MARSHALL DAY Acoustics

BURNHAM QUARRY
ASSESSMENT OF NOISE EFFECTS

Rp 003 20211322 | 28 August 2023

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Project: **BURNHAM QUARRY**

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SUMMARY

Marshall Day Acoustics has been engaged to assess noise emissions from Burnham 2020 Ltd's proposed Burnham quarry. We have assessed noise generation from the development – initial site establishment, gravel extraction and processing – with a particular focus on where these activities occur at the closest points to residential properties.

Noise mitigation has been considered in the design of the proposal, with the processing plant (the loudest noise source) located towards the centre of the site. Both long-term and temporary 3 metre high noise control bunds and stockpiles will be used at the site perimeter to further mitigate quarry noise effects on adjacent residences.

For the purposes of assessing compliance with the District Plan noise provisions, quarrying activity will commence at 0700 hrs and noise emissions from the site will not comply with the Operative District Plan (ODP) permitted activity night-time noise standards for the 30 minute period until 0730 hrs when ODP daytime noise limits apply. The largest margin of excess is 10 dB. We note this non-compliance does not alter the status of the activity which is full discretionary (for reasons other than noise) when assessed against the provisions of the ODP. The activity will comply with the Partially Operative District Plan (PDP) permitted activity noise limits at all times.

In order to assess potential noise effects of the operational site activities, we have provided project noise criteria that in our opinion are appropriate for the protection of residential amenity. The noise limits are identical to those in the PDP and reflect published guidance from the World Health Organisation and New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*. Our recommended project noise limits are set out below and apply within the notional boundary of a dwelling:

- Day 0700 to 2200 hrs 55 dB $L_{Aeq(15mins)}$
- Night 2200 to 0700 hrs 45 dB $L_{Aeq(15mins)}$ and 70 dB L_{AFmax}

Our detailed noise modelling, which is conducted on a conservative basis, confirms operational activities will comply with the proposed project noise limits and, as a result, noise effects will be reasonable in the context of the receiving environment.

We note both the ODP and PDP exempt traffic on public roads from compliance with the permitted activity noise limits. However, as a discretionary activity, it is appropriate to assess the potential noise effects from trucks. Moreover, we understand the proposed numbers of trucks will exceed the permitted activity standards in the ODP and PDP vehicle crossing rule. As a result, we have considered amenity effects on surrounding residents.

Trucks will travel to and from the site entrance on Aylesbury Road to State Highway 1. Existing traffic volumes are low on Aylesbury Road (north of Two Chain Road) and therefore there will be an adverse noise effect due to the increase in traffic noise, which, without mitigation, would be perceived as a slight to significant change in noise level during the day at existing dwellings. Truck noise effects can be mitigated with the provision of conventional noise control measures but these would need to be agreed with the affected landowner. Truck noise effects will be negligible to moderate at Burnham Camp which currently experiences elevated levels of traffic noise during the day.

Our assessment shows that construction activities, such as the implementation of noise control bunds, will comply with the applicable noise limits from New Zealand Standard NZS 6803: 1999 *Acoustics - Construction Noise*. Construction noise effects will be reasonable.

There will be no significant sources of vibration on site and we expect vibration effects to be negligible.

TABLE OF CONTENTS

1.0 INTRODUCTION

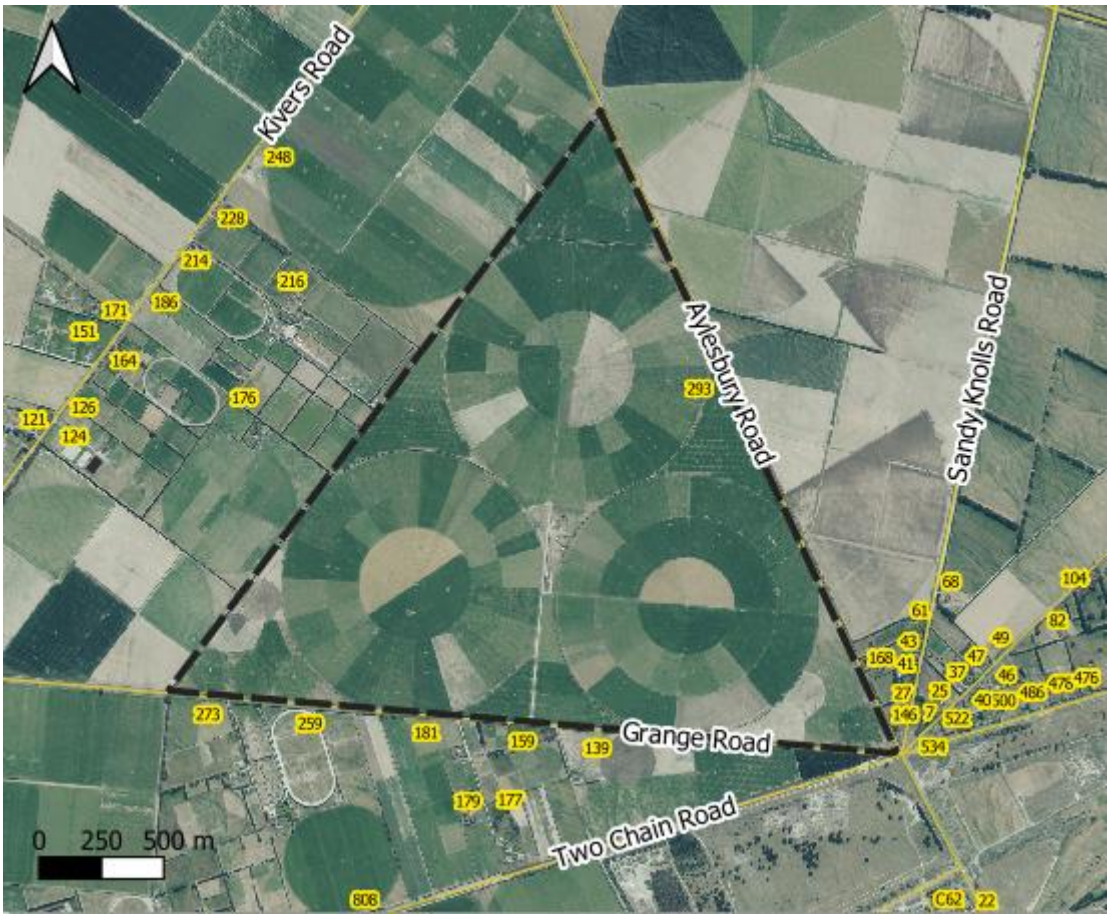
Marshall Day Acoustics has been engaged by Burnham 2020 Ltd to assess the potential noise effects associated with its proposed new quarry in Burnham, Christchurch. The quarry, to be known as "Burnham Quarry", will be located between Grange Road and Aylesbury Road, as shown in Figure 1.

This report describes:

- the proposed activity with respect to noise emissions;
- the nearest noise sensitive receivers and their existing noise environment;
- the applicable District Plan permitted activity standards and relevant published guidance;
- predicted noise levels over the lifespan of the quarry; and
- the potential adverse noise effects associated with the proposed activity.

A glossary of acoustical terminology used in this report is provided for reference in Appendix A.

Figure 1: Aerial view of the proposed site and nearest dwellings



2.0 PROPOSED ACTIVITY DESCRIPTION

Burnham 2020 Ltd is proposing a quarry with an expected lifetime of over 60 years. The proposal is described in detail in the land use consent application and in the following sections we focus on those aspects that have a bearing on noise generation.

The site will be excavated in phases with noise emissions changing with each phase. Figure 3 shows the overall landscape strategy for the proposal during each phase of extraction. From a noise perspective, the greatest potential noise effects are likely during Phases 1 to 4 which will take approximately the first 15 years. Initially, excavation will begin towards the central area of the site to create the processing area and stockyards, before proceeding clockwise around each irrigation pivot and clockwise around the site, starting at the southeast pivot. Extraction of Phase 13 is expected to occur between Years 56 to 60, noting that actual timings are dependent on demand for aggregate and are subject to change.

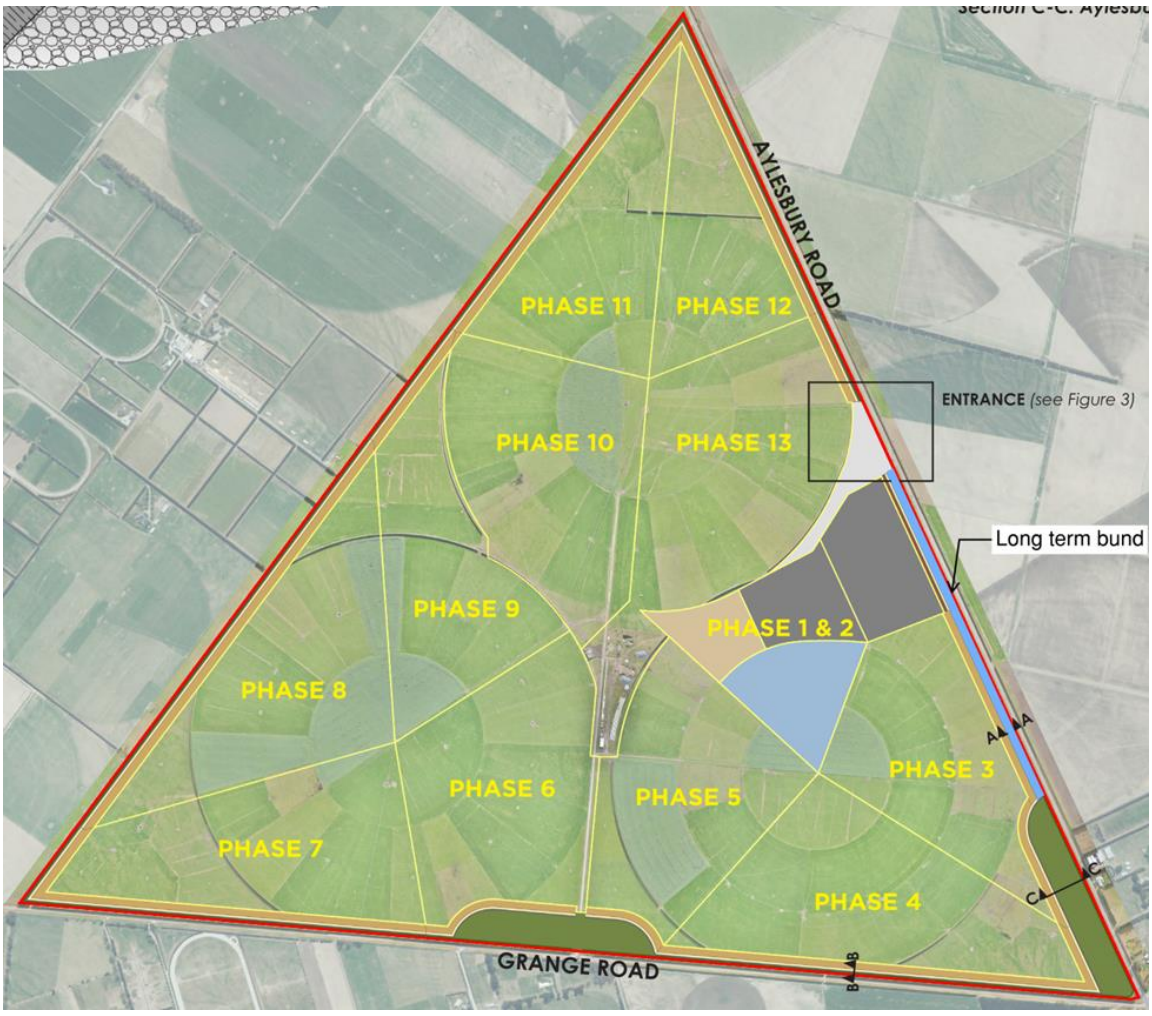
In the following sections, we discuss the key noise-related features of each phase. However, there are several aspects common to all phases and these are:

- A permanent 3 metre high noise control bund is proposed along part of the eastern site boundary as indicated in Figure 3.
- A 3 metre high stockpile will progressively be installed around the remainder of the site as extraction progresses. This stockpile will serve to act as a noise control bund.
- A 100 metre extraction setback from the property boundaries of existing dwellings will be established on Aylesbury and Grange Roads.
- A 17.5 metre extraction set back from the site boundary will be established for all other areas.
- Extraction will occur at a depth of approximately 10 metres meaning that the "working face" will act as an effective noise barrier for mobile equipment winning gravel. This is significant from a noise generation perspective as it means that noise sources are always screened from receivers by the edge of the pit. An example of this is shown in Figure 2. (As we discuss in Section 5.0, we have conservatively modelled the excavation depth as 8 metres.)

Figure 2: Example of loader activity at edge of pit

- Processing plant, loadout and stockyards will also be located on the floor of the excavated area approximately 10 metres below existing ground level.

Figure 3: Site layout and phasing [image: Boffa Miskell]



2.1 Site Establishment

On-site activities will commence by establishing the quarry entrance, site office, amenities, parking, and weighbridge areas. This will involve stripping overburden and constructing the amenities and services. Stripped overburden will be utilised for bunds along the site boundary.

Once the site amenities and services are completed, topsoil and overburden will be stripped from the future production zone and primary and secondary stockyards. The stripped material will be used to construct screening bunds around the stockyard area and permanent bunds along Aylesbury Road. Excess topsoil stripped from these areas will be stockpiled and used for rehabilitation as the extraction progresses.

Mobile processing equipment will be used during the site establishment and may be located at existing ground level.

2.2 Extraction

After the site establishment, extraction will continue from the pit floor at approximately 10 metres below ground level, advancing towards the closest receivers up to 17.5 metres from the site boundary.

Initially, the quarry will use standard extraction machinery – excavators, wheel loaders and trucks. However, throughout the quarry's life the equipment is likely to change with further advances in technology.

Trucks will be used to transport the extracted material from the active extraction area to the production zone. The Applicant is investigating using overland conveyors in future to supplement or replace haulage by trucks.

Temporary edge treatment stockpiles will be constructed when excavation is within 200m of a boundary and may be constructed up to a year in advance. Once all excavation within 200m is complete the stockpile will be used as topsoil for the battered edge of the pit.

2.3 Processing

All processing will take place in the production zone using a combination of fixed and mobile plant. Where possible, materials will be conveyed to the stockyard for direct loadout and some stockpiling or loadout may occur in the production zone. We have assumed that trucks will be used to transport material from the extraction zone to the stockyard. If conveyors are used, noise levels will be less.

The fixed plant configuration will be finalised closer to the start of operations to enable the adoption of the most appropriate technology. We understand the plant will be capable of crushing, screening, and washing aggregate extracted from the site and incorporating recycled aggregate alternatives into the finished products.

Mobile processing equipment will be used in the production zone to supplement the fixed plant production as necessary. It will use the same infeed and stockpile methodology as the fixed processing plant.

No crushing or washing of products will occur in the primary and secondary stockyard. In both stockyards materials will be moved and stockpiled directly from the production zone and then loaded out into road trucks. In the primary stockyard only, some materials may be wet or dry screened and/or combined with other products. All screens in the primary stockyard will be enclosed.

2.4 Heavy Vehicle Movements on Public Roads

Burnham 2020 Ltd has provided indicative truck movements for the project as set out in Table 1. Trucks will travel to and from the site via Aylesbury Road to State Highway 1.

Table 1: Heavy vehicle movement generation forecasts

Daily (Movements per day)		Peak Hour (Movements per hour)	
Busiest Day (Proposed Consented Limit)	**Average (40% of Busiest Day)**	**Busiest Hour (15% of Busiest Day)**	**Typical (10% of Average Day)**
750	300	112	30

On up to 30 occasions per year, the applicant is proposing 10 truck movements per hour between 0500 and 0700 hrs which is considered night-time in the District Plan. We discuss noise generation from truck movements in Section 9.0.

2.5 Hours of Operation

Burnham 2020 Ltd has supplied the following proposed hours of operation and associated activities set out in Table 2.

Table 2: Hours of operation

When			Proposed activity
At all times			Environmental mitigations (including dust control), light vehicle movements into and on site, operation of site office, site security and light maintenance
Early Morning	Monday to Saturday on up to 30 times per annum, excluding Public Holidays.	0500 to 0700	Loadout and access / egress of trucks operated by the quarry operator. (10 truck movements per hour).
	Sundays on up to 15 times per annum, excluding Public Holidays.	0500 to 0700	Loadout and access / egress of trucks operated by the quarry operator. (10 truck movements per hour)
Morning	Monday to Saturday, excluding Public Holidays.	0600 to 0700	Rehabilitation and movement of vehicles within site associated with that activity. Site pre-startup including operational warmup of on-site plant
Daytime		0700 to 2000	Full range of production activities within current operational area and/or primary and secondary stockyard

As described in Table 2, the production zone and stockyards will operate from 0700-2000 hours Monday to Saturday, while the following activities may take place at any time on any day:

- Environmental mitigations such as dust control
- Use of the site office
- Plant and equipment maintenance
- Light vehicle movements into and within the site

2.6 Light Vehicle Movements

In addition to the heavy traffic discussed above, we anticipate there will be light vehicle movements to and from the site each day. We expect the number of light vehicle movements will be low compared to the associated heavy traffic and existing traffic patterns on local roads. As a result, their noise generation will be negligible in the context of the project. We have therefore not discussed light traffic further in this report.

2.7 Rehabilitation

Excavated areas that are no longer active quarry areas will be progressively rehabilitated as required to enable productive use of the land. Edges will be battered to a maximum of 2:1. Rehabilitation of the pit floor will generally use soils from areas being actively stripped and the ground will be returned to pasture. For our assessment we have assumed that any silts required for rehabilitation will either be transported by trucks or earthworks machinery from the silt management zone.

3.0 EXISTING NOISE ENVIRONMENT

The proposed Burnham Quarry site is within the Selwyn District and both the site and surrounding properties have a rural zoning in both the Operative and Partially Operative District Plans. We discuss the underlying zoning and applicable noise limits further in Section 4.0.

Most of the land surrounding the site is under agricultural use with dwellings clustered near the Aylesbury Road and Two Chain Road intersection and further east along Two Chain Road. There are also dwellings on Kivers Road and south of the site on Grange Road.

The Selwyn Equestrian Centre is situated on Kivers Road approximately 500 metres from the site boundary. Burnham Military Camp is directly south of the Aylesbury Road and Grange Road intersection.

3.1 Measurement Locations

In May 2022 and July 2023 we measured the ambient noise levels at 6 different locations in the vicinity of the proposed quarry with the aim of establishing the existing noise levels at and near the proposed site. Figure 5 shows the measurement locations in relation to the site and the nearest dwellings, which are described in Table 3.

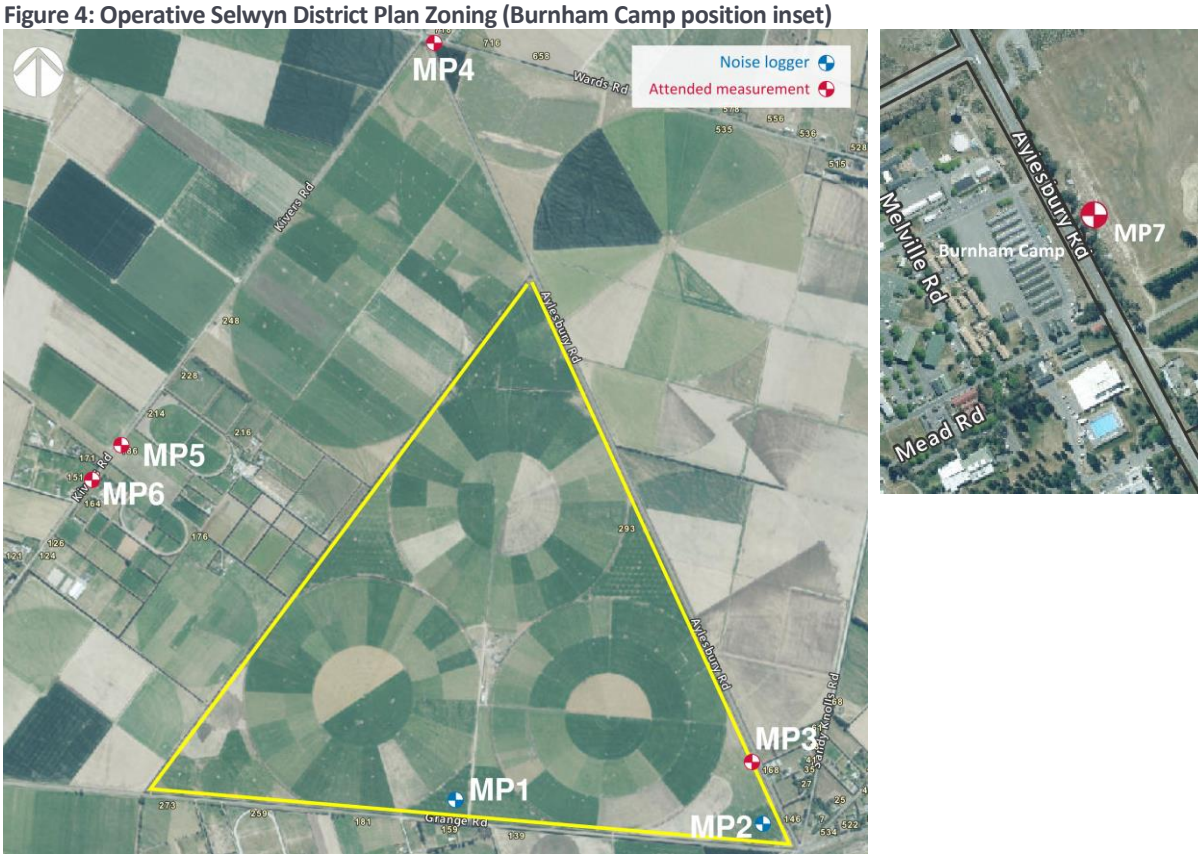
Table 3: Noise measurement location description

Ref	Location	Description
Unattended long duration logging		
MP1	Opposite 159 Grange Rd	Thursday 19 – Friday 27 May 2022 The position is the same distance from Grange Rd as the dwelling at 159 which is the closest dwelling to the south of the proposed site. Traffic on Grange Rd is the dominant noise source at the site.
MP2	Opposite 146 Aylesbury Rd	Friday 27 May – Friday 10 June 2022 The position is the same distance from Aylesbury Rd as the dwelling at 146 and is representative of the noise experienced by several dwellings along Sandy Knolls and Kerrs Roads which are the closest to proposed excavation in the south-east of the site. Traffic noise on Aylesbury, Two Chain and Grange Roads are dominant.
Attended short duration measurements – May 2022 and July 2023		
MP3	Aylesbury Road	Located approximately an equivalent distance from Aylesbury Road as the dwelling façade at 168.
MP4	Wards / Aylesbury Rd intersection	Representative of ambient noise environment in the vicinity of 718 Wards Road.
MP5 and MP6	Kivers Road	Representative of ambient noise environment in the vicinity of dwellings along Kivers Road.
MP7	Burnham Camp	Representative of ambient noise environment – measured at 7 metres from Aylesbury Road and corrected for distance to nearest Camp buildings.

All measurements were undertaken in general accordance with New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound*. Further details of the attended surveys and equipment are provided in Section C1.

Some road construction was occurring on Aylesbury Road south of the Grange Road intersection during these surveys. We consider that the survey positions were not generally significantly affected by the construction noise however, there may have been reduced traffic and therefore lower ambient noise levels overall.

Figure 4: Operative Selwyn District Plan Zoning (Burnham Camp position inset)



3.2 Measured noise levels – MP1 and MP2

Table 4 shows the measured average noise levels of the day and night-time periods, adjusted for adverse weather, from the long-term logging at positions 1 and 2. Figure 5 and Figure 6 show the average and daily variation in noise levels for MP1 and MP2 respectively.

At both locations local traffic movements were the dominant noise source along with natural environment sounds including wind generated leaf rustle and birdsong. Distant traffic on SH1 was also audible.

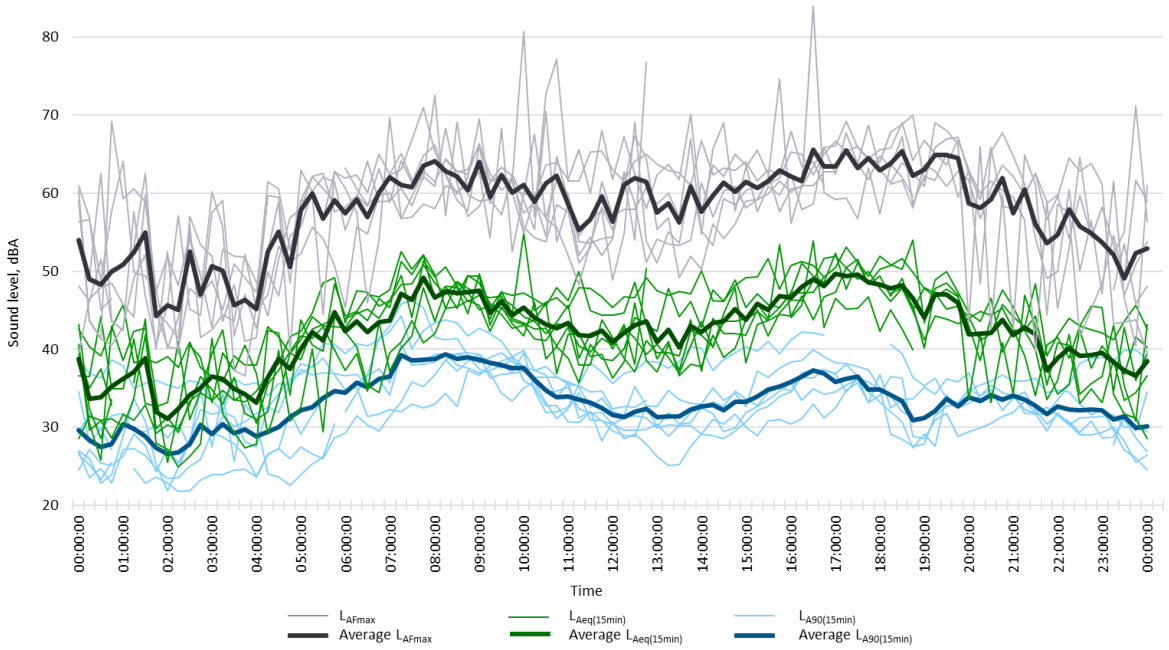
A plot of the noise levels throughout the logging periods is provided in Appendix C2.

The measured short term noise levels are shown in Table 5.

Table 4: Long term noise survey results

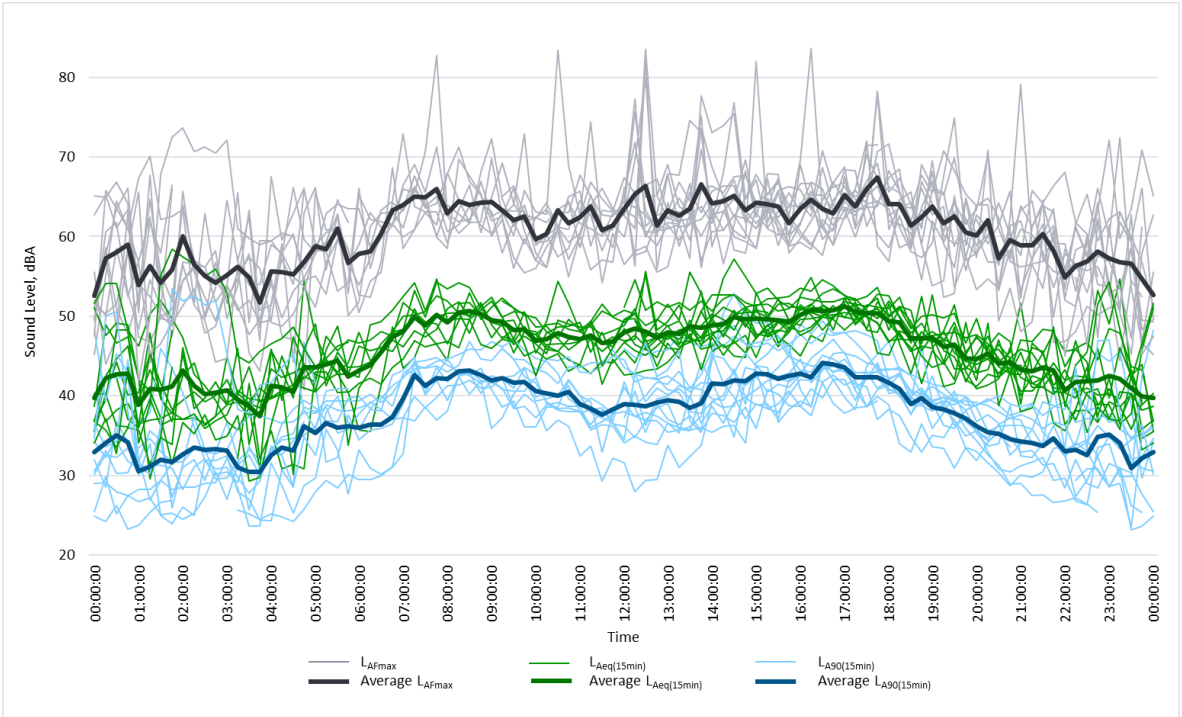
Period	MP1 average noise level, dB			MP2 average noise levels, dB		
	L_{Aeq}	L_{A10}	L_{A90}	L_{Aeq}	L_{A10}	L_{A90}
Day (0700-2200)	47	48	35	49	51	40
Night (2200-0700)	41	39	31	45	43	33

Figure 5: Position MP1 Grange Road – Average and daily variation of measured noise levels



Existing daytime noise levels at MP1 are 47 dB L_{Aeq} on average but vary over the course of the day. Passing traffic increases the noise levels by 10 dB between 0500 and 0800 hrs when a noise level of 49 dB L_{Aeq} is achieved before reducing to low 40's dB during the early afternoon. A second traffic noise peak of around 50 dB L_{Aeq} is achieved at 1700 hrs. Noise levels reduce steadily to around 40 dB L_{Aeq} at 2200 hrs.

Figure 6: Position MP2 Aylesbury Road - Average and daily variation of measured noise levels



The greater number of vehicle movements that passed this position mean that noise levels are slightly higher than MP1 and also show less variability during the daytime period. Noise levels begin

to increase at 0500 to a high of 50 dB L_{Aeq} at 0800 and 1700 hrs. During the early afternoon, noise levels are in the mid to high 40s dB L_{Aeq}.

3.3 Attended noise measurements – MP3 to MP7

Table 5 provides the measured noise levels at MP3 to MP7.

Table 5: Attended survey measurements

Position[A]	Approximate Location	Start time	Measured Noise Level, dB*			
			L_{Aeq}	L_{A10}	L_{a90}	L_{AFmax}
MP3	Aylesbury Road	12:05	63	54	39	89
		13:30	62	60	38	83
		15:00	61	56	38	82
MP3 arithmetic average			*62*	*57*	*38*	*85*
MP4	Aylesbury & Wards Rd intersection	12:11[B]	61	64	51	79
		14:57	61	63	42	77
		15:58	62	65	50	79
MP4 arithmetic average			*61*	*64*	*49*	*78*
MP5	Kivers Road	14:35	47	46	33	70
		16:18	44	48	36	59
MP6	Kivers Road	12:29	60	54	46	85
MP5 and MP6 arithmetic average			*56*	*51*	*42*	*71*
MP7	Burnham Camp[C]	14:30	64	67	51	83
		15:35	64	68	49	79
MP7 arithmetic average			*64*	*68*	*50*	*81*

[A] As shown in Figure 5

[B] All measurement durations are 15 minutes, aside from MP4 (12:11) which was cut short after 11 min

[C] The measured traffic noise level represented by the L_{Aeq} will reduce by approximately 9 dB at nearest Camp Buildings at 50 metres

Noise sources at these locations are similar to MP1 and MP2 in that passing vehicles dominate the noise environment with natural environment sounds audible in the lulls between traffic.

MP3 was selected to represent the existing traffic noise environment at 168 Aylesbury Road. As a result, noise levels are notably higher than the data collected at position MP2 which is further from the road – daytime noise levels are 62 dB L_{Aeq} on average compared with 50 dB L_{Aeq}. MP4 also experiences elevated traffic noise levels during the day – 61 dB L_{Aeq} on average.

Our site observations at MP5 and MP6 are that wind generated foliage noise was responsible for significant environmental noise levels and was not significantly affected by occasional passing traffic. Noise emissions at MP5 include local traffic and farm machinery in adjacent fields.

At MP7 Burnham Camp, traffic is the dominant noise source. Once corrected for distance, we estimate the daytime noise level at the closest Camp buildings to the road will be in the order of 55 dB L_{Aeq}.

4.0 NOISE ASSESSMENT CRITERIA

Below we discuss the applicable District Plan permitted activity noise standards. As the proposed activity is fully discretionary, it is appropriate for us to perform an assessment of noise effects and have therefore considered a range of relevant published guidance which we discuss below.

4.1 Selwyn Operative District Plan

The site and immediate surrounds are zoned rural in the Operative District Plan.

Noise

The proposed quarry is located in the Rural (Outer Plains) Zone of the Operative Selwyn District Plan. The permitted activity noise limits for the Rural Zone are reproduced in Table 6 below, from Table C9.3 of Rule 9.16.1. These limits are assessed at *"the notional boundary[1] of any dwelling, rest home, hospital, or classroom in any education facility except where that dwelling, rest home, hospital or classroom is located within a living zone".*

Table 6: Operative Selwyn District Plan noise limits for rural areas

Time Period	Noise Limit
Day – 0730 to 2000 hours	60 dB L_{A10}
	85 dB L_{Amax}
Night – 2001 to 0729 hours	45 dB L_{A10}
	70 dB L_{Amax}

Also of relevance to this application is Rule 9.16.6 which states:

> *Rule 9.16.1 does not apply to the following activities:*
>
> > *Rule 9.16.6.1 Noise from any motor vehicle or any mobile machinery (including farm machinery and stationary equipment not fixed to the ground).*

This exemption is commonly applied to mobile vehicles on quarry sites within the Selwyn District.

We note the ODP provides an exemption from the noise standards for construction as a temporary activity for a period of up to 12 months (Rule 9.16.6.3).

Vibration

Rule 9.17.1.2 provides a permitted activity standard for activities generating vibration.

> *9.17.1.2 Except for blasting, any activity which involves vibration from any other source complies with New Zealand Standard 2631:1985-89 Parts 1-3*

We note that blasting is not proposed as part of the activity.

Traffic

With reference to Rule 9.16.6.1 above, the permitted activity noise limits do not apply to traffic. However, we understand the proposed number of trucks will exceed the permitted activity standards set out in Rule 9.13 and, as a result, we are required to consider Rule 9.13.2.2:

> *Any potential adverse effects of traffic on the amenity values of surrounding residents and on other uses of the road, including (but not limited to) stock droving;*

[1] "Notional Boundary" means a line 20 metres from any side of a residential unit or other building used for a noise sensitive activity, or the legal boundary where this is closer to such a building.

4.2 Partially Operative District Plan (PDP)

Noise

Decisions were made on the proposed District Plan on 19 August 2023 and these provisions have legal effect.

Under the PDP, Burnham Quarry and the adjoining properties are in the General Rural Zone (GRUZ).

The proposed noise limits, where both the activity and the site receiving noise is in the General Rural Zone, from Rule NOISE-REQ1 – Table 5, are reproduced in Table 7 below. These limits are assessed *"at the notional boundary of any noise sensitive activity within any site receiving noise"*.

Table 7: PDP General rural zone notional boundary noise limits

Time Period	Noise Limit
Day – 0700 to 2200	55 dB L_{Aeq}
Night – 2200 to 0700	45 dB L_{Aeq}
	70 dB L_{Afmax}

The PDP provides permitted activity status to traffic on roads under Rule NOISE-R1:

3. *Traffic and rail noise generated within a land transport corridor. This does not apply to the testing (when stationary), maintenance, loading, or unloading of trains*

We understand the proposal will exceed the permitted activity trip generation under Rule TRAN-R4 Vehicle Crossings, and discretion is exercised against TRAN-MAT2 which, for all zones, requires consideration of:

1. *Any effects on the ease and safety of vehicle manoeuvring.*
2. *Whether the boundaries of a site support the formation of the vehicle crossing or accessway.*
3. *Whether the site can gain access from another road that is not a State Highway or Arterial Road listed in APP2 – State Highway, Arterial and Collector Road Classifications List.*
4. *The design and location of the vehicle crossing or accessway.*
5. *The anticipated number and type of vehicles, cycles, pedestrians or stock movements.*
6. *Any visual effects on road design and amenity values from not forming the vehicle crossing or accessway to the specified standards.*

Under TRAN-MAT2.6, potential adverse noise effects would typically be considered under the broad description of "amenity values". However, because of the large separation distance between the site's vehicle crossing and nearest noise sensitive locations, we expect the vehicle crossing will result in minimal adverse effects and have not considered this aspect further.

Construction Noise and Vibration

The proposed erection of temporary stockpiles and noise control bunds at the boundary would typically be assessed as construction noise. The applicable PDP construction noise limits are set out in NOISE-REQ2 and essentially replicate the provisions set out in New Zealand Standard NZS 6803: 1999 *Acoustics - Construction Noise*.

Whilst we do not expect the proposed activity to generate any significant vibration on site, we note Rule NOISE R-14 provides permitted activity standards for vibration and provides limits in NOISE-

TABLE4 - Vibration Thresholds. The limits are based on German Standard DIN 4150-3:2016 *Vibrations in buildings – Part 3: Effects on structures* which is in common use in New Zealand.

4.3 Other Guidance

4.3.1 National Environmental Noise Standards

The ODP requires noise to be measured and assessed in accordance with New Zealand Standard NZS 6801:1999 *Acoustics – Measurement of environmental sound* and NZS 6802:1991 *Assessment of environmental sound*.

The PDP and current industry best practice refer to the newer versions of these standards; NZS 6801:2008 *Acoustics – Measurement of environmental sound* and NZS 6802:2008 *Acoustics - Environmental Noise.*

NZS 6802:2008 recommends the following noise limits as the desirable upper noise limits of sound exposure at or within the boundary of any residential land use. These are included in NZS 6802 to guide territorial authorities in the development of local noise criteria, but it notes that the inclusion of an evening period and the hours of application are a matter for the local authority.

- Daytime – 55 dB $L_{Aeq(15\ min)}$
- Evening – 50 dB $L_{Aeq\ (15\ min)}$
- Night-time – 45 dB $L_{Aeq\ (15\ min)}$ and 75 dB L_{AFmax}

These values are consistent with the World Health Organization's Guidelines for Community Noise – discussed further in Section 4.3.2

4.3.2 International Guidance

The World Health Organisation's (WHO) Guidelines for Community Noise[2] is the key international guidance for environmental noise. This is commonly used in New Zealand as it discusses the health impacts of environmental noise and provides guideline values for the protection of health and sleep in various scenarios. The values that represent the onset of health effects in the general population for certain scenarios are reproduced below in Table 8.

Table 8: WHO Guideline Values for community noise in specific environments

Environment	Health effect(s)	dB L_{Aeq}	Time base	dB L_{AFmax}
Outdoor living area	Serious annoyance (daytime and evening)	55	16 hours	-
	Moderate annoyance (daytime and evening)	50	16 hours	-
Outside bedrooms	Sleep disturbance, window open	45	8 hours	60
Dwelling indoors	Speech intelligibility and moderate annoyance (daytime and evening)	35	16 hours	-
Inside bedrooms	Sleep disturbance (night-time)	30	hours	45

4.4 Recommended Assessment Criteria

In the following sections we assess the proposed activity's noise emissions for compliance against the ODP and PDP permitted activity noise standards. However, as a fully discretionary activity, we also evaluate the potential adverse noise effects and discuss suitable assessment criteria below:

[2] Berglund, B et al. *Guidelines for Community Noise.* World Health Organization (1999)

- The ODP daytime noise limit of 60 dB L_{A10} is outdated and deviates from what is currently considered a best practice noise limit for the protection of residential amenity.
- The ODP 60 dB L_{A10} is nominally 5 dB more lenient than the PDP, WHO and NZS6802 guidance. In light of this, and on review of the existing ambient daytime noise environment, we consider the PDP daytime noise limit of 55 dB L_{Aeq} will provide reasonable noise levels for nearby residential activity when assessed at the notional boundary of a dwelling.
- Whilst the ODP uses the L_{A10} noise metric, the PDP uses L_{Aeq} which represents current best practice for assessing noise emissions and is commonly referenced in published guidance describing appropriate levels of noise amenity. We propose L_{Aeq} is adopted for this project.
- At night, we consider the PDP noise limits of 45 dB L_{Aeq} and 70 dB L_{AFmax} to be appropriate. These limits reflect the recommended noise limits in WHO and NZS6802 for the protection of sleep.
- In the ODP, daytime is defined as 0730 to 2000hrs. The PDP reflects current best practice as outlined in NZS6802 which is that daytime is defined as 0700 to 2200 hrs.

Based on the above, we consider the noise limits provided in Table 9 are appropriate for assessing the project's on-site activity. These will result in a noise amenity commensurate with that anticipated by the ODP and PDP permitted activity standards and will result in reasonable noise effects.

Table 9: Recommended project noise limits

Time Period		Noise Limit
Day	0700 to 2200	55 dB L_{Aeq}
Night	2200 to 0700	45 dB L_{Aeq} and 70 dB L_{AFmax}

5.0 OPERATIONAL NOISE ASSESSMENT METHODOLOGY

The following sections describe our calculations of activity noise levels at the notional boundary of nearby dwellings in five different operational scenarios. We have focused on the scenarios that present the potential worst-case noise levels for the closest existing rural dwellings to the site. The following sections assess noise from both the short-term construction activities, operation of the quarry and truck movements on public roads.

5.1 Operational Scenarios

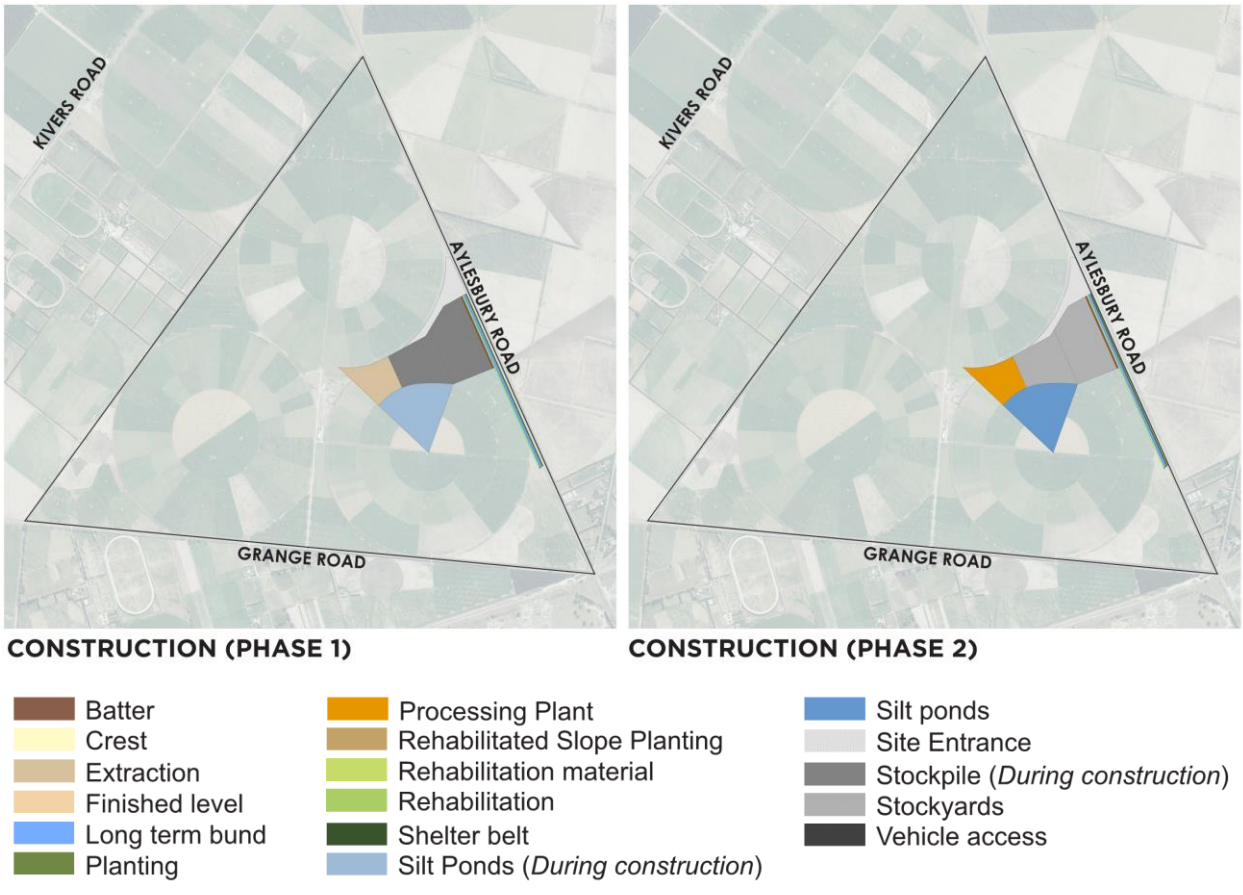
Scenarios 1 to 4 represent the typical daytime (0700 to 2000 hours) activities as described in Section 2.0, from site establishment to gravel extraction close to the dwellings in the south-east, south and west. Scenario 5 represents the operational activities expected during the evening and at night (from 2000 hours to 0700 hours).

5.1.1 Scenario 1 - Years 1 to 6 - Site Establishment (Phases 1 and 2)

The activity during years one to six will vary as the site is established. This phase, summarised in Section 2.1, will include gravel extraction and processing as well as the construction of site facilities and a permanent noise bund along Aylesbury Road. To represent a typical worst case operational scenario, we have modelled the following activities entirely at the existing ground level with one bund along the Aylesbury Road boundary of the stockyard area. The noise generating activities included are:

- Three mobile crushers, three mobile screens and three front end loaders in the processing area
- Two excavators extracting material from the primary stockyard zone
- 112 truck movements per hour in the stockyard

Figure 7: Years 1 to 6 (Phases 1 and 2) [image: Boffa Miskell]

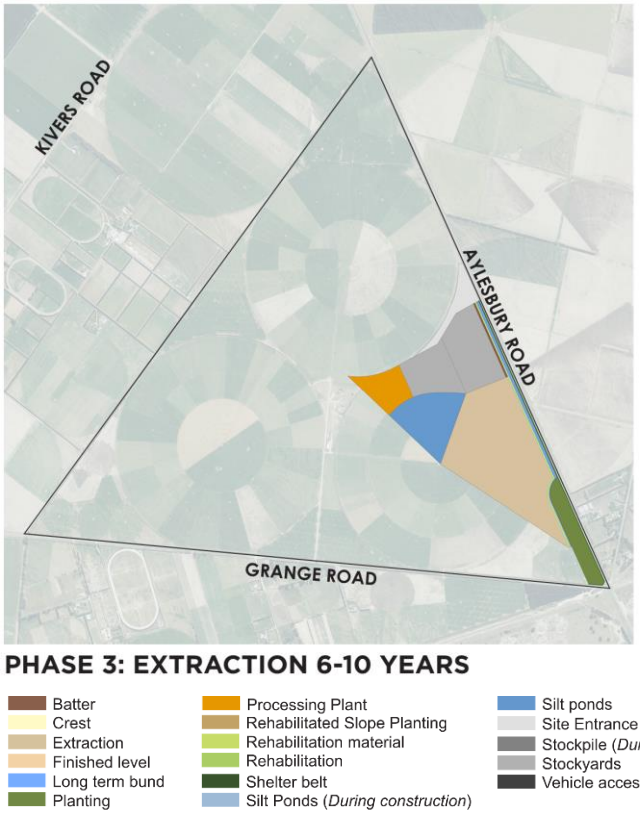


5.1.2 Scenario 2 – Years 6 to 10 (Phase 3)

Extraction in the south-east corner of the site with all machinery operating at 8 metres below ground level with the permanent bund along Aylesbury Road (refer to the location of the bunding as per phasing plan in Figure 3). Activities included are:

- Two front end loaders and one excavator working at the pit face (100 metre setback in south-east)
- Aggregate transported to the processing area by truck
- All processing, screening, and conveyance in the production zone
- Up to 112 truck movements per hour in the stockyard area

Figure 8: Years 6 to 10 (Phase 3) [image: Boffa Miskell]

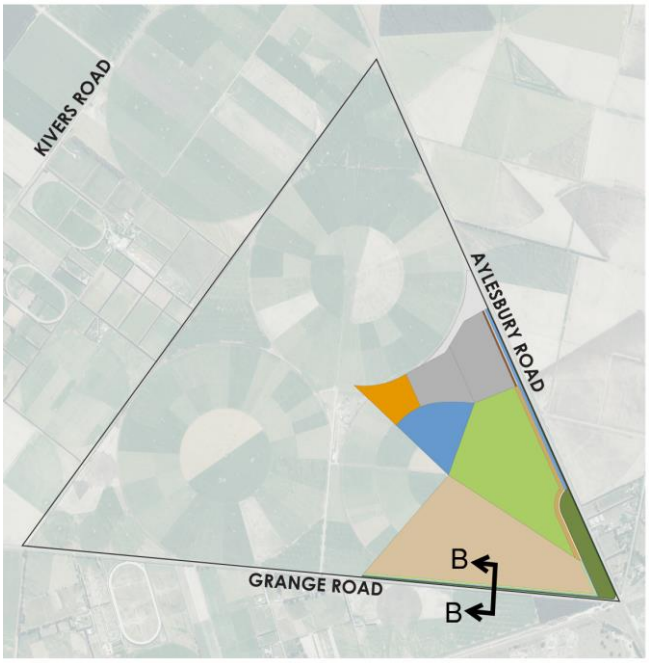


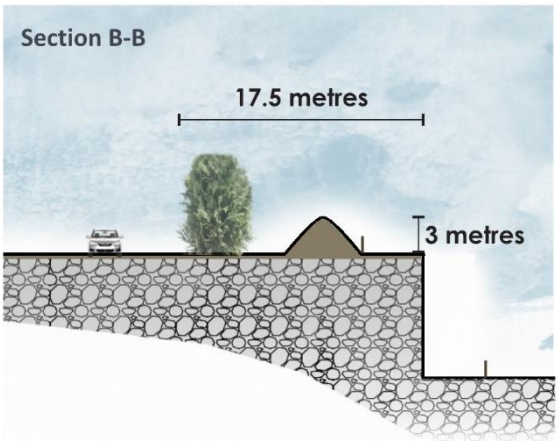
5.1.3 Scenario 3 – Years 11 to 15 (Phase 4)

Extraction towards the centre of the south site boundary, all at 8 metres below ground level with the permanent bund and a temporary bund along the south-eastern boundary. Activities include:

- Two front end loaders and one excavator working at the pit face
- Aggregate transported to the processing area by truck
- All processing, screening, and conveyance in the production zone
- Up to 112 truck movements per hour in the stockyard area

Figure 9: Years 11 to 15 (Phase 4) and section of temporary stockpile (Section B-B) [image: Boffa Miskell]





PHASE 4: EXTRACTION 11-15 YEARS

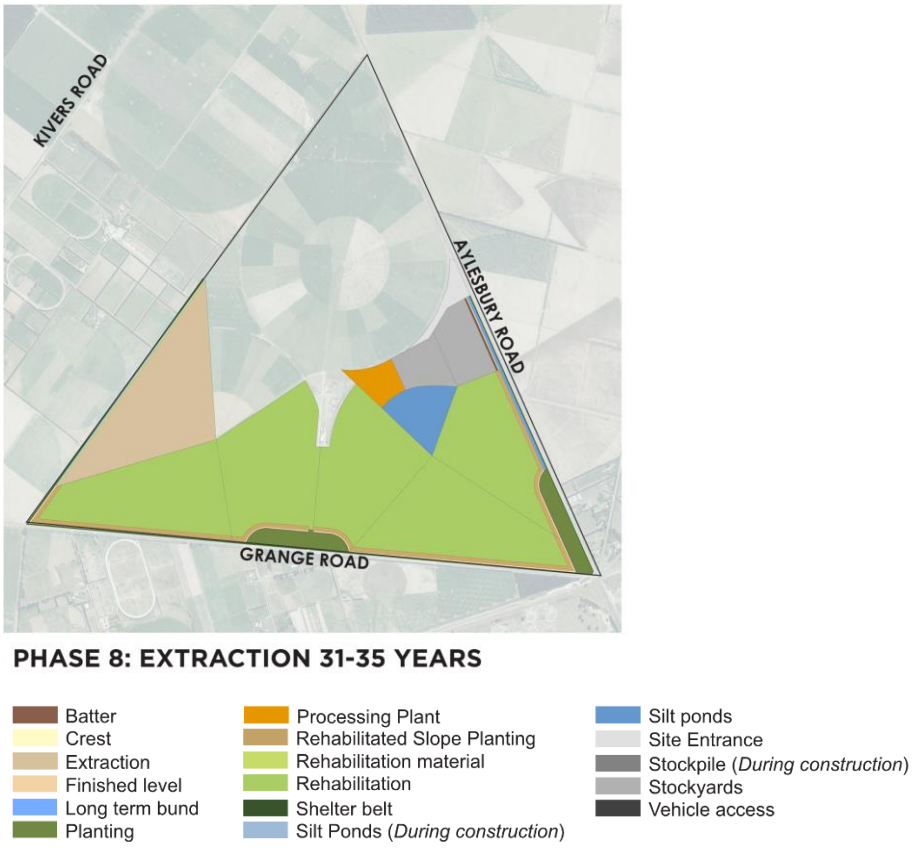
Batter
Crest
Extraction
Finished level
Long term bund
Planting
Processing Plant
Rehabilitated Slope Planting
Rehabilitation material
Rehabilitation
Shelter belt
Silt Ponds (*During construction*)
Silt ponds
Site Entrance
Stockpile (*During construction*)
Stockyards
Vehicle access

5.1.4 Scenario 4 – Years 31 to 35 – extraction to the west (Phase 8)

This scenario assesses noise emissions during extraction occurring at the closest point to the dwellings to the west. All machinery operating at 8 metres below ground level with the temporary stockpiling as indicated in Figure 10. Activities include:

- Two front end loaders and one excavator working at the pit face
- Aggregate transported to the processing area by truck
- All processing, screening, and conveyance in the production zone
- Up to 112 truck movements per hour in the stockyard area

Figure 10: Years 31 to 35 (Phase 8) [image: Boffa Miskell]



5.1.5 Scenario 5 – Night-time

As in Scenario 2 without any processing plant or machinery operating at the working face. 16 truck movements per hour in the stockyard.

5.1.6 Future scenarios

Gravel extraction and rehabilitation will continue clockwise around the site as represented by Phases 5 to 14 in Figure 1. For these phases, dwellings have larger separation distances to quarry extraction activities than those assessed in Scenarios 2, 3 and 4 above. As a result, predicted noise levels will be lower.

5.2 Calculation methodology

Environmental noise modelling was completed with the SoundPLAN v9.0 software suite. This software calculates the noise level at receivers in accordance with the International Standard ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation* which accounts for a range of factors that affect noise propagation outdoors including:

- The magnitude of noise sources
- Distance between the source and receiver
- Reflecting surfaces and the amount of ground absorption
- Screens, barriers, and/or other features in the propagation path
- Attenuation due to atmospheric absorption.

The effect of meteorological conditions is accounted for by assuming "supportive" propagation conditions – the wind is always going from the noise source to the receiver.

The estimated accuracy associated with this method is shown in Table 10 overleaf.

Table 10: Estimated accuracy for broadband noise (based on ISO 9613-2:1996)

Height, h*	Distance, d†	
	0 < d < 100 m	100 m < d < 1,000 m
0 < h < 5 m	±3 dB	±3 dB
5 m < h < 30 m	±1 dB	±3 dB

Note: These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.
** h is the mean height of the source and receiver.*
† d is the mean distance between the source and receiver.

All noise levels have been calculated as a 15-minute equivalent continuous average with no adjustments (dB $L_{Aeq\ (15\ min)}$). Special audible character and duration adjustments have not been included as quarrying activity is assumed to be constant throughout any 15 minute period and does not typically include any special audible characteristics, such as tonality or impulsiveness, that warrant adjustment.

5.3 Modelling assumptions

We have made the following assumptions during our calculations:

- Ground elevation across the site and surrounds is based on the *NZ Contours (Topo 1:50k)* data from the Land Information New Zealand Data Service (LINZ).
- Site terrain was modelled assuming excavation, in accordance with the proposed phasing, to a minimum of 8 metres below the existing ground level interpolated from the LINZ contours.
- Cadastral boundaries are based on the *NZ Primary Parcels* data from LINZ.
- The ground absorption coefficient is hard (G = 0.0) within the active site area and mixed (G = 0.5) everywhere else.
- No acoustic screening or shielding from bunds, buildings, or barriers outside of the site has been allowed for.
- All receiving dwellings are assumed to be single storey.
- Noise levels are calculated at the notional boundary and 1.5 m above the local ground level.

- Vehicle movements, when provided as a number of movements per hour, are assumed to be a constant level across the hour with 25% occurring in the 15 minute assessment period.

5.4 Noise Source Data

Our modelling uses data from previous measurements at similar quarry sites that generally correlates well with generic noise source data from British Standard BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*. Table 11 summarises the source data with sound power levels (L_{WA}) for fixed sources and sound exposure levels (L_{AE}) for moving sources.

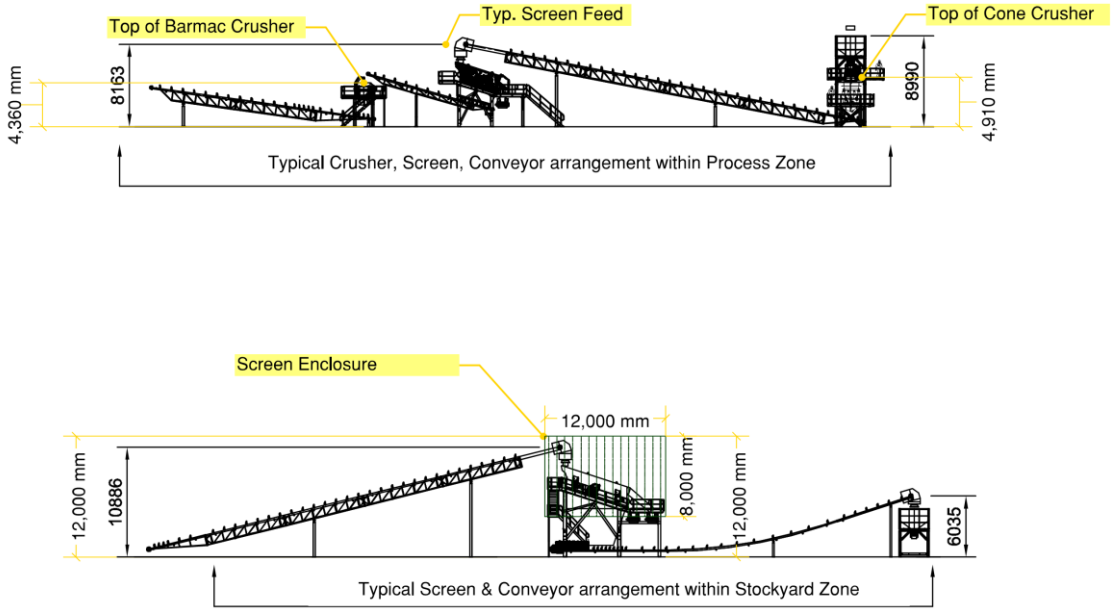
Table 11: Model noise source data

Item	Noise level (dB)	Source height* (m)
Road Truck	86 L_{AE} at 10 m	1.5
Excavator	108 L_{WA}	2.0
Front End Loader	105 L_{WA}	1.5
Mobile Crusher	112 L_{WA}	2.0
Mobile Screen	117 L_{WA}	3.0
Fixed Processing Plant		
Jaw Crusher	119 L_{WA}	4.0
Barmac Crusher	97 L_{WA}	3.0
Cone Crusher	117 L_{WA}	4.0
Screen	111 L_{WA}	10.0
Conveyers		
Inlet	99 L_{WA}	3.0
Belt	61 L_{WA} per metre	-
Transition	103 L_{WA}	-

**Source height is relative to the local terrain level at the source*

Figure 11 provides the typical arrangement and heights of the processing plant used in the noise modelling.

Figure 11: Heights and general arrangement of fixed processing plant



6.0 PREDICTED OPERATIONAL NOISE LEVELS

The predicted noise level contours for each scenario described in Section 5.1 are provided in Figure 12 to Figure 16. Larger versions of these plots are provided in Appendix D.

Figure 12: Scenario 1 - Years 1 to 6 - Site Establishment

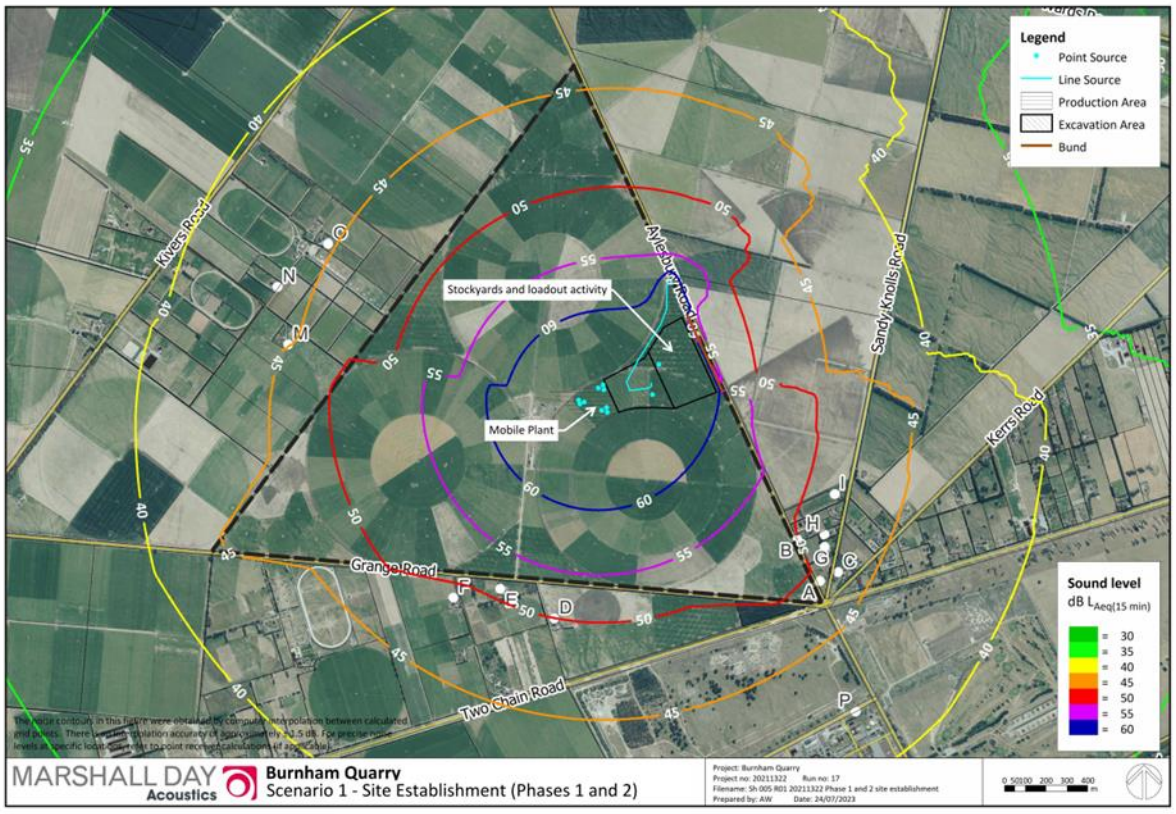


Figure 13: Scenario 2 – Years 7 to 10

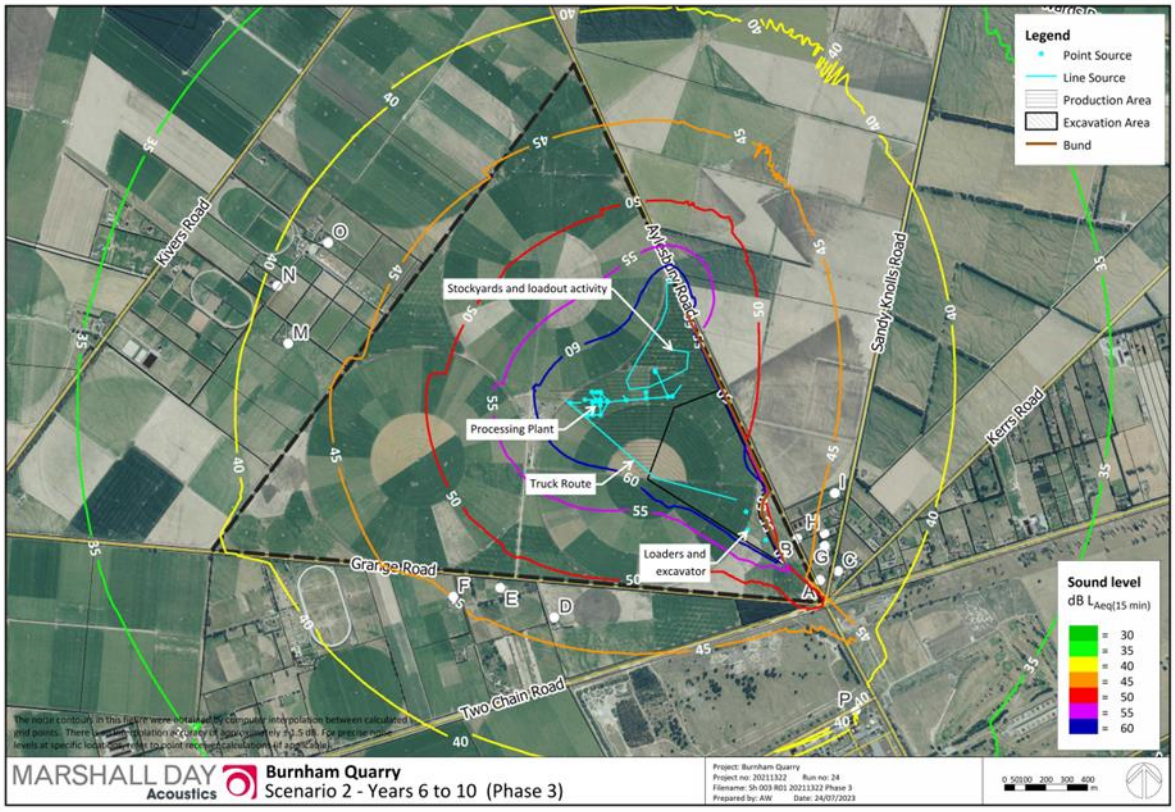


Figure 14: Scenario 3 – Years 11 to 15

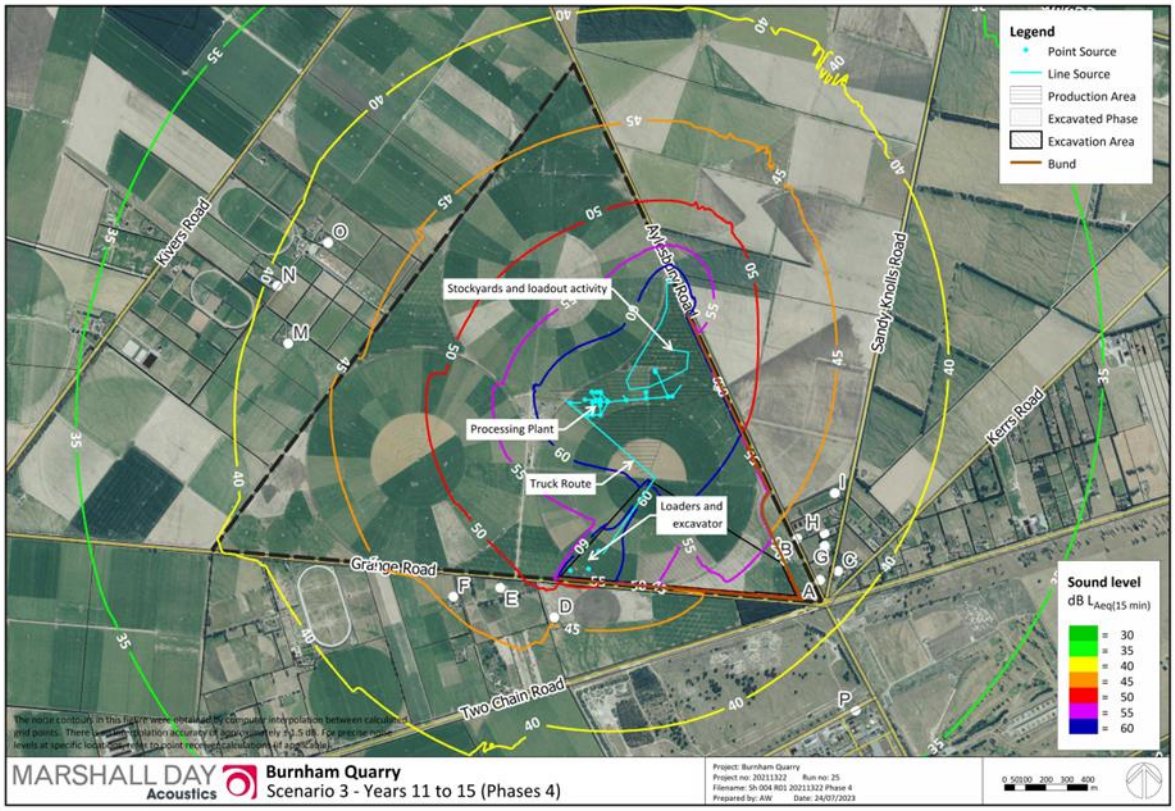


Figure 15: Scenario 4 - Years 31 – 35

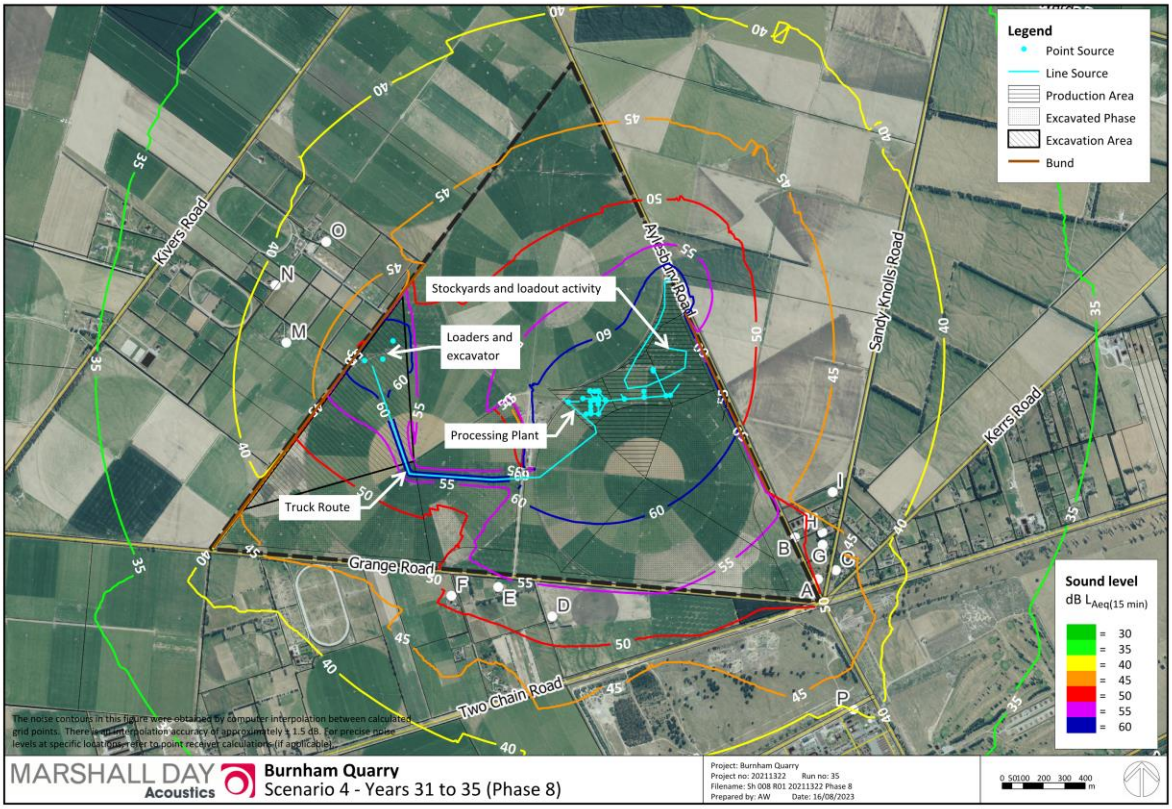


Figure 16: Scenario 5 – Night-time

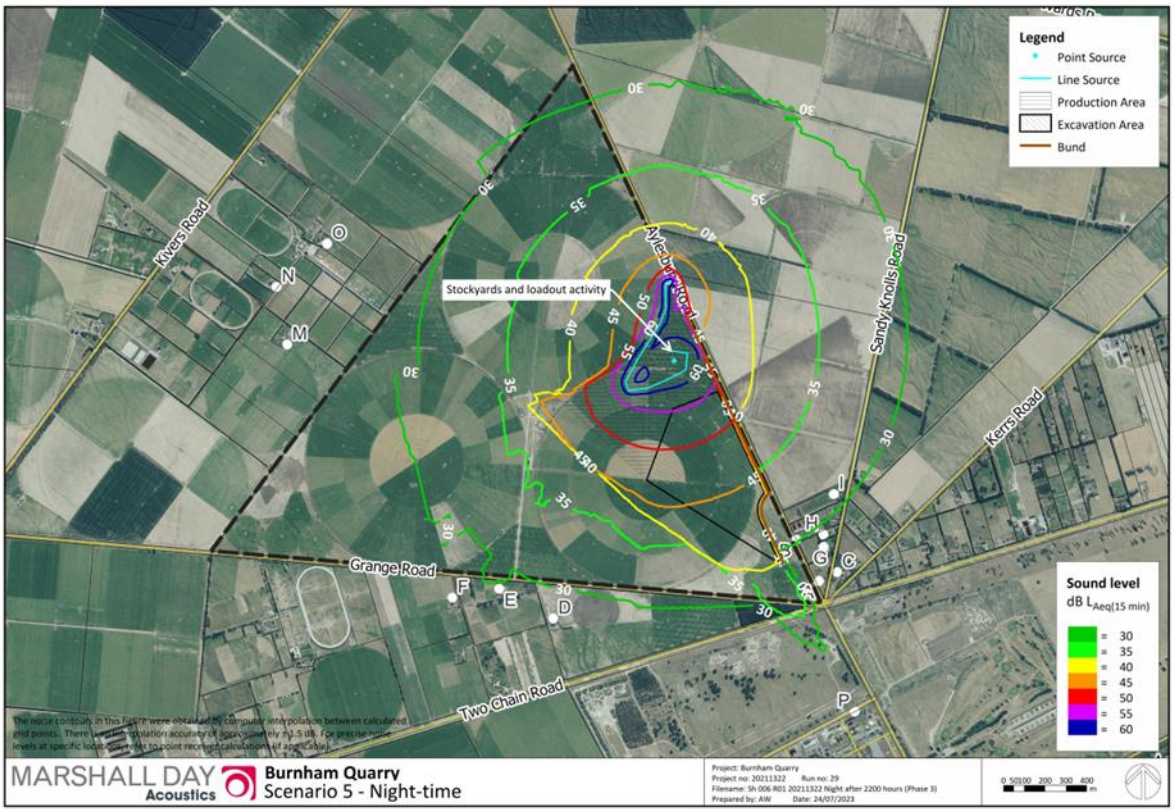


Table 12 provides the results of our noise modelling for the scenarios described in Section 5.1. This does not consider the noise from short term construction activities and truck movements on public roads.

Table 12: Calculated noise levels at point receiver locations, dB $L_{Aeq\ (15\ min)}$

		Daytime noise limit 55 dB L_{Aeq}				Night-time noise limit 45 dB L_{Aeq}
ID	**Address**	**Scenario 1 Establishment**	**Scenario 2 Years 6-10**	**Scenario 3 Years 11-15**	**Scenario 4 Years 31-35**	**Scenario 5 Night**
A	146 Aylesbury Road	47	44	42	49	28
B	168 Aylesbury Road	51	47	44	53	30
C	7 Kerrs Road	47	43	41	48	28
D	139 Grange Road	50	46	46	52	28
E	159 Grange Road	51	47	48	52	28
F	181 Grange Road	49	45	46	51	27
G	27 Sandy Knolls Road	48	44	43	49	29
H	35 Sandy Knolls Road	48	44	43	49	30
I	61 Sandy Knolls Road	48	44	43	43	31
J	578 Wards Road	38	37	36	37	24
K	716 Wards Road	37	34	34	34	19
L	718 Wards Road	36	33	33	33	18
M	176 Kivers Road	45	42	42	43	25
N	186 Kivers Road	44	41	41	41	24
O	216 Kivers Road	45	42	42	42	26
P	Burdons Road	42	40	37	41	23

The predicted noise levels in Table 12 show that all modelled scenarios will comply with the proposed project and PDP noise limits of 55 and 45 dB L_{Aeq} respectively during the day and night-time periods. Furthermore, we do not expect the night-time maximum noise criterion of 70 dB L_{AFmax} to be exceeded at any time. As a result, operational activity at the site will result in reasonable noise effects.

We note the modelled Scenario 5 – Night-time, does not include processing activity, but our predictions confirm that processing can occur in the night-time period between 0600 and 0700 hrs and comply with the proposed project noise limit of 45 dB L_{Aeq}.

For the purposes of assessing compliance with the applicable ODP permitted activity day/night noise limits of 60 and 45 dB L_{A10} respectively, it is appropriate to convert the metric L_{Aeq} to L_{A10} by adding 2 dB to the values in Table 12. Whilst noise emissions will mostly comply with the daytime and night-time noise limits, the proposed commencement of site activity at 0700 hrs means the night-time noise limit of 45 dB L_{A10} applies until 0730 hrs. The proposed activity will exceed the ODP permitted activity limit during this 30 minute period by up to 10 dB. We note these non-compliances do not affect the status of the application – it is already full discretionary.

7.0 CONSTRUCTION NOISE ASSESSMENT

Site establishment activities such as construction of amenities, initial bunding, and final rehabilitation activities are commonly assessed as construction noise rather than operational noise as they:

- Are temporary activities that occur for a short period
- The character and duration of noise are consistent with rural activities that would otherwise be permitted on site
- The work will result in long term benefits for the site – such as noise reduction from bunds

The nature of these activities mean people will typically tolerate a higher noise level as long as it is no higher than necessary and occurs at an appropriate time of day.

7.1 Construction Noise Limits

The ODP does not provide construction noise performance standards and we consider it appropriate to assess construction activities against New Zealand Standard NZS 6803:1999 *Acoustics - Construction Noise* which provides recommended noise limits based on the expected duration of the works. These limits, unlike the operational noise limits, are assessed at one metre from the façade of the building affected by the noise. We note that NZS 6803:1999 is the Standard referred to in the PDP.

Table 13 (reproduced from Table 2 of NZS 6803:1999) provides the recommended noise limits for rural dwellings. Based on our current understanding of the project, we expect that the "long term" limits will be appropriate.

Table 13: ***Recommended upper limits for construction noise received in residential zones and dwellings in rural areas***

Time of week	***Time period***	***Duration of work***					
		Typical duration (dBA)		***Short-term duration (dBA)***		***Long-term duration (dBA)***	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	*0630-0730*	*60*	*75*	*65*	*75*	*55*	*75*
	0730-1800	*75*	*90*	*80*	*95*	*70*	*85*
	1800-2000	*70*	*85*	*75*	*90*	*65*	*80*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*
Saturdays	*0630-0730*	*45*	*75*	*45*	*75*	*45*	*75*
	0730-1800	*75*	*90*	*80*	*95*	*70*	*85*
	1800-2000	*45*	*75*	*45*	*75*	*45*	*75*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*
Sundays and public holidays	*0630-0730*	*45*	*75*	*45*	*75*	*45*	*75*
	0730-1800	*55*	*85*	*55*	*85*	*55*	*85*
	1800-2000	*45*	*75*	*45*	*75*	*45*	*75*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*

7.2 Calculated Construction Noise Levels

Due to the central location of the processing zone and site amenities, construction activities in these areas are unlikely to have noise effects that differ significantly from the noise levels expected during normal site operations.

The construction activity that is likely to have the greatest noise effect will be the construction of the permanent bund and 3 metre topsoil stockpiles along Aylesbury and Grange Roads due to the proximity to dwellings at that intersection, and lack of screening between the bund and the dwellings.

We have calculated noise from construction activity using the methodology described in NZS 6803:1999, for bund construction adjacent to the closest dwelling with overburden stripping occurring in the initial extraction area. Table 14 provides the range of mobile equipment that could be used at their anticipated noise levels. Noise source data has been taken from BS5228.

Table 14: Indicative noise levels at 1m from a building façade

Equipment	Sound Power	Façade Noise Level (dB L_{Aeq})				Limit Setback (m)
	(dB L_{wA})	5m	10m	20m	50m	70 dB L_{Aeq}
20t tracked excavator	103	84	78	72	63	25
40t Articulated dump truck	107	88	82	76	67	36
28t Bulldozer	107	88	82	76	67	36
Grader	114	95	89	83	74	69

The rightmost column in Table 14 shows the set back distances required for each item of mobile plant to achieve the "long term duration" daytime construction noise limit of 70 dB L_{Aeq} – they are in the range 25 to 69 metres and therefore well within the setback distance of 100 metres to the nearest dwelling.

This analysis shows construction activities on site will comfortably comply with the applicable NZS 6803 noise limits and the PDP construction noise rule.

8.0 SITE GENERATED VIBRATION

There are no significant vibration sources associated with the operation of the proposed quarry (noting that there is no blasting required). The vibration-generating activities that will occur close to sensitive receivers are:

- Bund construction to the south-eastern boundary, using excavators and trucks; and
- Aggregate extraction by loaders at the edge of the quarry pit.

In our experience aggregate extraction results in very little vibration outside of the site, while bund construction is generally the activity with the most potential to generate vibration effects, due to its proximity to receivers (noting that the setback distance will be 100 metres from the nearest dwellings).

Both of these activities involve plant and equipment typical of construction activities. A number of documents provide guidance on the assessment and management of construction vibration, and these are discussed below.

8.1 Vibration Assessment Criteria

We consider it appropriate to consider potential vibration effects on buildings and human response through reference to the following guidance:

- Building damage – German Standard DIN 4150-3:2016 *"Structural Vibration - Effects of Vibration on Structures".* This standard is in common use in New Zealand and is referred to in PDP Rule NOISE R-14; and
- Human response – British Standard BS 5228-2:2009 "*Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration"*.

Both of these Standards provide vibration criteria in terms of the Peak Particle Velocity (PPV), which are summarised in the following sections.

8.1.1 Building Damage Criteria

The DIN 4150-3:2016 Standard provides conservative guidance designed to prevent any damage (even superficial) to buildings. It sets criteria for both long- and short-term vibration that apply in all axes at the building foundation or in horizontal axes at the highest floor adjacent to a façade wall.

The Standard defines 'short-term' vibration as *'vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*'. Common sources include blasting, drop-hammer piling, and dynamic consolidation. Long-term vibration is defined as all other vibration types not covered by the short-term vibration definition. Common sources include most construction machinery, vibratory rollers and vibro-hammer piling. Some sources (e.g. construction traffic) could be either or both, in which case the more stringent long-term values should be adopted. The key criteria are summarised in Table 15.

Table 15: Summary of building damage risk vibration criteria from DIN 4150-3:2016

Type of structure	Short-term				Long-term
	PPV at the foundation by frequency, mm/s			PPV at highest floor, mm/s	PPV at highest floor, mm/s
	1 – 10 Hz	10 – 50 Hz	50 – 100 Hz		
Commercial/Industrial	20	20 - 40	40 - 50	40	10
Residential/School	5	5 - 15	15 - 20	15	5
Historic or sensitive structures	3	3 - 8	8 - 10	8	2.5

The Standard states that *'experience has shown that if* [the guideline values] *are complied with, damage will not occur. Exceeding the* [guideline values] *slightly does not necessarily lead to damage'*.

8.1.2 Human Response Criteria

Annex B of British Standard BS 5228-2:2009 *"Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration"* provides guidance relating to human response to construction vibration in residential environments. These criteria are summarised in Table 16.

Table 16: Guidance for human response to construction vibration in BS 5228-2:2009, Annex B

Vibration (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Comparing these values with those derived from the DIN Standard above, it is clear that people are likely to perceive and potentially adversely respond to vibration levels significantly below those which may cause superficial building damage (such as cracking in paint or plasterwork). Additionally, people are generally more sensitive to vibration at frequencies higher than those which cause building damage.

8.2 Vibration Generation

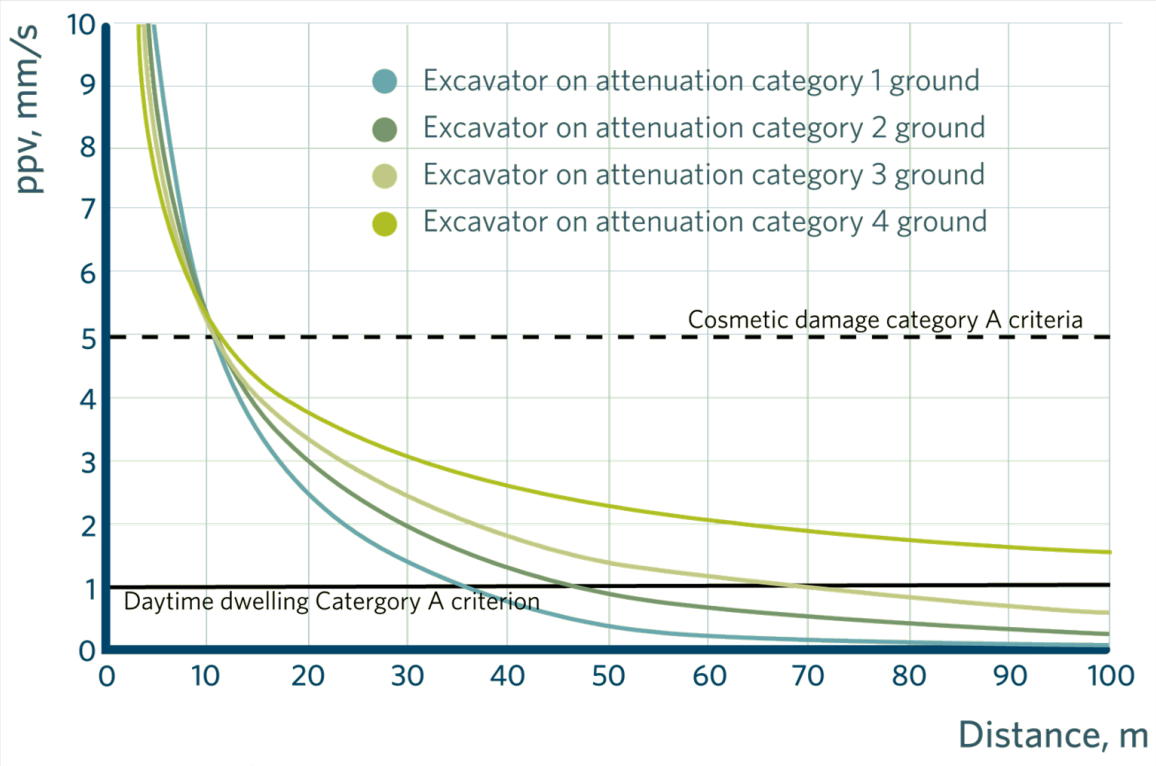
The closest dwelling to the construction of boundary bunds is at 168 Aylesbury Road, where the façade is approximately 100 metres from the proposed bund.

Vibration received at a location from any given source will vary depending on a number of factors that determine the ground propagation conditions, e.g. soil type, density, elasticity, etc. Figure 17 shows predicted vibration propagation over distance from an excavator for different ground types. This is from the NZTA's construction guidance[3] that has been developed based on empirical data discussed in their extensive research[4]. The ground categories are broadly from: 1 – weak or soft; to 4 – hard, competent rock.

[3] *State Highway Construction and Maintenance Noise and Vibration Guide*. NZ Transport Agency (2013).

[4] Cenek, PD, et al (2012) *Ground vibration from road construction*. NZ Transport Agency research report 485. 80pp.

Figure 17: Predicted vibration from a Sumitomo SH120 excavator (Figure 4.31 of NZTA's construction noise guide)



The footnote to the NZTA's figure above notes that:

> *'… some of these data have been measured at distances less than 10m and subsequently corrected for distance. Using the 10m source data generally results in an over-prediction of the vibration level at distances less than 50m compared to using the original source data at the closer distance …'*

In practice, our recent measurement experience with similar sources indicates that the guidance in Figure 17 is somewhat conservative, as is generally the case for many "prediction" methodologies. For example, our own measurement data indicates typical levels of:

- 1.1 mm/s at 10 metres from Hitachi Zaxis 330LC excavator loading dump truck;
- 0.2 mm/s at 19 metres from Hitachi Zaxis 670LCH excavator loading dump truck; and
- 1.5 mm/s at 10 metres from an excavator operating a diaphragm wall rig.

On the basis of the data above, the conservative NZTA guidance suggest that vibration levels from an excavator working at 20 metres may vary between 2.5 and 3.8 mm/s, whereas our own measurements indicate that the upper levels of vibration will be between 1 and 2 mm/s.

8.3 Vibration Assessment

At 100 metres, even the most conservative (highest) estimations of vibration generation above are comfortably below the residential building damage criterion of 5 mm/s. Similarly, we expect vibration will be below the 1.0 mm/s threshold from BS 5228-2:2009 and will likely be imperceptible in practice.

Aside from bund construction, vibration from other activities received at the closest dwelling will be minimal. Similarly, vibration received at any other property from all activities (including bund and stockpile construction) is not likely to be perceptible within dwellings.

9.0 NOISE FROM QUARRY TRAFFIC ON PUBLIC ROADS

Although road traffic noise generated outside of the site is not considered against the District Plan noise standards, reference to ODP Rule 9.12.2.2 requires us to assess the potential adverse noise effects on residential amenity.

There is no universally accepted way of assessing amenity effects from truck noise (as the District Plan noise limits do not apply), but the analysis typically falls into two categories:

i. The relative change in vehicle numbers (compared to existing) and how this changes the noise levels; and/or

ii. Predicting whether the future traffic noise levels would increase the existing ambient noise levels or exceed applicable guidance for residential amenity.

These matters will be considered in the following sections.

9.1 Assessment Criteria

In terms of national guidance, road traffic noise is outside of the scope of the usual environmental noise assessment Standard, NZS 6802. Guidance is instead given in New Zealand Standard NZS 6806:2010 *"Acoustics - Road-traffic noise - New and altered roads"*.

9.1.1 NZS 6806

For high-flow roads, traffic noise effects generally correlate best with longer term average noise levels. The lowest external noise criterion given in this Standard is 57 dB $L_{Aeq\ (24\ hr)}$, assessed at the façade of any sensitive building (e.g. dwelling) and based on the average annual daily traffic (AADT).

However, we note that NZS 6806 does not apply to existing roads, only new and altered roads with traffic volumes above 2000 AADT (at the design year). The Standard explains in clause 3.4.2 that:

> *'People's response to noise from traffic flows less than 2000 AADT is mostly to individual noise as a transient maximum sound level.'*

Furthermore, the Standard states (C1.3.1) that:

> *'Noise criteria recommended in this Standard are not intended to apply to low volume roads, for example those in isolated rural areas servicing a small number of dwellings … or business activities which generate low traffic volumes.'*

As we discuss below, Stantec's Transport Assessment Report (TAR) provides existing 5-day average traffic volumes on roads around the site as follows (refer to Appendix B):

- Aylesbury Road north of Two Chain Road — 460 vehicles per day
- Aylesbury Road south of Two Chain Road — 1,340 vehicles per day
- Aylesbury Road Burdons Road to State Highway 1 — 3,700 vehicles per day

This data shows that a significant portion of Aylesbury Road has traffic volumes less than 2,000 vehicles a day and, as a result, we consider that the guidance in NZS 6806 is generally not relevant to this project.

9.1.2 Noise Level Guidance

Similar mining and quarrying sites in recent years have adopted assessment criteria that were derived in part from detailed consideration over the application of both NZS 6802 and NZS 6806 to such site-specific traffic noise.

A daytime traffic noise criterion of 55 dB $L_{Aeq\,(1\,hr)}$ is commonly applied to noise from heavy vehicles[5]. There is no similar commonly adopted guidance for acceptable limits of night-time noise exposure, other than reference to the NZS 6802 and WHO guidance discussed respectively in Section 4.3 and Section 4.3.2 of this report.

9.1.3 Noise Level Change

As discussed above, in lieu of any applicable absolute noise level criteria, it is appropriate to consider the degree of noise change in an environment and any resulting noise effects. As a guide, Table 17 describes the typical subjective reaction to any difference in noise level and demonstrates how this may result in a given level of adverse effects.

Table 17: Change in noise level

Change in Sound Level (dBA)	Subjective Reaction	Impact or RMA Adverse Effect
1 - 2	Imperceptible change	Negligible/less than minor
3 - 4	Just perceptible change	Slight/Minor
5 - 8	Appreciable change	Noticeable
9 - 11	Doubling of loudness	Significant/Substantial
> 12	More than a doubling of loudness	Severe

In our experience the categories above correlate well with reactions to road traffic noise, particularly for roads where effects are more related to the continuous levels of "steady" sound.

9.2 Potentially Affected Locations

The properties that could be affected by trucks travelling to and from the site along Aylesbury Rd to the State Highway are identified in Figure 18 and are discussed in turn below:

- 168 Aylesbury Road
- 146 Aylesbury Road
- Burnham Camp

[5] A commonly cited Environment Court case related is *Brookby Quarries Limited* (ENV-2014-AKL-000048)

Figure 18: Nearest dwellings to proposed truck route

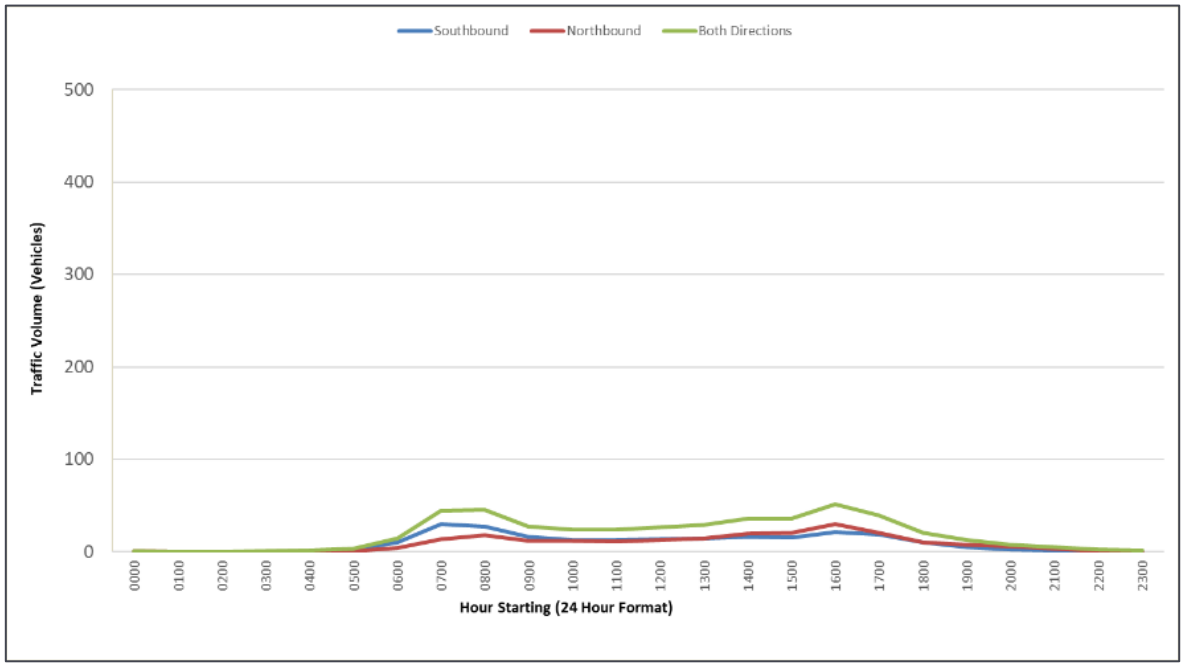
9.2.1 168 Aylesbury Road

The front façade of this dwelling is set back approximately 12 metres from Aylesbury Road. There is a business listed at this address and it is unclear if the dwelling is used for residential purposes – we have assumed so for this assessment.

Figure 19 provides the weekday traffic volume taken from the TAR and this indicates existing total traffic passing this property is 450 vehicles per day (with approximately 10% heavy vehicles) and movements almost exclusively occur between 0500 and 2000hrs. There are less than 10 vehicle movements past this property between 2200 and 0500hrs, at which point vehicle numbers start to increase. On average, there are currently 35 vehicles passing this dwelling every hour during the day, approximately 4 of which are heavy vehicles.

The average daytime noise level at the dwelling is in the low 60s dB $L_{Aeq(1hr)}$. At night the average noise level is approximately 40 dB $L_{Aeq(1hr)}$ when no vehicles are passing.

Figure 19: Weekday Hourly Traffic Volumes - Aylesbury Road north of Two Chain Road



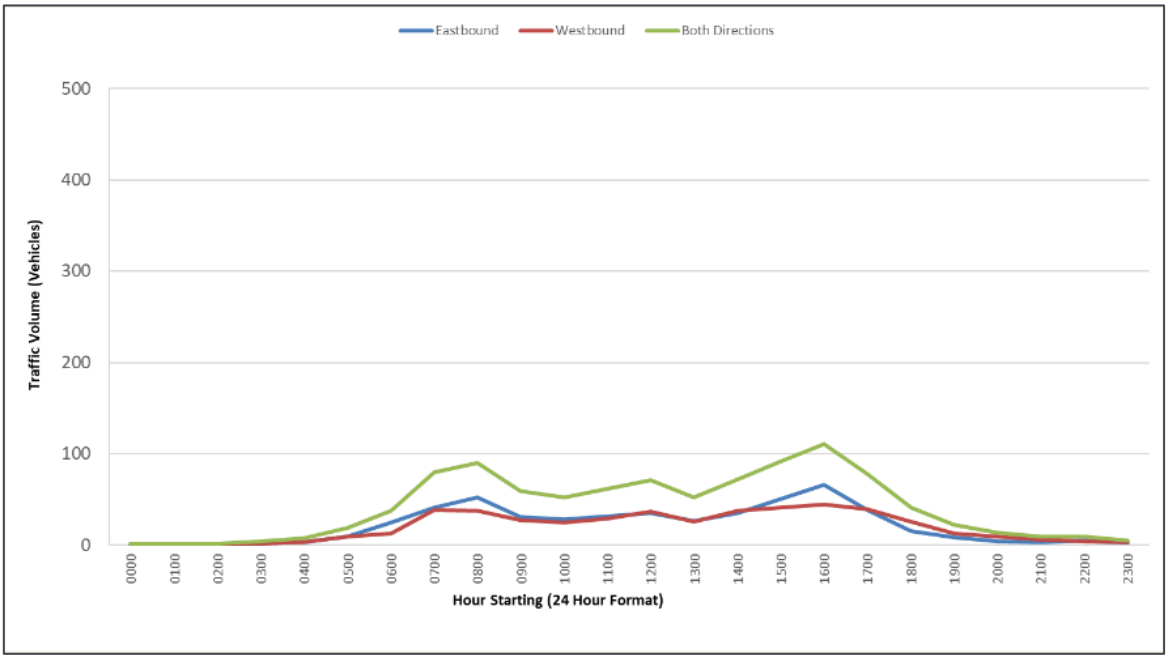
9.2.2 146 Aylesbury Road

This dwelling is approximately 40 metres from Aylesbury Road and broadly representative of the potential noise effects received at other adjacent dwellings on Sandy Knolls Road. The property receives traffic noise from both Aylesbury and Two Chain Roads. Other roads in the vicinity contribute noise to a lesser extent and there are relatively few movements on Sandy Knolls Road. Existing Aylesbury Road traffic movements are noted above. Two Chain Road carries approximately 1,000 vehicles per day (14% heavy vehicles) with most movements occurring between 0500 and 2000hrs.

The average daytime noise level at the dwelling is approximately 50 dB $L_{Aeq(1hr)}$. At night the average noise level is approximately 40 dB $L_{Aeq(1hr)}$.

Figure 20 provides the weekday hourly traffic volume for the closest section of Two Chain Road.

Figure 20: Weekday hourly traffic volumes on Two Chain Road east of Aylesbury Road



9.2.3 Burnham Camp

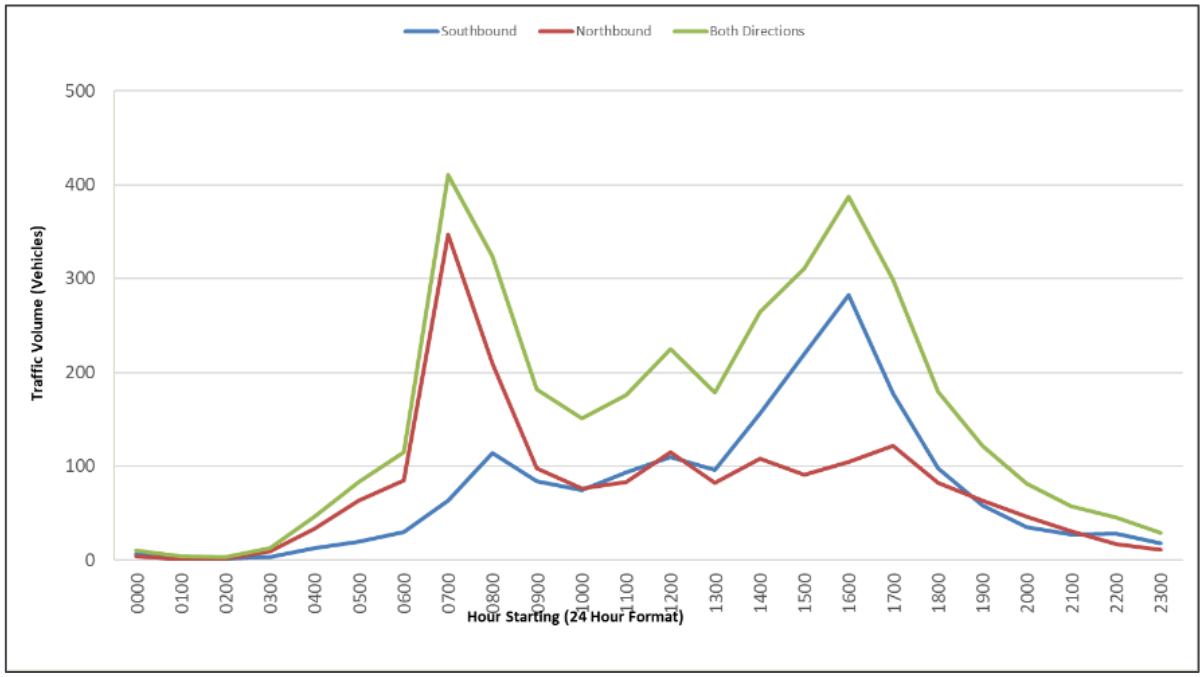
The section of Aylesbury Road past Burnham Camp currently carries relatively high vehicle numbers as indicated in Figure 21.

Traffic volumes are currently 3,700 vehicles per day between Burdons Road and State Highway 1. The hourly distribution shows morning and afternoon peaks and some activity into the late evening. Between 2200 and 0500 hrs there are approximately 150 vehicles past Burnham Camp and movements begin to steadily increase from around 0400 hrs. The Camp is also subject to traffic noise from State Highway 1 and this is likely to be more prominent at night.

We have based our analysis on the closest Camp buildings to Aylesbury Road which are the barrack-style structures set back approximately 50 metres. We do not know if activities within these building are noise sensitive but, in any event, provide a worst-case analysis. The most obvious residential dwellings within the Camp along Whites Road are much closer to SH1 and will experience relatively high existing traffic noise levels from SH1 and the railway and we do not consider them to be potentially affected.

During the day, the average noise level is in the order of 55 dB L_{Aeq} at the Camp. At night, the average noise level is approximately 45 dB L_{Aeq}.

Figure 21: Weekday Hourly Traffic Volumes on Aylesbury Road - Burdons Road to SH1



9.3 Proposed Truck Noise Levels

As noted in Section 2.4, the quarry proposes to have the following truck movements:

- Average 300 movements per day
  30 movements per hour
- Maximum 750 movements per day
  112 movements per hour

We have assessed the likely noise effects on an hourly basis at each of the representative locations for these average and maximum values of 30 and 112 movements per hour. We have used a truck noise source level of 84 dB L_{AE} at a distance of 10 metres.

As described in Table 2, the applicant is seeking the ability to have up to 10 truck movements per hour between 0500 and 0700 hrs which is considered night-time in both the ODP and PDP.

9.3.1 168 Aylesbury Road

The anticipated truck noise levels for 168 Aylesbury Road are presented in Table 18.

Table 18: 168 Aylesbury Road - Relative change in daytime noise levels for different truck movements

No. of truck movements per hour	Truck noise level, dB $L_{Aeq(1hr)}$	Relative change, dB	Potential adverse noise effect	Below the 55 dB $L_{Aeq(1hr)}$ guideline value?
30 (average)	61	+3 to +5	Slight to Noticeable	Not applicable[1]
112 (maximum)	67	+7 to +10	Significant	Not applicable[1]

Note [1]: the existing ambient traffic noise level already exceeds the 55 dB L_{Aeq} guideline noise level.

The relative change in truck noise level can be considered to have a noticeable to significant adverse effect at this dwelling for the average and maximum truck movements respectively. However, with the provision of noise mitigation at the property, such as the provision of a noise control fence, truck noise would notably reduce by an estimated 5 to 10 dB and would result in noise effects within an

acceptable range. We note that noise mitigation would only be possible through an agreement between the Applicant and property owner.

We note that this dwelling already experiences daytime noise levels in excess of the 55 dB L_{Aeq} guideline noise level for the protection of residential amenity.

9.3.2 146 Aylesbury Road

The anticipated truck noise levels for 146 Aylesbury Road are presented in Table 19.

Table 19: 146 Aylesbury Road - Relative change in daytime noise levels for different truck movements

No. of truck movements per hour	Truck noise level, dB $L_{Aeq(1hr)}$	Relative change, dB	Potential adverse noise effect	Below the 55 dB $L_{Aeq(1hr)}$ guideline value?
30 (average)	54	+3	Just perceptible / Slight	Yes
112 (maximum)	60	+10	Significant	No

The relative change in noise level can be considered to have a slight to significant noise effect for the proposed average and maximum truck movements. However, the absolute noise level of 54 dB $L_{Aeq(1hr)}$ for the "average" case, is considered acceptable in terms of a residential daytime noise amenity.

9.3.3 Burnham Camp

The anticipated truck noise levels for the closest Burnham Camp buildings to Aylesbury Road are presented in Table 20.

Table 20: Relative change in daytime noise levels for different truck movements

No. of truck movements per hour	Truck noise level, dB $L_{Aeq(1hr)}$	Relative change, dB	Description of effect	Below the 55 dB $L_{Aeq(1hr)}$ guideline value?
30 (average)	54	0 to 2 dB	Negligible	Not applicable[1]
112 (maximum)	60	0 to 5 dB	Negligible to moderate	Not applicable[1]

Note [1]: the existing ambient traffic noise level already equals or exceed the 55 dB L_{Aeq} guideline noise level.

Our assessment indicates that the proposed average and maximum truck movements along Aylesbury Road would have negligible to moderate noise effects at the closest buildings within Burnham Camp.

9.3.4 Early morning truck movements between 0500 to 0700 hrs

Whilst 0500 to 0700 is considered night-time in the both the ODP and PDP, Figure 19, 20 and 21 shows there are already notable traffic movements on Aylesbury Road and Two Chain Road during this time.

Table 21 shows the relative change in noise level for 10 truck movements per hour at each of the key assessment locations.

Table 21: Relative change in noise levels for 10 truck movements between 0500 and 0700 hrs

Location	10 movements per hour Truck noise level, dB $L_{Aeq(1hr)}$	Relative change, dB	Potential adverse noise effect
168 Aylesbury Road	56	5 to 10 dB	Noticeable to significant
146 Aylesbury Road	49	3 to 5 dB	Negligible to moderate
Burnham Camp	49	0 to 3 dB	Just perceptible / Slight

This analysis suggests the greatest potential for adverse noise effects will be for the dwelling at 168 Aylesbury Road. However, as noted above for daytime activity, the provision of appropriate noise control treatment will result in more reasonable noise effects for this dwelling.

Burnham Camp will be least affected by the proposed early morning truck movements as traffic noise levels are already elevated at this time of day, As a result we expect noise effects will be minimal at this location.

10.0 ASSESSMENT SUMMARY AND CONCLUSIONS

We have predicted noise levels for various operational scenarios that represent the highest activity noise levels on site. Our assessment shows the site will comply with our proposed project noise limits which will provide reasonable noise effects at nearby residences. We anticipate noise levels will be lower than predicted for most of the time.

For the purposes of assessing compliance against the District Plan permitted activity standards, we note the activity will exceed the Operative District Plan permitted activity noise limits by up to 10 dB between 0700 and 0730 hrs. This is a result of the cross over of proposed operational hours and the night-time hours of the Operative District Plan. The site will comfortably comply with the Partially Operative District Plan noise limits at all times.

Existing ambient noise levels at adjacent residences set back 50 to 70 metres from Grange and Aylesbury Roads are broadly 40 to 50 dB L_{Aeq} during the day. The noise environment is dominated by traffic and natural environment sounds. Dwellings closer to these roads will experience higher noise levels from traffic in the order of 60 dB L_{Aeq}. For these dwellings, site activities may be audible during lulls in traffic but a level that is below the recommended criteria and appropriate for the protection of residential amenity.

Noise from construction activities, including the formation of bunds and site facilities, will comfortably comply with the applicable New Zealand Standard.

Vibration generation is likely to be highest during the construction phase but is expected to be negligible at dwellings and significantly below the applicable criteria for structural damage and human response.

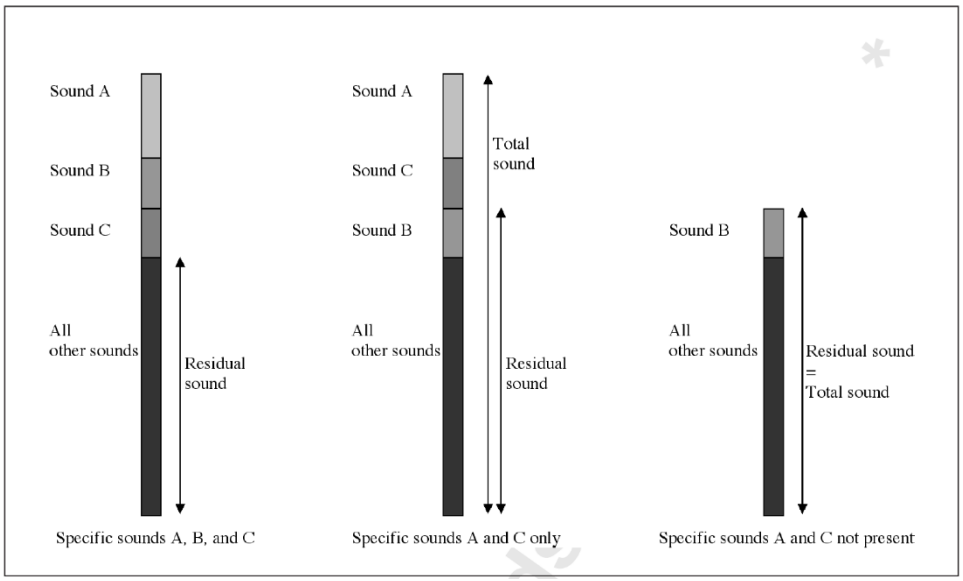
Noise effects from quarry trucks have the potential, without mitigation, to range between negligible and significant depending on the proximity of dwellings to the road and the existing traffic activity. For example, daytime noise effects at Burnham Camp will be negligible for proposed average truck volumes of 30 movements per hour. At 168 Aylesbury Road, daytime truck noise effects have the potential to be slight to significant for proposed average and maximum truck movements respectively. Noise mitigation at this property will reduce truck noise levels and noise effects would be in a more reasonable range.

11.0 RECOMMENDATIONS

In order to ensure reasonable noise effects from site activity at nearest residents, we have provided the following suggested text that may be drafted into conditions of consent:

1. The consent holder shall ensure that all activities on the site, measured in accordance with the provisions of NZS 6801:2008 "Acoustics – Measurement of environmental sound", and assessed in accordance with NZS 6802:2008 "Acoustics - Environmental Noise", shall not exceed the following noise limits within the notional boundary of any dwelling, during the following times:
   - Daytime 0700 to 2200 hrs 55 dB $L_{Aeq(15mins)}$
   - Night 2200 to 0700 hrs 45 dB $L_{Aeq(15mins)}$ and 70 dB L_{AFmax}
2. Construction activities including erection of structures and buildings, formation of site access roads, bund construction and site rehabilitation, shall be conducted in accordance with NZS 6803: 1999 "Acoustics - Construction Noise", and shall comply with the "long term duration" noise limits contained within Table 2 of that Standard.
3. Should vehicle reversing alarms be required in vehicles owned by the site operator, only broadband noise alarms are to be used. Tonal reversing alarms are not permitted.

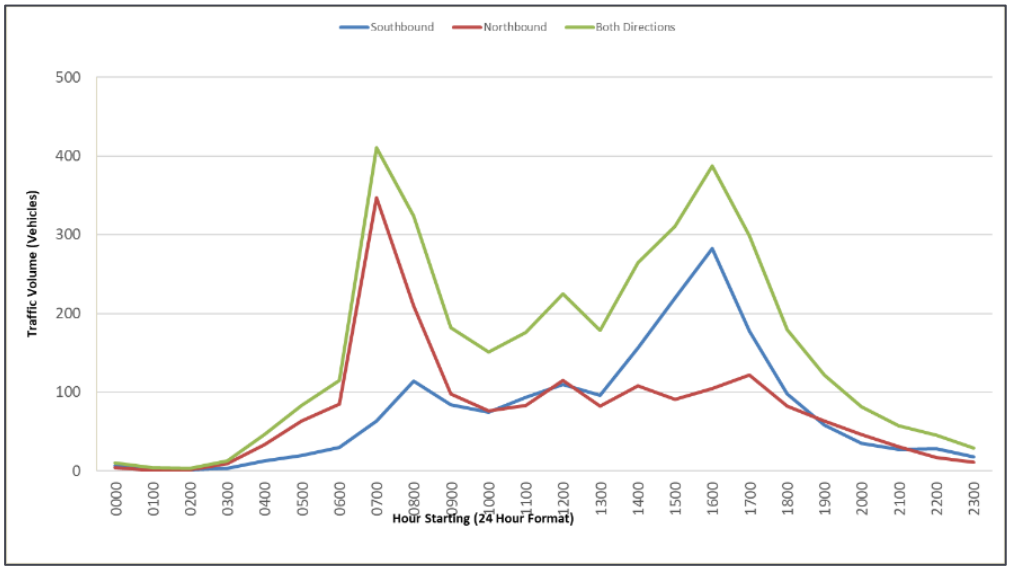
APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
dB	Decibel. The unit of sound level.
L_{A10}	The A-weighted sound level exceeded for 10% of the measurement period, measured in dB. Commonly referred to as the average maximum noise level.
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_w	Sound Power Level. The calculated level of total sound power radiated by a sound source. Usually A-weighted i.e. L_{WA}.
Background sound	The sound that is continuously present in a room our outdoor location. Often expressed as the A-weighted sound level exceeded for 90 % of a given time period i.e. L_{A90}.
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
Notional boundary	A line 20 metres from any side of a dwelling, or the legal boundary where this is closer to the dwelling. This definition is from NZS 6802:2008.
Total sound **Or** **Ambient sound**	The totally encompassing sound in a given situation at a given time, from all sources near and far, including the Specific Sound. See also Residual Sound.  This definition is from NZS 6802:2008.

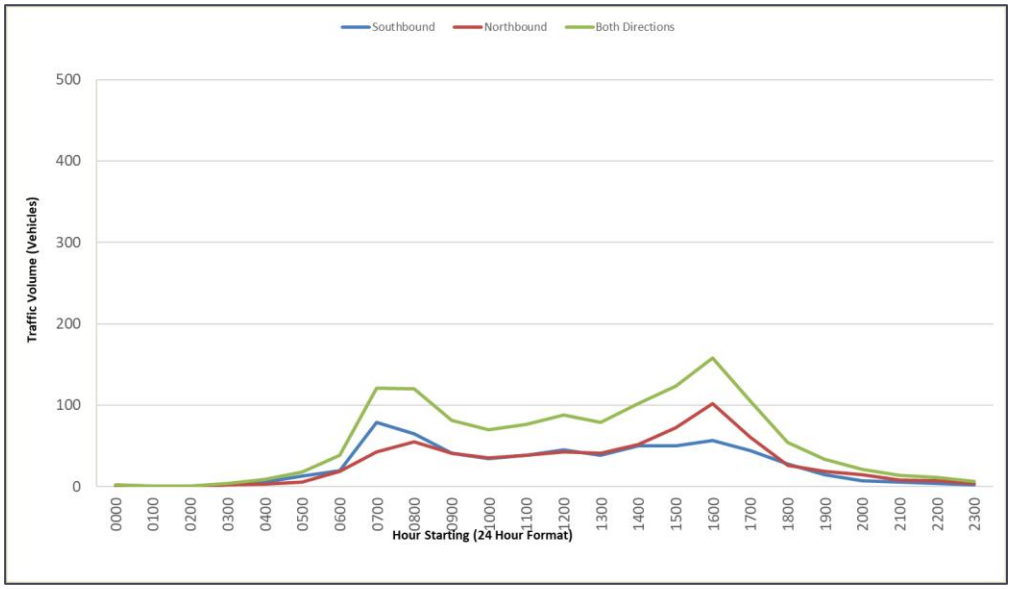
APPENDIX B SUMMARY OF STANTEC TRAFFIC DATA FOR AYLESBURY RD

Local Road Daily Traffic Volumes (vehicles per day)

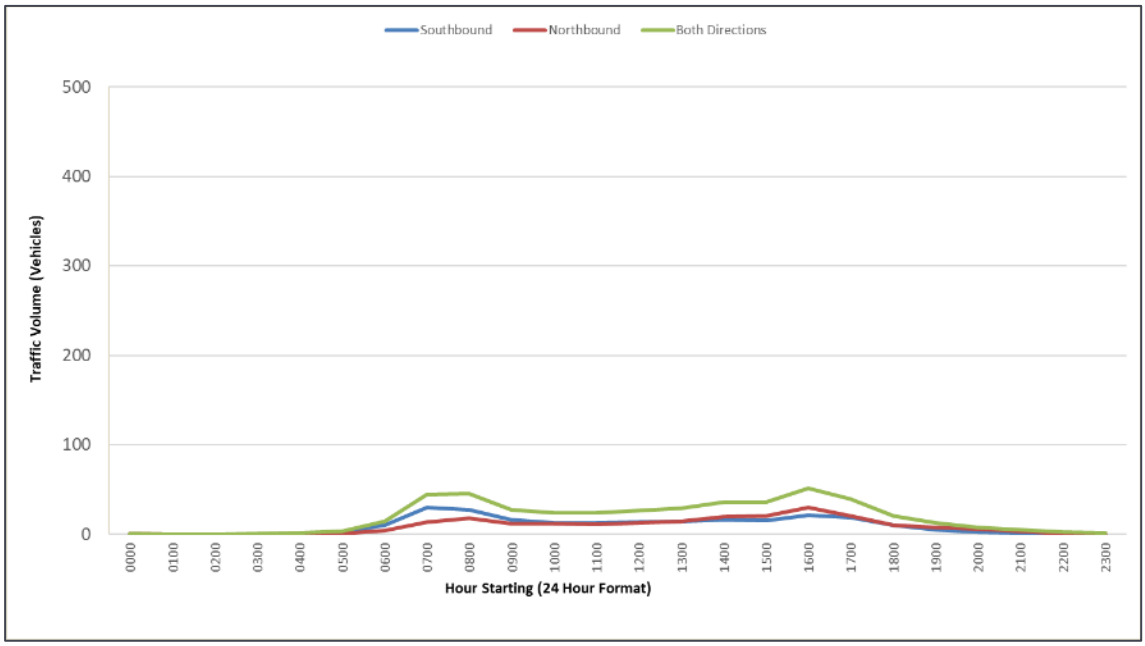
Road Location	Weekday (5 day) Average Volume	Average Daily Volume (7 day)	Date
Aylesbury Road north of SH1	3,700	3,350	July 2022
Aylesbury Road south of Two Chain Road	1,340	1,225	July 2022
Aylesbury Road north of Two Chain Road	460	460	July 2022



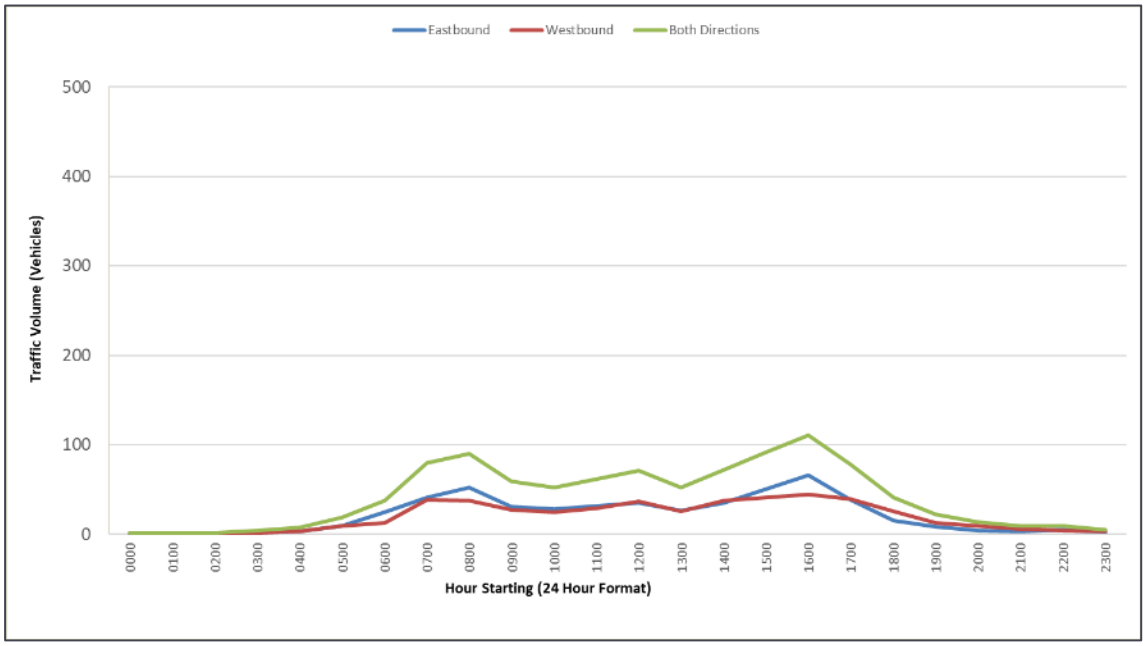
Weekday Hourly Traffic Volumes on Aylesbury Road North of SH1



Weekday Hourly Traffic Volumes on Aylesbury Road South of Two Chain Road



Weekday Hourly Traffic Volumes - Aylesbury Road north of Two Chain Road



Weekday hourly traffic volumes on Two Chain Road east of Aylesbury Road

APPENDIX C NOISE SURVEYS

C1 Attended survey details

19 May 2022

The key details of the noise survey are as follows:

Date: 19 May 2022, 1130 - 1330 hrs

Personnel: Anna Woods, Marshall Day Acoustics

Weather: Average temperature 16°C, 50% cloud cover, ~6 m/s wind from the north west.

Instrumentation: Brüel & Kjær Type 2250 analyser, serial 2683036, calibration due 22/09/2024
Brüel & Kjær Type 4231 calibrator, serial 2574264, calibration due 04/10/2023

Calibration: Field calibration of the equipment was carried out before measurements, and the calibration checked after measurements. Observed change less than 0.1 dB.

27 May 2022

The key details of the noise survey are as follows:

Date: 27 May 2022, 1400 - 1630 hrs

Personnel: Anna Woods, Marshall Day Acoustics

Weather: Average temperature 13°C, 0% cloud cover, ~4 m/s wind from the south east

Instrumentation: Brüel & Kjær Type 2250 analyser, serial 2683036, calibration due 22/09/2024
Brüel & Kjær Type 4231 calibrator, serial 2574264, calibration due 04/10/2023

Calibration: Field calibration of the equipment was carried out before measurements, and the calibration checked after measurements. Observed change less than 0.1 dB.

25 July 2023

The key details of the noise survey are as follows:

Date: 25 July 2023, 1300 - 1630 hrs

Personnel: Forester King, Marshall Day Acoustics

Weather: Average temperature 8°C, 100% cloud cover, ~3 m/s wind from the south west

Instrumentation: NTi XL2-TA analyser, serial A2A-20483-E0, calibration due 01/04/2024
Brüel & Kjær Type 4231 calibrator, serial 1882775, calibration due 20/02/2024

Calibration: Field calibration of the equipment was carried out before measurements, and the calibration checked after measurements. Observed change less than 0.1 dB.

C2 Long term noise logger results

Figure 22: Logger position 1 – 8.5 days

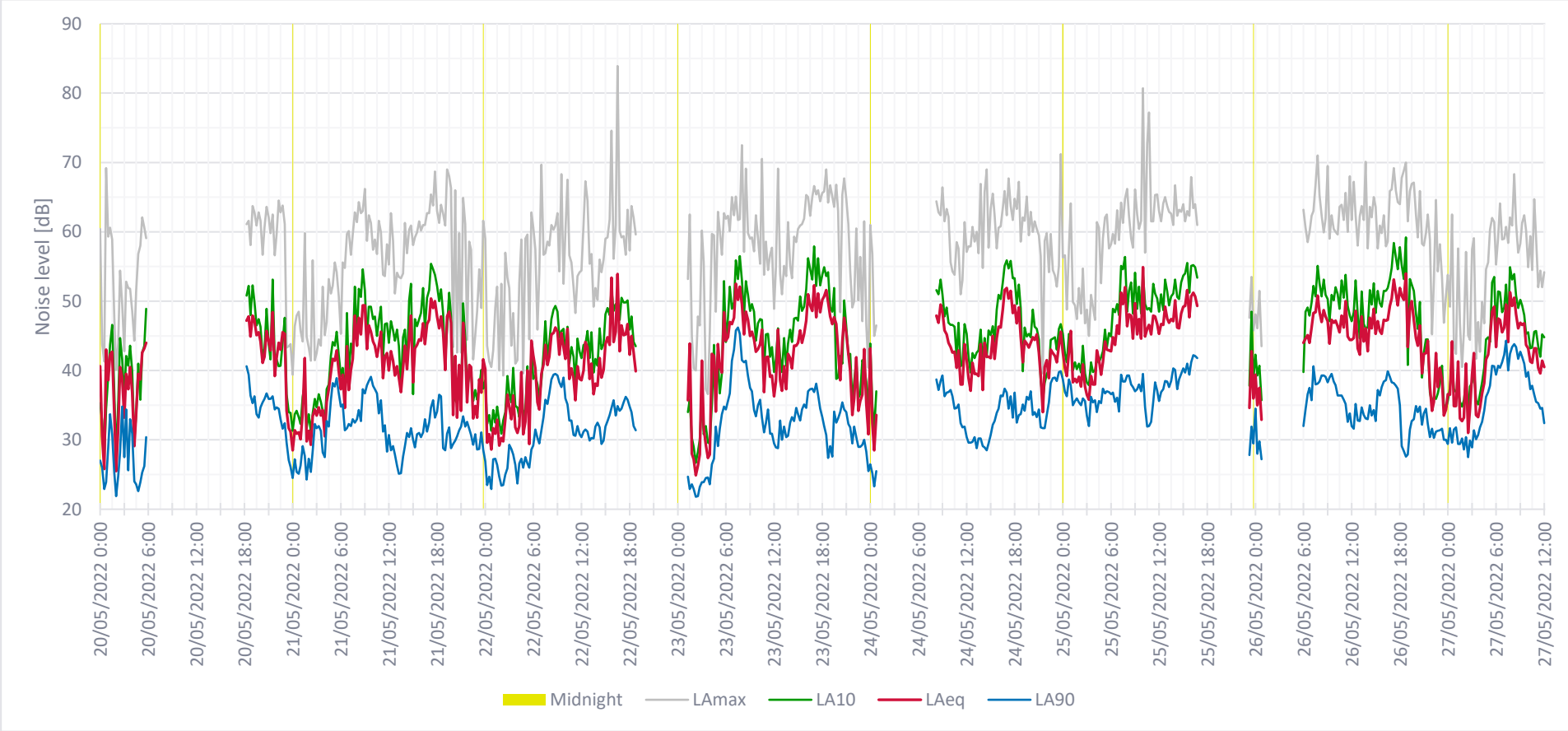
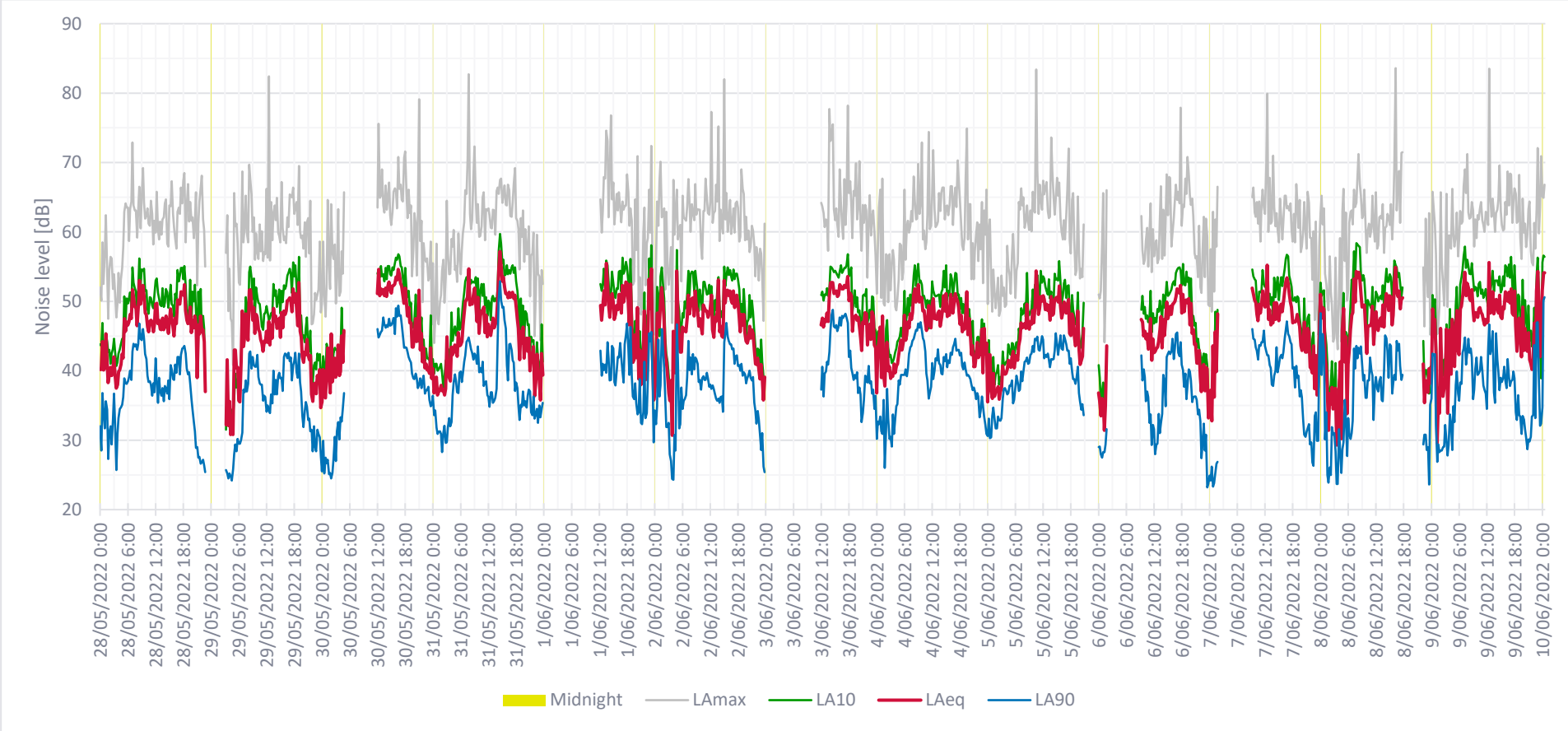


Figure 23: Logger position 2 – 13 days



APPENDIX D NOISE CONTOUR PLOTS

(following pages)