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## **KEMPSEY ROAD RESTORATION PROJECT**

## **NOISE AND VIBRATION IMPACT ASSESSMENT**

**REPORT J0273-01-R1**

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# 1 INTRODUCTION

Armidale Regional Council (ARC) proposes to carry out restoration works (the project) over a 45.8 kilometre (km) section of Kempsey Road and a 5 km section of Lower Creek Road (the project site). These roads were damaged by bushfires in the 2019/2020 summer season and subsequent flooding in 2020 and 2021. Emergency works were completed to reopen the roads to the public, however more comprehensive restoration works are required to bring these roads back to an acceptable pre-2019 condition.

Major components of the restoration work include:

- Site establishment including temporary offices and staff amenities, a concrete batching plant, quarries and material storage areas at a number of locations along Kempsey Road;
- Upslope scaling and slip remediation to minimise rockfall and related risks for later construction personnel;
- Construction of side tracks and passing bays, and widening of hairpin bends, to permit heavy vehicle access to work areas and traffic to pass work sites;
- Replacement and installation of culverts, headwalls and other surface water drainage structures;
- Reinstatement of bridge abutment scour protection;
- Road surface reinstatement; and
- Removal of temporary facilities and rehabilitation of work areas.

A total project duration of 41 months, equivalent to 3 years and 5 months, is anticipated although each receptor is unlikely to receive significant construction noise for the entire period.

This report has been commissioned by GeoLink Consulting Pty Ltd (GeoLINK) on behalf of ARC to form part of a Review of Environmental Factors (REF) being prepared by GeoLINK for the project.

## 1.1 Abbreviations and Terminology

The following acronyms, abbreviations and terminology are used in this report:

dB	Decibels, a logarithmic scale of noise levels (either sound power or sound pressure). Technically dB refers to unweighted decibels, without any frequency weighting applied
dBA	A-weighted decibels, a standard unit of sound or noise levels adjusted to the approximate frequency response of an average human ear
Sound power	Amount of sound energy a source produces per second, in watts (W) although more commonly expressed as decibels.
Sound pressure	Amount of sound pressure a source produces at a distance, in pascals (Pa) although more commonly expressed as decibels. References to decibels or dBA in this report will refer to sound pressure unless otherwise stated
Noise	unwanted sound
L <sub>Amax</sub>	The maximum a-weighted noise level in a defined period which is usually 15 minutes
L <sub>Aeq</sub>	The equivalent continuous, or acoustic average, A-weighted noise level over a defined measurement or assessment period which is usually 15 minutes
L <sub>A90</sub>	The noise level exceeded 90% of the time, more readily understood as the lowest 10% noise level typically assessed over 15 minute periods, representing the background noise level according to relevant NSW noise policies

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Hz	Hertz, units of frequency in cycles per second. Human hearing generally ranges from 20 Hz (very low pitch sound) to 20,000 Hz (very high pitch sound), although as people age their hearing range tends to reduce to a varying extent
ARC	Armidale Regional Council
EPA	NSW Environment Protection Authority
RNP	<i>Road Noise Policy</i> (DECCW now EPA, 2011)
ICNG	<i>Interim Construction Noise Guideline</i> (DECC now EPA, 2009)
DCNG	<i>Draft Construction Noise Guideline</i> (EPA, 2020)
INP	<i>NSW Industrial Noise Policy</i> (EPA, 2000) is referred to in the ICNG to determine background noise levels, and has since been superseded by the NPI
NPI	<i>Noise Policy for Industry</i> (EPA, 2017) is referred to in the DCNG to determine background noise levels
AVTG	<i>Assessing vibration: a technical guideline</i> (DEC now EPA, 2006)
REF	Review of Environmental Factors
RBL	Rating Background Level, the calculated or adopted background noise level in each of the day, evening and night periods used to determine intrusive noise levels as defined in the NPI
VDV	Vibration Dose Value, used to assess the amenity impact of intermittent vibration
Day	For noise assessment purposes, day is defined in the NPI as 7 am to 6 pm Monday to Saturday and 8 am to 6 pm Sundays and public holidays
Evening	For noise assessment purposes, evening is defined in the NPI as 6 pm to 10 pm
Night	For noise assessment purposes, night is defined in the NPI as 10 pm to 7 am Monday to Saturday and to 8 am on Sundays and public holidays

## 1.2 Environmental Noise Policies

The NSW government has developed or adopted policies and recommended procedures to assess environmental noise levels from various noise source categories. The following policy documents are relevant to this assessment:

- The *NSW Road Noise Policy* (RNP) includes recommended traffic noise criteria from arterial and local roads to residences and other sensitive land uses. The RNP also recommends the following NSW policies to assess noise impacts from road construction and maintenance projects and to assess ground vibration levels produced by road traffic;
- The *Interim Construction Noise Guideline* (ICNG) which includes recommended noise assessment procedures for construction projects. The ICNG will shortly be superseded, however at this time remains the most appropriate policy to assess noise from the project. The ICNG refers to the *NSW Industrial Noise Policy* for procedures to determine background noise levels;
- The *Draft Construction Noise Guideline* (DCNG) which, when finalised and published by the EPA as the *Construction Noise Guideline*, will supersede the ICNG. The DCNG is not currently intended to be used to assess construction projects as it is subject to change before being finalised, however any significant differences between the ICNG and the DCNG are considered in this assessment assuming the final *Construction Noise Guideline* will be similar to the DCNG;
- The *NSW Noise Policy for Industry* (NPI) which is intended to guide noise investigations for existing or proposed industrial developments. The NPI includes recommended procedures to determine background noise levels at receptors such as residences, and is referred to in sections of

the DCNG related to background noise levels. It replaces the earlier *NSW Industrial Noise Policy* and is therefore indirectly referred to in the ICNG; and

- *Assessing vibration: a technical guideline (AVTG)* includes recommended criteria and assessment procedures for continuous, impulsive and intermittent vibration to residences and other sensitive properties.

## 2 EXISTING ACOUSTIC ENVIRONMENT

### 2.1 Noise Levels

A detailed survey of existing noise levels has not been completed for this assessment. The following discussion of typical background noise levels is based on previous experience with other similar rural areas in NSW.

The project site is located in a relatively remote rural area between Kempsey and Armidale. Kempsey Road carried low traffic volumes before the fire and flood damage occurred and has carried lower traffic flows since the road was reopened to only local traffic. Intermittent traffic noise, with long periods of relative quiet between car passby events, is unlikely to occur for a sufficient proportion of each 15 minute assessment period to affect the background noise level. Other sources of environmental noise would depend on the location, time of day and on different rural activities that may occur from time to time.

Audible noise sources during the day would include occasional traffic, birds, insects, domestic animals, the effect of winds on trees and other foliage, and use of farm equipment such as tractors during some periods. Background noise levels during the day are likely to remain in the range 25 to 30 LA<sub>90,15min</sub> on most days. Occasional days over 30 LA<sub>90,15min</sub> would occur due to consistent winds, more active insects, or consistent use of tractors and similar equipment for ploughing, planting or harvesting.

Evening background noise levels would usually be affected by increased insect activity and are commonly higher than the day background levels, particularly in the warmer months when insects are more active. In the absence of significant insect noise, particularly in the cooler months, evening background levels would typically reduce to the range 20 to 25 LA<sub>90,15min</sub>. Other audible sources during the evening typically include intermittent traffic and domestic animals and may include farm equipment maintenance or similar activity.

Night background levels would be similar to the evening levels, although with less traffic and farm equipment activity. Night background levels may drop below 20 LA<sub>90,15min</sub> in the cooler months in the absence of nearby insects. Background noise levels typically increase in the last hour or two of the night, before 7 am, as birds and other animals begin the day's activity at dawn.

### 2.2 Ground Vibration Levels

As for noise levels, a detailed survey of existing vibration levels has not been completed for this assessment.

The only significant existing source of ground vibration for residences and other buildings would be intermittent road traffic, excluding agricultural activities and other sources near each residence that are under residents' control. Building vibration can also be caused by strong wind gusts, road traffic noise, aircraft noise and thunderstorms, although these sources produce vibration in the walls and roof of a residence via low frequency airborne noise rather than transmit vibration via the ground.

Traffic-induced ground vibration occurs as vehicle wheels travel over irregularities in the road surface. Vibration levels are primarily determined by the following factors:

- Road surface characteristics including the height of any corrugations and distance between crests, width and depth of potholes and the surface roughness which is mainly related to the height of larger rocks above the average surface level in unsealed road sections;

- Vehicle weight and axle loads;
- Suspension characteristics including unsprung weight, natural frequency and damping coefficients;
- Tyre pressure and sidewall strength;
- Vehicle speed;
- Distance from the road to a residence or other building;
- Ground characteristics including rock type, soil type and depth, any faults or other discontinuities in the rock and moisture content; and
- The natural frequency of building elements including the floor, walls and roof.

Higher vibration levels are generally caused by heavy vehicles with stiffer suspension, heavy live axles rather than independent suspension and high tyre pressures. Vibration levels will generally be higher in the absence of faults in the rock layers between the road and the residence and for shallow soil depths, and dry soil will generally transmit less vibration than soil with a high water content.

Vibration is generally most noticeable when the vibration frequency coincides with the natural frequency of a section of floor or other part of a residence. In the case of a residence built on a concrete slab floor, resonance effects are generally insignificant as ground vibration is transmitted directly to the floor.

The above discussion indicates vibration levels at a residence are affected by a wide variety of factors, are difficult to accurately predict and can change significantly from one vehicle passby event to the next. Vibration levels produced by road traffic are generally imperceptible at distances greater than 50 m from the road, although that may not be the case for all residences near the project site.

### 3 NOISE AND VIBRATION CRITERIA

#### 3.1 Road Noise Policy

The NSW Road Noise Policy (RNP) includes recommended procedures and criteria to assess road noise levels to residences and other sensitive properties. Noise criteria recommended in the RNP primarily apply to permanent situations such as new or upgraded public roads, rather than to temporary traffic flows due to a construction project. Traffic noise criteria and anticipated traffic noise levels are nevertheless considered in this assessment, given the expected duration of the project.

Section 2.3.1 and Table 3 of the RNP presents traffic noise criteria for residential land uses. Table 3 is reproduced below.

Table 3: Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria - dBA	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeways/arterial/sub-arterial road corridors	55 LAeq,15hr (external)	50 LAeq,9hr (external)
	2. Existing residences affected by noise from redevelopment of existing freeways/arterial/sub-arterial roads	60 LAeq,15hr (external)	55 LAeq,9hr (external)
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land-use developments		

<i>Road category</i>	<i>Type of project/land use</i>	<i>Assessment criteria - dBA</i>	
		<i>Day (7 am – 10 pm)</i>	<i>Night (10 pm – 7 am)</i>
<i>Local roads</i>	4. <i>Existing residences affected by noise from new local road corridors</i> 5. <i>Existing residences affected by noise from redevelopment of existing local roads</i> 6. <i>Existing residences affected by additional traffic on existing local roads generated by land-use developments</i>	<i>55 LAeq,1hr (external)</i>	<i>50 LAeq,1hr (external)</i>

Kempsey Road is considered either an arterial or a sub-arterial road for the purposes of noise assessment. The most relevant assessment criteria from Table 3 in the RNP is therefore 60 LAeq,15hr for the day period and 55 LAeq,9hr for the night period.

The RNP also recommends noise criteria for other sensitive land uses such as schools, hospitals and passive and active recreation areas. Two campgrounds exist within the project area, the Cracknback campgrounds near chainage 84000 and the George’s Junction Camping Ground near chainage 98100, however these camping grounds are expected to be closed for the duration of works due to access restrictions for visitors and would not be sensitive land uses for that time period.

Appendix C of the RNP discusses other acoustic issues associated with roads including;

- Section C1 points to the ICNG to assess noise impacts from road construction or maintenance projects; and
- Section C3 points to the AVTG to assess vibration levels produced by road traffic and road construction and maintenance projects.

### 3.2 Interim Construction Noise Guideline

Section 3 of the ICNG discusses qualitative and quantitative assessment methods for construction project, with the qualitative method preferred for projects that are likely to require more than three weeks to complete. The expected project duration is approximately 41 months, equal to 3 years and 5 months, therefore the quantitative method is appropriate for this assessment.

Quantitative construction noise management levels are recommended in Section 4.1.1 and Table 2 of the ICNG. The table is reproduced below.

Table 2: Noise at residences using quantitative assessment

<i>Time of day</i>	<i>Management level, LAeq,15min</i>	<i>How to apply</i>
<b>Recommended standard hours:</b>  <i>Monday to Friday</i> <i>7 am to 6 pm</i>  <i>Saturday</i> <i>8 am to 1 pm</i>  <i>No work on Sundays or public holidays</i>	<i>Noise affected</i> <i>RBL + 10 dB</i>	<i>The noise affected level represents the point above which there may be some community reaction to noise.</i> <ul style="list-style-type: none"> <li>• <i>Where the predicted or measured LAeq,15min is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</i></li> <li>• <i>The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise levels and duration, as well as contact details.</i></li> </ul>
	<i>Highly noise affected</i> <i>75 dBA</i>	<i>The highly noise affected level represents the point above which there may be strong community reaction to noise.</i> <ul style="list-style-type: none"> <li>• <i>Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:</i> <ol style="list-style-type: none"> <li><i>1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences.</i></li> <li><i>2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</i></li> </ol> </li> </ul>
<b>Outside recommended standard hours</b>	<i>Noise affected</i> <i>RBL + 5 dB</i>	<ul style="list-style-type: none"> <li>• <i>A strong justification would typically be required for works outside the recommended standard hours.</i></li> <li>• <i>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</i></li> <li>• <i>Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.</i></li> <li>• <i>For guidance on negotiating agreements see section 7.2.2.</i></li> </ul>

Table 2 of the ICNG requires the Rating Background Level (RBL), which is defined in section 2.3 of the NPI, to determine the noise affected and highly noise affected management levels for the assessment. Table 2.1 of the NPI recommends a minimum RBL of:

- 35 LA90,15min for the day period; and
- 30 LA90,15min for the evening and night periods.

These minimum RBLs apply if the measured or estimated site-specific RBL is lower than the minimum levels. As discussed in section 2 of this report, RBLs are typically lower than the minimum levels in remote rural areas and are assumed to be lower than the minimum levels at all receivers near the site. The minimum levels are therefore adopted as the RBLs for this assessment resulting in the following construction noise management levels determined according to the ICNG:

- Recommended standard hours:
  - noise affected level of 45 LAeq,15min; and
  - highly noise affected level of 75 LAeq,15min.
- Outside recommended standard hours, noise affected levels of:
  - 40 LAeq,15min during the remainder of Saturday, 7 am to 8 am and 1 pm to 6 pm, and during the day on Sundays and public holidays; and
  - 35 LAeq,15min during the evening and night.

### 3.3 Draft Construction Noise Guideline

While the DCNG was only intended for public consultation purposes, it is considered likely that a future guideline will contain similar assessment procedures and other recommendations. As a future guideline may be published within the next year or two, it can be considered relevant to this assessment.

Quantitative construction noise management levels are recommended in Section 5.3 and Tables 3 and 4 of the DCNG which are reproduced below.

*Table 3: Noise at residences using quantitative assessment – during recommended standard hours: Noise affected and highly noise affected management levels*

<i>Time of day</i>	<i>Management level, LAeq,15min</i>	<i>How to apply</i>
<i>Recommended standard hours: Monday to Friday 0700 to 1800 Saturday 0800 to 1300 No work on Sundays or public holidays</i>	<i>Noise affected RBL + 10 dB</i>	<i>Where the predicted or measured LAeq,15min is greater than the noise affected management level, the proponent shall apply all feasible and reasonable work practices to meet this level.  As a matter of good practice, noise should be reduced as far as reasonably practical.  The proponent should notify all potentially impacted residents.</i>
	<i>Highly noise affected 75 dBA</i>	<i>Where noise is above the highly noise affected management level, all feasible and reasonable mitigation shall be applied as well as engagement with the consent authority or regulator to identify other measures to manage noise impacts.  Where appropriate, engagement with the community is encouraged to determine the preferred mitigation approach, such as:</i> <ul style="list-style-type: none"> <li>• <i>Negotiated agreements and/or respite periods to restrict work activity</i></li> <li>• <i>Identification of times when the community is less sensitive to noise, including options for longer periods of construction in exchange for restrictions on construction times.</i></li> </ul>

Table 4: Noise at residences using quantitative assessment – outside the recommended standard hours: Noise affected and highly noise affected management levels

Time of day	Management level, LAeq, 15min <sup>1,2,3,4,5,6</sup>	How to apply
Outside recommended standard hours	Noise affected RBL + 5 dB	<p>Strong justification is required for works outside the recommended standard hours.</p> <p>The proponent shall apply all feasible and reasonable work practices to meet the noise affected management level.</p> <p>Where this cannot be met, residual impacts should be quantified and potentially impacted residents notified.</p> <p>The supplementary mitigation described in Table 5 should also be considered, subject to the application notes in section 5.4.</p>
	Highly noise affected 65 dBA	<p>The highly noise affected management level represents the point above which the supplementary mitigation described in Table 5 must be considered, subject to the application notes in section 5.4.</p> <p>The proponent must justify the selection of feasible and reasonable mitigation, including the supplementary mitigation, with emphasis on consultation with the community and the consent authority or regulator, and community views on work scheduling and respite periods, as described in section 5.4.</p>

1. The rating background level (RBL) used to determine the noise management level is the overall single-figure background noise level measured during each relevant assessment period. The assessment periods are either the recommended standard hours (see **Table 1**) or the period outside the recommended standard hours. The RBL should be determined using the procedure in the Noise Policy for Industry (NPI). This includes the adoption of the minimum RBL outlined in Table 2.1 of the NPI.
2. The shoulder period provisions described in the NPI apply to construction activities outside the recommended standard hours where these activities do not occur over the entire assessment period (defined by the NPI) and/or where there is a clear change in the noise environment.
3. The predicted noise levels are determined at the property boundary most exposed to construction noise at a height of 1.5m above ground level.
4. Where the property boundary is more than 30m from the affected residence, the location for measuring or predicting noise levels is at the most noise affected point within 30m of the residence. For multi-level residential buildings, the external points of reference for measurement and/or prediction are the two floors of the building most exposed.
5. Guidance on notification, engagement and consultation is provided in **section 7**.
6. The potential for sleep disturbance should be considered. Advice is provided in **section 5.7**.

The DCNG is effectively an updated version of the ICNG with similar recommended management levels, with the only significant change being the addition of a recommended highly noise affected level of 65 dBA outside normal construction hours. The DCNG also updates the recommended actions for each management level, although these recommendations were generally included in other sections of the ICNG.

While the DCNG was only intended for public consultation purposes, it is considered likely that a future guideline will contain similar assessment procedures and other recommendations. As a future finalised guideline may be published within the next year or two, it has been considered relevant to this assessment.

### 3.4 Assessing Vibration: A Technical Guideline

The AVTG recommends criteria and assessment procedures for the following vibration types:

- Continuous vibration such as that caused by manufacturing or similar machinery operating uninterrupted over an entire day or night period, steady and continuous road traffic or construction sources such as tunnel boring machines;
- Impulsive vibration with up to three distinct vibration events in an assessment period such as dropping large masses, loading or unloading vehicles or similar very occasional sources; and
- Intermittent vibration caused by sources such as intermittent road or rail traffic, concrete or rock breaking, impact pile driving or other construction activity.

Ground vibration associated with the project is therefore considered intermittent vibration. Section 2.4 of the AVTG recommends a vibration dose value (VDV) be used to assess and limit vibration levels while table 2.4 provides recommended VDV criteria for various situations. Section 2.5 discusses alternative approaches and potentially higher vibration criteria that may be applied for short term works of typically one week or less.

Relevant extracts from Section 2.4, Table 2.4 and Section 2.5 are included below.

#### 2.4 Acceptable values for intermittent vibration

*When assessing intermittent vibration, use the vibration dose value (VDV).*

*VDV accumulates the vibration energy received over the day and night periods. The vibration does is fully described in (British Standard) BS 6472-1992. Acceptable values of vibration dose are presented in Table 2.4.*

*There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values.*

*Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community.*

Table 2.4: Acceptable vibration does values for intermittent vibration (m/s<sup>1.75</sup>)

Location	Daytime <sup>1</sup>		Night-time <sup>1</sup>	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas <sup>2</sup>	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive values for critical areas.

#### 2.5 Short-term works

*When short-term works such as piling, demolition and construction give rise to impulsive vibrations, undue restrictions on vibration values may significantly prolong these operations and result in greater annoyance. Short-term works are works that occur for a duration of approximately one week.*

*In situations where work is short term, feasible and reasonable mitigation measures have been applied and the project has a demonstrated high level of social worth and broad community benefits, then higher vibration values (above the maximum) may apply. In such cases, best management practices should be used to reduce values as far as practicable and a comprehensive community consultation program should*

*be instituted. An example of a possible management strategy would be to restrict the times during which high vibration values occur to the least sensitive times of the day. Typical issues covered in a consultation program include a public contact point for handling complaints, and early notification of proposed operations and any significant changes to operations.*

Section 2.5 mentions impulsive vibration and could be interpreted as not applying to intermittent vibration as produced by the majority of construction activities. Nevertheless, Section 2.4 also acknowledges higher vibration values may be appropriate in some circumstances.

The preferred values of 0.20 m/s<sup>1.75</sup> during the day and 0.13 m/s<sup>1.75</sup> during the night are adopted as the primary vibration criteria at residences, although no work is expected to occur at night.

### 3.5 Australian Standard 2187.2-2006

AS2187.2-2006 *Explosives – Storage and use, Part 2: Use of explosives* contains useful guidance regarding the effect of vibration on buildings, including recommended vibration limits to avoid or minimise cosmetic and structural damage to various building types. The recommended vibration limits primarily apply to explosive blasting.

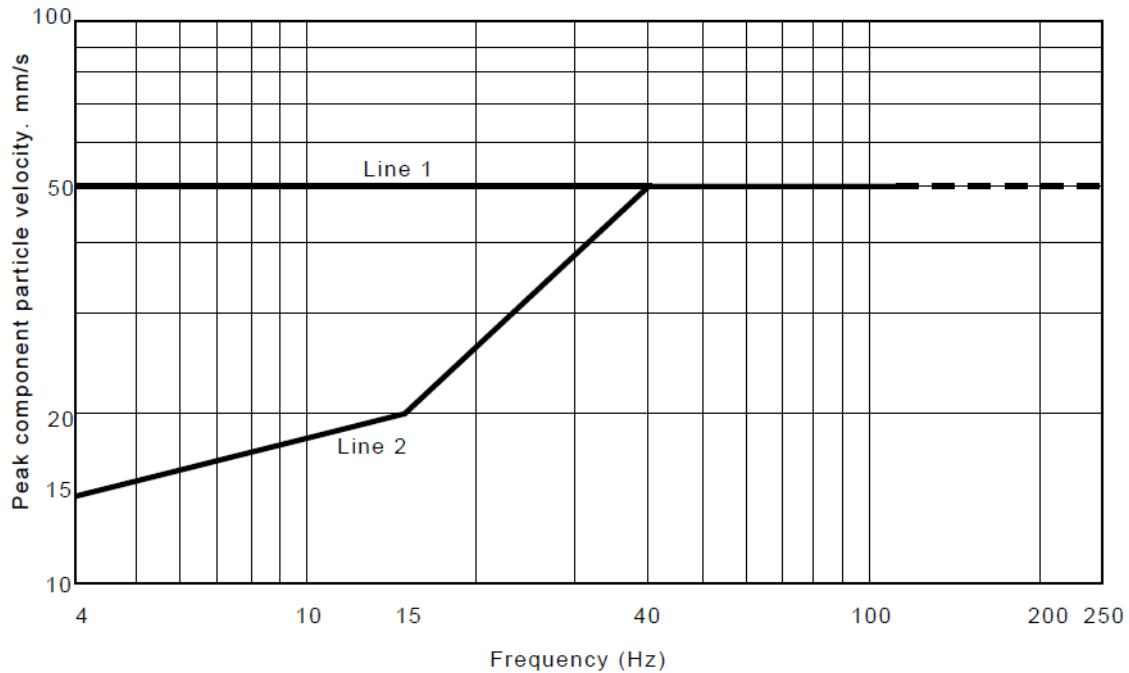
Appendix J of AS2187 references *British Standard 7385.2-1993* for recommended building damage criteria. Table 1 of BS7385 provides transient vibration guide values for cosmetic damage, reproduced below. Note that the structural damage criteria are significantly higher than the cosmetic damage criteria and are therefore not specifically considered.

Table 1 – Transient vibration guide values for cosmetic damage

Line (see Fig 1)	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

1. Values referred to are at the base of the building.
2. For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

Figure 1:



### 3.6 Vibration Criteria

Residents are generally not expected to receive significant vibration for an extended period of time. Sources of vibration associated with the project include:

- An excavator or dozer ripping and removing rock;
- A large excavator or dozer travelling over hard ground;
- A grader ripping or grading existing hard pavement, whether sealed or unsealed;
- A loaded truck travelling over uneven ground, particularly at relatively high speed;
- A vibrating compactor; and
- A vibrating roller.

As the VDV is a function of vibration level and time, and these factors will vary significantly at each residence, it is difficult to predict VDV values generated by the project. While the project is expected to require a few years to complete, significant vibration levels are expected at each residence for a total of a few hours as the pavement restoration crew passes the residence. Residences near a culvert restoration site may experience vibration for a longer period due to a vibrating compactor, although such work would not generally occur for more than a few days in total.

Given the relatively short time period in which noticeable vibration is expected to occur at each residence, strict compliance with the recommended VDV value is not considered necessary. As acknowledged in Section 2.5 of the AVTG, it is possible that significant vibration management measures may extend the works duration and consequently cause more annoyance to residents. This is particularly the case for this project as it includes significant disruption to road access to resident's properties.

The building damage criteria in AS2187.2 and BS7385.2, on the other hand, should not be exceeded at any time. The following management strategy is recommended to minimise the chance of cosmetic building damage and to reassure residents that vibration levels are managed appropriately:

- For residences more than 100 m from the road or a work site: management of vibration levels is unlikely to be required, although the construction contractor should be sensitive to comments or

complaints from residents regarding unexpectedly high vibration levels. Unexpectedly high vibration levels may be caused by ground conditions such as a high water table which results in more efficient transmission of vibration between the work site and the residence;

- For residences located 50 m to 100 m from the road or a work site: management of vibration levels may be required depending on ground conditions. The construction contractor should exercise care when ripping rock or operating a vibrating compactor or vibrating roller. Where possible, a smaller compactor or roller may be appropriate for these sites, or alternatively a larger non-vibrating roller may achieve acceptable compaction of the road surface or other material. It is usually possible to vary the compactor or roller vibrating speed to minimise vibration levels at nearby residences and it may be appropriate to consult residents regarding the level of vibration perceived by them at their residence; and
- For residences within 50 m of the road or a work site: management of vibration is likely to be required, particularly when ripping rock or operating vibrating compaction equipment. Vibration monitoring equipment is recommended for these residences to confirm vibration levels. Prior consultation with residents is recommended and, where possible, active consultation with residents and active monitoring of vibration levels is recommended as each vibration source commences to determine if vibration levels are acceptable. Where excessive vibration is perceived or measured, alternative strategies such as more passes using a smaller vibrating roller or using a larger, heavier non-vibrating roller are recommended to achieve the required material compaction.

The above management strategy relies on resident's perceptions of vibration and measured vibration levels, rather than just measured levels as residents usually become concerned about vibration damage at levels below 5 mm/s which is well below the cosmetic damage criteria of 15 to 50 mm/s. Residents will generally raise the alarm well before building damage is likely to occur. Management of vibration during construction work is required to reassure residents as well as avoid the risk of building damage, and vibration monitoring assists in reassuring residents that vibration levels are below the building damage criteria.

The higher vibration damage criterion of 50 mm/s applies to steel farm sheds and similar structures, as such structures are more resistant to vibration-related damage than residential buildings due to their lack of plasterboard and similar materials that can crack at joints at lower vibration levels.

### **3.6.1 Building Foundation Settlement**

It is possible that vibration levels below the cosmetic damage criterion of 15 to 50 mm/s may exacerbate, or trigger, building settlement due to poor or aging foundations. This is more common for older buildings that were constructed before a more detailed understanding of foundation design and reactive clay soils became widespread.

Over time, some foundations may develop reactive soil voids or other defects that reduce the loads they can withstand without settlement. Typically, such defects are caused by multiple wet and dry seasons and consequent expansion then contraction of soil around the foundations. Such buildings will typically settle over time, in the absence of vibration, and may develop cosmetic cracks in plasterboard and other relatively brittle materials. Significant structural damage due to settlement is less common.

In the case of a building that is about to settle further due to previous soil movement, construction vibration may trigger that settlement. It is important to acknowledge in these cases that settlement would have occurred in the following weeks or months and the vibration merely brought that event forward in time. Nevertheless, from the residents' perspective, it can appear that construction-related vibration caused settlement and, perhaps, some cosmetic cracking of brick, plasterboard or other materials.

Given the currently dry climate after a few years of above-average rainfall, building settlement is more likely to occur than in other years. The construction contractor should therefore be aware of resident's concerns regarding vibration-related damage, including cases where the construction work was not the primary cause of damage and merely brought existing latent damage forward in time.

## 4 CONSTRUCTION ACTIVITIES

A number of activities will need to be completed in sequence to deliver the project, as described in the Construction Methodology prepared by the construction contractor Seymour Whyte. This section discusses each of the major activities and noise sources likely to be associated with each activity, based on the preliminary activity descriptions and durations shown in the Construction Methodology. Sound power levels have been estimated for each phase of the work.

### 4.1 Construction Schedule

Figure 2 in section 3 of the Construction Methodology includes a detailed schedule and a description of each activity or group of activities, including:

- Install initial infrastructure including preliminary signs, traffic controls and laydown areas;
- Install additional signs at entry points including trails and tracks;
- Upslope stabilisation;
- Construct turning and passing bays for heavy vehicle access;
- Widen pinch points to permit delivery of larger items;
- Construct remaining laydown areas and stockpile areas;
- Install the main site office, satellite offices, camps, concrete batch plants and related facilities;
- Construct fuel storage facilities, helicopter landing pads and water supply facilities;
- Develop rock and gravel quarries;
- Construct temporary side tracks around longer duration works such as large culverts;
- Construct/restore longitudinal drains;
- Construct/restore culverts;
- Downslope stabilisation including soil nail and gravity walls;
- Bridge restoration including abutment scour protection;
- Unbound pavement restoration;
- Sealed pavement restoration;
- Remove ancillary facilities and rehabilitate sites;
- Rehabilitate temporary laydown and stockpile areas;
- Remove signs, traffic controls and other remaining temporary infrastructure.

The above list presents activities in the approximate sequence required to deliver the project, although some rearrangement of the sequence and significant overlap between activities are both likely to occur. The site is divided into six sections along Kempsey Road, with a seventh section including all work areas on Lower Creek Road. Construction work is generally proposed to occur from east to west (from Section 1 to Section 6) to improve the most-used sections of road before other sections, as the majority of residences are located east of Lower Creek Road.

A detailed traffic and logistics schedule has been developed considering the narrow road and limited opportunities for side tracks or detours, as discussed in Section 9 of the Construction Methodology. The proposed schedule includes the following components:

- 10-day working periods with the following restrictions:
  - Use of the road by resident's vehicles during the evening and night periods, from 6 pm to 7 am, and potentially during a midday break period;
  - No access to the road by residents' vehicles during work periods from 7 am to midday and from 1 pm to 6 pm; and
  - Limited and controlled midday to 1 pm access only to and from Lower Creek, not through the entire site.
- 4-day break periods with the following traffic controls:
  - Generally uncontrolled road access for residents;
  - No access for non-residents; and
  - Occasional controlled access during the day for heavy vehicles delivering fuel and other materials.

The proposed roster including a 10-day working period and 4-day break period will result in some work outside the standard construction hours recommended in the ICNG and DCNG. The Construction Methodology states this schedule was developed based on community consultation, implying the community prefers the proposed traffic restrictions and work on weekends rather than a longer period of construction, noise and traffic disruptions.

## 4.2 Infrastructure

The project is located in an area that is relatively remote from services and infrastructure such as worker accommodation, fuel and concrete supplies, and office space. Other facilities that would be required include stockpile and laydown areas distributed throughout the site, signs and traffic controls, turning and passing bays and water storage tanks. Initial works are therefore proposed to establish these and other required services.

### 4.2.1 Initial Signs, Traffic Controls and Security Gates

Initial signs and traffic controls would be installed adjacent to Kempsey Road at each end of the site, on Lower Creek Road and at the intersection of various trails and tracks. Signs are assumed to be attached using screws or bolts to steel posts hammered into the ground at each location.

Traffic controls are expected to include line marking, clearing small areas adjacent to the road and positioning trailer-mounted traffic lights in those areas. Some tree trimming or grass cutting may be required to achieve acceptable sight lines to each traffic light unit. Depending on the level of security required, steel gates may be attached to steel or timber posts set into the ground with concrete or may only require smaller posts hammered into the ground.

Noise sources for this work phase may include:

- Light utility vehicles to transport signs, posts, tools and other materials;
- Grass cutting machines potentially including small mowers, ride-on mowers and tractor-mounted slashers
- Tree trimming tools including chainsaws and hedge trimmers;
- Small earthmoving machines such as mini excavators or skid-steer loaders to level sites for traffic controls, and a light truck and trailer to transport these machines;
- A sledgehammer or similar to drive posts into the ground; and
- A skid steer fitted with an auger to prepare postholes for security gates.

The best case situation such as installing a simple sign is likely to require no more than 30 minutes, including a few minutes of hammering to drive the post and otherwise relatively quiet operations with hand tools. Hammering is likely to produce a sound power level of approximately 110 L<sub>Amax</sub>, equivalent to 95 L<sub>Aeq,15min</sub>, to drive two posts into the ground.

The worst case situation is likely to require up to 15 minutes of earthmoving to level a relatively small site, followed by a posthole auger and installation of posts and a gate. This situation will therefore require less than one hour operation of a skid steer loader or similar machine plus other quieter operations with hand tools. A sound power level of 110 L<sub>Amax</sub> and 100 L<sub>Aeq,15min</sub> is expected from this activity.

Signs, traffic control devices and security gates produce insignificant operating noise. Construction noise associated with these components would therefore only occur for a short period of time at the start of the project and for an equally short period of time to remove them near the end of the project.

#### **4.2.2 Upslope Stabilisation**

Rock slopes above the ground raise the potential for loose rocks to dislodge and fall to the road, endangering construction staff and passing vehicles. The initial construction stages therefore include stabilisation of upslope areas where required, as described in Section 10.2 of the Construction Methodology.

Activities associated with this phase would depend on the circumstances of each situation although the following sequence is expected to apply to most situations:

- Inspect each slope to identify areas that may require treatment;
- Remove or trim overhanging or unstable trees;
- Install anchor points at or near the top of the slope above treatment areas and attach climbing ropes. Powered winches may also be attached to an anchor point if heavy tools are required on the slope;
- Clear an area at the toe of the slope if required for access or for later removal of material extracted from the slope. Tools may include a chainsaw, brushcutter, skid steer loader or similar;
- Climb or abseil to treatment areas and more closely inspect the area to identify and implement treatment options. Treatment options may include:
  - Remove loose rocks with hand tools such as picks or hammers;
  - Remove loose rocks with powered tools such as jackhammers or drills;
  - Drill and install anchor bolts to prevent loose rocks from detaching and falling from the slope;  
or
  - Anchor steel or other mesh over an area to restrain loose rocks.

Once each slope is stabilised, any material removed from the slope will be loaded using a skid steer loader or equivalent machine into a small truck for removal.

Worst case noise sources therefore include a skid steer loader, petrol or diesel powered generator and a jackhammer or drill, although an air compressor and pneumatic jackhammer or drill may be required instead of a generator and electric hammer/drill. A hammer or drill mounted on an excavator may be used for site close to the ground. An excavator or loader is expected to produce a sound power level of approximately 100 L<sub>Aeq,15min</sub>, with a drill or jackhammer producing 115 L<sub>Amax</sub> and 110 L<sub>Aeq,15min</sub>.

Stabilisation works and associated construction noise would generally occur near the start of the project, although it is possible that some additional work may be required later if additional unstable areas are found.

#### **4.2.3 Turning and Passing Bays, Laydown and Stockpile Areas**

A large number of turning bays, passing bays, laydown areas and stockpile areas are proposed to be constructed early in the project adjacent to Kempsey Road and Lower Creek Road. Many of these areas will be rehabilitated at the end of the project, although some stockpile areas will remain after the project is completed for ongoing use by road maintenance personnel.

These areas have generally been located to take advantage of relatively level ground to minimise earthworks, although some clearing will be required for a few areas and minor earthworks is likely to be required for many areas. Clearing of relatively small trees and bushes may require a chainsaw and chipper, while site levelling would generally be completed with a small excavator or skid steer loader.

A chainsaw and chipper operating together are likely to produce a sound power level of approximately 115 LA<sub>max</sub> and 112 LA<sub>eq,15min</sub>, while a small excavator or loader is expected to produce 100 LA<sub>eq,15min</sub>. A period of a few hours would generally be expected per site, although larger sites may require an entire day to complete.

Other sources associated with phase include a small truck and light utility vehicles, although these sources will not operate for an extended period of time and would therefore produce relatively insignificant noise.

#### **4.2.4 Widen Pinch Points**

A small number of pinch points, or areas of narrow road on sharp curves that are likely to prevent long heavy vehicles from passing these points, have been identified and are described in Section 5.1.1 of the Construction Methodology. Pinch points are likely to require the following processes and equipment:

- Install climbing anchor points at the top of the slope, similar to those required for upslope stabilisation;
- Install a powered winch at the top of the slope to support the weight of a jackhammer;
- Use the jackhammer to remove rock that is out of reach of an excavator, and a drill if required to install upslope stabilisation bolts or other slope restraints;
- Use an excavator fitted with a hydraulic hammer to remove rock within approximately 8 m above the road surface; and
- Use a skid steer loader or similar machine to load the removed rock into a truck for removal from the site.

Depending on the amount of rock to be removed, this work may require a week or more to complete at each pinch point.

Worst case noise sources would include a skid steer loader, petrol or diesel powered generator and a jackhammer or drill, although an air compressor and pneumatic jackhammer or drill may be required instead of a generator and electric hammer/drill. An excavator or loader is expected to produce a sound power level of approximately 100 LA<sub>eq,15min</sub>, with a drill or jackhammer potentially reaching a sound power level of 115 LA<sub>max</sub> and 110 LA<sub>eq,15min</sub>.

No pinch points exist close to residences, therefore noise from this activity is unlikely to cause a noise impact to any residence.

#### **4.2.5 Site Office, Satellite Offices, Camps**

The major compound including site offices and the accommodation camp are proposed to be established in Section 3, at approximately chainage 85000. Alternative locations for the main compound and accommodation camp are in Section 4 at approximately chainage 89700. Minor compounds, some of which may include satellite offices, are proposed to be established at various locations along the site.

The major compound would include fuel storage and dispensing facilities, water supply tanks and an emergency helicopter landing pad. Minor compounds would generally include a water supply tank and may include smaller fuel storage facilities. Other helicopter landing pads may be installed near areas where helicopters are required for material deliveries or to provide access to upslopes that are otherwise difficult to access.

Construction of the major compound and accommodation camp is assumed to require the following processes and equipment:

- An excavator, grader and roller to level the site and compact the soil;
- Trucks, a grader and roller to deliver, place and compact a surface layer of gravel;
- An excavator to prepare foundations for buildings;
- Trucks and perhaps a mobile crane to deliver, unload and install equipment including portable buildings, skid-mounted water and fuel tanks, power generators and a sewage treatment system and associated tanks; and
- Various hand tools including saws, drills and screwdrivers to install minor components such as handrails, water and sewer pipes and electrical cables.

A period of approximately 8 weeks may be required to construct the main compound and site offices. Smaller compounds including satellite offices and smaller fuel and water storage facilities would require similar processes and equipment, for a shorter time period of perhaps 2 to 3 weeks.

The highest construction sound power level from each site is likely to occur during the levelling and compacting phase, or alternatively during the gravel installation phase. These phases are expected to produce a sound power level of 110 LAeq,15min from an excavator, truck, grader and roller operating simultaneously.

Operation of the main compound is likely to include the following significant sources:

- Power generators operating 24 hours per day, producing a total sound power level of approximately 98 LAeq,15min assuming relatively quiet containerised units;
- Large air conditioners and ventilation systems attached to the dining hall, offices and other large buildings, expected to produce a sound power level of up to 90 LAeq,15min each or 98 LAeq,15min combined;
- Air conditioners on individual accommodation units, expected to produce a sound power level of 65 LAeq,15min each and 85 LAeq,15min combined; and
- Intermittent truck, construction plant and light vehicle movements, producing an estimated 114 LAm<sub>ax</sub>, up to 110 LAeq,15min during busy times.

The main compound and camp are therefore expected to produce a combined sound power level of 111 LAeq,15min during busy times and 101 LAeq,15min at other times without significant vehicle movements.

#### **4.2.6 Concrete Batch and Volumetric Mixing Plants**

As the project area is remote from existing concrete batch plants, Sections 6.1 and 6.2 of the Construction Methodology describe the establishment of a mobile concrete batch plant and a number of volumetric mixing plants. The concrete batch plant would provide a concrete mix in larger batches while the volumetric mixing plants would produce smaller amounts of concrete as required. Concrete from each plant would be transported to the work sites using agitator trucks of various sizes and configurations.

The main concrete batch plant is proposed to be installed near the western end of the site at approximately chainage 118000, 10 km from the nearest residence adjacent to the project area and

3.6 km from the nearest residence outside the project area to the north-west. Given this remote location, construction and operation of the main concrete batch plant is not likely to be audible at any residence and is not considered further in this assessment.

Volumetric mixing plants are proposed at three other locations distributed along the site and are likely to require the following processes and equipment:

- An excavator to construct an elevated platform and ramp of earth, with the platform and ramp material either obtained from the surrounding area or delivered to each site by truck;
- A compactor and/or roller to compact the ramp and platform;
- An excavator, compactor and roller to level and compact a stockpile area for later storage of concrete ingredients;
- Trucks to deliver gravel and a grader and roller to distribute and compact the gravel over the stockpile area; and
- A truck and crane to install a cement silo and associated augers and related equipment.

A period of approximately 1 to 2 weeks may be required to construct the stockpile area and mixer platform and install other equipment

The highest construction sound power level from each site is likely to occur during the stockpile area levelling and compacting phase, or alternatively during the gravel installation phase. These phases are expected to produce a sound power level of 110 LAeq,15min from an excavator, truck, grader and roller operating simultaneously.

Operation of each volumetric mixer is likely to produce a sound power level of:

- 110 LAmax and 100 LAeq,15min from the mixer itself;
- 108 LAmax and 105 LAeq,15min from an agitator truck; and
- 102 LAeq,15min from a loader that is used to transfer stockpiled materials such as sand and gravel to the mixer.

A combined sound power level of 112 LAmax and 108 LAeq,15min is therefore considered reasonable for operation of each volumetric mixer.

#### **4.2.7 Rock and Gravel Quarries**

Two quarries are proposed to be used to produce gravel and other products required for the project. Smiths Quarry is located at approximate chainage 83300 and White Rock Quarry is located at approximate chainage 110400. Section 8 of the Construction Methodology discusses these quarries including rock types, extraction and processing limitations.

Based on the information presented in the Construction Methodology, each quarry is likely to require:

- Ripping and extracting raw material with a 25t excavator, followed by loading the raw material into a truck;
- Transport by truck to an off-site location for White Rock Quarry (due to insufficient space within the quarry) or to a processing and stockpiling area adjacent to Smiths Quarry;
- Crushing, screening and stockpiling the material; and
- Using a front-end loader to load crushed material into trucks for delivery to work sites.

Simultaneous operation of a 25t excavator, raw material truck, crushing and screening plant, loader and product truck is likely to produce a sound power level of 118 LAeq,15min. Noise from Smiths Quarry is considered to closest residences, while White Rock Quarry is remote from any residence.

#### **4.2.8 Temporary Side Tracks**

The majority of culverts would be replaced without requiring a traffic bypass track, as a temporary steel bridge over the work area would be used to allow traffic to pass during work breaks. Large or deep culverts, or where multiple adjacent culvert pipes are installed, require an excavation that may be too wide to be spanned by a temporary bridge. In these cases, and where the terrain is suitable, a diversion track is proposed to allow traffic movements past the work site.

Diversion tracks are likely to be constructed using the following equipment:

- An excavator, grader and roller to form the bypass track route, remove unsuitable material and compact the surface;
- Trucks to deliver gravel, an excavator or loader to distribute the gravel, and a grader and roller to smooth and compact the track's surface; and
- Various smaller tools to install signs, edge markers and similar components.

Delivering, placing and finishing the gravel surface is likely to produce the highest sound power level associated with this activity, estimated at 110 LAeq,15min.

### **4.3 Road Restoration**

Road restoration works primarily include surface water controls, slope stabilisation, pavement construction and bridge scour protection. The following sections describe processes and equipment likely to be required for each of these tasks.

#### **4.3.1 Restore Longitudinal Drains**

Longitudinal drains are those that run parallel to the road, particularly the drains on the upslope side that collect surface water and direct that water to the nearest culvert. The Construction Methodology does not provide details regarding restoration works for these drains however the following processes and equipment are assumed:

- An excavator with an offset boom and a v-drain bucket to form a new or clean an existing drain;
- A truck to collect and transport material removed by the excavator;
- In some cases, particularly where the longitudinal drain includes a steep slope, a truck, excavator and concrete agitator may be required to install anti-scour materials such as riprap or gabions, a concrete apron or erosion control mats; and
- Trucks to deliver and spread grass seeds and water to encourage vegetation growth within and adjacent to the completed drain.

As erosion control is not expected to be required in all areas, an estimated sound power level of 106 LAeq,15min is expected from an excavator and truck. If an agitator truck is also required to install concrete for erosion control, the estimated sound power level increases to 109 LAeq,15min which is not a significant increase.

#### **4.3.2 Construct and Restore Culverts**

As described in Sections 11.2 to 11.16 of the Construction Methodology, culverts requiring installation or restoration range from a single 600 mm pipe to multiple pipes up to 3000 mm diameter. While this is a significant range of sizes, the processes and equipment required to construct and restore culverts are similar for all culverts and include:

- An excavator to expose and remove the existing culvert or excavate the site of a new culvert, and a truck to remove excavated material to a nearby stockpile;

- Replacement of unsuitable material and installation of pipe bedding material using an excavator, truck, vibratory compactor and air compressor;
- Delivery of new pipes by truck and installation using an excavator;
- Delivery and installation of initial backfill material such as stabilised sand, using an excavator, truck, compactor and air compressor
- Installation of general fill material using the excavator, compactor and air compressor, with a truck required to deliver additional fill material in some cases; and
- Installation of upstream and downstream scour protection such as a kerb or pit, riprap, gabions, a concrete apron or erosion control mats, using a truck to deliver materials, an excavator to place materials, an air compressor and drill if rock bolts are required and a concrete agitator truck if concrete is required.

The majority of processes associated with culvert installation or restoration require a truck, excavator, air compressor and compactor, for a typical sound power level of 108 LAeq,15min. Installation of scour protection is likely to require additional equipment such as a rock drill or an agitator truck, for a total sound power level of 109 LAeq,15min as a drill and agitator truck are unlikely to operate simultaneously.

A number of hand tools including power saws and drills are expected to be required, for example to construct concrete formwork, however these sources contribute insignificant noise compared to the large diesel powered machines described above.

#### **4.3.3 Downslope Stabilisation**

As described in Section 12 of the Construction Methodology, downslope stabilisation would generally include soil nails or rock bolts then mesh and shotcrete. In this assessment, downslope stabilisation includes areas specifically identified in the Construction Methodology as requiring stabilisation downslope of the road and stabilisation of the downslope end of culverts. The following processes and equipment are expected to be required:

- An excavator, perhaps with a long reach boom, to profile the face and remove loose material;
- An excavator-mounted hydraulic drill to create holes for the soil nails or rock bolts;
- A grout mixer and pump to fill the hole around the nails or bolts;
- An excavator and concrete agitator to supply and place concrete if required;
- An excavator to lift mesh sheets into place for fixing to the soil nails; and
- A shotcrete mixer/agitator and pump.

Drilling and shotcreting are likely to produce a sound power level of 108 LAeq,15min, with other stages expected to produce a lower sound power level.

In some locations gravity walls may be installed to stabilise the slope, requiring the following processes and equipment:

- An excavator to remove loose material and create a trench at the base of the slope for the first row of blocks, with a truck to remove excavated material;
- A compactor then an excavator and truck to compact the base of the trench then deliver and install bedding material;
- A truck to deliver blocks and an excavator to lift blocks into place;
- A concrete agitator to deliver and place concrete backfill behind the block wall; and
- A truck and excavator to deliver and place remaining fill material.

A sound power level of 110 LAeq,15min is likely to be produced by an excavator, truck and concrete agitator or an air compressor, compactor, excavator and truck operating together. Other equipment combinations are likely to produce a lower sound power level.

#### **4.3.4 Bridge Scour Protection**

As described in Section 13 of the Construction Methodology, scour protection is required for six bridge sites. The following processes and equipment are expected to be required:

- A rock or concrete drill to install temporary anchor points for a spider excavator;
- A spider excavator to travel down the river banks to the work site, prepare benches to store materials; remove loose material from around the bridge piers and abutments, fill the scour holes with stabilised sand, install geotextile and anchor pins, and place a rock mattress over the geotextile;
- A concrete agitator to deliver and mix stabilised sand and concrete; and
- Trucks to deliver various materials.

A sound power level of 105 LAeq,15min would be produced by the excavator and truck most of the time, with up to 109 LAeq,15min when a concrete agitator is required.

#### **4.3.5 Unbound Pavement Restoration**

Unbound or unsealed pavement requires restoration over a significant proportion of the project area and is described in Section 14 of the Construction Methodology. This phase will most likely require the following processes and equipment:

- A grader and skid steer loader to remove the existing damaged pavement, including a truck and loader to remove unsuitable material where required;
- Alternatively a grader, roller and water cart to tyne, shape and compact the existing pavement material; and
- A truck, grader, roller and water cart to deliver, shape and compact subbase and pavement material, including a skid steer loader for minor tasks where required.

A sound power level of up to 110 LAeq,15min is expected from this phase.

#### **4.3.6 Sealed Pavement Restoration**

Two sections of Kempsey Road, for a total length of approximately 2.8 km, are proposed to be sealed as described in Section 15 of the Construction Methodology. Process and equipment would be similar to those described for unbound pavement restoration, with the addition of:

- A skid steer loader to sweep the unsealed pavement;
- A bitumen truck to deliver and spray the sealer material;
- A truck to deliver and spread surface aggregates; and
- A multi-tyred roller to finish the pavement surface.

A sound power level of 110 LAeq,15min is expected from simultaneous operation of the bitumen truck, aggregate truck and roller, therefore noise levels from unbound and sealed pavement construction are expected to be similar although areas of sealed pavement will require additional time to complete.

## 4.4 Rehabilitation

Rehabilitation work would vary considerably over different areas of the project site. The most intensive rehabilitation works are likely to be required in the following areas:

- Side access tracks around large culvert work sites;
- Compound, camp, concrete batch and volumetric mixing sites; and
- Laydown and stockpile areas that are not required for ongoing road maintenance.

The following processes and equipment are expected for these and other areas requiring rehabilitation:

- A mobile crane and truck, or a truck fitted with a crane, to remove major items including portable buildings, generators and concrete batch plant components;
- Low loader trucks to remove earthmoving equipment such as excavators, graders and rollers;
- An excavator and truck to remove unwanted materials such as gravel and to deliver and place fill material where required to restore the original landform;
- A truck and skid steer loader to deliver and spread topsoil and other similar materials;
- A hydromulch truck, or equivalent, to seed disturbed areas; and
- Periodic watering of rehabilitated areas using a water cart.

A sound power level of 106 LAeq,15min is expected from a truck and either an excavator or a skid steer loader, with a similar sound power level from a truck-mounted hydromulch system or a mobile crane. As multiple items may be removed simultaneously, large compounds and the camp may produce a total sound power level of 109 LAeq,15min during this phase.

## 5 RECEIVED NOISE AND VIBRATION LEVELS

Noise levels at each residence would be affected by the activities proposed to occur near each residence and the distance between the residence and each activity. Each residence is considered and discussed separately in this section.

Residences were identified from the Construction Methodology and from Google Earth and have been numbered in chainage order on Kempsey Road then Lower Creek Road. Residences located more than 500 m from the project site are unlikely to be affected by noise from the project and have been omitted from the assessment, although some project activities may be audible at these residences at times.

Multiple construction activities are unlikely to occur at the closest point to each residence simultaneously, therefore noise levels from multiple activities are unlikely to sum to a higher total noise level. As each table shows calculated noise levels for the minimum setback distance from each activity, actual noise levels would often be lower than the levels shown in the tables as each activity progresses along the project site. Longer term sites, such as volumetric mixing sites, are an exception as noise from these sites will occur intermittently over a period of many months.

### 5.1 Section 1, Chainage 73000 – 77000

Section 1 extends from the eastern end of the project site for a distance of 4 km along Kempsey Road, including two residences R1 and R2.

#### 5.1.1 R1, 7380 Kempsey Road

This residence is located approximately 65 m north-east of Kempsey Road at chainage 74300, as shown in Figure 1. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 1.

**Figure 1: R1, 7380 Kempsey Road**



**Table 1: Calculated Noise Levels to R1, 7380 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/ laydown/stockpile	Typical	100	74300	75	54
	Chainsaw, chipper	112	74350	95	64
Drains	Typical	106	74300	65	62
Culverts	Typical	108	74280	75	62
	+Drill or concrete	109	74280	75	63
Downslope stabilisation	Drill, shotcrete	108	74280	80	62
	Worst case	110	74280	80	64
Pavement	Restoration	110	74300	65	66
Rehabilitation	Typical	106	74300	75	60

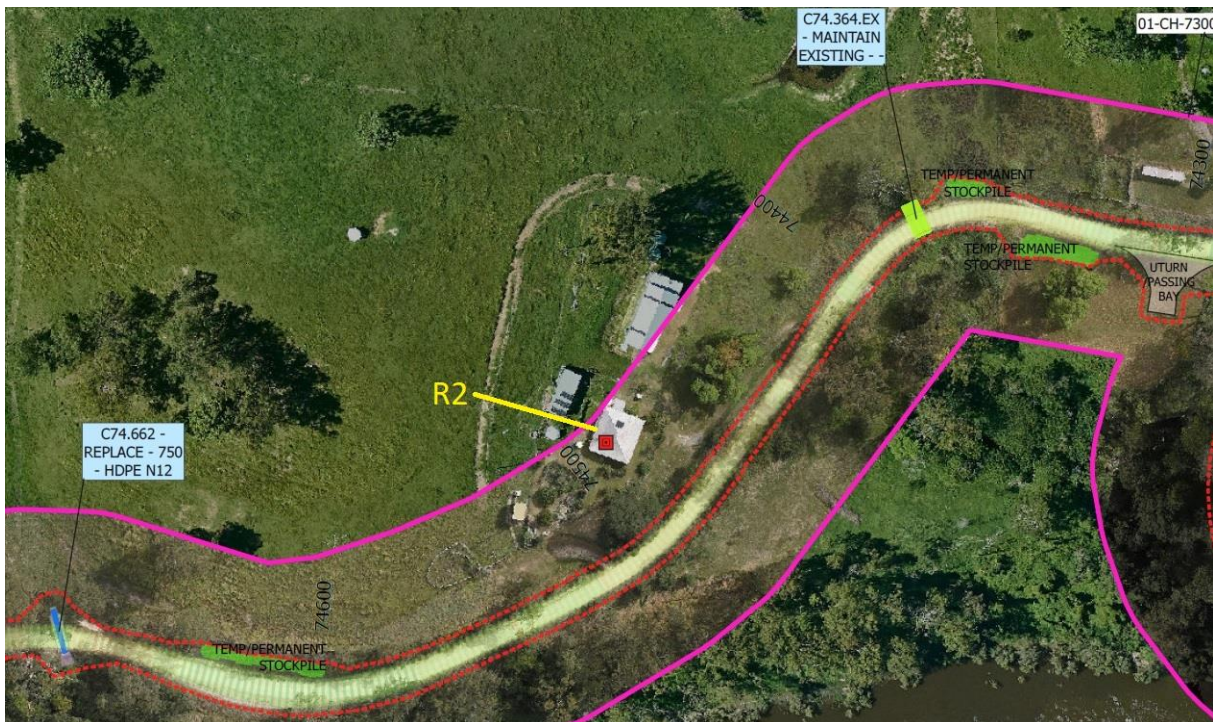
Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management may be required for this residence as discussed in Section 3.6, particularly during restoration of the culvert and pavement immediately in front of the residence.

### 5.1.2 R2 Elanero, 7458 Kempsey Road

This residence is located approximately 20 m west of Kempsey Road at chainage 74480, as shown in Figure 2. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 2.

**Figure 2: R2, Elanero, 7458 Kempsey Road**



**Table 2: Calculated Noise Levels to R2, Elanero, 7458 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	74350	100	52
	Chainsaw, chipper	112	74350	100	64
Side track	Construction	110	74980	400	50
Drains	Typical	106	74480	20	72
Culverts	Typical	108	74270	180	55
	+Drill or concrete	109	74270	180	56
Downslope stabilisation	Drill, shotcrete	108	74270	180	55
	Worst case	110	74270	180	57
Bridge scour protection	Excavator, truck	105	75150	570	42
	+Concrete	109	75150	570	46
Pavement	Restoration	110	74480	20	76
Rehabilitation	Typical sites	106	74350	100	58

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Orange shading Exceeds the 'highly noise affected' level

Ground vibration management is likely to be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

## 5.2 Section 2, Chainage 77000 – 85000

Section 2 extends from the western end of Section 1 for a distance of 8 km along Kempsey Road, including 11 residences R3 to R13.

### 5.2.1 R3 McGees Flat, 290 Lagoon Creek Road

This residence is located approximately 45 m south of Kempsey Road at chainage 77460, as shown in Figure 3. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 3.

**Figure 3: R3 McGees Flat, 290 Lagoon Creek Road.**



**Table 3: Calculated Noise Levels to R3 McGees Flat, 290 Lagoon Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	77500	75	54
Side track	Construction	110	76400	850	43
Drains	Typical	106	77440	50	64
Culverts	Typical	108	77680	240	52
	+Drill or concrete	109	77680	240	53
Downslope stabilisation	Drill, shotcrete	108	77680	240	52
	Worst case	110	77680	240	54
Pavement	Restoration	110	77440	45	69
Rehabilitation	Typical sites	106	77500	75	60

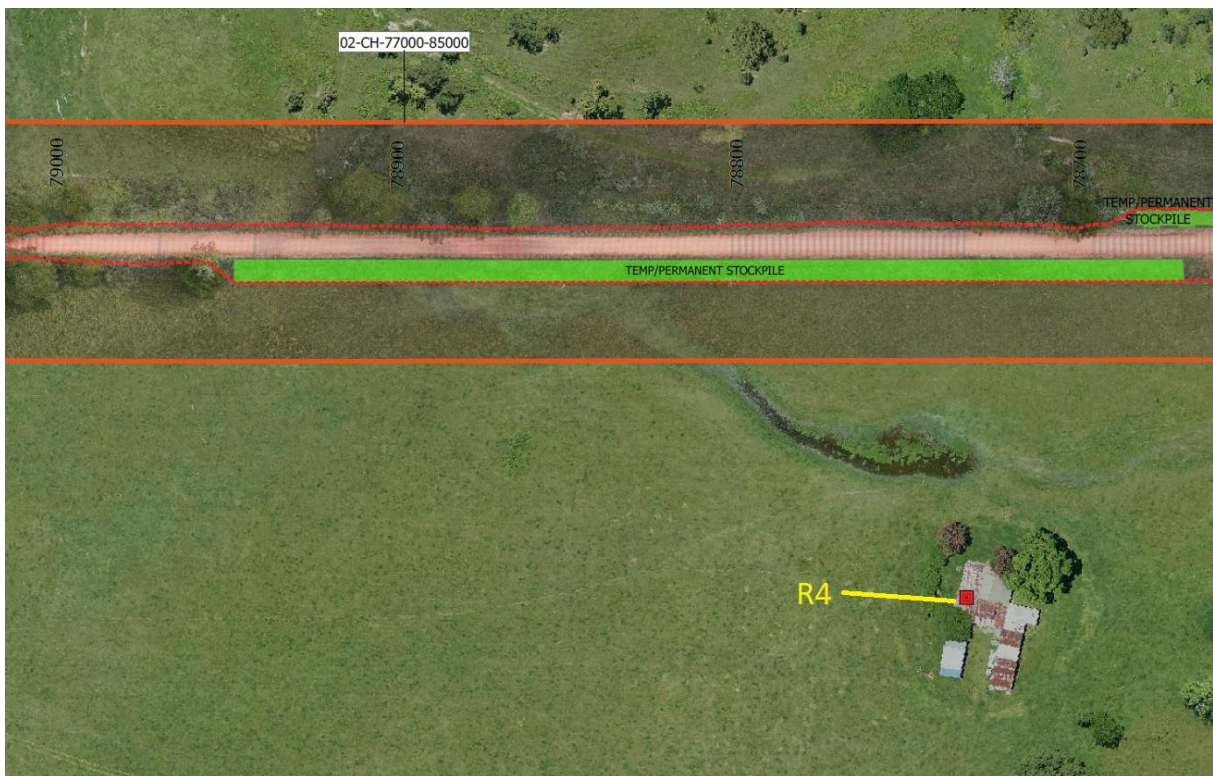
Green shading Exceeds the ‘noise affected’ level outside standard construction hours  
 Blue shading Exceeds the ‘noise affected’ level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

**5.2.2 R4 Greenoak, 7885 Kempsey Road**

This residence is located approximately 90 m south of Kempsey Road at chainage 78720, as shown in Figure 4. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 4.

**Figure 4: R4 Greenoak, 7885 Kempsey Road.**



**Table 4: Calculated Noise Levels to R4 Greenoak, 7885 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	78720	80	54
Volumetric mixing	Construction	110	79530	800	44
	Operation	108	79530	800	42
Side track	Construction	110	78500	210	56
Drains	Typical	106	78720	95	58
Culverts	Typical	108	78460	260	52
	+Drill or concrete	109	78460	260	53
Downslope stabilisation	Drill, shotcrete	108	78460	260	52
	Worst case	110	78460	260	54

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Pavement	Restoration	110	78720	90	63
Rehabilitation	Typical sites	106	78720	80	60

Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

### 5.2.3 R5, 8007 Kempsey Road

This residence is located approximately 590 m north of Kempsey Road at chainage 79650, as shown in Figure 5. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 5.

**Figure 5: R5, 8007 Kempsey Road.**



**Table 5: Calculated Noise Levels to R5, 8007 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	79650	570	37
Volumetric mixing	Construction	110	79580	580	47
	Operation	108	79580	580	45
Side track	Construction	110	79300	700	45
Drains	Typical	106	79650	590	43
Culverts	Typical	108	79250	750	42
	+Drill or concrete	109	79250	750	43
Downslope stabilisation	Drill, shotcrete	108	79250	750	42
	Worst case	110	79250	750	44
Pavement	Restoration	110	79650	590	47
Rehabilitation	Typical sites	106	79650	570	43

Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

**5.2.4 R6 Carrolls Creek, 8148 Kempsey Road**

This residence is located approximately 70 m south-west of Kempsey Road at chainage 81330, as shown in Figure 6. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 6.

**Figure 6: R6 Carrolls Creek, 8148 Kempsey Road.**



**Table 6: Calculated Noise Levels to R6 Carrolls Creek, 8148 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	81430	110	51
Volumetric mixing	Construction	110	81330	90	63
	Operation	108	81330	90	61
Volumetric mixing (alternate)	Construction	110	81130	180	57
	Operation	108	81130	180	55
Side track	Construction	110	81500	180	57
Drains	Typical	106	81330	75	60
Culverts	Typical	108	81210	110	59
	+Drill or concrete	109	81210	110	60
Downslope stabilisation	Drill, shotcrete	108	81210	110	59
	Worst case	110	81210	110	61
Pavement	Restoration	110	81330	70	65
Rehabilitation	Typical sites	106	81330	90	59

Blue shading Exceeds the 'noise affected' level within standard construction hours

Residence 5 is located approximately 90 m south of a proposed volumetric mixing and laydown site and approximately 180 m west of an alternative site. Assuming both sites are available and have similar characteristics, the more remote site east of the residence would be preferred from an acoustic perspective as it is further from the residence with consequent lower noise levels.

As both sites are located within private property, selection of a site would be subject to consultation and negotiation with the owners of this residence. This provides residents with the opportunity to consider noise issues in the negotiation process.

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence and the culvert close to the residence.

### 5.2.5 R7, Smiths Creek Road

This residence is located off Smiths Creek Road approximately 370 m north-east of Kempsey Road at chainage 82650, as shown in Figure 7. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 7.

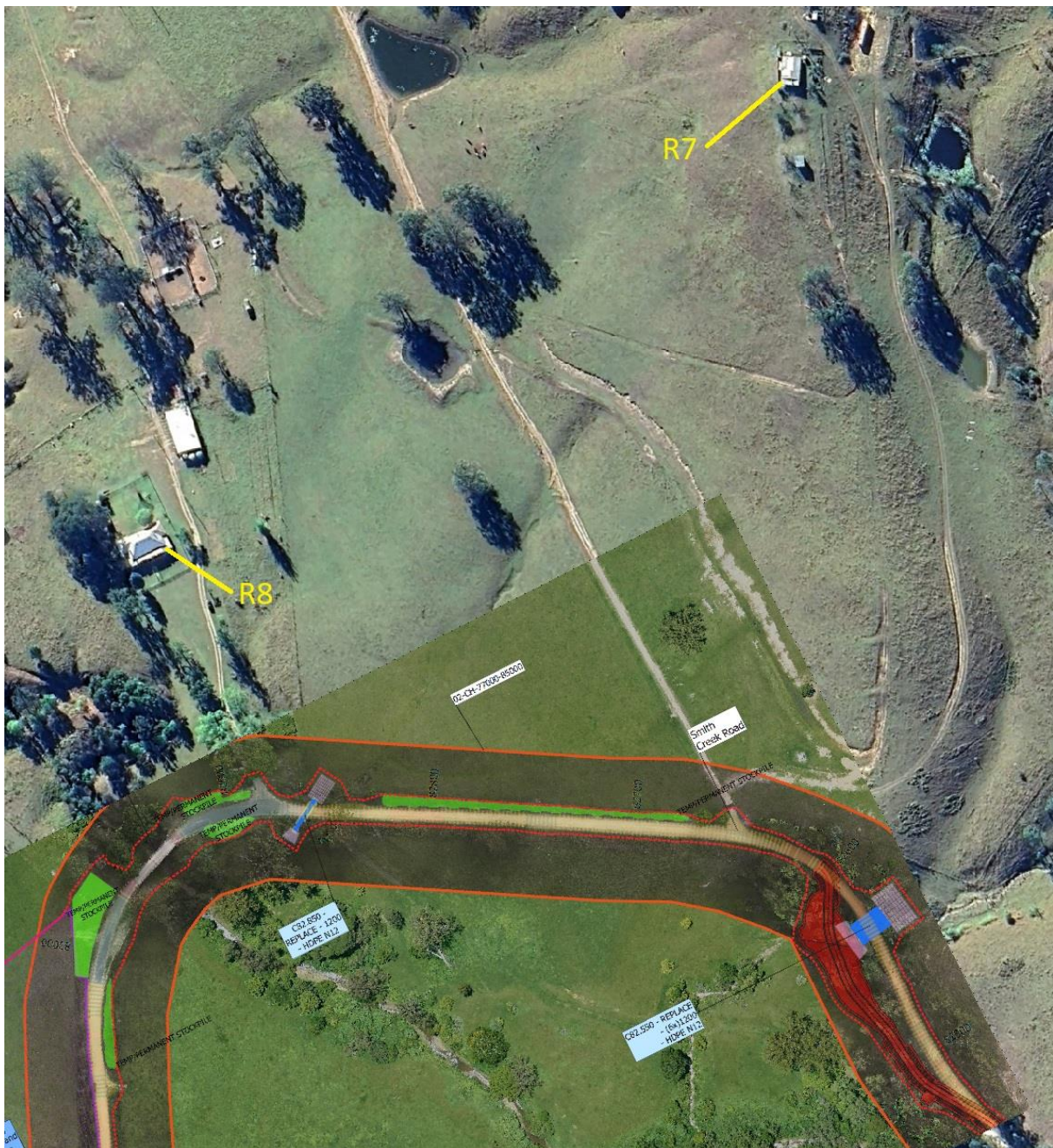
**Table 7: Calculated Noise Levels to R7, Smith Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	82700	370	41
Quarry	Extraction, crushing, loading	118	83100	650	54
Side track	Construction	110	82600	390	50
Drains	Typical	106	82650	370	47
Culverts	Typical	108	82850	420	48
	+Drill or concrete	109	82850	420	49
	Drill, shotcrete	108	82850	430	47

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Downslope stabilisation	Worst case	110	82850	430	49
Bridge scour protection	Excavator, truck	105	82940	470	44
	+Concrete	109	82940	470	48
Pavement	Restoration	110	82650	370	51
Rehabilitation	Typical sites	106	82700	370	47
	Smiths Quarry processing area	109	83100	650	45

Green shading Exceeds the 'noise affected' level outside standard construction hours  
 Blue shading Exceeds the 'noise affected' level within standard construction hours

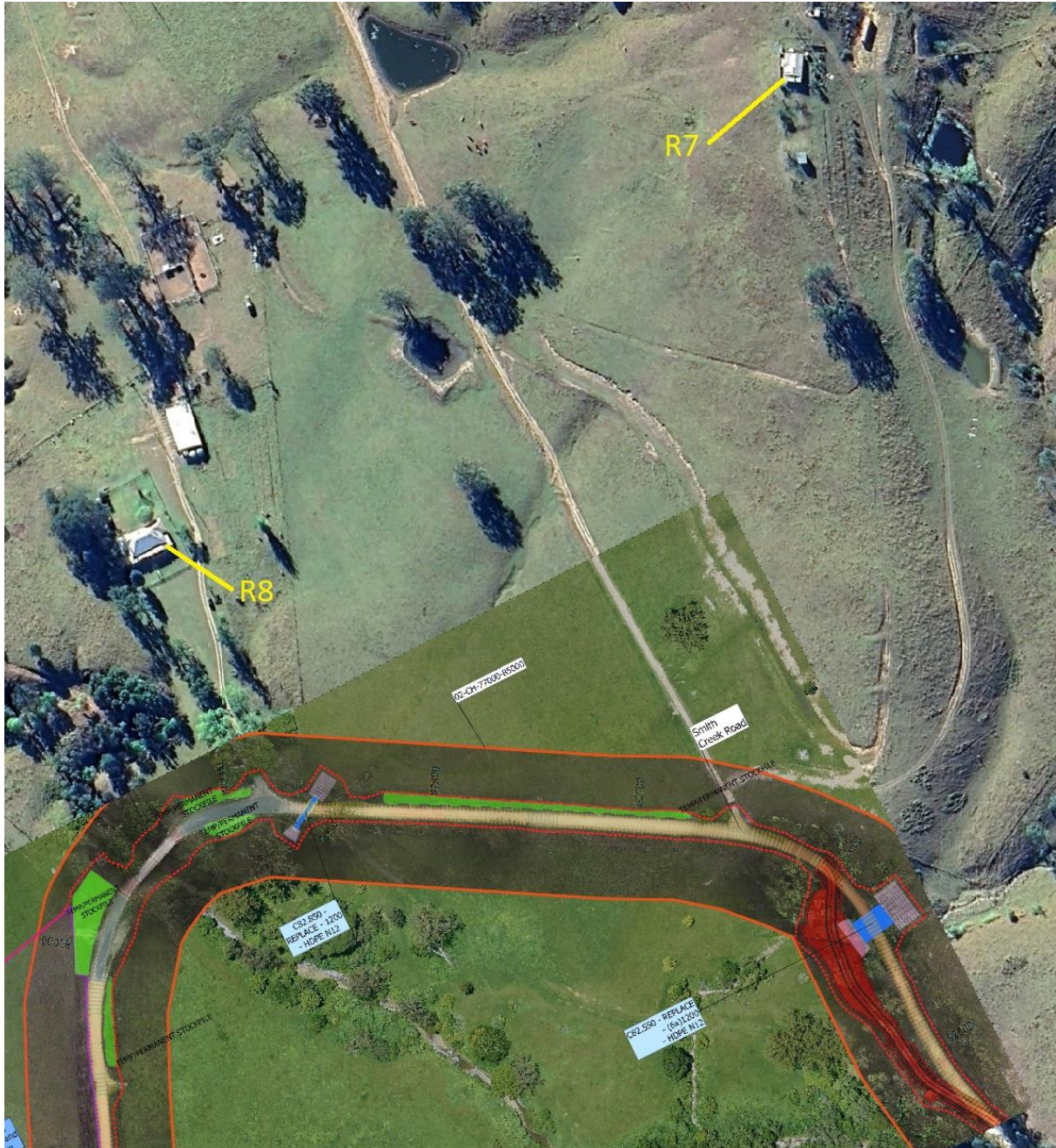
**Figure 7: R7, Smith Creek Road.**



**5.2.6 R8, 8314 Kempsey Road**

This residence is located approximately 130 m north-east of Kempsey Road at chainage 82890, as shown in Figure 8. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 8.

**Figure 8: R8, 8314 Kempsey Road.**



**Table 8: Calculated Noise Levels to R8, 8314 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	82890	120	50

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Quarry	Extraction, crushing, loading	118	83100	290	61
Side track	Construction	110	82600	370	51
Drains	Typical	106	82890	130	56
Culverts	Typical	108	82860	150	56
	+Drill or concrete	109	82860	150	57
Downslope stabilisation	Drill, shotcrete	108	82860	150	56
	Worst case	110	82860	150	58
Bridge scour protection	Excavator, truck	105	82940	130	55
	+Concrete	109	82940	130	59
Pavement	Restoration	110	82890	130	60
Rehabilitation	Typical sites	106	82890	120	56
	Smiths Quarry processing area	109	83100	290	52

Blue shading Exceeds the 'noise affected' level within standard construction hours

### 5.2.7 R9, 8404 Kempsey Road

This residence is located approximately 210 m north-east of Kempsey Road at chainage 83740, as shown in Figure 9. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 9.

**Table 9: Calculated Noise Levels to R9, 8404 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	83480	400	40
	+Drill, jackhammer	110	83480	400	50
Turning/passing/laydown/stockpile	Typical	100	83910	320	42
Compound, camp	Construction	110	85000	1200	40
	Typical	101	85000	1200	31
	Busy period	111	85000	1200	41
Volumetric mixing	Construction	110	84950	1200	40
	Operation	108	84950	1200	38
Quarry	Extraction, crushing, loading	118	83450	440	52 <sup>1</sup>
Drains	Typical	106	83740	220	51
Culverts	Typical	108	83700	230	53
	+Drill or concrete	109	83700	230	54
Downslope stabilisation	Drill, shotcrete	108	83700	230	53
	Worst case	110	83700	230	55
Pavement	Restoration	110	83740	220	55
Rehabilitation	Typical sites	106	83910	320	48
	Smiths Quarry processing area	109	83100	550	41 <sup>1</sup>

<sup>1</sup> Includes a -5 dBA shielding correction

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 9: R9, 8404 Kempsey Road.**



### 5.2.8 R10 Riverside Haven, 8421 Kempsey Road

This residence is located approximately 40 m south of Kempsey Road at chainage 83850, as shown in Figure 10. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 10.

**Figure 10: R10 Riverside Haven, 8421 Kempsey Road.**



**Table 10: Calculated Noise Levels to R10 Riverside Haven, 8421 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	83480	300	42
	+Drill, jackhammer	110	83480	300	52
Turning/passing/ laydown/stockpile	Typical	100	83900	80	54
Compound, camp	Construction	110	85000	1080	41
	Typical	101	85000	1080	32
	Busy period	111	85000	1080	42
Volumetric mixing	Construction	110	84950	1080	41
	Operation	108	84950	1080	39
Quarry	Extraction, crushing, loading	118	83450	390	53 <sup>1</sup>

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Drains	Typical	106	83850	40	66
Culverts	Typical	108	83700	100	60
	+Drill or concrete	109	83700	100	61
Downslope stabilisation	Drill, shotcrete	108	83700	100	60
	Worst case	110	83700	100	62
Pavement	Restoration	110	83850	40	70
Rehabilitation	Typical sites	106	83900	80	60
	Smiths Quarry processing area	109	83100	560	41 <sup>1</sup>

1 Includes a -5 dBA shielding correction

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

### 5.2.9 R11, 8476 Kempsey Road

This residence is located approximately 70 m north of Kempsey Road at chainage 84310, as shown in Figure 11. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 11.

**Table 11: Calculated Noise Levels to R11, 8476 Kempsey Road, LAeq,15min.**

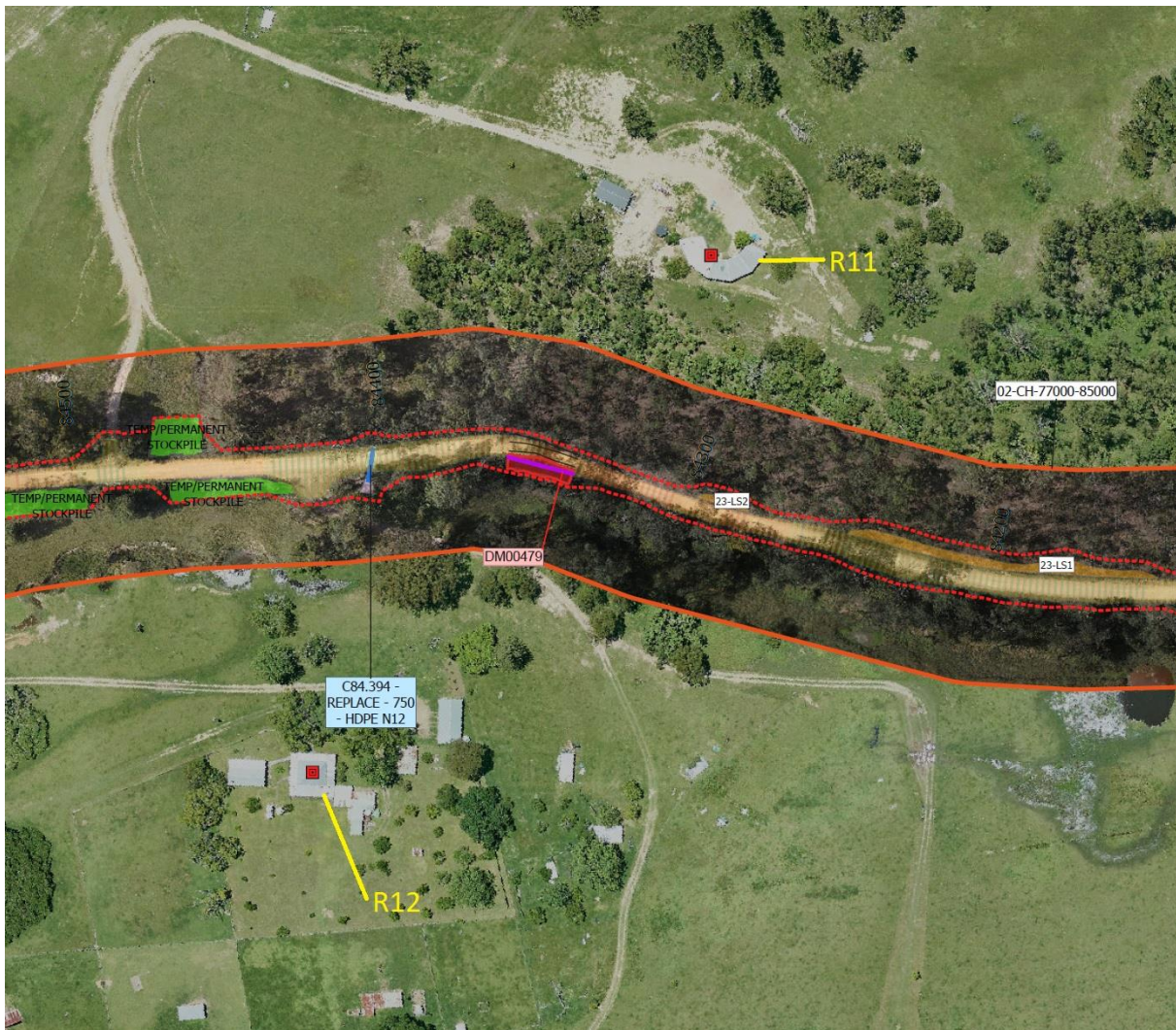
Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	84240	110	51
	+Drill, jackhammer	110	84240	110	61
Turning/passing/laydown/stockpile	Typical	100	84450	160	48
Compound, camp	Construction	110	85000	630	46
	Typical	101	85000	630	37
	Busy period	111	85000	630	47
Volumetric mixing	Construction	110	84950	650	46
	Operation	108	84950	650	44
Quarry	Extraction, crushing, loading	118	83450	830	47 <sup>1</sup>
Drains	Typical	106	84310	70	61
Culverts	Typical	108	84400	120	58
	+Drill or concrete	109	84400	120	59
Downslope stabilisation	Drill, shotcrete	108	84350	90	61
	Worst case	110	84350	90	63
Pavement	Restoration	110	84310	70	65
Rehabilitation	Typical sites	106	84450	160	54
	Main camp	109	85000	630	45

1 Includes a -5 dBA shielding correction

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 11: R11, 8476 Kempsey Road.**

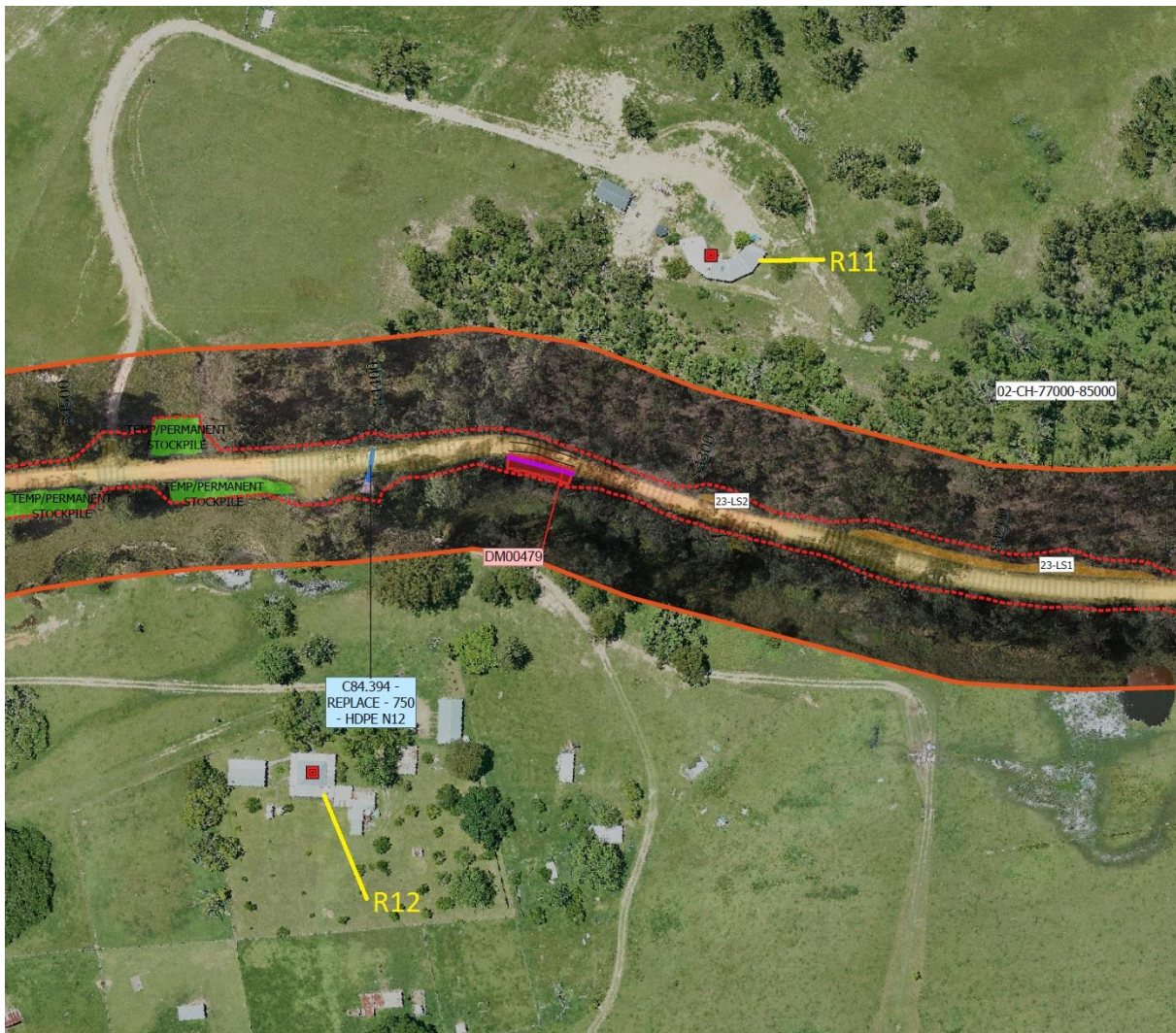


Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence and during the upslope and downslope stabilisation works near the residence.

#### **5.2.10 R12 McCormacks Flat, 8493 Kempsey Road**

This residence is located approximately 90 m south of Kempsey Road at chainage 84430, as shown in Figure 12. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 12.

**Figure 12: R12 McCormacks Flat, 8493 Kempsey Road.**



**Table 12: Calculated Noise Levels to R12 McCormacks Flat, 8493 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	84240	190	46
	+Drill, jackhammer	110	84240	190	56
Turning/passing/ laydown/stockpile	Typical	100	84430	80	54
Compound, camp	Construction	110	85000	540	47
	Typical	101	85000	540	38
	Busy period	111	85000	540	48
Volumetric mixing	Construction	110	84950	500	48
	Operation	108	84950	500	46
Quarry	Extraction, crushing, loading	118	83450	980	45 <sup>1</sup>
Drains	Typical	106	84430	90	59
Culverts	Typical	108	84400	80	62
	+Drill or concrete	109	84400	80	63
	Drill, shotcrete	108	84350	110	59

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Downslope stabilisation	Worst case	110	84350	110	61
Pavement	Restoration	110	84430	80	64
Rehabilitation	Typical sites	106	84430	80	60
	Main camp	109	84950	500	47

1 Includes a -5 dBA shielding correction

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

### 5.2.11 R13, 8573 Kempsey Road

This residence is located approximately 260 m south of Kempsey Road at chainage 84900, as shown in Figure 13. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 13.

**Table 13: Calculated Noise Levels to R13, 8573 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	84240	710	35
	+Drill, jackhammer	110	84240	710	45
Turning/passing/laydown/stockpile	Typical	100	84700	330	42
Compound, camp	Construction	110	85000	300	52
	Typical	101	85000	300	43
	Busy period	111	85000	300	53
	Night	103 <sup>1</sup>	85000	390	43 <sup>1</sup>
Volumetric mixing	Construction	110	84950	180	57
	Operation	108	84950	180	55
Quarry	Extraction, crushing, loading	118	83450	1500	46
Drains	Typical	106	84900	260	50
Culverts	Typical	108	84400	580	45
	+Drill or concrete	109	84400	580	46
Downslope stabilisation	Drill, shotcrete	108	84350	640	44
	Worst case	110	84350	640	46
Pavement	Restoration	110	84900	260	54
Rehabilitation	Typical (stockpile area)	106	84700	330	48
	Main compound, volumetric	109	84950	180	56

1 Estimated noise levels in the absence of noise mitigation measures

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 13: R13, 8573 Kempsey Road.**



Residence 13 is relatively close to the proposed major compound, camp and volumetric mixing area. In the absence of noise mitigation measures, this residence is expected to receive up to 43 LAeq,15min at night from combined operation of the power generators, dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 13 with these recommended noise mitigation measures applied.

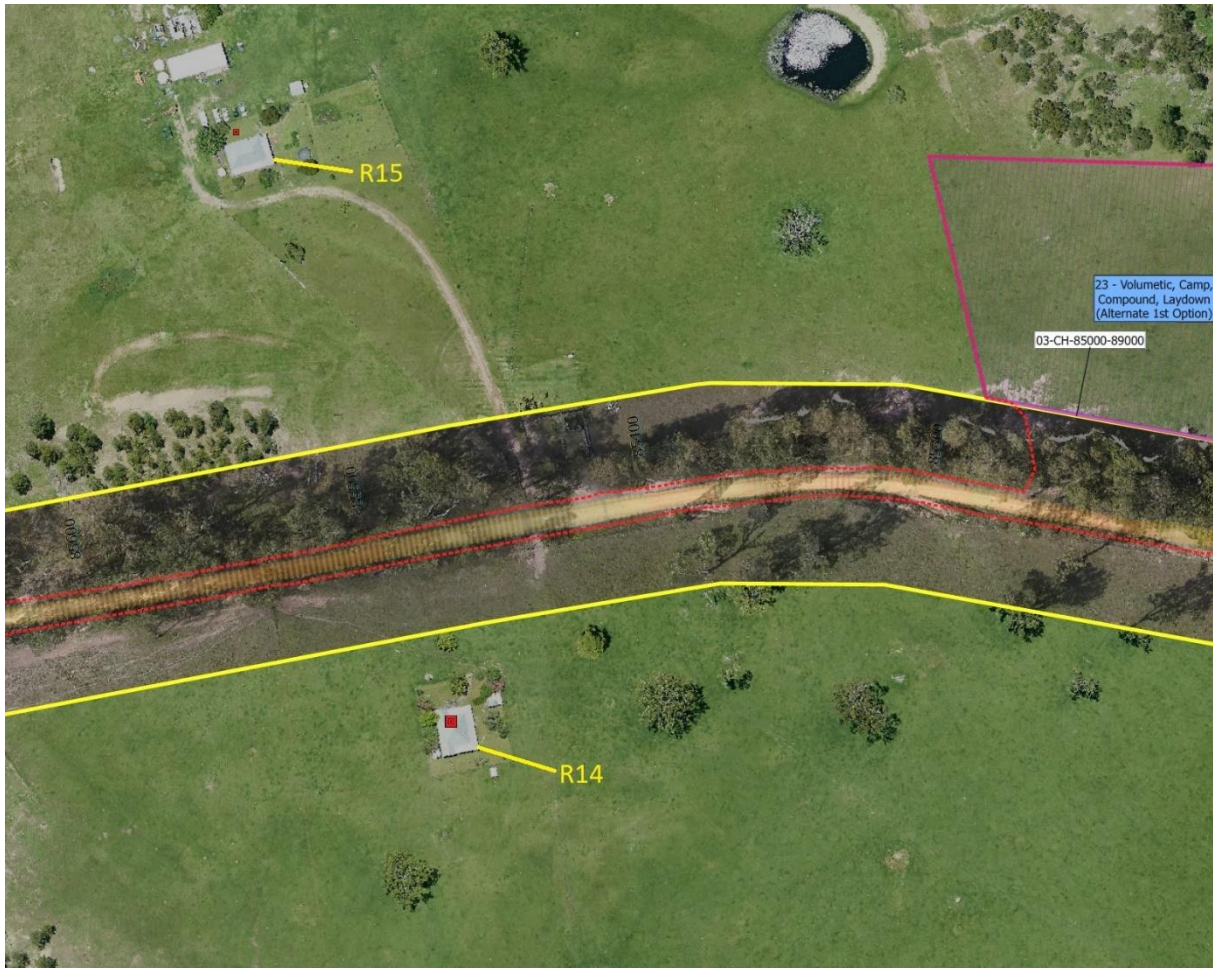
### **5.3 Section 3, Chainage 85000 – 89000**

Section 3 extends from the western end of Section 2 for a distance of 4 km along Kempsey Road, including 7 residences R14 to R20.

**5.3.1 R14, 8574 Kempsey Road**

This residence is located approximately 50 m south of Kempsey Road at chainage 85470, as shown in Figure 14. According to SIX Maps, this residence has the same address as Residence 15 as they are located on the same lot. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 14.

**Figure 14: R14, 8574 Kempsey Road.**



**Table 14: Calculated Noise Levels to R14, 8574 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	86200	630	36
	+Drill, jackhammer	110	86200	630	46
Turning/passing/ laydown/stockpile	Typical	100	85640	160	48
Compound, camp	Construction	110	85080	400	50
	Typical	101	85080	400	41
	Busy period	111	85080	400	51
	Night	103 <sup>1</sup>	85050	430	41 <sup>1</sup>
Volumetric mixing	Construction	110	85000	490	48
	Operation	108	85000	490	46

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Drains	Typical	106	85470	50	64
Culverts	Typical	108	85710	230	53
	+Drill or concrete	109	85710	230	54
Downslope stabilisation	Drill, shotcrete	108	85710	230	53
	Worst case	110	85710	230	55
Pavement	Restoration	110	85470	50	68
Rehabilitation	Typical (turning bay)	106	85640	160	54
	Main compound, volumetric	109	85080	400	49

1 Estimated noise levels in the absence of noise mitigation measures  
 Green shading Exceeds the 'noise affected' level outside standard construction hours  
 Blue shading Exceeds the 'noise affected' level within standard construction hours

Residence 14 is relatively close to the proposed major compound, camp and volumetric mixing area. In the absence of noise mitigation measures, this residence is expected to receive up to 41 LAeq,15min at night from combined operation of the power generators, dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

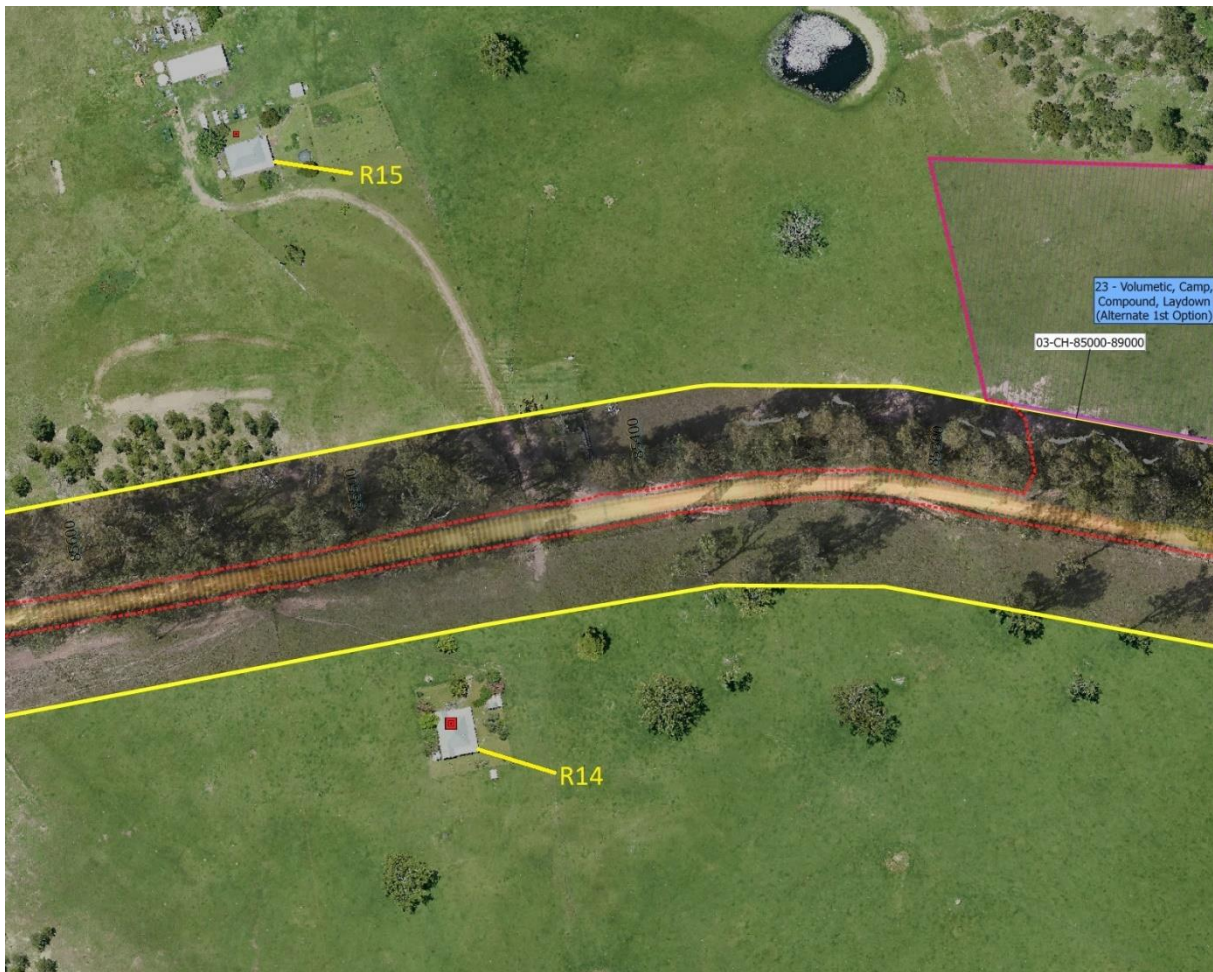
Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 14 with these recommended noise mitigation measures applied.

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

### 5.3.2 R15, 8574 Kempsey Road

This residence is located approximately 140 m north of Kempsey Road at chainage 85520, as shown in Figure 15. According to SIX Maps, this residence has the same address as Residence 14 as they are located on the same lot. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 15.

**Figure 15: R15, 8574 Kempsey Road.**



**Table 15: Calculated Noise Levels to R15, 8574 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	86200	440	39
	+Drill, jackhammer	110	86200	440	49
Turning/passing/laydown/stockpile	Typical	100	85640	190	46
Compound, camp	Construction	110	85080	410	50
	Typical	101	85080	410	41
	Busy period	111	85080	410	51
	Night	103 <sup>1</sup>	85050	440	42 <sup>1</sup>
Volumetric mixing	Construction	110	85000	620	46
	Operation	108	85000	620	44
Drains	Typical	106	85520	140	55
Culverts	Typical	108	85710	200	54
	+Drill or concrete	109	85710	200	55
Downslope stabilisation	Drill, shotcrete	108	85710	210	54
	Worst case	110	85710	210	56
Pavement	Restoration	110	85520	140	59

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Rehabilitation	Typical (stockpile area)	106	85640	190	52
	Main compound, volumetric	109	85080	410	49

1 Estimated noise levels in the absence of noise mitigation measures

Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

Residence 15 is relatively close to the proposed major compound, camp and volumetric mixing area. In the absence of noise mitigation measures, this residence is expected to receive up to 42 LAeq,15min at night from combined operation of the power generators, dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the ‘noise affected’ level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 15 with these recommended noise mitigation measures applied.

### 5.3.3 R16, 8853 Kempsey Road

This residence is located approximately 130 m north of Kempsey Road at chainage 87980, as shown in Figure 16. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 16.

**Table 16: Calculated Noise Levels to R16, 8853 Kempsey Road, LAeq,15min.**

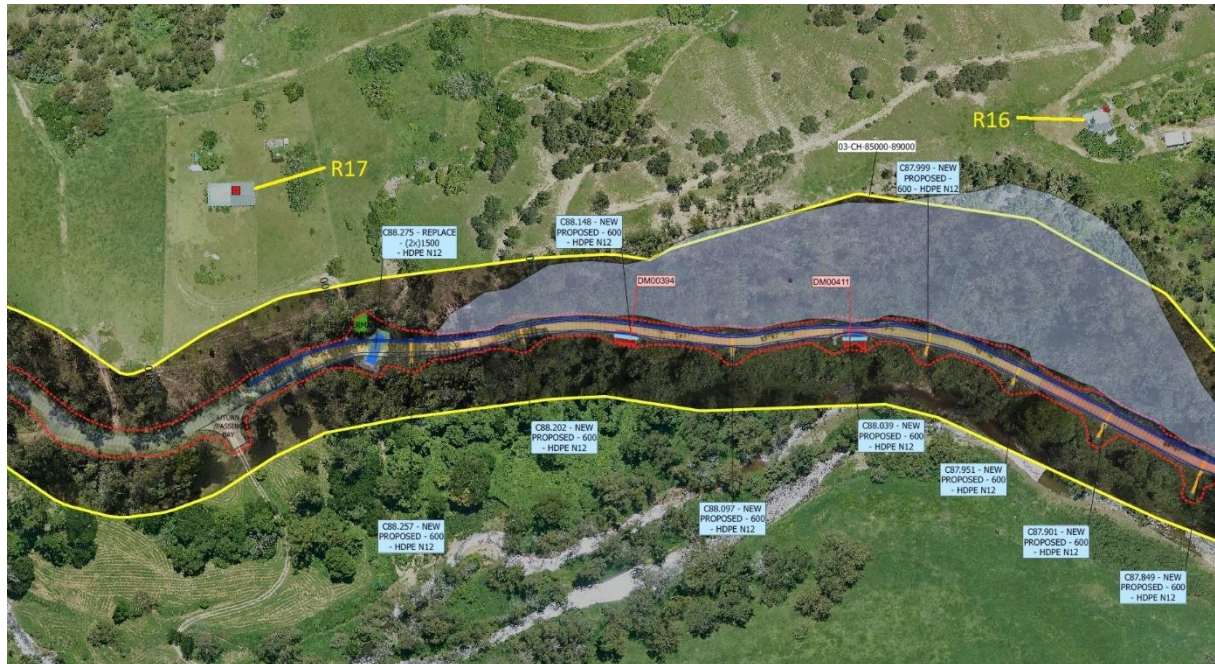
Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	87980	70	55
	+Drill, jackhammer	110	87980	70	65
Turning/passing/ laydown/stockpile	Typical	100	88290	360	41
Drains	Typical	106	87980	130	56
Culverts	Typical	108	87960	130	58
	+Drill or concrete	109	87960	130	59
Downslope stabilisation	Drill, shotcrete	108	87960	130	58
	Worst case	110	87960	130	60
Bridge scour protection	Excavator, truck	105	88580	630	41
	+Concrete	109	88580	630	45

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Pavement	Restoration	110	87980	130	60
Rehabilitation	Typical sites	106	88290	360	47

Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

**Figure 16: R16, 8853 Kempsey Road.**



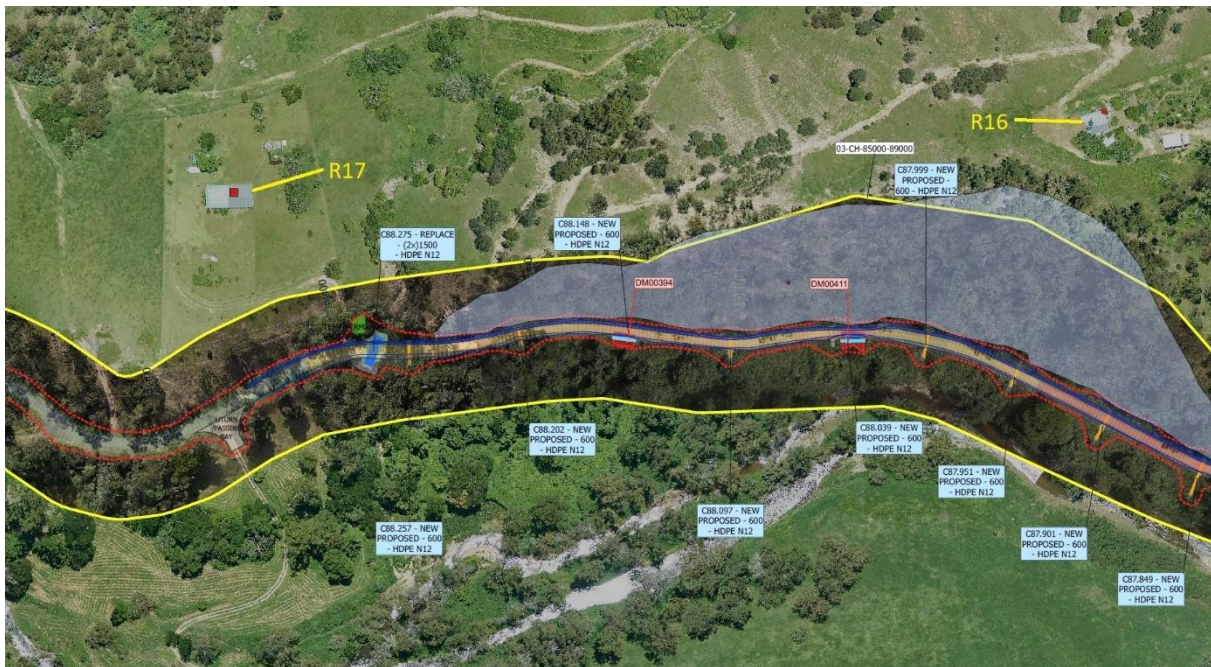
Residence 16 is located above a large upslope that may require stabilisation. A distance of 70 m assumed in Table 16 represents a point near the top of the slope, although much of the work on this and other upslopes would occur at a greater distance from the residence.

Ground vibration management may be required for this residence as discussed in Section 3.6 during the upslope stabilisation work, assuming rock removal and drilling is required within approximately 100 m from the residence.

**5.3.4 R17, 8851 Kempsey Road**

This residence is located approximately 80 m north-west of Kempsey Road at chainage 88330, as shown in Figure 17. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 17.

**Figure 17: R17, 8851 Kempsey Road.**



**Table 17: Calculated Noise Levels to R17, 8851 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	88250	110	51
	+Drill, jackhammer	110	88250	110	61
Turning/passing/laydown/stockpile	Typical	100	88290	80	54
	Chainsaw, chipper	112	88290	80	66
Drains	Typical	106	88330	80	60
Culverts	Typical	108	87960	90	61
	+Drill or concrete	109	87960	90	62
Downslope stabilisation	Drill, shotcrete	108	87960	90	61
	Worst case	110	87960	90	63
Bridge scour protection	Excavator, truck	105	88580	190	51
	+Concrete	109	88580	190	55
Pavement	Restoration	110	88330	80	64
Rehabilitation	Typical sites	106	88290	80	60

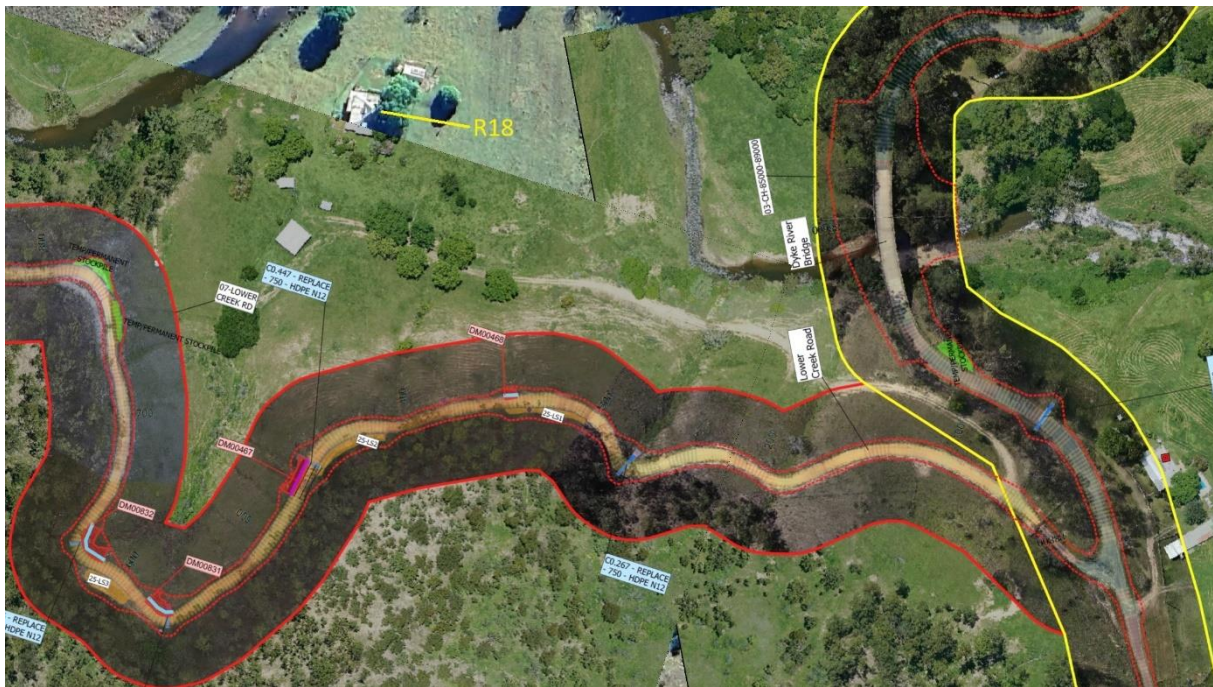
Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence and the culvert near the residence.

### 5.3.5 R18 Orange View, 4 Lower Creek Road

This residence is located approximately 250 m west of Kempsey Road at chainage 88660 and approximately 150 m north of Lower Creek Road at chainage 400, as shown in Figure 18. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 18.

**Figure 18: R18 Orange View, 4 Lower Creek Road.**



**Table 18: Calculated Noise Levels to R18 Orange View, 4 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	410	160	48
	+Drill, jackhammer	110	410	160	58
Turning/passing/laydown/stockpile	Typical	100	770	140	49
Compound, camp (alternative location)	Construction	110	89430	920	43
	Typical	101	89430	920	34
	Busy period	111	89430	920	44
	Night	103	89430	920	36
Drains	Typical	106	400	150	54
Culverts	Typical	108	450	170	55
	+Drill or concrete	109	450	170	56
Downslope stabilisation	Drill, shotcrete	108	450	170	55
	Worst case	110	450	170	57
Bridge scour protection	Excavator, truck	105	88580	250	49
	+Concrete	109	88580	250	53
Pavement	Restoration	110	400	150	58
Rehabilitation	Typical sites	106	770	140	55
	Main compound, camp	109	89430	920	42

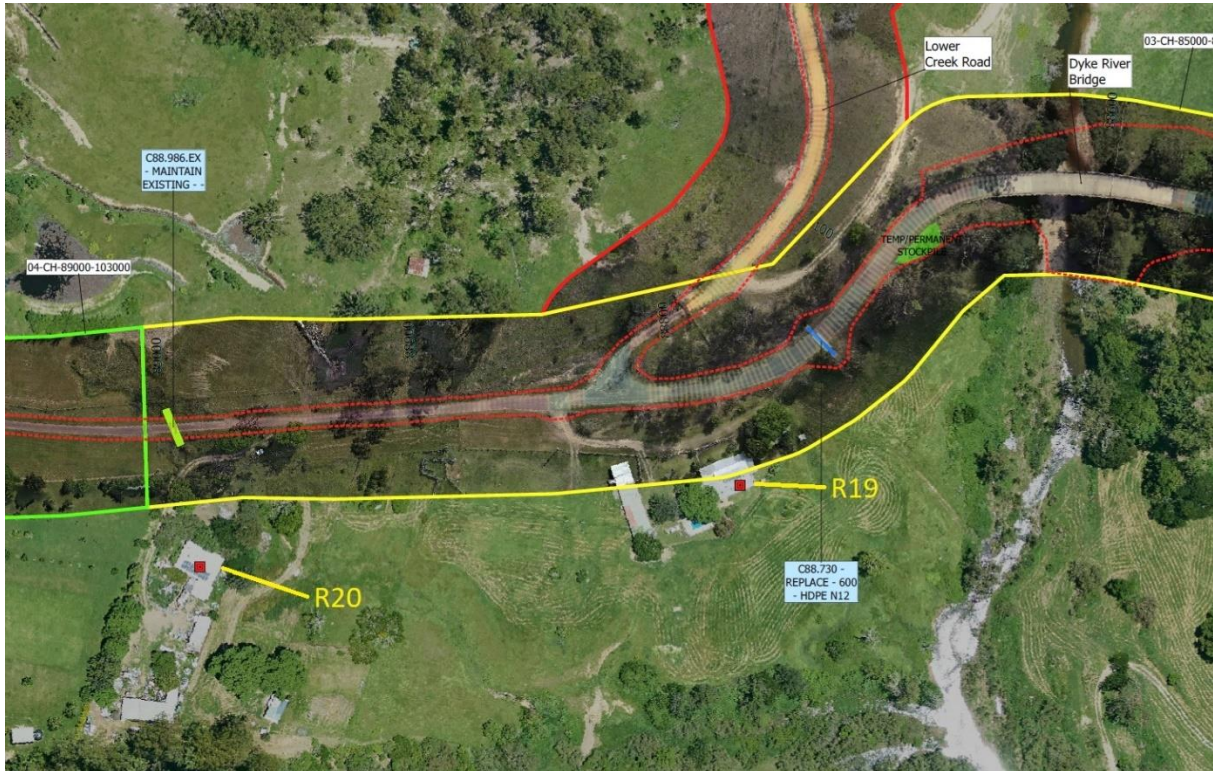
Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

### 5.3.6 R19, 8899 Kempsey Road

This residence is located approximately 30 m east of Kempsey Road at chainage 88780, as shown in Figure 19. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 19.

**Figure 19: R19, 8899 Kempsey Road.**



**Table 19: Calculated Noise Levels to R19, 8899 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	410	370	41
	+Drill, jackhammer	110	410	370	51
Turning/passing/laydown/stockpile	Typical	100	88700	90	53
Compound, camp (alternative location)	Construction	110	89430	630	46
	Typical	101	89430	630	37
	Busy period	111	89430	630	47
	Night	103	89430	630	39
Drains	Typical	106	88780	30	68
Culverts	Typical	108	88750	50	66
	+Drill or concrete	109	88750	50	67
Downslope stabilisation	Drill, shotcrete	108	88750	50	66
	Worst case	110	88750	50	68
Bridge scour protection	Excavator, truck	105	88640	140	54
	+Concrete	109	88640	140	58
Pavement	Restoration	110	88780	30	72

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Rehabilitation	Typical sites	106	88700	90	59
	Main compound, camp	109	89430	630	45

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence, and may also be required while restoring the culvert near the residence.

### 5.3.7 R20, 8919 Kempsey Road

This residence is located approximately 50 m east of Kempsey Road at chainage 88980, as shown in Figure 20. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 20.

**Table 20: Calculated Noise Levels to R20, 8919 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	410	490	33 <sup>1</sup>
	+Drill, jackhammer	110	410	490	43 <sup>1</sup>
Turning/passing/ laydown/stockpile	Typical	100	88700	300	42
Compound, camp (alternative location)	Construction	110	89430	430/680	48
	Typical	101	89430	430/680	39
	Busy period	111	89430	430/680	49
	Night	103	89430	430/680	40 <sup>2</sup>
Side track	Construction	110	90020	970	42
Drains	Typical	106	88980	50	64
Culverts	Typical	108	88750	240	52
	+Drill or concrete	109	88750	240	53
Downslope stabilisation	Drill, shotcrete	108	88750	240	52
	Worst case	110	88750	240	54
Bridge scour protection	Excavator, truck	105	88640	340	46
	+Concrete	109	88640	340	50
Pavement	Restoration	110	88980	50	68
Rehabilitation	Typical sites	106	88700	300	48
	Main compound, camp	109	89430	430	48

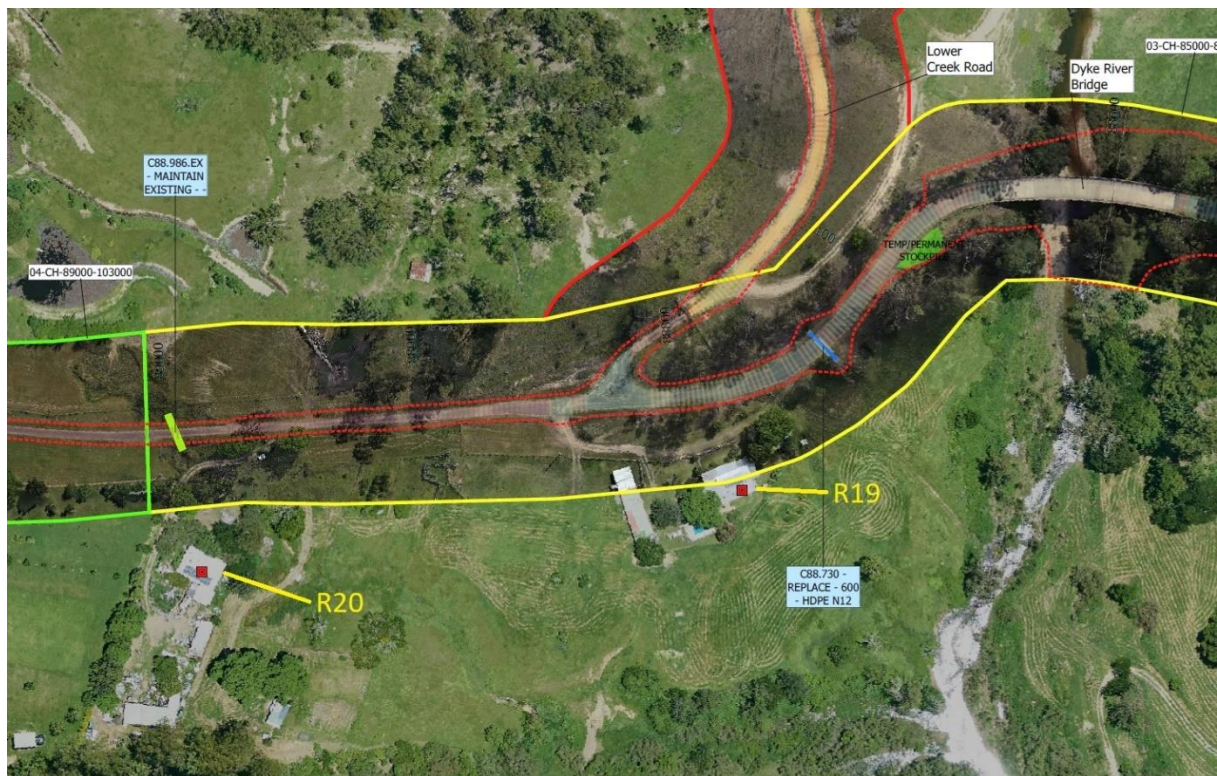
1 Noise levels include a -5 dBA shielding correction

2 Estimated level in the absence of noise mitigation measures

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 20: R20, 8919 Kempsey Road.**



Residence 20 is relatively close to an alternative location for the major compound and camp. In the absence of noise mitigation measures, this residence is expected to receive up to 40 LAeq,15min at night from combined operation of the power generators, office and dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 20 with these recommended noise mitigation measures applied.

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

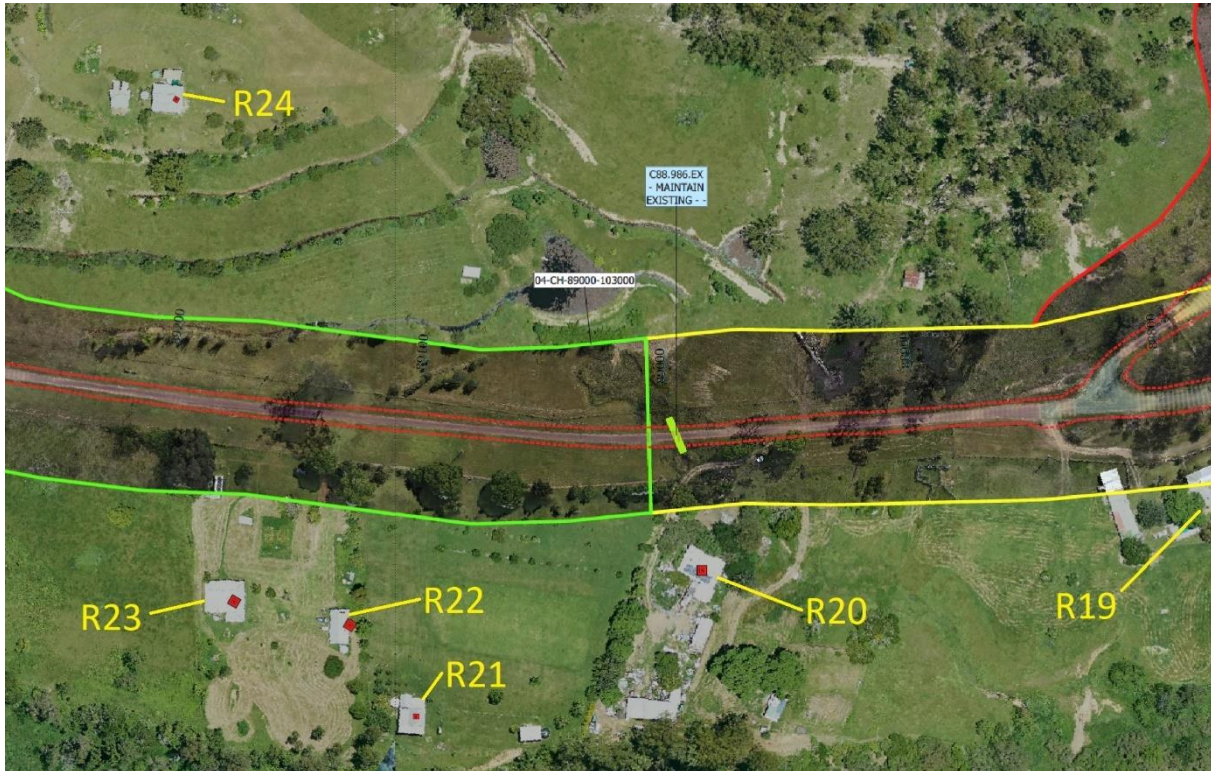
#### **5.4 Section 4, Chainage 89000 – 103000**

Section 4 extends from the western end of Section 3 for a distance of 14 km along Kempsey Road, including 9 residences R21 to R29.

### 5.4.1 R21 Frog Cottage, 8929 Kempsey Road

This residence is located approximately 110 m east of Kempsey Road at chainage 89080, as shown in Figure 21. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 21.

**Figure 21: R21 Frog Cottage, 8929 Kempsey Road.**



**Table 21: Calculated Noise Levels to R21 Frog Cottage, 8929 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	89450	380	40
Compound, camp (alternative location)	Construction	110	89430	360/670	49
	Typical	101	89430	360/670	40
	Busy period	111	89430	360/670	50
	Night	103	89430	360/670	41 <sup>1</sup>
Side track	Construction	110	90020	970	42
Drains	Typical	106	89080	110	57
Culverts	Typical	108	88750	370	49
	+Drill or concrete	109	88750	370	50
Downslope stabilisation	Drill, shotcrete	108	88750	370	49
	Worst case	110	88750	370	51
Bridge scour protection	Excavator, truck	105	88640	470	44
	+Concrete	109	88640	470	48
Pavement	Restoration	110	89080	110	61
Rehabilitation	Typical sites	106	89450	380	46
	Main compound, camp	109	89430	360	50

- 1 Estimated level in the absence of noise mitigation measures  
 Green shading Exceeds the ‘noise affected’ level outside standard construction hours  
 Blue shading Exceeds the ‘noise affected’ level within standard construction hours

Residence 21 is relatively close to an alternative location for the major compound and camp. In the absence of noise mitigation measures, this residence is expected to receive up to 41 LAeq,15min at night from combined operation of the power generators, office and dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the ‘noise affected’ level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 21 with these recommended noise mitigation measures applied.

#### 5.4.2 R22 Orange Grove Huts, 8937 Kempsey Road

This residence is located approximately 80 m east of Kempsey Road at chainage 89120, as shown in Figure 22. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 22.

**Table 22: Calculated Levels to R22 Orange Grove Huts, 8937 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	89450	340	41
Compound, camp (alternative location)	Construction	110	89430	320/630	50
	Typical	101	89430	320/630	41
	Busy period	111	89430	320/630	51
	Night	103	89430	320/630	42 <sup>1</sup>
Side track	Construction	110	90020	920	43
Drains	Typical	106	89120	80	60
Culverts	Typical	108	88750	390	48
	+Drill or concrete	109	88750	390	49
Downslope stabilisation	Drill, shotcrete	108	88750	390	48
	Worst case	110	88750	390	50
Bridge scour protection	Excavator, truck	105	88640	480	43
	+Concrete	109	88640	480	47
Pavement	Restoration	110	89120	80	64

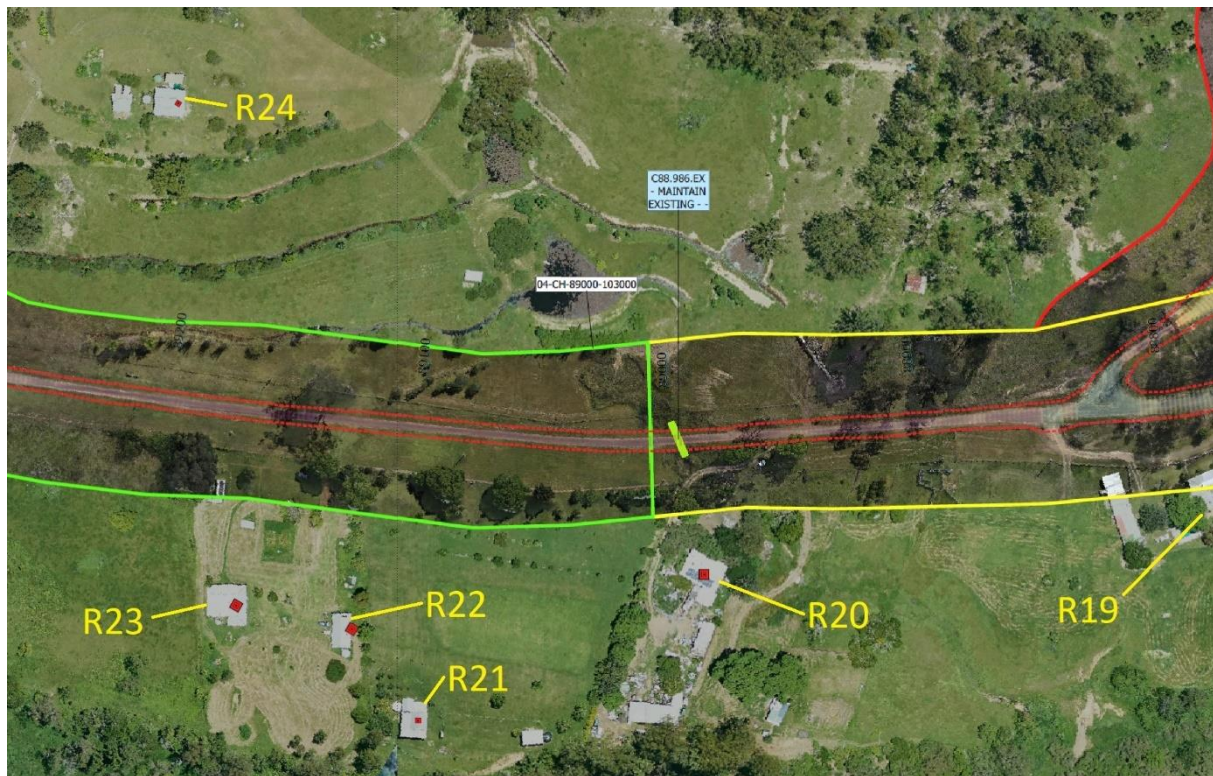
Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Rehabilitation	Typical sites	106	89450	340	47
	Main compound, camp	109	89430	320	51

1 Estimated level in the absence of noise mitigation measures

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 22: R22 Orange Grove Huts, 8937 Kempsey Road.**



Residence 22 is relatively close to an alternative location for the major compound and camp. In the absence of noise mitigation measures, this residence is expected to receive up to 42 LAeq,15min at night from combined operation of the power generators, office and dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

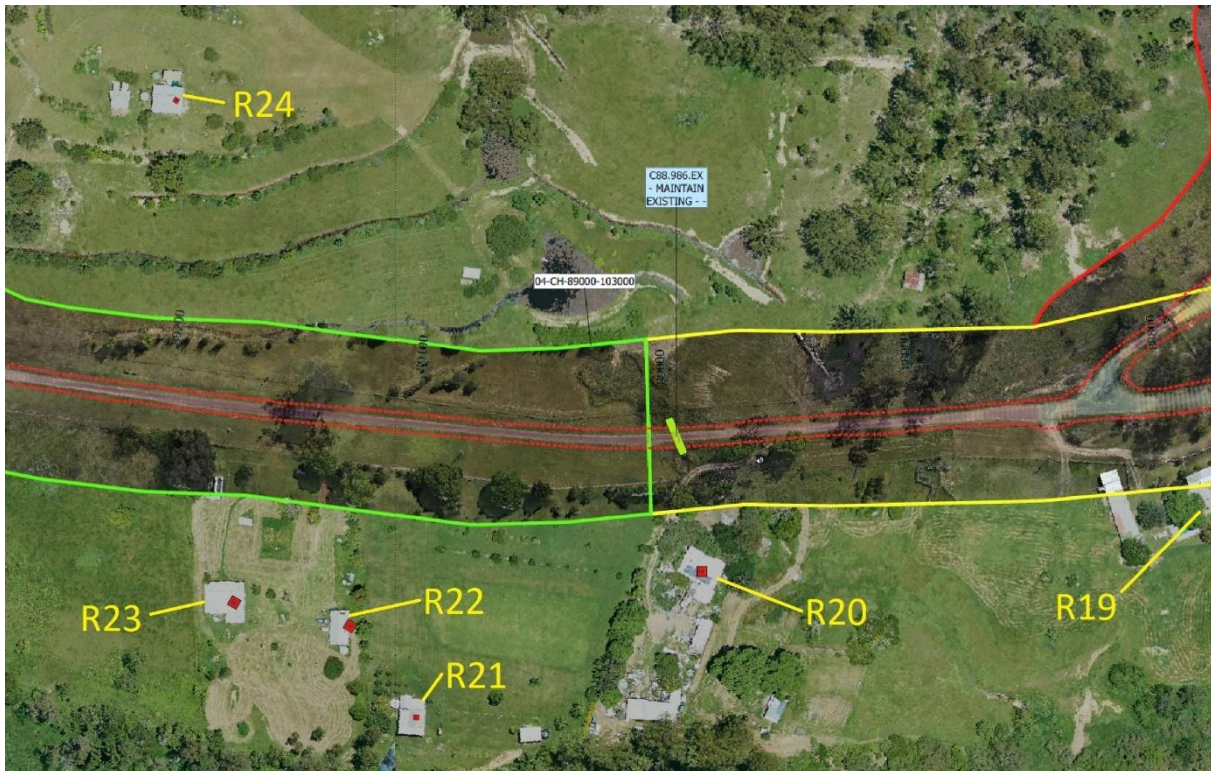
Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 22 with these recommended noise mitigation measures applied.

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

### 5.4.3 R23 Orange Grove, 8937 Kempsey Road

This residence is located approximately 70 m east of Kempsey Road at chainage 89170, as shown in Figure 23. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 23.

**Figure 23: R23 Orange Grove, 8937 Kempsey Road.**



**Table 23: Calculated Levels to R23 Orange Grove, 8937 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	89450	290	43
Compound, camp (alternative location)	Construction	110	89430	270/590	51
	Typical	101	89430	270/590	42
	Busy period	111	89430	270/590	52
	Night	103	89430	270/590	43 <sup>1</sup>
Side track	Construction	110	90020	880	43
Drains	Typical	106	89170	70	61
Culverts	Typical	108	88750	430	47
	+Drill or concrete	109	88750	430	48
Downslope stabilisation	Drill, shotcrete	108	88750	430	47
	Worst case	110	88750	430	49
Bridge scour protection	Excavator, truck	105	88640	520	43
	+Concrete	109	88640	520	47

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Pavement	Restoration	110	89170	70	65
Rehabilitation	Typical sites	106	89450	290	49
	Main compound, camp	109	89430	270	52

1 Estimated level in the absence of noise mitigation measures

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Residence 23 is relatively close to an alternative location for the major compound and camp. In the absence of noise mitigation measures, this residence is expected to receive up to 43 LAeq,15min at night from combined operation of the power generators, office and dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet the 35 LAeq,15min noise affected level at Residence 23 with these recommended noise mitigation measures applied.

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

#### 5.4.4 R24, 8920 Kempsey Road

This residence is located approximately 100 m west of Kempsey Road at chainage 89220, as shown in Figure 24. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 24.

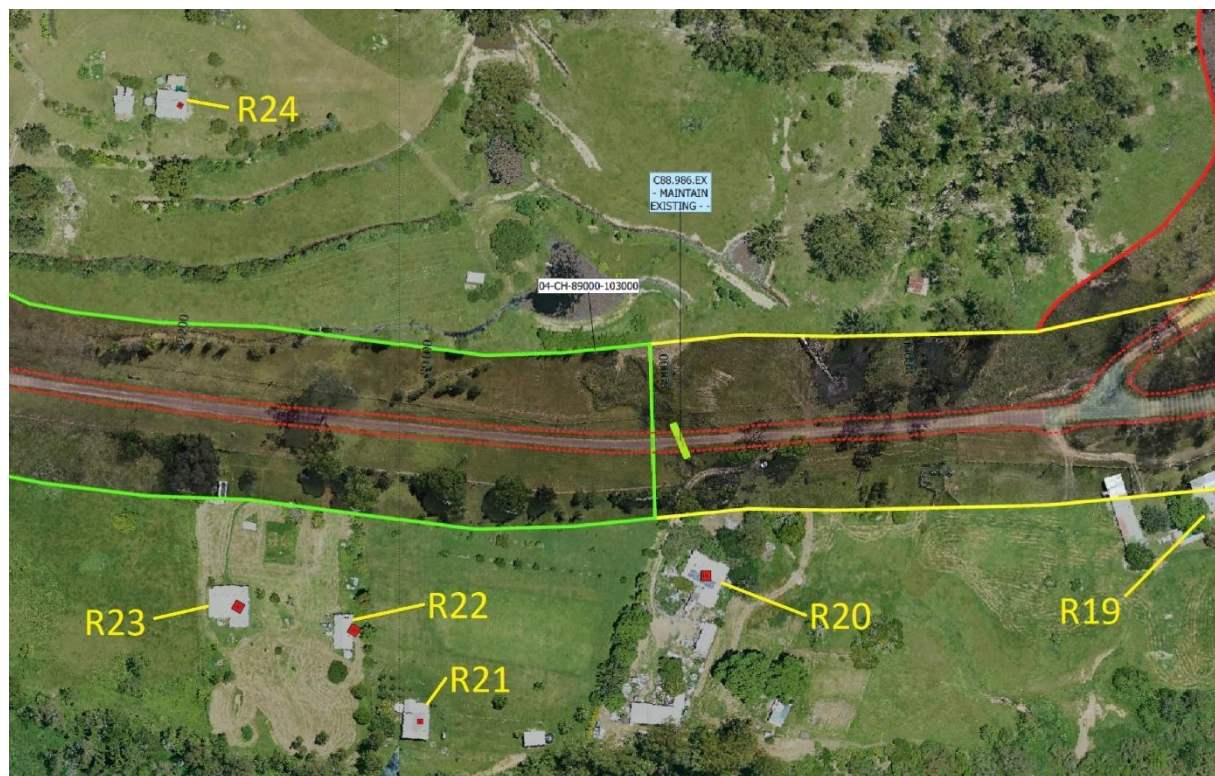
**Table 24: Calculated Levels to R24, 8920 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	89450	210	46
Compound, camp (alternative location)	Construction	110	89430	210/410	56
	Typical	101	89430	210/410	47
	Busy period	111	89430	210/410	57
	Night	103	89430	210/410	46 <sup>1</sup>
Side track	Construction	110	90020	720	45
Drains	Typical	106	89170	100	58

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Culverts	Typical	108	88750	470	47
	+Drill or concrete	109	88750	470	48
Downslope stabilisation	Drill, shotcrete	108	88750	470	47
	Worst case	110	88750	470	49
Bridge scour protection	Excavator, truck	105	88640	550	42
	+Concrete	109	88640	550	46
Pavement	Restoration	110	89220	100	62
Rehabilitation	Typical sites	106	89450	210	52
	Main compound, camp	109	89430	210	55

1 Estimated level in the absence of noise mitigation measures  
 Green shading Exceeds the 'noise affected' level outside standard construction hours  
 Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 24: R24, 8920 Kempsey Road.**



Residence 24 is relatively close to an alternative location for the major compound and camp. In the absence of noise mitigation measures, this residence is expected to receive up to 46 LAeq,15min at night from combined operation of the power generators, office and dining hall air conditioning and ventilation equipment and multiple small air conditioners on accommodation units. The expected noise level exceeds the 'noise affected' level of 35 LAeq,15min recommended in the ICNG for the night period.

The following mitigation measures are recommended to provide the lowest practical noise level from these sources at night:

- Select and install the quietest available containerised generator units;

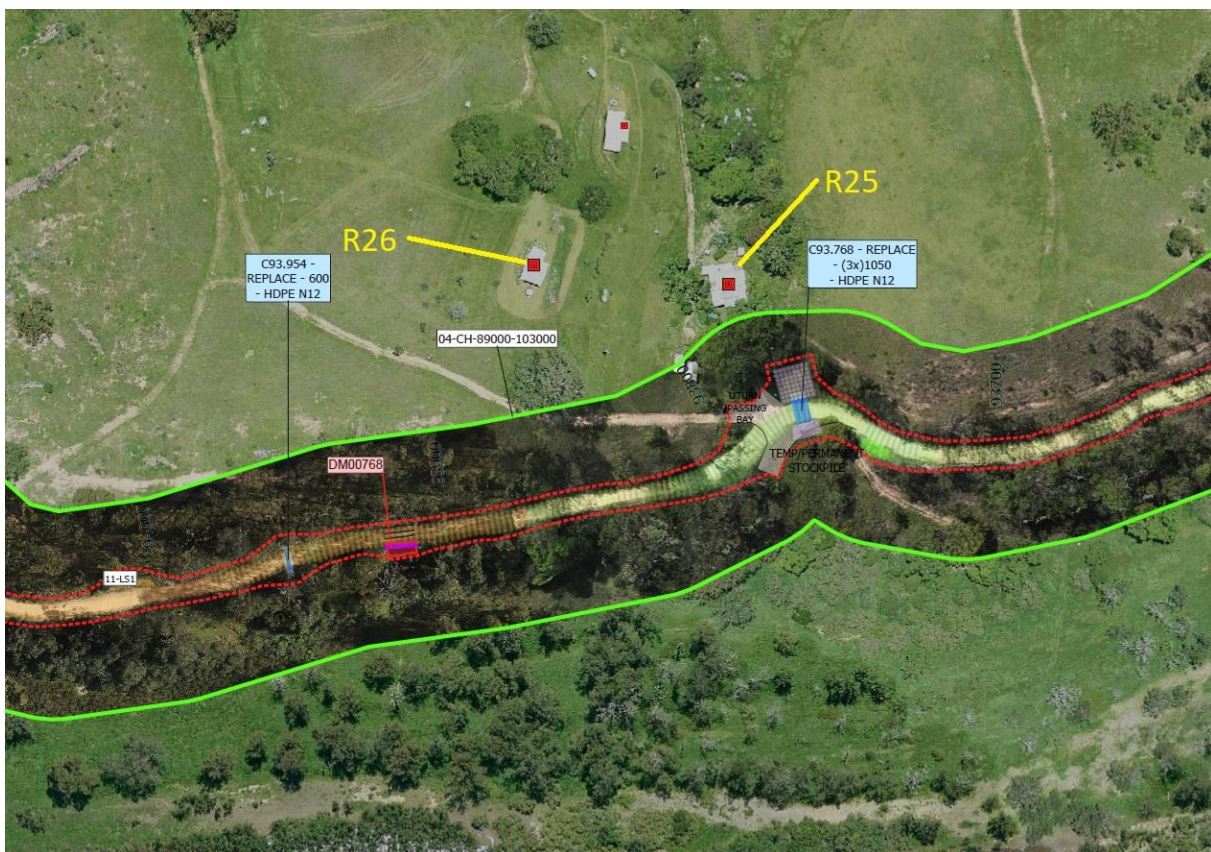
- Install generators in a location that is shielded from closest residences where possible, with the loudest side or end facing away from closest residences;
- Select and install the quietest air conditioners and ventilation systems on larger buildings such as the dining hall and main offices, and install these units on the side of each building that is shielded from closest residences; and
- Select and install the quietest available air conditioner on each accommodation unit.

Night noise levels are considered likely to meet or at least approach the 35 LAeq,15min noise affected level at Residence 24 with these recommended noise mitigation measures applied.

#### 5.4.5 R25 Riverview, 9400 Kempsey Road

This residence is located approximately 40 m north of Kempsey Road at chainage 93780, as shown in Figure 25. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 25.

**Figure 25: R25 Riverview, 9400 Kempsey Road.**



**Table 25: Calculated Levels to R25 Riverview, 9400 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	94210	360	41
	+Drill, jackhammer	110	94210	360	51
Turning/passing/laydown/stockpile	Typical	100	93790	35	61
Drains	Typical	106	93780	40	66

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Culverts	Typical	108	93770	40	68
	+Drill or concrete	109	93770	35	70
Downslope stabilisation	Drill, shotcrete	108	93770	40	68
	Worst case	110	93770	40	70
Pavement	Restoration	110	93780	40	70
Rehabilitation	Typical sites	106	93790	35	67

Green shading Exceeds the 'noise affected' level outside standard construction hours

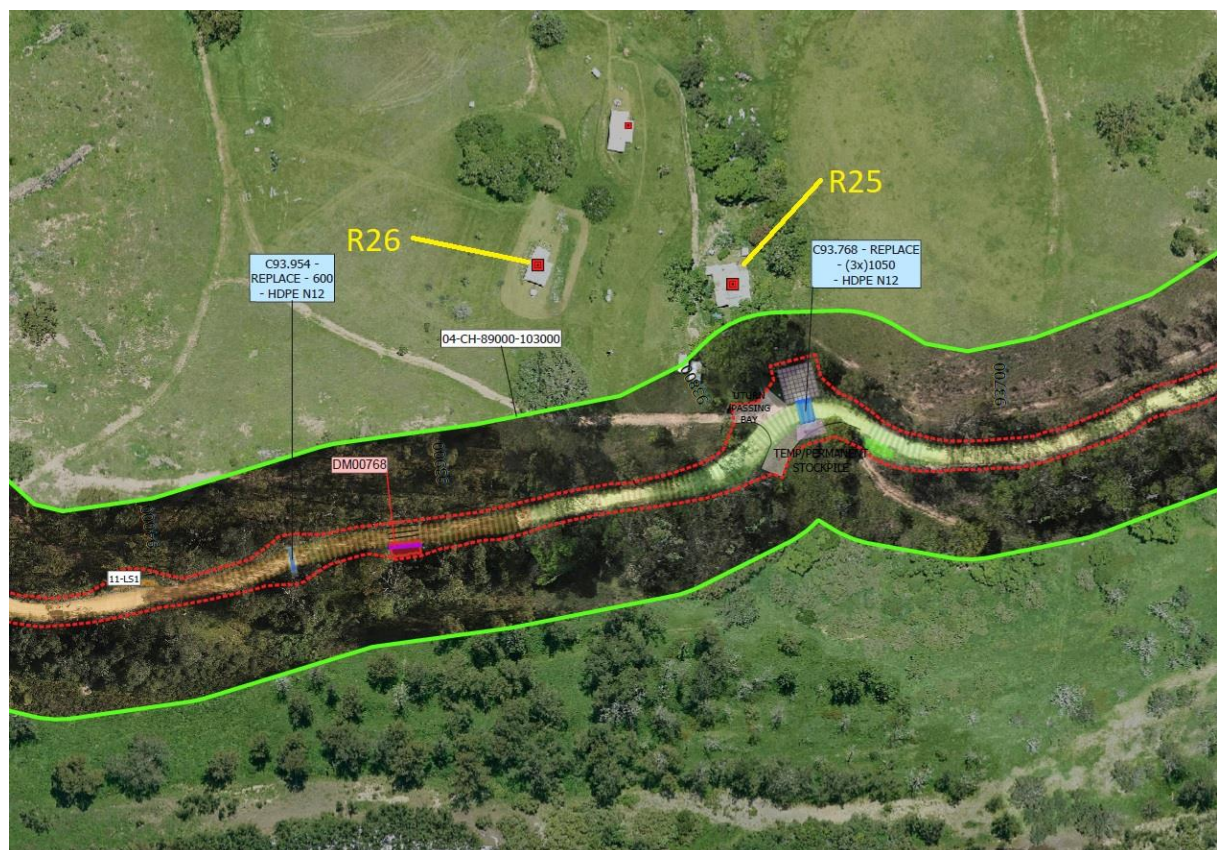
Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the culvert and pavement immediately in front of the residence.

#### 5.4.6 R26 Riverview Cabin, 9400 Kempsey Road

This residence is located approximately 80 m north of Kempsey Road at chainage 93850, as shown in Figure 26. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 26.

**Figure 26: R26 Riverview Cabin, 9400 Kempsey Road.**



**Table 26: Calculated Levels to R26 Riverview Cabin, 9400 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	94210	300	42
	+Drill, jackhammer	110	94210	300	52
Turning/passing/laydown/stockpile	Typical	100	93790	80	54
Drains	Typical	106	93850	80	60
Culverts	Typical	108	93770	100	60
	+Drill or concrete	109	93770	90	62
Downslope stabilisation	Drill, shotcrete	108	93770	100	60
	Worst case	110	93770	100	62
Pavement	Restoration	110	93850	80	64
Rehabilitation	Typical sites	106	93790	80	60

Green shading Exceeds the ‘noise affected’ level outside standard construction hours

Blue shading Exceeds the ‘noise affected’ level within standard construction hours

Residence 26 is understood to be a holiday cabin, normally let to visitors for short term stays, which is likely to be unoccupied for the duration of the project due to regular road closures and consequent access difficulties for visitors.

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence and the culvert near the residence, although vibration management recommended for Residence 25 will also control vibration levels to this residence so no additional management measures are expected to be required.

A second cabin is visible in Figure 25 further from Kempsey Road however this cabin has not been specifically assessed as it is also likely to remain vacant for the duration of the project.

#### 5.4.7 R27 Bass Lodge, 9829 Kempsey Road

This residence is located approximately 35 m north-west of Kempsey Road at chainage 98090, as shown in Figure 27. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 27.

**Table 27: Calculated Levels to R27 Bass Lodge, 9829 Kempsey Road, LAeq,15min.**

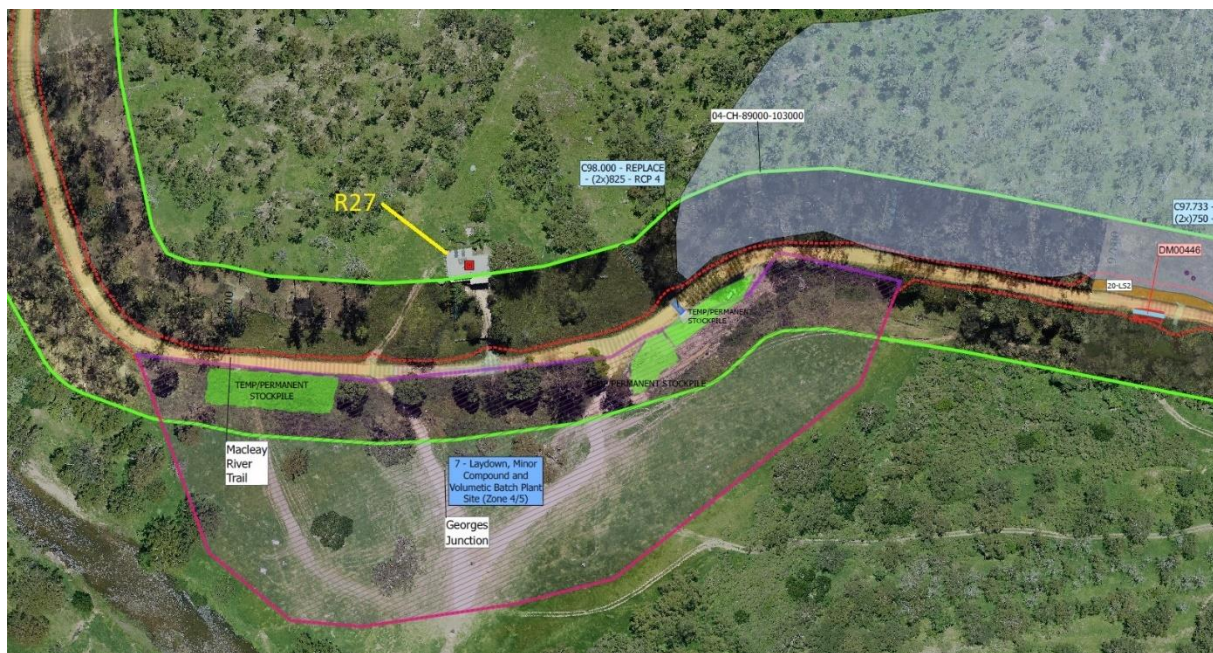
Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	97800	260	44
	+Drill, jackhammer	110	97800	260	54
Turning/passing/laydown/stockpile	Typical	100	98150	80	54
Minor compound	Construction	110	98090	50	68
	Typical	101	98090	50	59
	Busy period	111	98090	50	69
Volumetric mixing	Construction	110	98090	50	68
	Operation	108	98090	50	66
Drains	Typical	106	98090	35	67

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Culverts	Typical	108	98000	80	62
	+Drill or concrete	109	98000	80	63
Downslope stabilisation	Drill, shotcrete	108	98000	90	61
	Worst case	110	98000	90	63
Pavement	Restoration	110	98090	35	71
Rehabilitation	Typical sites	106	98150	80	60
	Minor compound	109	98090	50	67

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 27: R27 Bass Lodge, 9829 Kempsey Road.**



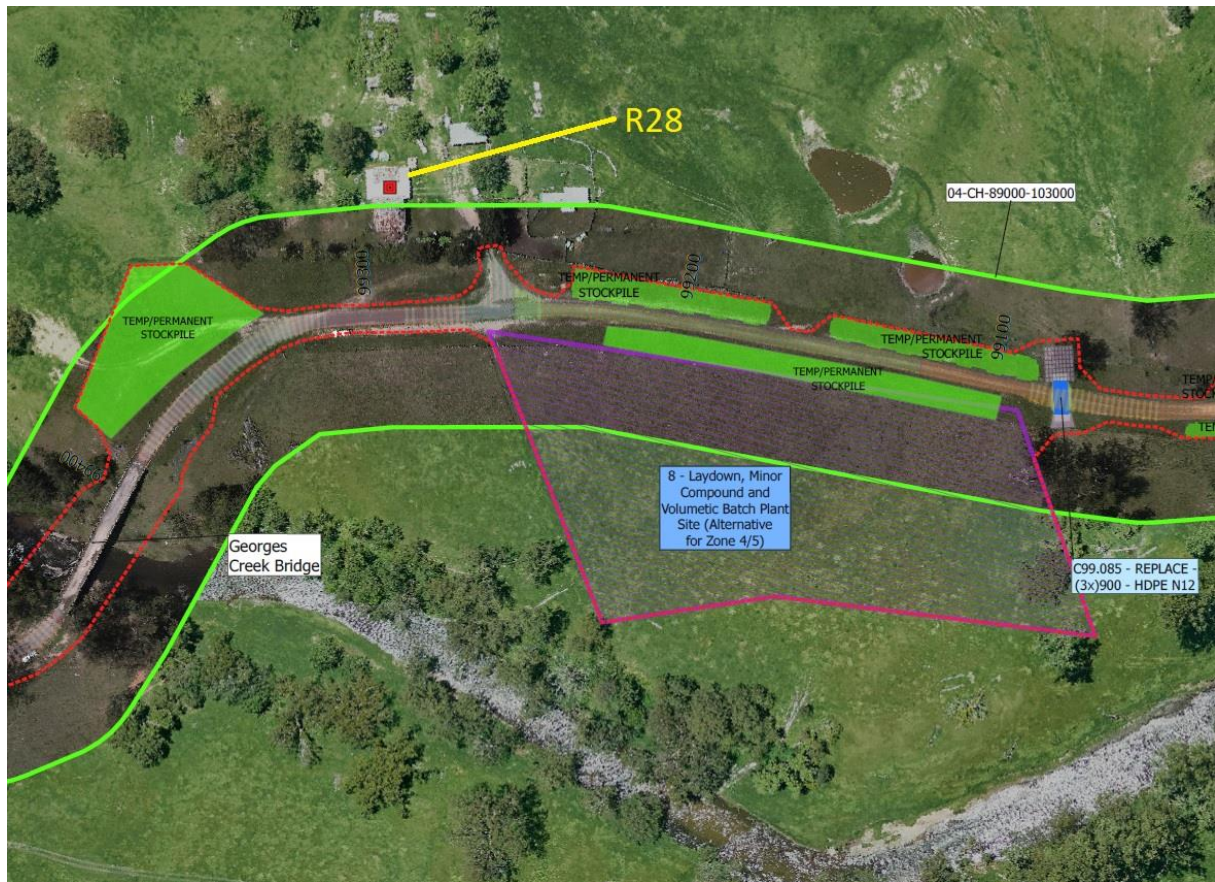
The layout of the minor compound and the location of the volumetric mixing plant should be selected to maximise the setback distance from this residence. If a generator is required for this site and the generator is expected to continue operating at night or may be started before 7 am, then the generator should also be located as far from the residence as possible to minimise night noise levels.

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

#### 5.4.8 R28, 9950 Kempsey Road

This residence is located approximately 25 m east of Kempsey Road at chainage 99290, as shown in Figure 28. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 28.

**Figure 28: R28, 9950 Kempsey Road.**



**Table 28: Calculated Levels to R28, 9950 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	99340	50	58
Minor compound (alternative location)	Construction	110	99260	50	68
	Typical	101	99260	50	59
	Busy period	111	99260	50	69
Volumetric mixing	Construction	110	99260	50	68
	Operation	108	99260	50	66
Drains	Typical	106	99290	25	70
Culverts	Typical	108	99080	200	54
	+Drill or concrete	109	99080	200	55
Downslope stabilisation	Drill, shotcrete	108	99080	200	54
	Worst case	110	99080	200	56
Bridge scour protection	Excavator, truck	105	99400	110	56
	+Concrete	109	99400	110	60
Pavement	Restoration	110	99290	35	71
Rehabilitation	Typical sites	106	99340	50	64
	Main compound, camp	109	99260	50	67

Blue shading Exceeds the 'noise affected' level within standard construction hours

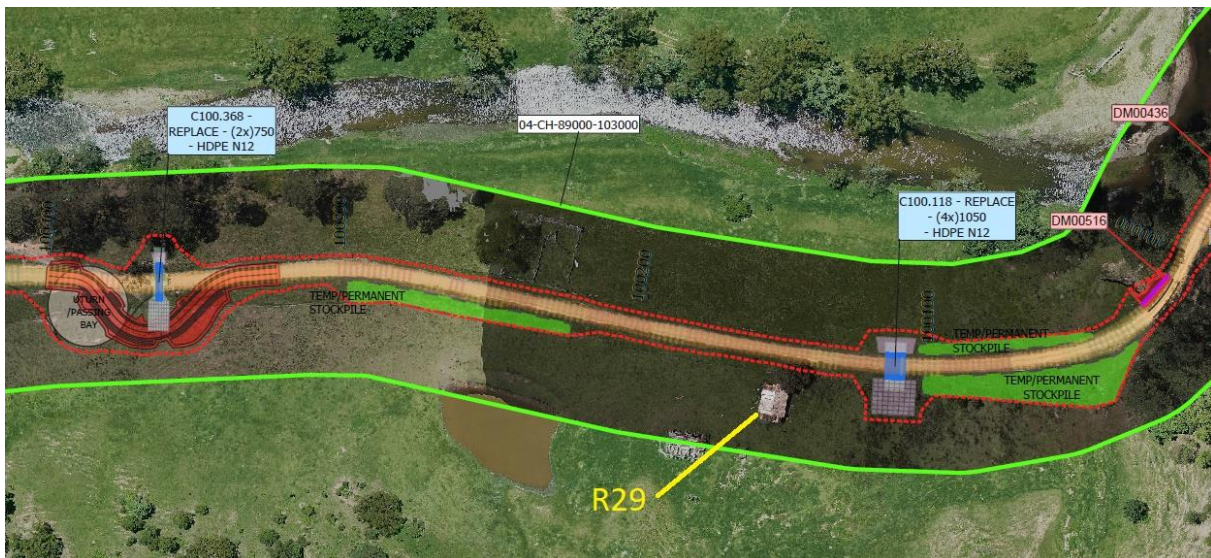
The layout of the minor compound and the location of the volumetric mixing plant should be selected to maximise the setback distance from this residence. If a generator is required for this site and the generator is expected to continue operating at night or may be started before 7 am, then the generator should also be located as far from the residence as possible to minimise night noise levels.

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

#### 5.4.9 R29 Rosewood, 10039 Kempsey Road

This residence is located approximately 10 m west of Kempsey Road at chainage 100150, as shown in Figure 29. This building is not marked as a residence in the Construction Methodology and may no longer be occupied, however it is included in this assessment in case it is still habitable and occupied. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 29.

**Figure 29: R29 Rosewood, 10039 Kempsey Road.**



**Table 29: Calculated Levels to R29 Rosewood, 10039 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	100000	150	48
	+Drill, jackhammer	110	100000	150	58
Turning/passing/laydown/stockpile	Typical	100	100100	45	59
Minor compound (alternative location)	Construction	110	99260	800	44
	Typical	101	99260	800	35
	Busy period	111	99260	800	45
Volumetric mixing	Construction	110	99260	800	44
	Operation	108	99260	800	42
Side track	Construction	110	100320	170	57
Drains	Typical	106	100150	10	78
Culverts	Typical	108	100110	30	70
	+Drill or concrete	109	100110	30	71

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Downslope stabilisation	Drill, shotcrete	108	100110	30	70
	Worst case	110	100110	30	72
Pavement	Restoration	110	100150	10	82
Rehabilitation	Typical sites	106	100100	45	65
	Minor compound	109	99260	800	43

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Orange shading Exceeds the 'highly noise affected' level

Ground vibration management is strongly recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence, given the very short distance from the road to the residence. Vibration management is also recommended while restoring the culvert near the residence.

## 5.5 Section 5, Chainage 103000 – 111700

Section 5 extends from the western end of Section 4 for a distance of 7.7 km along Kempsey Road, including 1 residence R30.

### 5.5.1 R30 Murrungi, 10550 Kempsey Road

This residence is located approximately 200 m east of Kempsey Road at chainage 105400, as shown in Figure 30. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 30.

**Table 30: Calculated Levels to R30 Murrungi, 10550 Kempsey Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Upslope stabilisation	Earthmoving	100	105530	250	44
	+Drill, jackhammer	110	105530	250	54
Turning/passing/ laydown/stockpile	Typical	100	105290	200	46
	Chainsaw, chipper	112	105290	200	58
Minor compound (alternative location)	Construction	110	105290	70	65
	Typical	101	105290	70	56
	Busy period	111	105290	70	66
Volumetric mixing (alternative location)	Construction	110	105290	70	65
	Operation	108	105290	70	63
Side track	Construction	110	103850	370	51
Drains	Typical	106	105400	200	52
Culverts	Typical	108	105460	220	53
	+Drill or concrete	109	105460	220	54
Downslope stabilisation	Drill, shotcrete	108	105460	220	53
	Worst case	110	105460	220	55
Pavement	Restoration	110	105400	200	56



**5.7.1 R31, 237 Lower Creek Road**

This residence is located approximately 50 m east of Lower Creek Road at chainage 2620, as shown in Figure 31. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 31.

**Figure 31: R31, 237 Lower Creek Road.**



**Table 31: Calculated Levels to R31, 237 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/ laydown/stockpile	Earthmoving	100	2720	120	50
Side track	Construction	110	2500	130	60
Drains	Typical	106	2620	50	64

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Culverts	Typical	108	2710	100	60
	+Drill or concrete	109	2710	100	61
Downslope stabilisation	Drill, shotcrete	108	2710	100	60
	Worst case	110	2710	100	62
Pavement	Restoration	110	2620	50	68
Rehabilitation	Typical sites	106	2720	120	56

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management may be required for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence and perhaps during restoration of the culvert near the residence.

### 5.7.2 R32, 333 Lower Creek Road

This residence is located approximately 30 m east of Lower Creek Road at chainage 3680, as shown in Figure 32. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 32.

**Figure 32: R32, 333 Lower Creek Road.**



**Table 32: Calculated Levels to R32, 333 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/ laydown/stockpile	Earthmoving	100	3120	340	41
Side track	Construction	110	4250	480	48
Drains	Typical	106	3680	30	68
Culverts	Typical	108	3050	360	49
	+Drill or concrete	109	3050	360	50

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Downslope stabilisation	Drill, shotcrete	108	3050	360	49
	Worst case	110	3050	360	51
Pavement	Restoration	110	3680	30	72
Rehabilitation	Typical sites	106	3120	340	47

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

### 5.7.3 R33, 367 Lower Creek Road

This residence is located approximately 20 m west of Lower Creek Road at chainage 3730, as shown in Figure 33. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 33.

**Figure 33: R33, 367 Lower Creek Road.**



**Table 33: Calculated Levels to R33, 367 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	3120	410	40
Side track	Construction	110	4250	450	49
Drains	Typical	106	3730	20	72
Culverts	Typical	108	3050	440	47
	+Drill or concrete	109	3050	440	48
	Drill, shotcrete	108	3050	440	47

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Downslope stabilisation	Worst case	110	3050	440	49
Pavement	Restoration	110	3730	20	76
Rehabilitation	Typical sites	106	3120	410	46

Blue shading Exceeds the 'noise affected' level within standard construction hours

Orange shading Exceeds the 'highly noise affected' level

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement immediately in front of the residence.

### 5.7.4 R34 Goolembar, 400 Lower Creek Road

This residence is located approximately 100 m east of Lower Creek Road at chainage 4120, as shown in Figure 34. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 34.

Figure 34: R34 Goolembar, 400 Lower Creek Road.



Table 34: Calculated Levels to R34 Goolembar, 400 Lower Creek Road, LAeq,15min.

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	4390	320	42
Side track	Construction	110	4250	180	57
Drains	Typical	106	4120	100	58
Culverts	Typical	108	4270	200	54

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
	+Drill or concrete	109	4270	200	55
Downslope stabilisation	Drill, shotcrete	108	4440	360	49
	Worst case	110	4440	360	51
Pavement	Restoration	110	4120	100	62
Rehabilitation	Typical sites	106	4390	320	48

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

### 5.7.5 R35, 478 Lower Creek Road

This residence is located approximately 30 m east of Lower Creek Road at chainage 4760, as shown in Figure 35. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 35.

**Table 35: Calculated Levels to R35, 478 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	4420	260	44
Side track	Construction	110	4300	380	50
Drains	Typical	106	4760	30	68
Culverts	Typical	108	4790	30	70
	+Drill or concrete	109	4790	30	71
Downslope stabilisation	Drill, shotcrete	108	4790	30	70
	Worst case	110	4790	30	72
Pavement	Restoration	110	4760	30	72
Rehabilitation	Typical sites	106	4420	260	50

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement and culvert immediately in front of the residence.

**Figure 35: R35, 478 Lower Creek Road.**



### 5.7.6 R36, 478 Lower Creek Road

This residence is located approximately 45 m south-west of Lower Creek Road at chainage 4900, as shown in Figure 36. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 36.

**Figure 36: R36, 478 Lower Creek Road.**



**Table 36: Calculated Levels to R36, 478 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	4420	260	44
Side track	Construction	110	4300	380	50
Drains	Typical	106	4900	45	65
Culverts	Typical	108	4890	45	67
	+Drill or concrete	109	4890	45	68
Downslope stabilisation	Drill, shotcrete	108	4890	40	68
	Worst case	110	4890	40	70
Pavement	Restoration	110	4900	45	69
Rehabilitation	Typical sites	106	4420	260	50

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

Ground vibration management is recommended for this residence as discussed in Section 3.6 during restoration of the pavement and culvert immediately in front of the residence.

### 5.7.7 R37, 500 Lower Creek Road

This residence is located approximately 100 m south of Lower Creek Road at chainage 5050, just beyond the project site, as shown in Figure 37. Nearest project activities, minimum setback distance from each activity and calculated noise levels at the residence are presented in Table 37.

**Table 37: Calculated Levels to R37, 500 Lower Creek Road, LAeq,15min.**

Activity	Details	Sound Power	Chainage	Distance, m	Received, LAeq,15min
Turning/passing/laydown/stockpile	Earthmoving	100	4420	340	41
Side track	Construction	110	4300	410	50
Drains	Typical	106	5000	140	55
Culverts	Typical	108	4890	240	52
	+Drill or concrete	109	4890	240	53
Downslope stabilisation	Drill, shotcrete	108	4890	240	52
	Worst case	110	4890	240	54
Pavement	Restoration	110	5000	140	59
Rehabilitation	Typical sites	106	4420	340	47

Green shading Exceeds the 'noise affected' level outside standard construction hours

Blue shading Exceeds the 'noise affected' level within standard construction hours

**Figure 37: R37, 500 Lower Creek Road.**



## 6 RECOMMENDATIONS

A number of noise and vibration control and management measures have been recommended in Section 5 of this report. This section consolidates the recommendations and provides additional information.

### 6.1 Recommended Noise Control Measures

Given the majority of residences are expected to receive noise levels over the 'noise affected' level of 45 LAeq,15min for a number of construction activities, noise control and management measures are recommended for this project.

The construction contractor should prepare and implement a construction noise management plan for the project, including but not limited to the following:

- Use of best available technology that is economically achievable for each construction task;
- Use of the quietest available equipment that is available for each task and locating that equipment appropriately, including:
  - Maintaining all equipment in good condition, with particular emphasis on noise control devices such as engine exhaust silencers, to minimise noise from each machine;
  - Replacing all tonal reverse alarms with broadband reverse alarms, and adjusting the noise level of reverse alarms to the lowest practical level to minimise noise without compromising worker safety;
  - Selecting the quietest available power generators, air conditioners and other camp and compound equipment, particularly for equipment that operates at night within audible range of a residence; and
  - Arranging the layout of camps and compounds to minimise noise to residences with particular consideration for noise sources that operate at night (generators, air conditioners) and high noise level sources (earthmoving equipment, volumetric mixing equipment and trucks).
- Management of equipment to minimise noise, including:
  - Switching diesel powered or other machines off when not being used, rather than leaving machines idling for an extended period;
  - Use of mild engine speed and power where possible, rather than full speed, to minimise engine and exhaust noise;
  - Maintaining roads, laydown areas and stockpile areas in reasonable condition where practical, to minimise noise from vehicles travelling over uneven surfaces. This particularly applies to empty dump trucks and similar machines that can produce significant impact noise;
  - Minimising travel distance for tracked vehicles such as dozers and excavators;
  - Minimising the material drop height from an excavator bucket, particularly for the first load of material being deposited into a truck, to minimise impact noise as the material lands in the truck body;
  - Avoiding and minimising vehicle movements along the road and starting other equipment before 7 am to avoid sleep disturbance for residents;
  - Avoiding audible alarms, horns and similar devices sometimes used by an excavator operator to indicate to the truck driver that the truck is loaded; and
  - Avoiding start-up horns and similar warning devices and sources within camps and compounds, particularly for early morning (7 am) starts near residences.

## 6.2 Recommended Vibration Control Measures

A number of residences are located within 50 m of the road or other work site and have the potential to receive significant ground-borne vibration. While vibration levels are not expected to cause damage to any residence, perceptible vibration usually causes concern for residents and requires careful management.

The following vibration mitigation and management measures are recommended for potential sources of significant vibration including ripping rock or operating a vibrating compactor or vibrating roller:

- For residences located 50 m to 100 m from the road or a work site, a smaller compactor or roller should be used where practical, or alternatively use a larger non-vibrating roller. For vibrating compactors and rollers, variation of the vibration speed may avoid resonance and achieve lower vibration levels at the residence where residents report excessive vibration at the usual vibrating speed of the machine; and
- For residences within 50 m of the road or a work site, a smaller compactor or roller or a larger non-vibrating roller may be required. Prior consultation with residents and vibration monitoring is recommended. Where possible, residents should be consulted and vibration levels monitored in real time as the compactor or roller begins operating or approaches the residence, to determine whether vibration levels are acceptable or to immediately stop and modify work or equipment to achieve acceptable vibration levels.

## 7 CONCLUSION

This assessment has shown the proposed Kempsey Road and Lower Creek Road reconstruction works are expected to produce a construction noise level above the 'noise affected' level recommended in relevant NSW Government construction noise policies. Noise levels above the 'noise affected' level trigger the noise management recommendations in Section 6.1 of this report to minimise impacts to residents.

Residents will generally experience significant construction noise for short time periods, typically a few days each for most residents as work is completed at the closest point to the residence, with longer time periods of lower noise level as work crews and equipment approach then recede from each residence. The limited duration of significant construction noise at each residence will limit the level of impact, notwithstanding the significant construction noise levels to residences located close to the road.

Residences near compounds, volumetric mixing sites or the main camp are likely to experience audible construction noise for a higher percentage of the time throughout the construction project. Noise control and mitigation measures have been recommended for these sites to minimise impacts to closest residents.

Vibration levels caused by compactors and vibrating rollers, and perhaps by ripping rock in some locations, are unlikely to cause damage to any residence or other structure but have the potential to cause concern to residents. Vibration mitigation and management measures, to limit vibration levels and to reassure residents regarding damage to structures, have been recommended in Section 6.2 of this report.

Predicted acoustic impacts are unlikely to be considered unacceptable at any residence, particularly considering the short term nature of any impacts and the benefits provided by the project to residents.