Road); and ▪ Ch. 23,100 to 23,900 (160m northwest of London Road through to adjacent Robson Road).
N8	Operation of the Western Highway generates noise emissions from vehicular traffic. Areas where the VicRoads Traffic Noise Reduction Policy 2005 **Does Not Apply**.	▪ Noise disturbance within the local community, dwellings or other sensitive receptors, including individual receptors. ▪ **Locations Where Policy Does Not Apply:** ▪ Sections where either one or both alignments are located inside the existing road reserve include all areas not identified in N7.

16.8 Environmental Management Measures

VicRoads has a standard set of environmental management measures which are typically incorporated into its construction contracts for road works and bridge works. These measures have been used as the starting point for the assessment of construction related risks, and are described in detail in Chapter 21 (Environmental Management Framework). In some instances, additional Project specific environmental management measures have been recommended to reduce risks.

Management measures specific to each identified noise and vibration risk and the residual risk rating are outlined in Table 16-8.

Table 16-8 Noise and Vibration Environmental Management Measures and Residual Risk

Risk No.	Environmental Management Measures	Residual Risk Rating
N1	Comply with section 1200.12 Noise and section 1150.01 Working Hours of the VicRoads Contract Specifications Contractor to implement a communication strategy with the key stakeholders and the community to manage the impacts of construction noise and limit disturbance to local amenity. Contractor to implement a noise mitigation strategy for construction activities with consideration to the EPA Publication 480 - Environmental Guidelines for Major Construction Sites (1996) and EPA Publication 1254 - Guidelines for Noise Control (2008), as well as, referring to 'Typical Construction Plant and Equipment Noise Attenuation Over Distance' table, contained in the EES Noise and Vibration Impact Assessment Report (GHD, 2012g). Construction noise shall be monitored where its impact is likely to create substantial nuisance or inconvenience to sensitive receptors.	Negligible
N2	As per Risk N1	Negligible

Risk No.	Environmental Management Measures	Residual Risk Rating
N3	As per Risk N1; and Evening and weekend works may occur at certain stages during the Project. If the contractor is required to undertake work during evening or weekend times, this would need to be approved by the VicRoads Superintendent. A condition of VicRoads approval would be that all relevant stakeholders are consulted including nearby residents. In the event that it becomes apparent that the working hours are to be exceeded by more than 30 minutes, or work is required out of hours in an emergency, the Contractor would have a process in place that would immediately: ▪ notify and obtain approval from the Superintendent; ▪ where required by the Superintendent, notify the Environment Protection Authority; and ▪ advise surrounding property owners/occupiers that would be disturbed by any activity. ▪ Should 'unavoidable works' be required for evening or night time work, then where possible section 5.2.2 (b) and (c) of the VicRoads Noise Guidelines – Construction and Maintenance Works 2007 would be adhered to.	Low
N4	As per Risk N1 and N3	Low
N5	As per Risk N1 and N3 Contractor to locate site compounds away from sensitive receivers and limit noise as much as practicable.	Low
N6	Comply with section 1150.04 Ground Vibration of the VicRoads Contract Specifications. If construction works causing vibration are required within 50 m of a sensitive receptor (building) a construction vibration assessment would be undertaken prior to works being carried out and appropriate methods of construction employed to minimise impacts. Timing of the works to be conducted during the recommended operational hours, to reduce vibration levels to residential properties. Residents to be made aware of the construction times and the duration they would likely be affected, through letterbox drops, personal meetings and community meetings. Residents to be pre-warned of high vibration events (e.g. piling operations), and any operations being undertaken outside recommended hours. Public notification would be given a minimum of 72 hours prior to planned works. As a precaution the contractor would undertake a dilapidation survey for any buildings, structures or utilities located within 50 m of construction works. Equipment operators to be made aware of potential vibration issues problems and of techniques to minimise vibration effects during construction works.	Low
N7	Limit potential noise production during design stage through the use of alignment shifts, pavement materials, speed limits and other such items as required. Adhere to VicRoads Traffic Noise Reduction Policy 2005: Noise attenuation would be required for sensitive receptors that exceed 63 dB(A) (and the Policy is found to apply) Consideration for retrofitting (e.g. double glazed windows, barriers) would be given where noise levels at sensitive receptors exceed 68 dB(A) (and the Policy is found to apply). Where a "new alignment" as described in the VicRoads Traffic Noise Reduction Policy (2005) is constructed (and the Policy is found to apply), noise monitoring to check compliance with the policies noise level objectives for Category A and B sensitive receptors would be carried out. Where the noise criteria outlined in the Traffic Noise Reduction Policy (2005) are exceeded, mitigation works as outlined in the policy would be carried out as required.	Negligible
N8	Limit potential noise production during design stage through the use of alignment shifts, pavement materials, speed limits and other such items as required. Should noise related complaints be received, VicRoads would carry out noise monitoring, as required, to confirm noise levels are below the objectives.	Negligible

16.8.1 Residual Risks

Following implementation of the recommended mitigation measures there are not expected to be any significant impacts. The overall risk from noise and vibration impact is minor to negligible.

16.9 Conclusion

The construction and operation of the Project has the potential to create adverse effects from noise and vibration at some sensitive receivers.

Construction noise impacts would be negligible as work should be undertaken during normal daytime hours. Suitable mitigation measures would be in place for any work undertaken outside these hours, in accordance with the EPA Noise Control Guidelines 2008.

Vibration effects on human comfort or structures are expected to be minimal and precautionary mitigation measures are proposed. These include providing prior notice to occupiers, and undertaking a pre-construction inspection of any structures near a works area.

Fourteen sensitive receivers are located within 50m of the proposed alignment and due to their proximity they may notice vibration impacts during construction. While vibration levels during construction could be noticeable at these dwellings, the vibration levels are not expected to be sufficient to cause damage to the structural integrity of the buildings and infrastructure.

Modelling of operational noise shows that in some areas, the proposed alignment would be closer to sensitive receivers than the existing highway and therefore noise levels may increase, and in other cases it would be further away, reducing noise levels.

Overall, slightly more dwellings would experience a clearly noticeable reduction (decrease of 5dB(A) or more), than a clearly noticeable increase (increase of 5dB(A) or more) in noise levels due to the proposed alignment.

The impact assessment identified that there are sensitive receptors, particularly north-east of Great Western, that would require further investigation to confirm if noise mitigation measures would be required.

Further acoustic assessment following completion of the detailed alignment design would be required to clarify areas and the extent to which noise attenuation may be required.

Noise attenuation would be considered for the affected properties however, normal road wear and tear is expected to reduce these levels to within policy guidelines.

In summary, the construction and operational impacts from noise and vibration is considered to be low following implementation of the recommended mitigation measures.

Oddfellows Bridge, Western Highway