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Newcastle Sand Pty Ltd

Newcastle Sand - Bobs Farm

Noise and Vibration Impact Assessment Report

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Executive Summary

A noise and vibration impact assessment has been completed to determine the potential impacts of the proposed sand quarry at Bobs Farm on noise-sensitive receptors within the surrounding area.

The quarry will introduce an additional 120 heavy vehicle movements along Nelson Bay Road. Based on noise modelling conducted, traffic noise levels associated with the additional heavy vehicles results in insignificant increases in traffic noise levels of up to 0.3dB(A) during adverse weather conditions. This increase in noise level is not detectable by the human ear.

Noise associated with construction stages of the quarry are predicted to exceed at some receptors during neutral and adverse weather conditions. The implementation of a Construction Noise and Vibration Management Plan (CNVMP) will be critical in minimising noise impacts as far as possible, along with communicating with, and managing the expectations of surrounding receptors.

Future potential operational noise levels at the nearest noise sensitive receivers were predicted using the SoundPLAN noise model for three stages (2, 4 and 8) considered to be worst case scenarios due to their proximity to sensitive receptors. For each scenario, noise levels were predicted during both neutral and worst-case weather conditions.

Noise levels are predicted to comply in Stage 2 but exceed the day and night-time operational criteria without acoustic mitigation for Stages 4 and 8. Vipac recommends an operation hold once Stage 2 is complete to be able to provide onsite noise measurements of equipment and monitoring at nearby receptors to aid in providing effective noise mitigation strategies for all future stages.

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1 Introduction

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Newcastle Sand to conduct a Noise and Vibration Impact Assessment of the proposed Sand Farm located on 3631 Nelson Bay Road, (Deposited Plans DP753204 (40.9ha)), Bob's Farm NSW.

This report addresses Item 3 of the Key Issues list detailed in the Department of Planning, Housing and Infrastructure 'Planning Secretary's Environmental Assessment Requirements (SEARs) issued on the 18th of December 2025 and reproduced in Table 1-1.

Table 1-1 - SEARs Noise Requirements (SSD-99860959)

Key Issues	3. Noise A noise impact assessment including: • A detailed assessment of the likely construction operational and off-site transport noise impacts of the development in accordance with the *Interim Construction Noise Guideline*, *NSW Noise Policy for Industry* and the *NSW Road Noise Policy* respectively and having regard to the *Voluntary Land Acquisition and Mitigation Policy*. If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under *the Interim Construction Noise Guideline*; • Reasonable and feasible mitigation measures to minimise noise emissions; and • Consideration of monitoring and management measures, in particular real-time and attended noise monitoring.

2 Glossary of Terms

A list of commonly used acoustical terms (and their definition) used in this report is provided below in Table 2-1 as an aid to readers of the report.

Table 2-1 – Definition of Acoustic Terms

Term	Definition
$L_{Aeq,T}$	Time-averaged A-weighted sound level over period *T*, representing overall acoustic energy.
$L_{A1,T}$	Noise level exceeded for 1% of the measurement period, representing short-term peak noise events within the period
$L_{A10,T}$	Noise level exceeded for 10% of the period; commonly used for road traffic noise.
$L_{A90,T}$	Noise level exceeded for 90% of the period; used in Australia as the descriptor for background noise.
Vibration Dose Value (VDV)	Cumulative measure of human exposure to vibration over time.
Peak Particle Velocity (PPV)	Maximum instantaneous ground vibration velocity, used for building damage assessment.
Airblast Overpressure	Pressure wave from blasting, measured with linear weighting (dB(Lin)).
Receptor	Any noise-sensitive location such as a dwelling, school or community facility.

3 Project Description

3.1 Site Location

The Bobs Farm site deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200 km north of Sydney, near Bobs Farm, NSW. The surrounding area is predominantly zoned as rural with minimal primary production. The site is located in Bob's Farm approximately 27 km north-east of Newcastle and approximately 14 km south-west of Nelsons Bay. The site is bounded to the south by Nelson Bay Road and to the north by Marsh Road. The location of the proposed development site is illustrated in Figure 3-1.

Figure 3-1 - Site Location

3.2 Background

The proposed site was previously the subject of a similar sand quarry application in 2019 but was ultimately withdrawn. The previous proposal sought consent to extract up to 750,000 tonnes of sand per annum for a period of 15 years. Ambient noise monitoring previously conducted as part of the previous application has been utilised for the purposes of this current assessment.

3.3 Proposed Operations

The Proponent seeks to develop the site for an extractive industry as a sand quarry. Consent is sought for annual extraction of 530,000tpa for 10 years, equating to a total life-of-quarry sand extraction of approximately 4.4 million tonnes. It is anticipated the proposal would average sales of 10,000 to 12,000 tonnes per week.

The site has an area of approximately 40.9ha with the proposal seeking to use the entirety of the subject site for extractive industry purposes except for:

- A 15m buffer between the site boundary and any areas of extraction.
- The existing right-of-carriage way including a 3m buffer in the north-east of the site and the area east of this right-of-carriageway.
- The existing electricity easement including a 3m buffer at the southern end of the site and the vegetated area to the south of this easement Dry (surface) sand extraction only is proposed.

No dredging activity or below-groundwater-level extraction is proposed with only dry (surface) sand extraction being employed.

Preparation of the site and proposed sand quarry operations would broadly comprise:

- Construction of a new left-in left-out intersection
- Establishment of processing and sales area including installation of onsite office (Atco structure), installation of screening and wash facilities, designation of stockpiling areas, and use of the existing dwelling at the site for a manager's residence.
- Staged vegetation clearing and topsoil stripping.
- Dry extraction methods only down to a maximum of 0.7m above the ground water table.
- Ongoing rehabilitation.

Day-to-day operations would require two (2) articulated haul trucks (Volvo A40G) loaded by a hydraulic excavator (Volvo EC350) to transport raw sand from the extraction area to the on-site processing facility being a full electric screen and wash plant. Equipment will include excavators, front-end loaders, haul trucks, conveyors and water carts. Operations would utilise modern, well-maintained equipment incorporating advanced noise attenuation and fuel efficiency technology to reduce operational impacts on the surrounding environment.

The site is connected to power as well as Hunter Water Corporation's reticulated potable water supply. Potable water is proposed to be used for sand wash operations. Reticulated sewer is not available and so facilities would rely on a pump-out system.

Sales would be by haulage truck at a maximum of ten (10) loaded trucks per hour equating to a maximum of 60 loaded trucks per day. All transport trucks would travel east along Nelson Bay Road and complete a U-turn at the Port Stephens Drive roundabout. Haulage trucks will be prohibited from using Marsh Road. The site will be accessed by way of a new left-in left-out intersection onto Nelson Bay Road. The existing access to the site at the electricity easement is proposed to be retained for access to the existing dwelling as a manager's residence.

Progressive rehabilitation of exhausted areas will take place in accordance with an approved rehabilitation plan. The proposed post-quarry use of the site is to return the site to its current condition, being the same ratio of vegetated land and land used for the purpose of extensive agriculture.

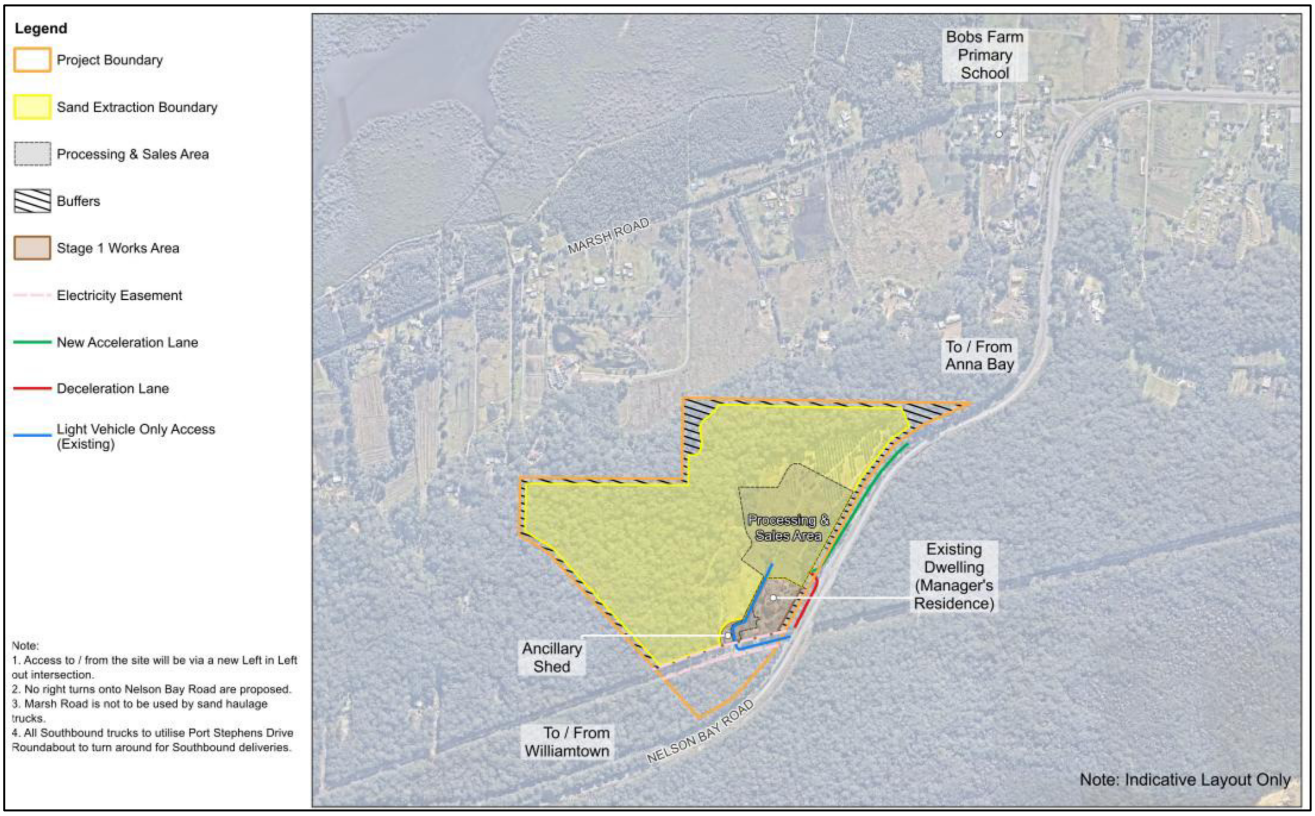

Figure 3-2 - Site Plan

3.4 Operational Hours

Proposed operation hours for the quarry are detailed in Table 3-1.

Table 3-1 - Proposed Operation Hours

Activity	Operating Hours
Sand processing, washing and production	7am to 5pm, Monday to Friday 7am to 4pm, Saturday
Sales	6am to 6pm, Monday to Friday 7am to 4pm, Saturday Closed Sunday and Public Holidays.
Maintenance activities	24 hours a day, 7 days a week, providing maintenance activities are inaudible at any privately-owned residence.

The proposed extraction staging design is provided below in Figure 3-3.

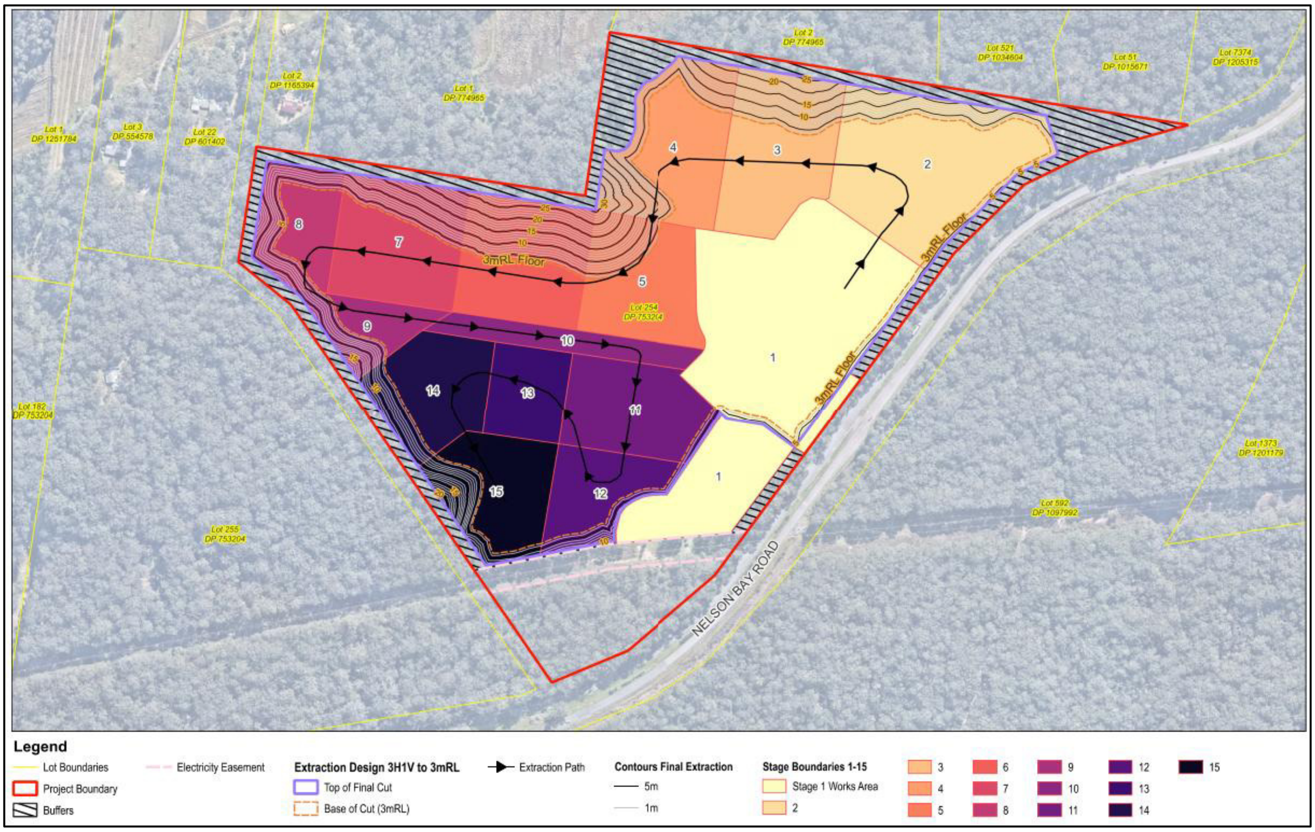

Figure 3-3 - Proposed Quarry Design

3.5 Noise Sensitive Receivers

The closest existing dwellings to the extraction area are located approximately 55m to west of the extraction area in the northeastern corner of the site, and 60m from the extraction area in the bottom west corner of the proposed quarry. The sensitive receptors considered in this assessment are presented in Table 3-2 and illustrated Figure 3-4 and Figure 3-5.

Table 3-2 - Noise Sensitive Receptors

Reference	Description	Distance from Site Boundary (approx.)	UTM Coordinates	
			Easting	Northing
R1	724 Marsh Road - Residential	250m	407080	6373782
R2	776 Marsh Road - Residential	650m	407432	6374056
R3	772 Marsh Road - Residential	650m	407410	6374157
R4	764 Marsh Road (Marsh Road Public School)	700m	407377	6374169
R5	762 Marsh Road - Residential	700m	407313	6374153
R6	760 Marsh Road (Marsh Road Public Hall)	700m	407306	6374183
R7	756 Marsh Road - Residential	650m	407270	6374128
R8	710 & 712 Marsh Road - Residential	500m	406822	6374040
R9	698 Marsh Road - Residential	150m	406807	6373689
R10	666 Marsh Road - Residential	350m	406409	6373926
R11	650 Marsh Road - Residential	350m	406345	6373915
R12	686 Marsh Road (Shark and Ray Centre)	250m	406209	6373694
R13	686 Marsh Road (Tourist Accommodation – Managers Residence)	40m	406497	6373636
R14	686 Marsh Road (Tourist Accommodation – Nearest Eco Cabins)	60m	406444	6373588
R15	644 Marsh Road - Residential	50m	406123	6373508
R16	640 Marsh Road - Residential	60m	406016	6373514
R17	630 Marsh Road - Residential	150m	405912	6373456
R18	3551 Nelson Bay Road - Residential	200m	405906	6373182
R19	3515 Nelson Bay Road - Residential	500m	405758	6372941
R20	723 Marsh Road - Residential	650m	406868	6374185
R21	731 Marsh Road - Residential	700m	407003	6374232
R22	761 Marsh Road - Residential	800m	407322	6374277
R23	767 Marsh Road - Residential	800m	407385	6374280
R24	781 Marsh Road - Residential	800m	407503	6374223
R25	3780 Nelson Bay Road - Residential	700m	407631	6374081
R26	3724 Nelson Bay Road - Residential	500m	407629	6373758
R27	3790 Nelson Bay Road - Residential	400m	407547	6373678
R28	774 Marsh Road - Residential	450m	407339	6373929
R29	3679 Nelson Bay Road	200m	407189	6373682

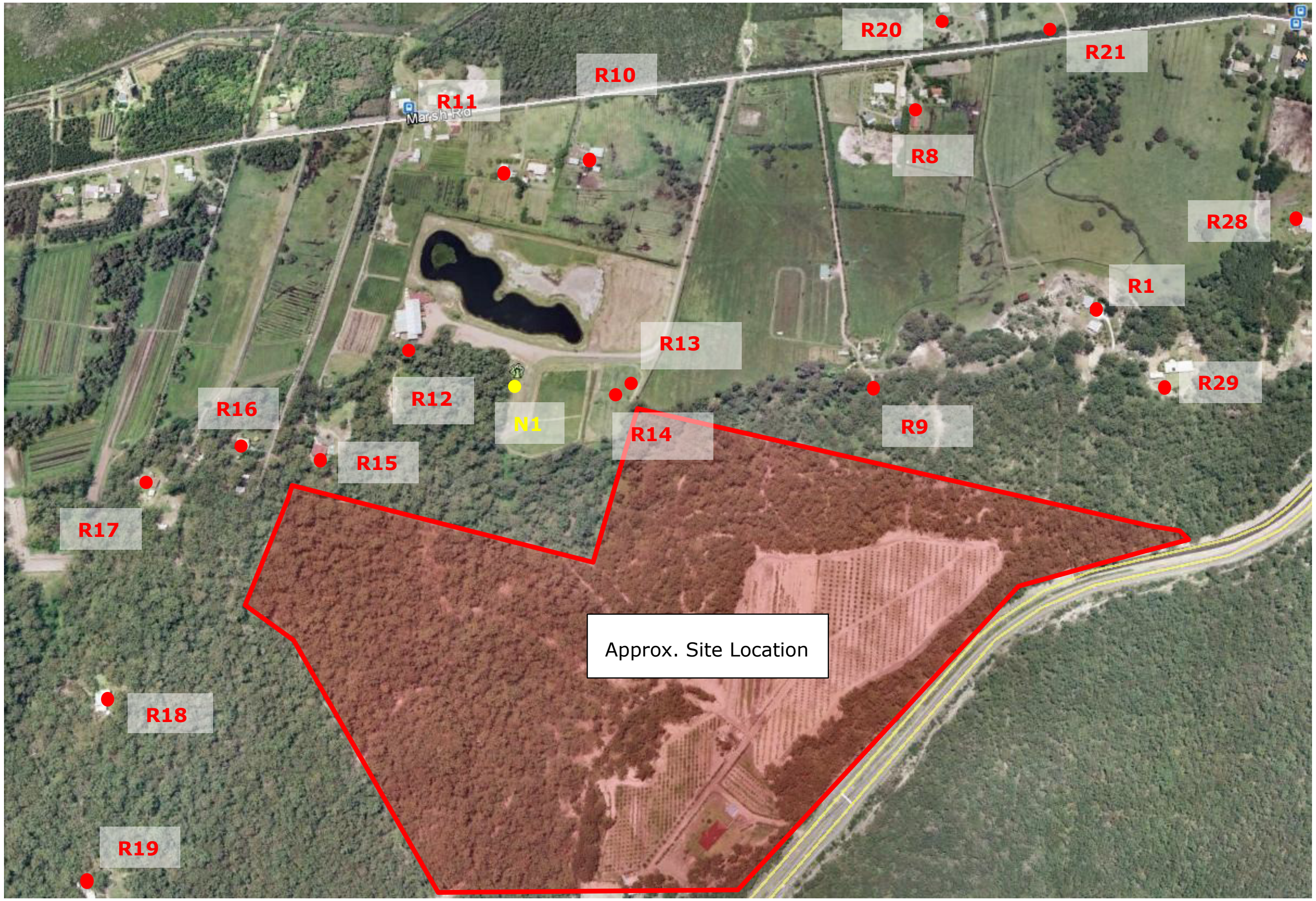

Figure 3-4 - Noise Sensitive Receivers (R9 - R17, R20, R21) and Noise Monitoring Location N1

Figure 3-5 - Noise Sensitive Receivers R1-R8 and R22-R28 and Noise Monitoring Location N2

4 Existing Noise Environment

Vipac installed noise logging equipment at two locations to measure baseline environmental noise levels at representative noise sensitive receptor locations in the vicinity of the proposed sand quarry site as part of the site work completed for the previous application for the proposed site in 2019. The noise monitoring data captured in 2019 is considered to still be representative of the current ambient noise levels within the surrounding area. The location of the monitoring points are listed in Table 4-1 and shown in Figure 3-4 and Figure 3-5. Monitoring was undertaken for a period of one week between the 1st and 8th of October 2019 and conducted in accordance with AS1055:2018 – Acoustics – Description and Measurement of Environmental Noise.

The primary aim of the noise logging survey was to determine the existing environmental noise levels of the potentially affected area and to enable an assessment of the potential noise impacts on the receiving environment. Logger Location 1 (N1) is considered representative of the ambient environment experienced by sensitive receivers northwest and west of the site while Logger Location 2 (N2) is representative of receivers northeast and east of the site.

Table 4-1 - Monitoring Locations

Loc.	Noise Survey Dates	Location / Address	Instrument	Serial No.
N1	1st – 8th October 2019	686 Marsh Road	RION NL-42	00521660
N2	1st – 8th October 2019	762 Marsh Road	RION NL-42	00621927

The microphones were installed in a free field location and 1.5m above ground level. The instruments were programmed to accumulate noise data continuously over sampling periods of 15-minutes for the entire monitoring period. Internal software then calculates and stores the Ln percentile noise levels for each sampling period, which can later be retrieved for detailed analysis.

All equipment was calibrated by a National Association of Testing Authorities (NATA) accredited laboratory. The instruments were field calibrated using an Onno-Sokki calibrator immediately before and after monitoring.

Table 4-2 presents a summary of the current ambient noise levels at the monitoring locations. Graphical representation of the monitoring results is presented in Appendix B.

Table 4-2 - Summary of Current Ambient Noise Levels (dB(A))

Loc.	Period	L_{Aeq}	L_{A90}	RBL
N1 (R9-19)	Day	49	40	35
	Evening	50	45	42
	Night	44	37	28
N2 (R1-8, R20-29)	Day	51	45	40
	Evening	49	43	34
	Night	43	37	26

Weather during the monitoring period was mostly fine with light winds, temperatures ranging between 7 and 35 degrees Celsius (source: Bureau of Meteorology – RAAF Williamtown Station (ID: 061078) with rainfall occurring on the morning of the 5th of October between 9am and 1pm. This weather affected data has been excluded from the analysis.

5 Assessment Methodology, Noise and Vibration Criteria

5.1 NSW EPA Noise Policy for Industry 2017

NSW Noise Policy for Industry (NPfI) (2017) sets limits on the noise that may be generated by a wide array of facilities and includes guidance that is applicable for the assessment of potential noise impacts from the operational stages of developments such as the proposed sand quarry. These limits are dependent upon the existing noise levels at the site and are designed to ensure changes to the existing noise environment are minimised and deal with the intrusiveness of the noise and the amenity of the environment. The most stringent of the limits is taken as the Project Specific Noise Level which is the most stringent of the amenity criteria or the intrusiveness criteria for the location.

The amenity criteria for this project are recommended acceptable $L_{Aeq,T}$ noise levels for residences in rural areas as provided in Table 2.2 of the NPI. Amenity criteria are formulated to protect against cumulative impacts.

The intrusiveness noise criterion requires that the $L_{Aeq,15minutes}$ for the noise source, measured at the most sensitive receiver under worst-case conditions, should not exceed the Rated Background Level (RBL) by more than 5dB, represented as follows:

- $L_{Aeq,15minutes}$ < RBL+ 5dB

Noise levels associated with the proposed sand quarry at nearby noise sensitive receptors (located in the surrounding area) should not exceed the Project Specific Noise Levels detailed in Table 5-1, which have been determined from the lower of the amenity and intrusiveness criteria.

Table 5-1 - Project Specific Noise Levels at Noise Sensitive Receptors dB(A) - Residential

Location	Period	L_{Aeq}	RBL	Recommended Amenity Noise Level L_{Aeq}	Intrusiveness Criteria Level	Project Specific Noise Level
N1 (R9-19)	Day	49	35	50	40	40
	Evening	50	42	45	47	45
	Night	44	28 (30*)	40	33 (35*)	35
N2 (R1-8, R20-28)	Day	51	40	50	45	45
	Evening	49	34	45	39	39
	Night	43	26 (30*)	40	31 (35*)	35

*NSW NPI states that where the rating background noise level is found to be less than 30dB(A) for the evening and night periods, then it is set to 30dB(A); where it is found to be less than 35dB(A) for the daytime periods, then it is set to 35dB(A).

Table 5-2: Project Specific Noise Levels dB(A) – Non-residential

Loc.	Period	Recommended Amenity Level
R4 - Marsh Road Public School	When in Use	40[1] $L_{Aeq\ (1hr)}$(external)
R6 - Marsh Road Public Hall	When in Use	55 $L_{Aeq\ (1hr)}$
R12 - Shark and Ray Centre	When in Use	55 $L_{Aeq\ (1hr)}$

5.2 Sleep Disturbance Assessment Approach

The NPfI refers to the NSW Road Noise Policy for criteria when assessing sleep disturbance. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages. The NPI states that:

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,\ 15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52dB(A) or the prevailing RBL plus 15dB, whichever is the greater,

A detailed maximum noise level event (sleep disturbance) assessment should be undertaken.

[1] The recommended amenity noise level for school classrooms is an internal level of 35db(A). Vipac have assumed 5dB transmission loss through an open window to assess the impact as an external level.

Guidance indicating the potential for sleep disturbance is set out in the NSW Road Noise Policy (RNP) and is summarised as follows:

> The NSW Office of Environment and Heritage (OEH) reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.
>
> From the research, OEH recognised that current sleep disturbance criterion of an $L_{A1,\ (1\ minute)}$ not exceeding the L_{A90}, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, OEH will continue to use it as a guide to identify the likelihood of sleep disturbance.
>
> This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.
>
> The detailed analysis should cover the maximum noise level or $L_{A1,\ (1\ minute)}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:
>
> - How often high noise events will occur,
> - Time of day (normally between 10pm and 7am),
> - Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The $L_{A1,\ (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. The NSW Department of Environment, Climate Change and Water (DECCW) will accept analysis based on either $L_{A1,\ (1\ minute)}$ or $L_{A(Max)}$.

Table 5-3 details the criteria for sleep disturbance for each of the individual noise receiver locations.

Table 5-3 - Sleep Disturbance Noise Criteria at Noise Sensitive Receptors dB(A) - Residential

Location	Period	L_{A90}	Criteria (L_{A90} + 15)
N1 (R9-19)	Night	37	L_{A1} 52dB(A)
N2 (R1-8, R20-28)		37	

5.3 NSR Road Noise Policy (RNP)

The requirements of the NSW Road Noise Policy (RNP) published by the Department of Environment, Climate Change and Water (DECCW) are also applicable to this assessment. Table 5-4 summarises the road category to establish the noise assessment criteria based on the type of road and the land use developments. The proposed development has the potential to generate additional traffic on Nelson Bay Road that can potentially impact on the nearby noise sensitive receivers.

Table 5-4 - Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of project / land use	Assessment Criteria/ Target Noise Level, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road (Nelson Bay Road)	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,\ (15hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)

Note: These criteria are for assessment against façade- corrected noise levels when measured in front of a building façade. Hence, a correction factor of 2.5 dB is added to the predicted noise levels.

Section 3.4 of the RNP states where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable mitigation measures to meet the criteria. In assessing these measures, any increase in total traffic noise level should be limited to 2dB above that of the corresponding 'no build option'.

In addition to the criteria detailed in the table above, the magnitude of increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered. Residences experiencing increases in total traffic noise level above the relative increase criteria in Table 5-5 below should also be considered for mitigation.

Table 5-5 Relative Increase Criteria for Residential Land Uses

Road Category	Type of project / land use	Total traffic noise level increase, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road (Nelson Bay Road)	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq,\ (15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq,\ (9\ hour)}$ + 12 dB (external)

A relative increase of 12dB represents slightly more than an approximate doubling of perceived loudness (AS2659.1–1988) and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise.

The noise assessment criterion for non-residential land use is listed in Table 5-6**.** This criterion is applied when assessing the impact and determining mitigation measures in the following situations:

- When there is a new road or road development.
- When there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads.

Table 5-6 - Road traffic noise assessment criteria for non-residential land uses

Existing sensitive land use	Assessment criteria- dB(A)		Additional Consideration
	Day (7am – 10pm)	Night (10pm – 7am)	
School classrooms	$L_{Aeq,1hr}$ 40 (Internal) When in use	-	In the case of a building used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of worship	$L_{Aeq,1hr}$ 40 (Internal)	$L_{Aeq,1hr}$ 40 (Internal)	The criteria are internal, i.e. the inside of a Church. Areas outside the place of worship, such as Churchyard or Cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise.
Childcare facilities	Sleeping rooms $L_{Aeq,1hr}$ 35 (Internal) Indoor Play areas $L_{Aeq,1hr}$ 40 (Internal) Outdoor Play areas $L_{Aeq,1hr}$ 55 (External)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Commercial and Industrial Premises	Shopping Mall $L_{Aeq,}$45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Shopping Mall $L_{Aeq,}$45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Information on desirable internal noise levels is contained in Australian Standard 2107:2000.

Where internal noise levels were specified for the applicable criteria outlined in Table 5-6 above, +10dB was added to approximate to an external noise level, for the purposes of the traffic noise assessment which is undertaken to assess noise levels externally to noise sensitive properties.

5.3.1 Practice Note 3 (Sleep Disturbance Impact)

A substantial portion of the DECC NSW Road Noise Policy (RNP) discusses a review of international research on the subject of sleep disturbance associated with noise. The guidance regarding road traffic noise and potential impacts on sleep disturbance expands on previous guidance set out in the RTA Environmental Noise Management Manual (ENMM) and earlier guidance set out in the Environmental Protection Authority Environmental Criteria for Road Traffic Noise (ECRTN).

The most recent guidance set out in the RNP states that "*there appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise*". The RNP refers to the RTA Practice Note 3 protocol as the method for assessing and reporting on maximum noise levels that may cause sleep disturbance. The guidelines indicate that:

- Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum internal noise levels of 65-70 dB(A) are not likely to significantly affect health and well-being.

5.4 Construction Noise

The NSW Interim Construction Noise Guideline 2009 (ICNG) recommends standard hours for normal construction work which are Monday to Friday from 7am to 6pm, Saturdays from 8am to 1pm, and no work on Sundays or public holidays.

Where predicted noise levels from construction works during standard hours are above the noise affected level at a sensitive receptor, feasible and reasonable mitigation measures should be considered and where appropriate, adopted. The ICNG Table 2 provides guidance on establishing noise management levels (NML) for residential receptors during standard hours and is reproduced in Table 5-7.

Table 5-7 - Construction Noise at Residences using Quantitative Assessment

Time of Day	Management Level L_{Aeq} (15min)	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10	The noise affected level represents the point above which there may be some community reaction to noise. • 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. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noise activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near residences. • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level.

Time of Day	Management Level L_{Aeq} (15min)	How to Apply
		• Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 of the ICNG

The ICNG criteria for commercial and industrial premises are as follows:

- Classrooms at school and other educational institutions: Internal noise level 45dB(A).
- Offices, retail outlets: external $L_{Aeq\ (15min)}$ 70dB(A).

The project specific noise criteria for construction noise are provide in Table 5-8.

Table 5-8 - Project Specific Criteria for Construction Noise ($L_{Aeq,15min}$ dB(A))

Receptor	Time of Day	Rating Background Level (RBL), dB(A)	Noise Affected, dB(A)	Highly Noise Affected, dB(A)
N1 NSRs	Standard Hours	35	45	75
	Outside Standard Hours	28	33	
N2 NSRs	Standard Hours	40	50	75
	Outside Standard Hours	26	31	
R4, R6, R12	When in use	-	50*	-

*Assuming approximately 5dB(A) attenuation through an open façade to determine an external noise level from a given internal criterion.

5.5 Vibration Criteria

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration, and the possibility of them being disturbed or annoyed.
- Vulnerability of the building structures to vibration induced damaged.
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

Humans are very sensitive to vibration, and they can be disturbed, annoyed, and have their work activities interfered with if the levels are too high. The DECC "Assessing Vibration – Technical Guideline" (2006) and British Standard 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1 – Vibration sources other than blasting provides guidance on human response to vibration in buildings. The guidelines set down base vibration levels at which there would be minimal interference to occupants.

BS6841:1987 Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock also sets out guidance on the effects of physical health from sustained exposure to vibration. However, it is unlikely that such levels would be encountered from construction, demolition or sand quarrying activities. The frequency weighting to be applied to the vibration levels are obtained from BS6841.

The criteria and guidelines relating to human response are summarised below.

5.5.1 DECC Assessing Vibration: A Technical Guideline

The DECC "Assessing Vibration – Technical Guideline" (2006) provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards 6472:1992 "Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)".

For continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted RMS acceleration values. For intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV).

The DECC guidelines also include a section on mitigation when the predicted vibration value exceeds the criteria. Vibration mitigation may be achieved by way of:

- Controlling the vibration at the source, using the application of Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).
- Controlling the transmission of vibration.
- Controlling the vibration at the receiver

5.5.2 British Standard 6472:2008 – Evaluation of Human Exposure to Vibration in Buildings

BS6472:1992 was updated in 2008 by BS6472:2008 Parts 1 and 2. BS6472:2008 Part 1 sets out vibration levels at which minimal comment is likely to be provoked from the occupants of a building subject to vibration (BS6472:2008 Part 2 relates to Blast-induced vibration). BS 6472 takes into account the fact that humans perceive vertical vibrations to a greater extent than horizontal vibrations, although the effect is reversed at very low frequencies, below 4 Hz.

The evaluation of building vibration with respect to annoyance and comfort for occupants, over all weighted values of vibration is the preferred method of evaluation.

Continuous vibration would be generated for typical construction work. The curves in Figure 5-1 represent the magnitudes of continuous vibration in buildings for Z-axis acceleration, below which adverse comments or complaints are rare. Multiplication factors are applied to the base level curve to define criteria for residential or office spaces. There are similar curves for x and y-axes.

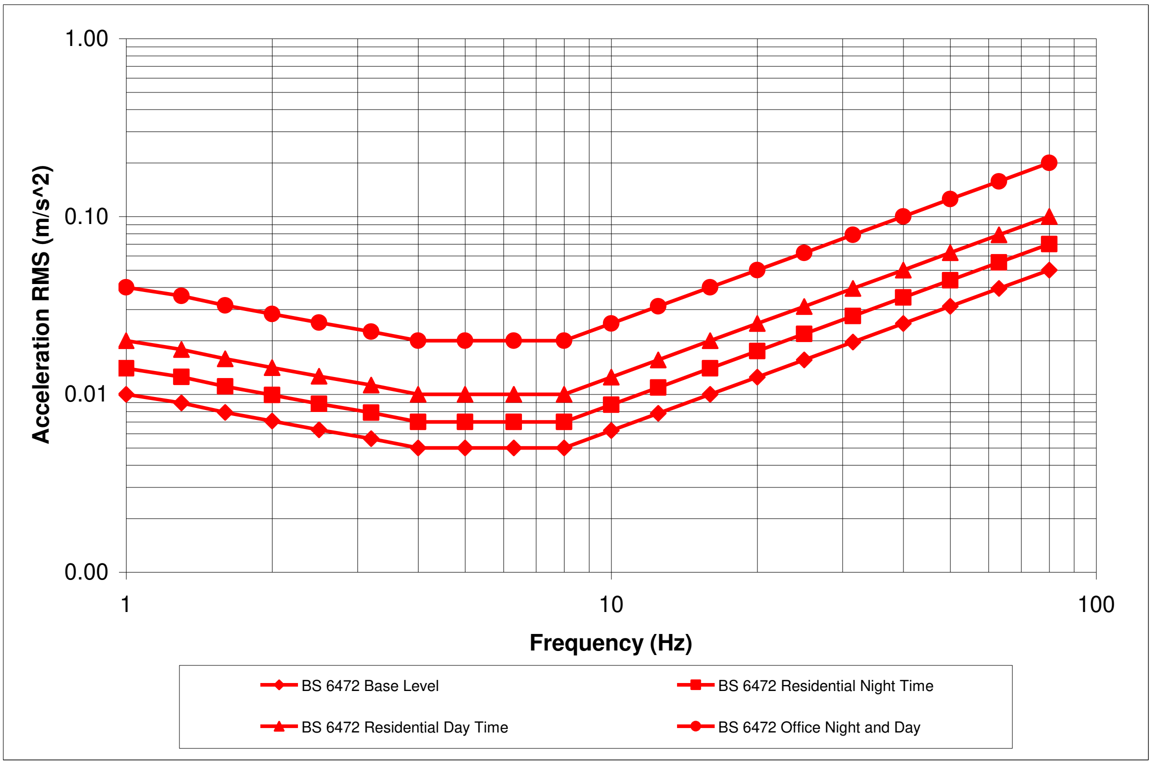

Figure 5-1 - BS 6472 building vibration levels. Z-axis

The Vibration Dose Value in BS 6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibrations. Vibration Dose Value or the VDV represents a single value amount used to quantify the level of vibration.

The recommended VDV levels outlined in the OEH Vibration Guidelines (based on the BS6472:1992 Standard) which specifies levels of VDV expressed in daytime, night-time and typical human response are presented in Table 5-9. Table 5-10 presents levels of VDV expressed in daytime, night-time and typical human response, based on the updated BS6472:2008 Part 1.

Table 5-9 - Acceptable vibration dose values for intermittent vibration in various buildings (m/s1.75)

Location	Daytime[1]		Night-time	
	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$
Critical areas[2]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Note 1: Daytime is 07:00 am to 10:00 pm and night-time is 10:00 pm to 07:00 am.

Note 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 criteria for critical cases.

Table 5-10 - Vibration dose value ranges which might result in various probabilities of adverse comment within various buildings (m/s1.75)

Place and time	Low probability of adverse comment $m/s^{1.75}$ Note 1	Adverse comment possible $m/s^{1.75}$	Adverse comment probable $m/s^{1.75}$ Note 2
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Office buildings 16h day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2
Workshop buildings 16h day	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Note 1: Below these ranges, adverse comment is not expected.

Note 2: Above these ranges, adverse comment is very likely.

Vibration frequency was assessed in a range from 8Hz - 80 Hz, as predominant frequencies are known to be above 8Hz. Vibration levels below the low probability of adverse comment range presented in Table 5-10 correspond to a low probability of disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches the higher range levels in the possible and probable categories. Values up to the maximum level in Table 5-9 can only be used where all reasonable and feasible measures have been implemented and they can be justified.

Criteria for exposure to continuous and impulsive vibration with regard to PPV levels expressed in daytime and night-time (outlined in the OEH Vibration Guidelines) is provided in Table 5-11.

Table 5-11 - Peak Particle velocity for z-axis

Place	Time	Peak Particle velocity (mm/s) for z-axis vibration - Frequency range 8Hz-80Hz	
		Exposure to continuous vibration (16h day, 8h night)	Impulsive vibration excitation with up to three occurrences
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day Night	0.14 to 0.28 0.14 to 0.28	0.14 to 0.28 0.14 to 0.28
Residential	Day Night	0.28 to 0.56 0.2 to 0.4	8.6 to 17.0 2.8 to 5.6
Office	Day Night	0.56 to 1.1 0.56 to 1.1	18.0 to 36.0 18.0 to 36.0
Workshops	Day Night	1.1 to 2.2 1.1 to 2.2	18.0 to 36.0 18.0 to 36.0

5.6 Structural Response to Vibration

The response of a building to vibration is affected by several factors that include its type of foundation: the underlying ground conditions, its construction and the state of the building.

BS 7385: Part 2-1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground borne vibration provides guidance values for building damage, as well as guidance on vibration measurement and data analysis. The German Standard DIN 4150: Part 3-1999 Structural vibration - Effects of vibration on structures also provides guidelines for evaluating the effects of vibration on structures.

5.6.1 German Standard DIN 4150-3:1999 – Structural Vibration – Effects of Vibration on Structures

The German Standard DIN 4150: Part 3-1999 Structural Vibration Part 3: Effects on buildings and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

Short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated.

Table 5-12 provides guideline limits for short-term vibration to ensure that damage reducing the serviceability of a building will not occur provided vibration levels do not exceed these limits. This is also shown graphically in Figure 5-2. Vibration at the foundation is taken as the maximum absolute value in the x, y, and z directions, and vibration at the highest floor is the maximum of the in-plane components.

Table 5-12 - DIN4150-3 Vibration Limits

Type of structure	Guideline values for velocity in mm/s			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

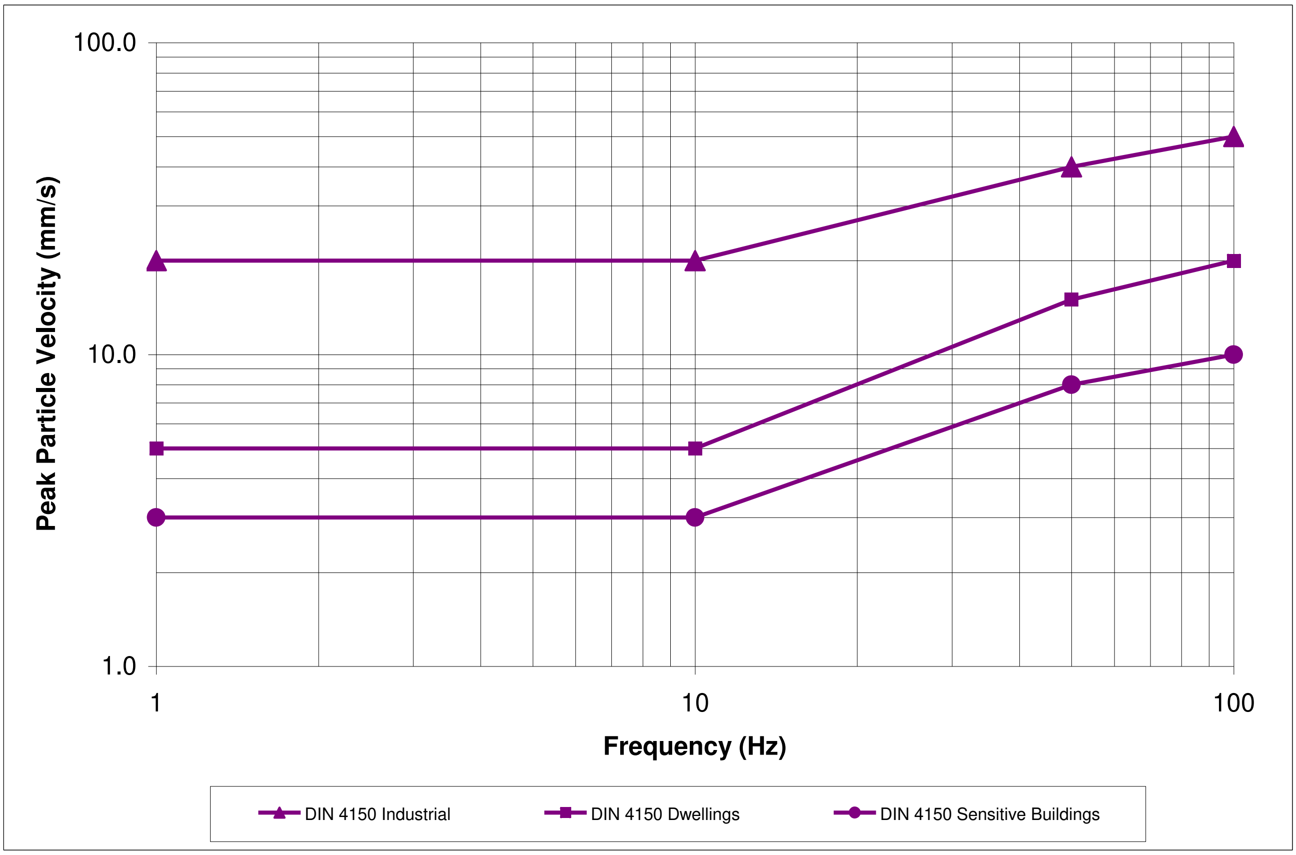

Figure 5-2- DIN 4150-3 Vibration Limits

5.6.2 British Standard 7385 Part 2 – 1993 Guide to Damage Levels from Groundborne Vibration

The limits for transient vibration, above which cosmetic damage could occur to buildings, are given in Table 5-13 and shown graphically in Figure 5-3.

These guide values however relate predominantly to transient vibration that does not give rise to resonant responses in structures. The guide values in Table 5-13 should be reduced by up to 50%, in the case of dynamic loading caused by continuous vibration. The values presented in BS 7385-2 are frequency dependant levels that are judged to give a minimal risk of vibration-induced damage.

Table 5-13 - Transient vibration guide values for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced 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
Note 1: Values referred to are at the base of the building Note 2: For the residential buildings group, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded		

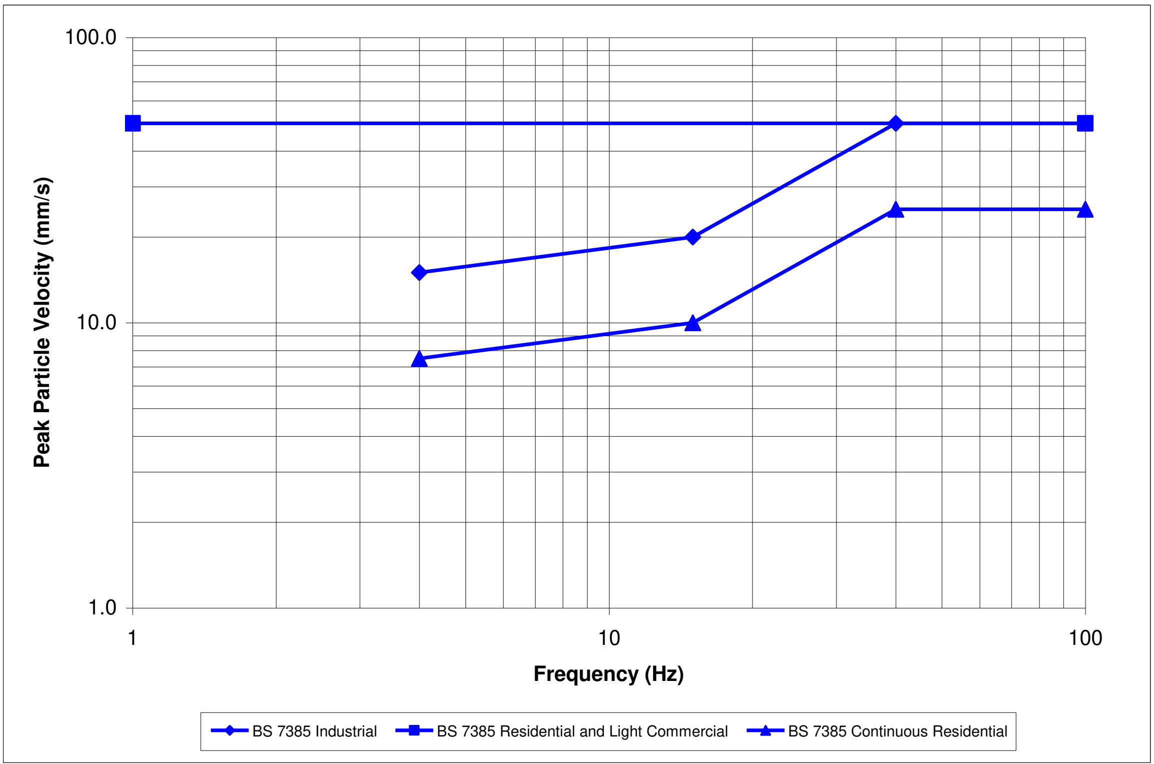

Figure 5-3 - Transient Vibration Guide for Cosmetic Damage

5.6.3 Construction Vibration Assessment Criteria Summary

A comparison to the above criteria is shown in Figure 5-4. PPV values have been used for the human disturbance values, in order to compare against building damage guide values.

The human disturbance criterion from BS 6472 for continuous vibration is significantly lower than the various threshold damage levels from DIN 4150 and BS 7385. This is due to humans being able to perceive vibration levels that are well below those that could cause any risk to damage to a building or its contents.

The values in DIN 4150 are levels that if complied with, damage will not occur. If levels are exceeded damage will not necessarily occur, however if they are significantly exceeded, then further investigations will be required.

The vales in BS 7385 are the lowest vibration levels above which damage has been credibly demonstrated. This is the basis on which the values are much higher than those of DIN 4150. Based on the above, the following criterion is deemed most appropriate and is recommended for use in this assessment:

When the adjacent building subject to vibration is being occupied, continuous vibration levels from BS 6472 will be used to assess human perception. Human perception occurs at lower thresholds than that for building damage and during occupied periods will be the limiting criteria.

When it is un-occupied, vibration levels from DIN 4150 will be used to protect the building from cosmetic damage.

Table 5-14 provides a summary of vibration management levels criterion at the sensitive receivers (which have been determined in accordance with the *Interim Construction Noise Guideline*).

Table 5-14- Human perception and cosmetic damage criteria (minimum value)

Type	Human Perception and cosmetic damage criteria	
	Human Perception (mm/s)	Cosmetic Damage (mm/s)
Residential	0.28-0.56	5

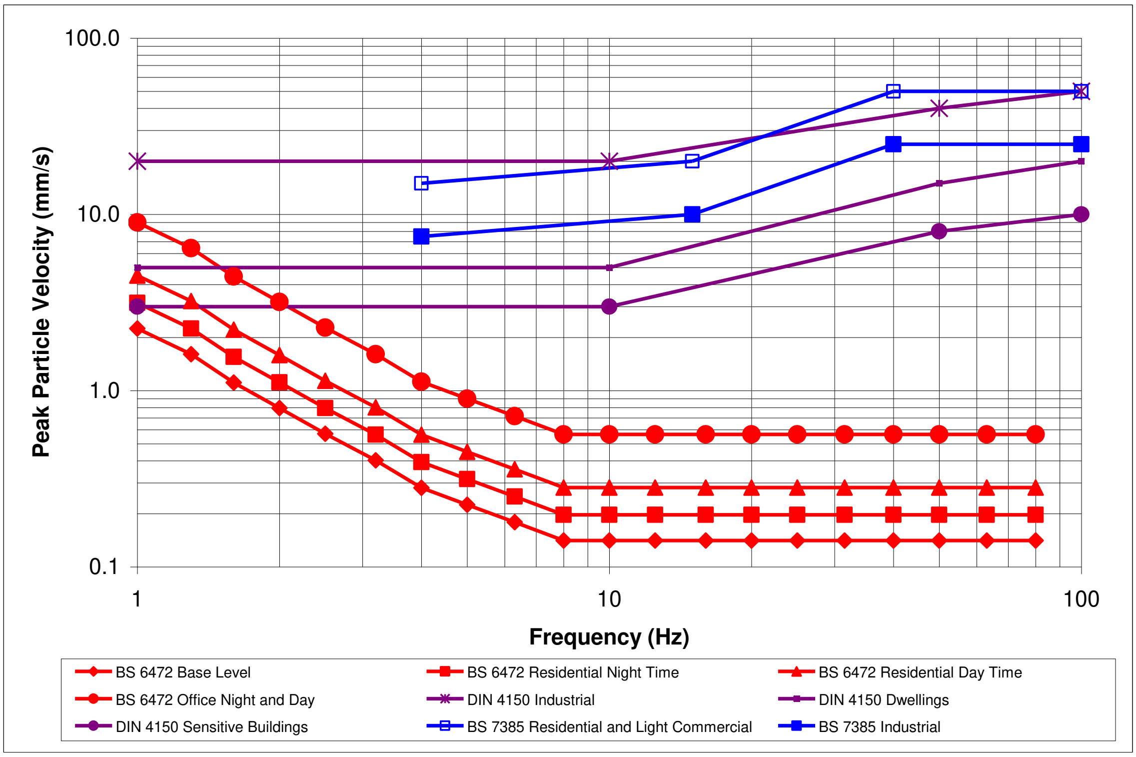

Figure 5-4 - Human Disturbance and Building Damage Guide Values

6 Noise Modelling

Noise modelling has been undertaken using the SoundPLAN computational noise modelling software package. The use of the SoundPLAN software and referenced modelling methodology is accepted for use in the state of NSW by the EPA for environmental noise modelling purposes. Vipac have undertaken numerous noise modelling and impact assessments previously using SoundPLAN for a range of projects, including infrastructure development and industrial projects.

6.1 Geographical Data

Newcastle Sand supplied topographical details of the area to Vipac and Table 6-1 below lists the drawings received and used in the noise prediction model.

Table 6-1 – Drawings/files Used

Drawing Title/File Reference	Description	Date
DEM points 2m	Natural Terrain Levels (3D Lidar Points) of the site and surrounding areas	12/02/2026
Extraction Stages 1-15 3D dxf	3D final pit levels of each stage	16/03/2026
Extraction Staging Plan	As per Figure 3-3	10/04/2026

6.2 Operational Phases

6.2.1 Noise Sources

A list of plant for use in the noise modelling has been compiled in coordination with Newcastle Sand and with details of the extraction process and plant as outlined in Section 3.

Details of the plant and equipment that will be used during the operational phase of the proposed sand quarry and indicative sound power levels are listed in Table 6-2. Where appropriate, sound power levels of equipment measured by Spectrum Acoustics at the nearby Cabbage Tree Quarry have been utilised as the majority of equipment at that quarry will be utilised for this project. Vipac have been informed all measurements were conducted in accordance with modified ISO 6395 methodology.

In the absence of measured or supplied L_{A1} data, L_{A1} noise levels have been conservatively assumed to be 10dB above the corresponding L_{Aeq} values. This assumption represents an intentionally extreme worst-case scenario, as L_{A1} levels for this type of activity would ordinarily be expected to align closely with, or only marginally exceed, the L_{Aeq}. Applying a +10 dB allowance therefore provides a highly precautionary upper bound on potential maximum noise events and ensures the assessment remains conservative under all plausible operating conditions.

Table 6-2 - Sound Power Levels (Lw).

Description	Sound Power levels		Sound Power Reference Source	Approx Source Heights
	L_w, L_{Aeq}(dB(A))	L_w, L_{A1}(dB(A))		
Volvo EC350E Excavator	104	-*	Spectrum Acoustics	2m
Volvo A40G x 2 Articulated Dump Truck	106 (per vehicle)	-*	Spectrum Acoustics	2m
Sales Loader (Volvo L220 x 2)	109 (per vehicle)	119	Spectrum Acoustics**	2m
Reverse Alarm x 2	105*** (per alarm)	115	Note 1	2m
Conveyor System Head Drive	97	-*	BS5228-1-2009	3m
Screens	101	-*	Spectrum Acoustics	3m
Pump x 2	100 (per pump)	-*	BS5228-1-2009	0.5m
Export Road Truck	103	113	Spectrum Acoustics	2m
McLanahan Wash Plant	101	-*	Spectrum Acoustics****	3m
McLanahan De-watering Screen	101	-*		3m

[1]'Auditory backup alarms: distance-at-first detection via in-situ experimentation on alarm design and hearing protection effects' - K. Alali and J.G Casali.

*L_{A1} levels not required as this noise source is not proposed to operate in the nighttime period.

**The measured spectrum was utilised for the Sales Loader, however the overall SWL detailed in the specification sheet of the Volvo L220 was utilised for a conservative assessment.

***Includes 5dB(A) penalty to account for tonality.

****Noise data of wash plant and de-watering screen unable to be provided. The equipment is expected to be of a similar noise level to the measured screen.

6.2.2 Scenarios

The quarry will progress in stages as per the staging plan in Figure 3-3. For the purposes of providing a worst-case assessment, Vipac has modelled operation of Stages 2, 4 and 8 to demonstrate the stages of operation that are closest to the sensitive receptors adjacent.

The model was prepared including all current nearby buildings and known future developments/buildings to accurately predict potential impacts from the quarry. The model includes all relevant noise sources as stated in Table 6-2, and assesses the total cumulative impact on all surrounding receivers at any one time for each modelled stage.

6.2.3 Assumptions

The operational scenarios are based on the following assumptions:

- Initial excavation of Stage 1 down to 3 metres AHD, being a minimum 0.7m above the groundwater level, will take place before any processing or operation equipment is brought to the site. Consequently, Stage 1 is considered 'construction only', and it is expected any sand extracted as part of the excavation of Stage 1 will be stockpiled until operation can commence at 3 metres AHD.
- Topsoil/overburden is cleared completely on a stage-by-stage basis from Stage 2 onward before any extraction commences.
- All extraction occurs from bottom of pit level, resulting in equipment operating behind the pit walls in each stage to maximise shielding from the natural terrain levels.
  - Each stage scenario has been modelled utilizing final pit design levels (i.e. terrain levels at completion of extraction of the stage) with extraction noise sources at the closest distance to the relevant receptors for each stage. Source locations are shown in Figure 6-1 to Figure 6-4.
  - The location of noise sources associated with the processing of material remain consistent through Stages 2, 4 and 8.
  - It is assumed that all noise sources will operate behind the closest pit walls to the relevant NSRs.
- Operational frequency assumptions (per 15-minute assessment period):
  - Screen(s) – 100% between 7am and 5pm.
  - Conveyer head drive – 100% between 7am and 5pm.
  - Pumps – 100% between 7am and 5pm.
  - Excavator (Volvo EC350) – 100% between 7am and 5pm.
  - Articulated Trucks (Volvo A40G) – 1 trip every 15 minutes between 7am and 5pm. Only one truck travelling between extraction and processing area per 15 minutes.
  - Sales Loaders (Volvo L220) – 5 minutes per export truck movement.
  - Export Road Truck – 2.5 events per 15 minutes (120 per day) between 6am and 6pm.
  - Reverse Alarms – 20 seconds per vehicle movement
  - Wash Plant – 100% between 7am and 5pm.
  - De-watering Screen – 100% between 7am and 5pm.
- Noise sources associated with the processing of sand are modelled in locations identified in the drawings and outlined in Figure 6-1.
  - The supplied design levels for Stages 1-4 do not align with the internal haul road location in the processing plant plan. For example, the Stage 4 design levels indicate an AHD of approx. 14.8m at the haul road entrance point into the processing area. It is assumed that articulated vehicles will not be entering the processing area via this path. Consequently, where applicable, line sources modelling articulated trucks travelling between the excavator and processing plant maintain operation at 3m AHD 'bottom of pit' levels.

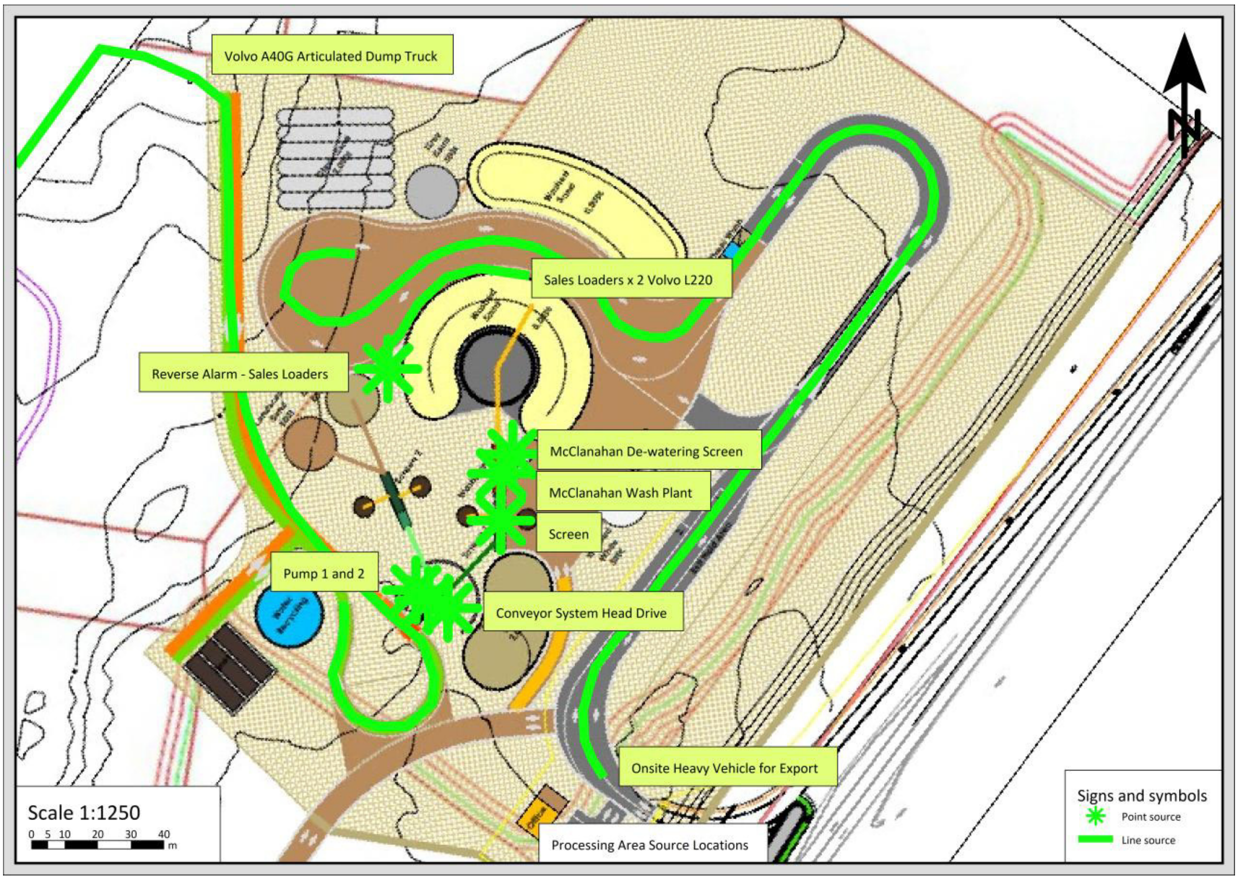

Figure 6-1 - Operational Source Locations - Processing Area

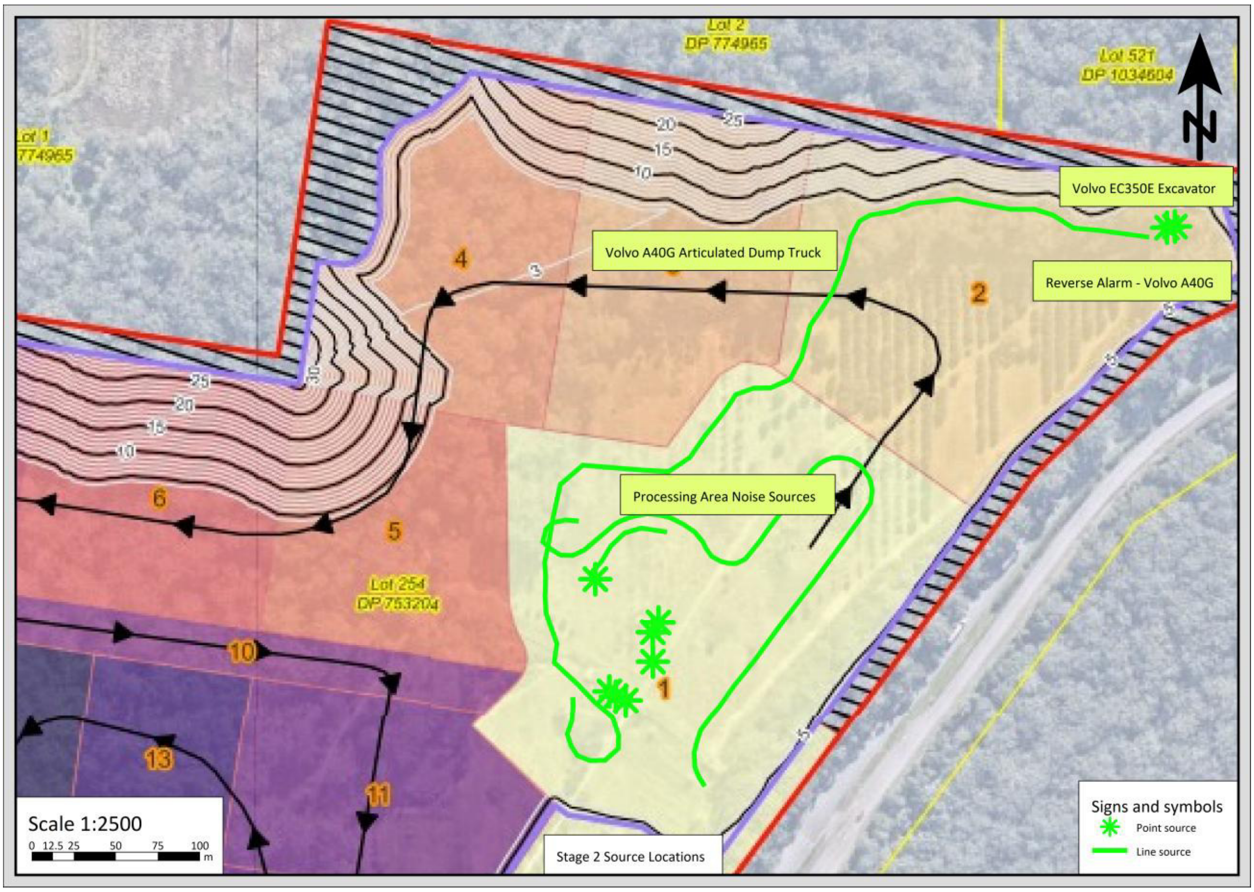

Figure 6-2 - Operational Source Locations - Stage 2

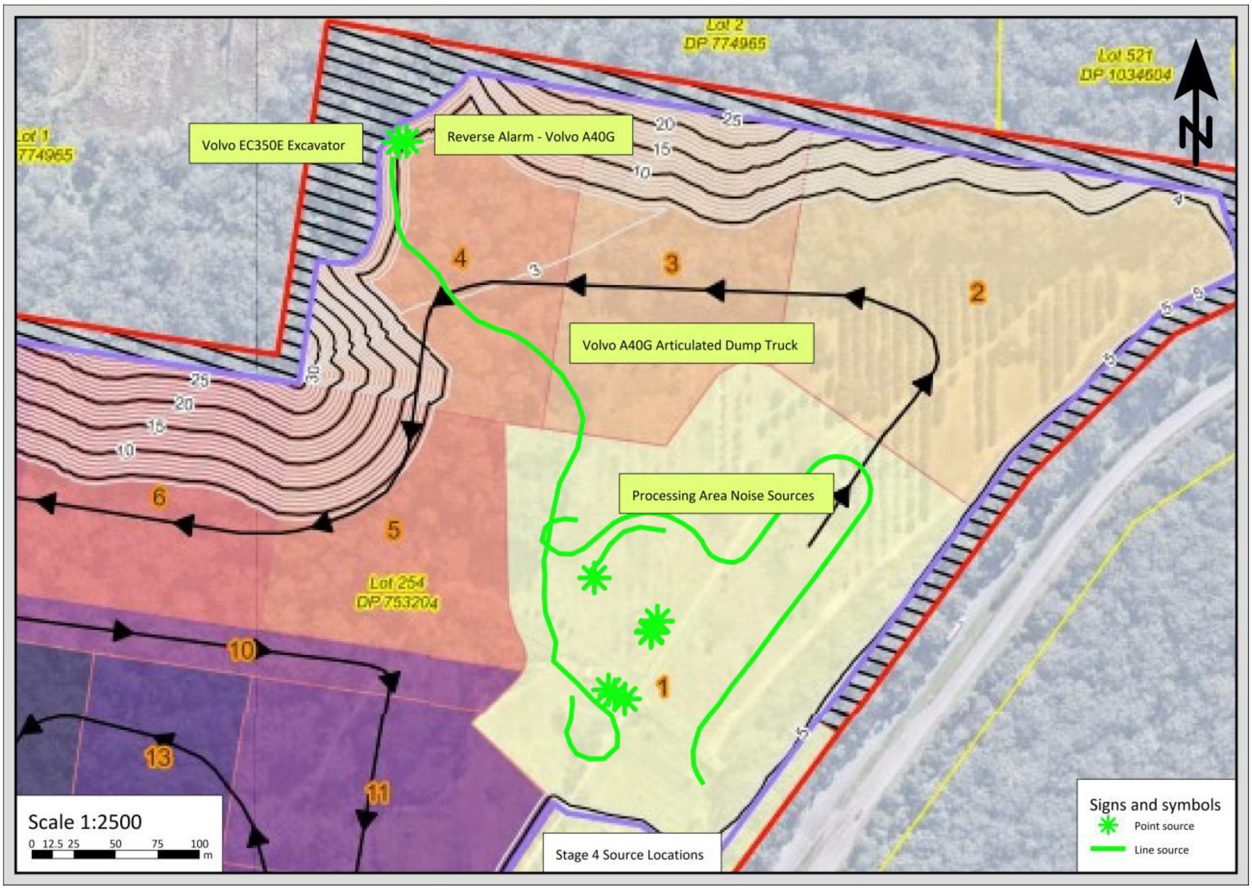

Figure 6-3 - Operational Source Locations - Stage 4

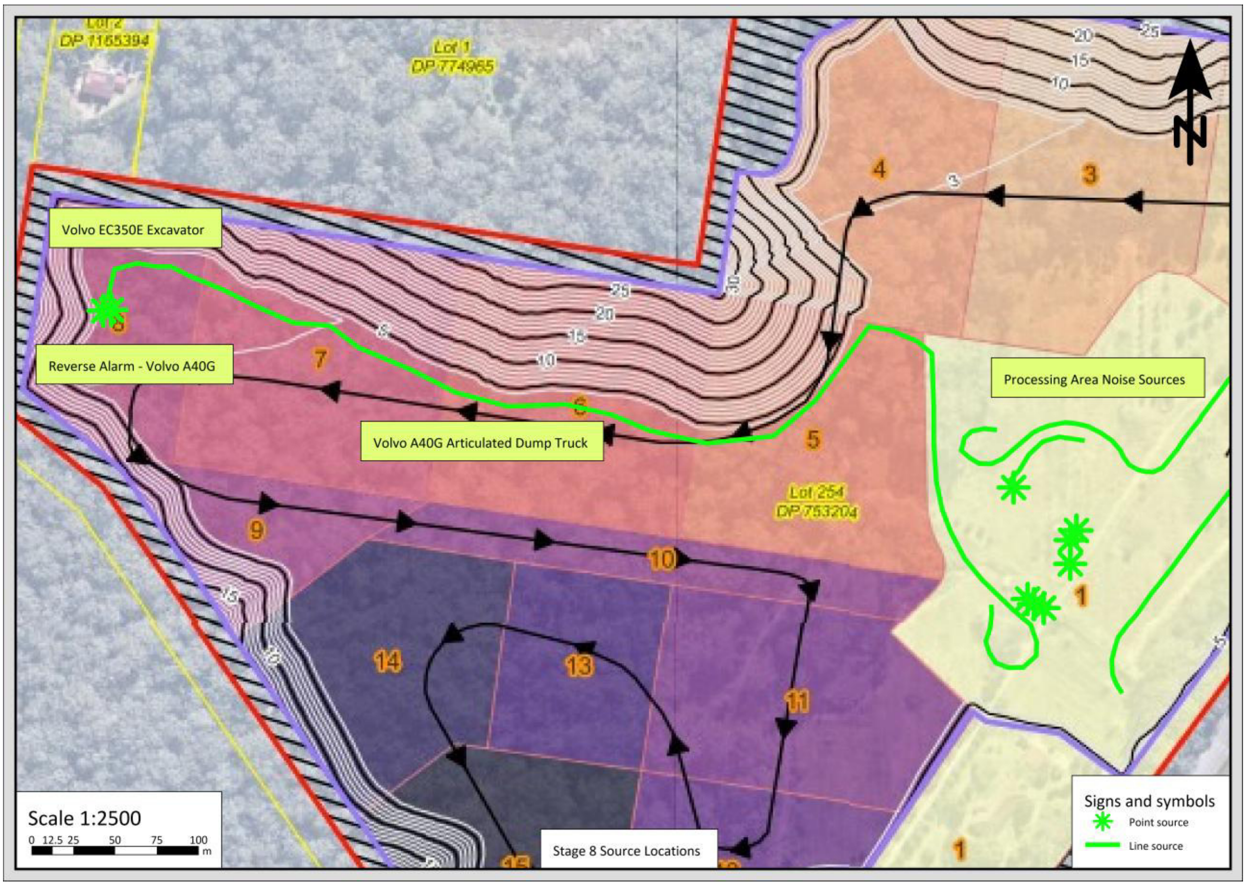

Figure 6-4 - Operational Source Locations - Stage 8

6.2.4 Weather Conditions

Five acoustic modelling scenarios were assessed for the operational phase of the proposed sand quarry within the SoundPLAN program using CONCAWE algorithms under both neutral and worst-case weather conditions for the day and night periods. It should be noted that sound will propagate further through the atmosphere under certain weather conditions dependent on air pressure variations, wind speed and direction variations, temperature inversions etc. The 'worst-case' weather conditions chosen were those highly conducive to the propagation of sound. These worst-case weather conditions are generally experienced when there are wind speeds of 2-3m/s in the direction from the source to the receiver during temperature inversion scenarios in the nighttime (Pasquill Stability Category F).

Table 6-3 presents the weather parameters used in the CONCAWE calculations based on annual data from the Bureau of Meteorology (BoM) Weather Station at Nelson Bay.

Table 6-3 - SoundPLAN Weather Parameters

Parameter	Day		Night	
	Neutral	Worst-case	Neutral	Worst-case
Pasquill Stability Category	D	D	D	F
Wind Speed (m/s)	0	3	0	3
Humidity (%)	57	57	75	75
Temperature (deg Celsius)	16	16	10	10
Met Category	3	5	4	6

6.3 Construction Noise and Vibration

The construction activities are assumed to likely be undertaken to the same mobile plant utilised for extraction:

- 2 x Volvo A40G articulated dump trucks
- 1 x Volvo EC350 35t excavator.

The noise and vibration issues during construction works would include airborne noise, ground-borne noise, ground-borne vibration and airborne vibration from construction activities including work sites, construction traffic, excavation and preparatory works. It is noted that for construction, the client confirms that there would be no piling, rock breaking or blasting activities (causing air-blast overpressure) for this project. This is a conservative representation of potential construction noise levels due to typical activities expected. The mobile equipment was modelled as operating on the natural ground surface of each stage at full power/load to represent normal construction activities.

6.4 Noise Impact from Generated Traffic

Traffic will enter and exit the site via a 'left in, left out' arrangement from new entrance off Nelson Bay Road at the southern end of the site. Vehicles will travel along the private road down the ramp to the processing area, travel back up the ramp to exit turning left onto Nelson Bay Road. Trucks travelling toward Newcastle will also pass the site heading westbound. As a result, traffic numbers have been updated for both east and westbound directions of Nelson Bay Road.

Newcastle Sand have confirmed an average of 46 and a maximum of 60 laden vehicles will utilise the site per day, resulting in an average of 92 and a maximum of 120 heavy vehicle movements generated by the site, per day, increasing the AADT of Nelson Bay Road by a maximum 120, raising it from 15,311 to 15,431 vehicles per day representing an increase of 0.78%. Vipac has assessed the maximum number of vehicles for the purposes of a conservative assessment.

Traffic noise levels were predicted using the CoRTN (1988) algorithm within SoundPLAN, using a 24-hour time-histogram to represent hourly variations in traffic volumes. The traffic inputs, including the adopted AADT and heavy-vehicle percentage, are provided in Table 6-4. The AADT were applied across the day and night assessment periods assuming an 80/20 day/night percentage split, with levels energy-averaged to obtain the required daytime $L_{Aeq,\ (15\ hour)}$ and night-time $L_{Aeq,\ (9\ hour)}$ results at all assessed receivers by applying a -3dB correction from the modelled L_{A10} to obtain the L_{Aeq}.

Table 6-4 - Traffic Volumes – Nelson Bay Road

Traffic Details	Nelson Bay Road at 80km/hr	
	Existing Traffic	Existing + 120 HV p/d
Average Daily Traffic (2014 data)	15311	15431
15-hour traffic flows (Day Period)	12249	12359
9-hour traffic flows (Night Period)	3062	3072

% Percentage Heavy Vehicles	4	4.7

7 Results

7.1 Construction Noise and Vibration

Noise sources have been modelled in a central location of each corresponding stage and are assumed to operate continuously (with reverse alarms occurring for approximately 50% of the time).

7.1.1 Predicted Noise Levels

Noise prediction modelling has been carried out to assess the potential impact associated with the proposed quarry at the nearest noise sensitive receptors.

The predicted construction noise levels are representative of each of the worst case stages for both neutral conditions and worst-case conditions during standard and non-standard hours are presented in Table 7-1 to Table 7-4. A sample of these tables has been reproduced graphically and are shown in Appendix A.

Table 7-1 – Stage 1 Construction – Overall Predicted Noise Impact (L_{Aeq})

NSR	Criteria, dB(A)		Stage 1					
	Standard	Non-standard	Neutral	Compliant		Worst-case	Compliant	
				Standard	Non-standard		Standard	Non-standard
R1	50	31	39	✓	×	44	✓	×
R2	50	31	32	✓	×	37	✓	×
R3	50	31	33	✓	×	38	✓	×
R4	50	-	30	✓	-	35	✓	-
R5	50	31	31	✓	✓	35	✓	×
R6	50	-	20	✓	-	25	✓	-
R7	50	31	31	✓	✓	36	✓	×
R8	50	31	21	✓	✓	25	✓	✓
R9	45	33	33	✓	✓	37	✓	×
R10	45	33	21	✓	✓	26	✓	✓
R11	45	33	19	✓	✓	23	✓	✓
R12	50	-	20	✓	-	24	✓	-
R13	45	33	24	✓	✓	27	✓	✓
R14	45	33	22	✓	✓	27	✓	✓
R15	45	33	19	✓	✓	23	✓	✓
R16	45	33	19	✓	✓	23	✓	✓
R17	45	33	31	✓	✓	35	✓	×
R18	45	33	32	✓	✓	37	✓	×
R19	45	33	29	✓	✓	34	✓	×
R20	50	31	23	✓	✓	27	✓	✓
R21	50	31	30	✓	✓	35	✓	×
R22	50	31	29	✓	✓	34	✓	×
R23	50	31	28	✓	✓	33	✓	×
R24	50	31	17	✓	✓	22	✓	✓
R25	50	31	28	✓	✓	33	✓	×
R26	50	31	33	✓	×	38	✓	×
R27	50	31	32	✓	×	37	✓	×
R28	45	33	20	✓	✓	25	✓	✓

R29	50	31	38	✓	×	42	✓	×

Table 7-2 – Stage 2 Construction – Overall Predicted Noise Impact (L_{Aeq})

NSR	Criteria, dB(A)		Stage 2					
	Standard	Non-standard	Neutral	Compliant		Worst-case	Compliant	
				Standard	Non-standard		Standard	Non-standard
R1	50	31	44	✓	×	48	✓	×
R2	50	31	30	✓	✓	35	✓	×
R3	50	31	29	✓	✓	34	✓	×
R4	50	-	26	✓	-	31	✓	-
R5	50	31	27	✓	✓	32	✓	×
R6	50	-	16	✓	-	21	✓	-
R7	50	31	29	✓	✓	33	✓	×
R8	50	31	28	✓	✓	32	✓	×
R9	45	33	40	✓	×	43	✓	×
R10	45	33	18	✓	✓	22	✓	✓
R11	45	33	18	✓	✓	22	✓	✓
R12	50	-	19	✓	-	24	✓	-
R13	45	33	23	✓	✓	27	✓	✓
R14	45	33	23	✓	✓	27	✓	✓
R15	45	33	23	✓	✓	28	✓	✓
R16	45	33	28	✓	✓	33	✓	✓
R17	45	33	20	✓	✓	25	✓	✓
R18	45	33	31	✓	✓	35	✓	×
R19	45	33	27	✓	✓	32	✓	✓
R20	50	31	26	✓	✓	31	✓	✓
R21	50	31	24	✓	✓	29	✓	✓
R22	50	31	25	✓	✓	29	✓	✓
R23	50	31	26	✓	✓	30	✓	✓
R24	50	31	17	✓	✓	22	✓	✓
R25	50	31	21	✓	✓	26	✓	✓
R26	50	31	28	✓	✓	32	✓	×
R27	50	31	33	✓	×	38	✓	×
R28	45	33	21	✓	✓	26	✓	✓
R29	50	31	43	✓	×	46	✓	×

Table 7-3 – Stage 4 Construction – Overall Predicted Noise Impact (L_{Aeq})

NSR	Criteria, dBA()		Stage 4					
	Standard	Non-standard	Neutral	Compliant		Worst-case	Compliant	
				Standard	Non-standard		Standard	Non-standard
R1	50	31	31	✓	✓	35	✓	×
R2	50	31	33	✓	×	38	✓	×
R3	50	31	32	✓	×	37	✓	×
R4	50	-	29	✓	-	35	✓	-
R5	50	31	31	✓	✓	35	✓	×
R6	50	-	30	✓	-	35	✓	-
R7	50	31	31	✓	×	36	✓	×
R8	50	31	39	✓	×	44	✓	×
R9	45	33	34	✓	×	37	✓	×
R10	45	33	42	✓	×	46	×	×
R11	45	33	40	✓	×	44	✓	×
R12	50	-	41	✓	-	46	✓	-
R13	45	33	44	✓	×	47	×	×
R14	45	33	45	✓	×	48	×	×
R15	45	33	40	✓	×	44	✓	×
R16	45	33	37	✓	×	42	✓	×
R17	45	33	35	✓	×	40	✓	×
R18	45	33	34	✓	×	39	✓	×
R19	45	33	19	✓	✓	24	✓	✓
R20	50	31	35	✓	×	40	✓	×
R21	50	31	33	✓	×	38	✓	×
R22	50	31	30	✓	✓	34	✓	×
R23	50	31	28	✓	✓	34	✓	×
R24	50	31	28	✓	✓	33	✓	×
R25	50	31	28	✓	✓	33	✓	×
R26	50	31	22	✓	✓	27	✓	✓
R27	50	31	31	✓	✓	35	✓	×
R28	45	33	32	✓	✓	37	✓	×
R29	50	31	36	✓	×	41	✓	×

Table 7-4 – Stage 8 Construction – Overall Predicted Noise Impact (L_{Aeq})

NSR	Criteria, dB(A)		Stage 8					
	Standard	Non-standard	Neutral	Compliant		Worst-case	Compliant	
				Standard	Non-standard		Standard	Non-standard
R1	50	31	12	✓	✓	17	✓	✓
R2	50	31	11	✓	✓	16	✓	✓
R3	50	31	12	✓	✓	17	✓	✓
R4	50	-	10	✓	-	15	✓	-
R5	50	31	10	✓	✓	15	✓	✓
R6	50	-	12	✓	-	17	✓	-
R7	50	31	11	✓	✓	16	✓	✓
R8	50	31	17	✓	✓	21	✓	✓
R9	45	33	19	✓	✓	23	✓	✓
R10	45	33	23	✓	✓	27	✓	✓
R11	45	33	24	✓	✓	28	✓	✓
R12	50	-	28	✓	-	31	✓	-
R13	45	33	24	✓	✓	27	✓	✓
R14	45	33	25	✓	✓	29	✓	✓
R15	45	33	57	×	×	59	×	×
R16	45	33	55	×	×	57	×	×
R17	45	33	47	×	×	51	×	×
R18	45	33	46	×	×	50	×	×
R19	45	33	25	✓	✓	29	✓	✓
R20	50	31	17	✓	✓	22	✓	✓
R21	50	31	14	✓	✓	19	✓	✓
R22	50	31	11	✓	✓	16	✓	✓
R23	50	31	10	✓	✓	15	✓	✓
R24	50	31	<10	✓	✓	14	✓	✓
R25	50	31	<10	✓	✓	13	✓	✓
R26	50	31	<10	✓	✓	10	✓	✓
R27	50	31	13	✓	✓	18	✓	✓
R28	45	33	12	✓	✓	16	✓	✓
R29	50	31	16	✓	✓	20	✓	✓

Construction noise levels are generally predicted to exceed during non-standard construction hours. It is recommended that construction remain with standard hours of construction. Standard hours construction is predicted to exceed at receptors R10, 13 and 14 during adverse weather conditions in Stage 4, and R15 to 18 in Stage 8 during both standard and non-standard hours in neutral and worst-case weather conditions. An appropriate construction noise management plan is recommended to be developed to minimise exceedance and manage expectations at these receptors. Note – no receptors are classified as 'highly noise affected'.

7.1.2 Construction Vibration

Both continuous/quasi-continuous and intermittent vibration has been considered during construction operations (which will be temporary in nature). Most machinery items are likely to generate continuous or quasi-continuous vibration during their operation (e.g. construction machinery movements), and some intermittent or transient vibration could possibly be caused during loading/unloading of trucks).

Ground-borne vibration resulting from construction activities and operations are compared against the applicable criteria relating to human comfort and potential structural damage (usually in terms of Peak Particle Velocity, PPV). The recommended limits or guide values (refer to Section 5.5) for transient vibration to ensure minimal risk of cosmetic damage to residential buildings (and community buildings) are in the range 15 to 20 mm/s PPV (depending on the frequency), with higher limits of 50 mms/ for industrial buildings. The stipulated human comfort criterion (lower limit) for vibration is typically 1 mm/s PPV (to an upper limit of 2 mm/s).

For the purposes of a conservative assessment, ground vibration predictions for different types of vibratory compaction rollers were calculated from accepted semi-empirical algorithms for predicting propagation of ground vibration (Ref: BS 5228-2; *Ground Vibration from Construction Works*, UK TRL Report 429 (Hiller & Crabb, 2000)). The ground vibration predictions for other types of construction machinery were based on previously measured data by Vipac or sourced noise data for construction machinery from various vibration databases and literature references (Ref: *Ground Vibration Engineering* (Srbulov, 2010), *Construction Vibrations* (Dowding, 2000), CALTRANS *Construction Vibration Manual* (US CALTRANS, 2013), US FTA *Transit Noise & Vibration Manual* (2018)). This assessment utilises data associated with vibratory rollers for the purposes of a worst-case assessment, as it is expected that vibration generated by the excavator and articulated dump trucks will be significantly less, thus if compliance can be demonstrated for a vibratory roller, compliance is expected for excavators and dump trucks.

The calculation formulae used for ground vibration predictions (in terms of Peak Particle Velocity, V_{PPV} in mm/s) for vibratory compaction rollers are given as follows (Ref: BS 5228-2; Hiller & Crabb, 2000):

Table 7-5 - Ground Vibration Prediction Formulae

Normal compaction passes:	$V_{PPV} = ks * n\text{^}0.5 * (A/(x+w))\text{^}1.5$	[mm/s]	ks	75	50% exceedance probability
			ks	143	33% exceedance probability
			ks	276	5% exceedance probability
Transient startup/shutdown:	$V_{PPV} = kt * n\text{^}0.5 * (A\text{^}1.5/(x+w)\text{^}1.3)$	[mm/s]	kt	65	50% exceedance probability
			kt	106	33% exceedance probability
			kt	177	5% exceedance probability
	x	distance along ground from roller to receiver (m)			
	n	number of vibrating drums in roller			
	A	nominal amplitude of vibrating roller (mm)			
	w	width of vibrating drum (m)			

** Note: The exceedance probability represents the level of conservatism in the predictions, where a 5% predicted level would be the most conservative or worst-case situation (higher prediction) to represent the maximum level predicted for 95% of possible cases and therefore only 5% of cases likely to exceed the predicted level.*

Ground vibration levels have been predicted for different distances by applying these accepted calculation formulae and using actual parametric data for a range of proprietary vibratory rollers, such as BOMAG BW-series tandem vibratory rollers (2-drums, front and rear), for a range of masses up to 20 tonnes.

From the operation of up to 20-tonne vibratory rollers (during worst case transient start-up/shutdown operation), the range of predicted ground vibration levels are 1 to 1.5 mm/s at 50 m distance (with levels less than 0.5 mm/s beyond 100 m distance). Predicted worst case vibration levels from vibratory roller operation meet the human comfort criteria and are well below structural damage criteria for all nearby buildings.

A conservative prediction of the potential ground-borne vibration impacts associated with the other proposed construction activities and mobile equipment operations has been made (primarily quasi-continuous vibration). Ground vibration levels (in mm/s PPV) from other construction machinery items (e.g. excavators, truck unloading, other than vibratory rollers) are typically in the range of 0.1 to 1 mm/s at distances of 25 to 50 m. Truck traffic (over rough/irregular surfaces) will typically generate ground vibration levels of 0.1 to 0.5 mm/s (or less) at distances of 25 to 50 m. As a result, predicted vibration levels would meet the human comfort criteria and are well below structural damage criteria for all nearby buildings.

7.2 Predicted Noise Levels for Operational Phases (L_{Aeq}) – No Mitigation

Noise prediction modelling has been carried out to assess the potential impact associated with the proposed quarry at the nearest noise sensitive receptors.

The predicted noise levels representative of each of the worst case stages for both neutral conditions and worst-case conditions during day and night-time (no operation planned during evening periods) are presented in Table 7-6 to Table 7-8. A sample of these tables has been reproduced graphically and are shown in Appendix A.

Table 7-6 – Stage 2 Operation – Overall Predicted Noise Impact without Mitigation (L_{Aeq})

NSR	Day Period No Mitigation, dB(A)					Night Period No Mitigation, dB(A)				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	39	43	✓	✓	35	18	23	✓	✓
R2	45	30	35	✓	✓	35	11	17	✓	✓
R3	45	30	35	✓	✓	35	12	17	✓	✓
R4	40	27	32	✓	✓	40	<10	14	✓	✓
R5	45	28	33	✓	✓	35	<10	13	✓	✓
R6	55	18	23	✓	✓	55	<10	<10	✓	✓
R7	45	26	31	✓	✓	35	<10	14	✓	✓
R8	45	20	24	✓	✓	35	<10	<10	✓	✓
R9	40	31	35	✓	✓	35	<10	14	✓	✓
R10	40	19	24	✓	✓	35	<10	<10	✓	✓
R11	40	18	23	✓	✓	35	<10	<10	✓	✓
R12	55	18	22	✓	✓	55	<10	<10	✓	✓
R13	40	22	26	✓	✓	35	<10	<10	✓	✓
R14	40	22	26	✓	✓	35	<10	<10	✓	✓
R15	40	29	33	✓	✓	35	<10	<10	✓	✓
R16	40	32	37	✓	✓	35	<10	13	✓	✓
R17	40	31	35	✓	✓	35	<10	14	✓	✓
R18	40	32	37	✓	✓	35	11	17	✓	✓
R19	40	28	33	✓	✓	35	<10	13	✓	✓
R20	45	18	23	✓	✓	35	<10	<10	✓	✓
R21	45	22	27	✓	✓	35	<10	14	✓	✓
R22	45	26	31	✓	✓	35	<10	12	✓	✓
R23	45	26	31	✓	✓	35	<10	13	✓	✓
R24	45	20	25	✓	✓	35	<10	<10	✓	✓
R25	45	25	31	✓	✓	35	<10	10	✓	✓
R26	45	30	35	✓	✓	35	12	17	✓	✓
R27	45	29	34	✓	✓	35	10	16	✓	✓
R28	45	18	23	✓	✓	35	<10	<10	✓	✓
R29	45	40	45	✓	✓	35	16	21	✓	✓

Table 7-7 – Stage 4 Operation – Overall Predicted Noise Impact without Mitigation (L_{Aeq})

NSR	Day Period No Mitigation, dB(A)					Night Period No Mitigation, dB(A)				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	36	40	✓	✓	35	18	23	✓	✓
R2	45	29	34	✓	✓	35	11	17	✓	✓
R3	45	30	35	✓	✓	35	12	17	✓	✓
R4	40	27	32	✓	✓	40	<10	14	✓	✓
R5	45	27	32	✓	✓	35	<10	13	✓	✓
R6	55	18	23	✓	✓	55	<10	<10	✓	✓
R7	45	24	29	✓	✓	35	<10	14	✓	✓
R8	45	32	37	✓	✓	35	<10	<10	✓	✓
R9	40	28	32	✓	✓	35	<10	14	✓	✓
R10	40	38	42	✓	×	35	13	18	✓	✓
R11	40	36	40	✓	×	35	12	18	✓	✓
R12	55	36	41	✓	×	55	<10	11	✓	✓
R13	40	50	52	×	×	35	19	24	✓	✓
R14	40	48	51	×	×	35	16	21	✓	✓
R15	40	29	33	✓	✓	35	<10	<10	✓	✓
R16	40	32	37	✓	✓	35	<10	13	✓	✓
R17	40	31	35	✓	✓	35	<10	14	✓	✓
R18	40	32	37	✓	✓	35	11	17	✓	✓
R19	40	28	32	✓	✓	35	<10	13	✓	✓
R20	45	29	34	✓	✓	35	<10	<10	✓	✓
R21	45	27	33	✓	✓	35	<10	14	✓	✓
R22	45	25	30	✓	✓	35	<10	12	✓	✓
R23	45	26	31	✓	✓	35	<10	13	✓	✓
R24	45	18	24	✓	✓	35	<10	<10	✓	✓
R25	45	25	30	✓	✓	35	<10	10	✓	✓
R26	45	30	35	✓	✓	35	<10	17	✓	✓
R27	45	29	34	✓	✓	35	10	16	✓	✓
R28	45	18	23	✓	✓	35	<10	<10	✓	✓
R29	45	34	39	✓	✓	35	16	21	✓	✓

Table 7-8 – Stage 8 Operation – Overall Predicted Noise Impact without Mitigation (L_{Aeq})

NSR	Day Period No Mitigation, dB(A)					Night Period No Mitigation, dB(A)				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	36	40	✓	✓	35	18	23	✓	✓
R2	45	30	35	✓	✓	35	11	17	✓	✓
R3	45	30	35	✓	✓	35	12	17	✓	✓
R4	40	27	32	✓	✓	40	<10	14	✓	✓
R5	45	27	32	✓	✓	35	<10	13	✓	✓
R6	55	17	22	✓	✓	55	<10	<10	✓	✓
R7	45	24	29	✓	✓	35	<10	14	✓	✓
R8	45	18	22	✓	✓	35	<10	<10	✓	✓
R9	40	28	32	✓	✓	35	<10	14	✓	✓
R10	40	35	39	✓	✓	35	14	19	✓	✓
R11	40	33	38	✓	✓	35	13	18	✓	✓
R12	55	23	27	✓	✓	55	<10	11	✓	✓
R13	40	40	44	✓	×	35	20	25	✓	✓
R14	40	29	33	✓	✓	35	16	21	✓	✓
R15	40	51	53	×	×	35	<10	14	✓	✓
R16	40	47	50	×	×	35	10	15	✓	✓
R17	40	36	41	✓	×	35	12	17	✓	✓
R18	40	41	45	×	×	35	12	18	✓	✓
R19	40	28	33	✓	✓	35	<10	13	✓	✓
R20	45	17	22	✓	✓	35	<10	<10	✓	✓
R21	45	23	28	✓	✓	35	<10	14	✓	✓
R22	45	25	30	✓	✓	35	<10	12	✓	✓
R23	45	26	31	✓	✓	35	<10	13	✓	✓
R24	45	18	23	✓	✓	35	<10	<10	✓	✓
R25	45	25	31	✓	✓	35	<10	10	✓	✓
R26	45	30	35	✓	✓	35	12	17	✓	✓
R27	45	29	34	✓	✓	35	10	16	✓	✓
R28	45	19	24	✓	✓	35	<10	<10	✓	✓
R29	45	34	39	✓	✓	35	16	21	✓	✓

7.2.1 Day/Night Operation Summary – No Mitigation

The results of the noise modelling show that there are a number of exceedances predicted at the closest sensitive receivers to onsite activities at the quarry during Stages 4 and 8. The exceedances are primarily related to the internal articulated dump truck routes and excavators within the pit. The operation of 120 heavy vehicles movements per day does not contribute to the levels of exceedance at the nearest sensitive receivers, primarily due to the large distances separating receivers and the location of the heavy vehicles loading on the site.

Without any noise mitigation measures, exceedances can be observed at the following:

Table 7-9 - Exceeding Receiver Summary – No mitigation

Phase	Worst Case Conditions without Mitigation	
	Day	Night
Stage 2	None	None
Stage 4	R10-14	None
Stage 8	R13, R15-18	None

Given exceedances of the noise criteria are predicted, it is necessary to investigate potential mitigation measures to determine whether compliance may be achievable.

7.3 Sleep Disturbance Assessment

Noise prediction modelling has been carried out to assess the potential sleep disturbance impact associated with the proposed sand quarry on the existing noise environment at the nearest noise sensitive receptors located in proximity to the site during potential operation in the night period. The predicted noise levels representative of the operational phase for both neutral conditions and worst-case conditions during the night-time are presented in Table 7-10 below.

Table 7-10 – Sleep Disturbance Assessment

Rec #	Predicted Noise Levels L_{A1} dB(A)						
	Criteria	Stage 2		Stage 4		Stage 8	
		Neutral	Worst-case	Neutral	Worst-case	Neutral	Worst-case
R1	52	44	49	44	49	44	49
R2	52	40	45	40	45	40	45
R3	52	41	46	41	46	41	46
R4	N/A						
R5	52	33	38	33	38	33	38
R6	N/A						
R7	52	34	40	34	40	34	40
R8	52	26	31	26	31	26	31
R9	52	36	41	38	43	38	43
R10	52	27	32	45	50	45	50
R11	52	26	31	43	48	43	48
R12	N/A						
R13	52	32	36	46	50	50	54
R14	52	32	36	42	47	42	47
R15	52	30	35	30	35	37	42
R16	52	36	41	36	41	42	47
R17	52	34	40	34	40	42	47
R18	52	37	42	37	42	42	47
R19	52	32	38	32	38	32	38
R20	52	28	33	28	34	28	34
R21	52	34	40	34	40	34	40
R22	52	34	39	34	39	34	39
R23	52	33	38	33	38	33	38
R24	52	36	42	36	42	36	42
R25	52	37	42	37	42	37	42
R26	52	40	45	40	45	40	45
R27	52	39	45	39	45	39	45
R28	52	28	33	28	33	28	33
R29	52	44	49	44	49	44	49

*Receivers R4, R6, R12 do not have applicable sleep disturbance criteria as they are not residential buildings

Operational noise levels at all receptors are predicted to comply with the sleep disturbance criteria except for R13 where a 2dB(A) exceedance is predicted during Stage 8 Operations under adverse weather conditions. Refer to Section 8 for recommendations.

7.4 Traffic Noise Assessment

Noise modelling has also been undertaken to assess the potential noise impacts associated with the additional vehicle movements on Nelson Bay Road. The noise model has taken into account all the sources associated with traffic that will be generated by the proposed sand quarry as outlined in Section 6.4 to determine the cumulative noise levels in the area.

The results of the traffic noise predictions associated with the proposed sand quarry development are presented in Table 7-11.

Table 7-11 - Cumulative Traffic Noise Impact – Day/Evening (7am-10pm)

Rec #	Day/Evening Period ($L_{Aeq,15hr}$), dB(A)				
	Existing Traffic	**Projected Traffic**	**Criteria**	**Compliance**	**Maximum Difference**
R1	50.7	50.9	**60**	✓	0.2
R2	56.8	57	**60**	✓	0.2
R3	54.2	54.4	**60**	✓	0.2
R4	58	58.2	**50**	✓*	0.2
R5	53.2	53.4	**60**	✓	0.2
R6	50.7	50.9	**50**	✓*	0.2
R7	54.9	55.1	**60**	✓	0.2
R8	47.9	48.1	**60**	✓	0.2
R9	50.2	50.4	**60**	✓	0.2
R10	44.5	44.8	**60**	✓	0.3
R11	44.2	44.4	**60**	✓	0.2
R12	42.8	43	**55**	✓	0.2
R13	43.5	43.8	**60**	✓	0.3
R14	42.5	42.7	**60**	✓	0.2
R15	47.2	47.4	**60**	✓	0.2
R16	47.4	47.6	**60**	✓	0.2
R17	45.9	46.1	**60**	✓	0.2
R18	51.9	52.1	**60**	✓	0.2
R19	54.7	54.9	**60**	✓	0.2
R20	47.4	47.6	**60**	✓	0.2
R21	48.4	48.6	**60**	✓	0.2
R22	52.1	52.3	**60**	✓	0.2
R23	53.3	53.5	**60**	✓	0.2
R24	59.7	59.9	**60**	✓	0.2
R25	66.5	66.7	**60**	✓*	0.2
R26	63.3	63.5	**60**	✓*	0.2
R27	59.8	60	**60**	✓*	0.2
R28	59.3	59.5	**60**	✓	0.2
R29	56.3	56.5	**60**	✓	0.2

Table 7-12 - Cumulative Traffic Noise Impact – Night (10pm-7am)

Rec #	Night Period ($L_{Aeq,15hr}$), dB(A)				
	Existing Traffic	**Projected Traffic**	**Criteria**	**Compliance**	**Maximum Difference**
R1	46.9	47	**55**	✓	0.1
R2	53	53	**55**	✓	0
R3	50.4	50.4	**55**	✓	0
R4	-	-	**-**	-	-
R5	49.4	49.5	**55**	✓	0.1
R6	-	-	**-**	-	-
R7	51.1	51.2	**55**	✓	0.1
R8	44.1	44.2	**55**	✓	0.1
R9	46.4	46.4	**55**	✓	0
R10	40.7	40.8	**55**	✓	0.1
R11	40.4	40.4	**55**	✓	0
R12	-	-	**-**	-	-
R13	39.8	39.8	**55**	✓	0
R14	38.7	38.8	**55**	✓	0.1
R15	43.4	43.5	**55**	✓	0.1
R16	43.6	43.6	**55**	✓	0
R17	42.1	42.2	**55**	✓	0.1
R18	48.1	48.2	**55**	✓	0.1
R19	50.9	51	**55**	✓	0.1
R20	43.6	43.7	**55**	✓	0.1
R21	44.6	44.7	**55**	✓	0.1
R22	48.3	48.3	**55**	✓	0
R23	49.5	49.6	**55**	✓	0.1
R24	55.9	56	**55**	✓*	0.1
R25	62.7	62.8	**55**	✓*	0.1
R26	59.5	59.6	**55**	✓*	0.1
R27	56	56.1	**55**	✓*	0.1
R28	55.5	55.6	**55**	✓*	0.1
R29	52.5	52.6	**55**	✓	0.1

7.4.1 Traffic Noise Summary

The predicted existing traffic levels at receivers R4, R6 and R25-27 during the daytime, and R24-R28 are slightly higher than the daytime noise criteria for the current traffic flows. As stated in Section 3.4 of the Road Noise Policy, with regard to existing residences and other sensitive land uses affected by additional traffic on existing roads, generated by land use development, any increase in total traffic noise level should be limited to 2dB above that of the corresponding existing noise level at any residential property. As seen from Table 7-11 and Table 7-12, increases in the predicted traffic noise levels with the additional 120 heavy vehicle movements per day at all locations are within the acceptable limits with the negligible increases of up to 0.3dB(A) during the day and evening and 0.1dB(A) during the night.

Given the increases are insignificant and well below the relative increase criteria detailed in Table 5-5 (Base traffic + 12dB), the increased traffic from the quarry along Nelson Bay Road is predicted to comply with the relevant road traffic noise criteria.

7.5 Vibration Assessment

Vibration may be generated as a result of the sand extraction works and transport of sand to the processing plant. Vibration has been considered both in respect of potential damage of buildings and potential annoyance to the occupants. This section provides guidance on the vibration impacts that may be expected from the activities associated construction and operation of the sand quarry.

In many cases, it is the occupants'/residents' fear of building damage that enhances the potential annoyance. The most common form of vibration measurement is peak particle velocity (PPV) in mm/s. In respect to building damage, a vibration level limit and frequency is normally specified, however, in respect of potential annoyance to receivers, a combination of vibration level frequency and duration is more appropriate. This is normally termed as a dose value.

Table 7-13 summarises the anticipated level of vibration associated with the plant and equipment that is likely to be used. It should be noted that the vibration levels presented in Table 7-13 are indicative levels only. The actual vibration levels that may impact upon properties located in the vicinity of the proposed sand quarry may vary. This is due to the fact that vibration magnitudes will dissipate at varying levels dependent on ground conditions and source level variations associated with operational conditions of the plant and equipment.

Table 7-13 - Vibration Levels of Equipment

Activity	Description	Typical Ground Vibration Level
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact is considered unlikely.
	Bulldozers/excavators ripping	1mm/s to 2mm/s at distances of approximately 5 metres. At distances greater than 20 metres, vibration is usually below 0.2mm/s.
Extraction	Excavator	<1mm/s at distances of approximately 10 metres
	Truck traffic (on normal smooth road)	0.01mm/s to 0.2mm/s at the footings of buildings located 10m-20 metres from a roadway (note that very large surface irregularities can cause levels up to five to ten times higher).

The nearest receivers to the proposed sand quarry are located approximately 40m (R13) and 50m (R15) from the nearest mining property boundary. Based on the vibration levels provided in Table 7-13, it is unlikely that there would be any vibration impacts generated by the excavation plant that would give rise to annoyance or structural damage at any of the nearest receivers. Vibration monitoring would need to be undertaken in the unlikely event that any works were to be carried out within 50 metres of residences where vibration may be generated by equipment. Beyond 100 metres there is a low probability of annoyance for all activities.

7.6 Impacts on Fauna

There are no current government policies or other accepted guidelines that provide recommended noise and vibration level thresholds or limits in relation to noise impact on terrestrial fauna. In Australia, there are no noise studies presently available that deal with noise impacts on native species for long-term exposure, therefore a general literature review has been carried out for potential fauna impacts.

There is limited knowledge or understanding of the effects of noise on fauna given that the research and studies on animals to date has been limited to small, disconnected, anecdotal or correlational studies as opposed to coherent programs of controlled experiments (Manci et al (1988), Larkin, (1996), Radle, (1998), Wyle (2003), Warren et al, (2006), Dooling and Popper (2007) and (Dooling, Fay, and Popper (2000)). Noise may adversely affect wildlife by interfering with communication, masking the sounds of predators and prey and causing stress or avoidance reactions, and in some cases may lead to changes in reproductive or nesting behaviour. At sufficiently high levels, noise could cause temporary or permanent hearing damage.

In general, Radle (2007) states the consensus that terrestrial animals will avoid any industrial or plant or construction area where noise or vibration presents an annoyance to them. Additionally, Radle (2007) observed many animals react to new noise initially as a potential threat (potentially followed by startle/fright and avoidance), but quickly 'learn' that the noise is not associated with a threat. Most wildlife is generally mobile and will act to avoid noise and vibration if it is perceived to be annoying.

The response to noise by animals can depend on a wide variety of factors including noise level, noise spectrum (frequency distribution), noise characteristics (such as impulsiveness, rate of onset, tonality, modulation etc.), duration, temporal variation, number and type of events, level of ambient noise, time of day/season/year, and the animal's age, sex, type of activity at the time, breeding situation and past experience, and the type of animal species/genera, hearing thresholds, individual differences etc.

Studies have shown the reaction to noise can vary from species to species, including those that are known to have adapted to human activity. Environment Australia (1998) suggests that unusual noise, in combination with close proximity visual stimulation, is enough to disturb any animal, including humans. In addition, any sudden and unexpected intrusion, whether acoustic or of another nature, may also produce a startle or panic reaction.

Studies of the impact of the sonic boom on domestic and wild animals show that these species are unaffected by repeated booms and farmers have reported birds actually perching on scare guns after only a couple of days operation (Environment Australia, 1998). From a literature review, it has been considered that noise levels up to 60 dB(A) do not result in negative or adverse response to impacted animals or livestock. Noise levels up to 80 dB(A) can generate startle responses in birds and animals, and noise levels in excess of 90 dB(A) may cause negative impact such as behavioural responses.

The predicted noise levels from the quarry operations are approximately 50-55 dB(A) at the site boundary during Stages 4 and 8 and these noise levels are not expected to cause adverse response to animals or livestock. Typically, animals will avoid high noise areas and it is expected that animals will relocate away from such areas.

To summarise, the impacts of noise on animals is generally inconclusive. In general, there is no or little evidence of cause and effect regarding behavioural or physiological effects on domestic animals, and possibly slight evidence of some effects on some types of wild animals (especially for high or impulsive levels of noise). Finally, it is noted that animals tend to habituate to disturbances over time, particularly when it is steady and associated with non-threatening activity.

8 Recommendations – Exceedance Management

8.1 Operational Hold Point

To ensure the accuracy of the predictive noise modelling and to refine mitigation strategies for subsequent extraction stages, it is recommended that a formal operational hold point be implemented at the completion of Stage 2. This hold point will allow the Proponent to verify actual site noise emissions under real operating conditions before progressing to deeper and more receptor-proximate stages of the quarry.

The purpose of the Stage 2 hold point is to:

- Validate model assumptions relating to equipment sound power levels and operational frequencies.
- Quantify actual noise emissions from the extraction, haulage and processing/sales area during normal operation.
- Measure noise levels at key receptors, particularly those that are currently predicted to experience exceedances in later stages (e.g., R15–R18 and R16 during Stage 8).
- Identify any variance between predicted and measured noise levels and determine whether additional mitigation is required before advancing to Stage 3 and beyond.
- Provide a valid evidence base for refining an Operational Noise and Vibration Management Plan (ONVMP) and updating stage-specific noise envelopes.

To achieve these outcomes, the following actions are recommended:

- On-site attended and unattended noise monitoring should be undertaken during representative daytime and night-time operating conditions, including periods of adverse meteorology if possible.
- Receptor-based monitoring should be conducted at a minimum of R10-18, and at any other locations where community concern may be raised.
- Operational activity logs (equipment usage, haulage frequency, extraction location, weather conditions) should be maintained to correlate measured noise levels with actual site conditions.
- Model recalibration should be undertaken using the measured data to refine predictions for Stages 3–15, with particular emphasis on stages where exceedances are forecast even with mitigation.
- Updated mitigation recommendations should be prepared where measured levels exceed predictions or where compliance margins are narrower than anticipated.

Progression to Stage 3 should only occur once the verification monitoring and modelling demonstrates that:

- Operational noise levels are consistent with, or lower than, modelled predictions.
- Recommended mitigation measures (if any) have been implemented, and
- Any additional controls required to ensure compliance in later stages have been identified and incorporated into the ONVMP.

8.2 General Operational Management Measures

The following measures are recommended to be incorporated into the operation of the quarry:

- Excavation should progress with the focus of ensuring all equipment benefits from the maximum amount of shielding from the pit walls for each stage.
- Restriction of excavation during adverse weather conditions. Onsite weather data should be monitored frequently to determine wind speed and direction. Where wind speeds are observed to be unfavorable for noise propagation to certain receptors, operation should be reconsidered to pause/provide respite, or relocate to another area of the stage/quarry during those conditions to avoid adverse impact.
- Installation of broadband 'quacker' style reverse alarm systems on all mobile equipment.
- Optimisation of haul routes between excavation and processing plant to keep truck movements shielded by pit walls and bunds.
- Installation of temporary mobile acoustic barriers where high noise activities are expected.

8.3 Construction and Operational Management Plans

In order to manage the expectations of nearby sensitive receivers, in particular those which still exceed criteria with the inclusion of physical noise barriers, it is recommended the quarry adopt a Construction and Operational Noise and Vibration Management Plan (CONVMP). The primary objectives of a CONVMP is to:

- Minimise noise and vibration emissions to the maximum possible extent.
- Provide a process for the investigation of complaints relating to noise and vibration in a timely manner and for derivation of measures that deal effectively with the causes of legitimate complaints.
- Reduce the potential for exceedances relating to noise and vibration emissions.
- Document proactive mitigation measures for each noise and vibration source.
- Identify proposed long-term noise and vibration monitoring locations, equipment and frequency for the Quarry's environmental monitoring program.
- Identify stage-specific trigger levels for construction and operational noise as necessary for key receptors.
    - Implementation of automated alerts when trigger levels are exceeded.
- Document actions and responsibilities in the event of an exceedance of a noise and vibration trigger level or a legitimate complaint.

8.3.1 Stage Noise Forecasts

For the benefit of the surrounding stakeholders, the following is recommended to be included as part of the Operational Noise Management Plan:

Before each new extraction stage begins, the quarry should prepare Stage Noise Forecasts (SNF's) that includes:

- Updated 3D terrain and bund topography
- Predicted noise levels for the upcoming stage.
- Identification of high-noise activities and periods.
- Proposed operational restrictions or controls if exceedances are predicted.
- Expected duration of stage extraction and any exceedances that are unable to be avoided.

It is recommended that this information be provided via letterbox drop as part of a 'Stage Commencement Notification Package' to all involved stakeholders.

9 Conclusion

A noise impact assessment has been undertaken to determine the potential noise impact of the proposed sand quarry at Bobs Farm on noise sensitive receptors in the surrounding area of the proposed development site.

Future potential noise levels at the nearest noise sensitive receivers were predicted using the SoundPLAN noise model for 4 construction stages and 3 operational stages. For each stage, noise levels were predicted in the day and night period (including sleep disturbance) during both neutral and adverse weather conditions.

Noise levels are predicted to comply with the day and night criteria except for a small number of the closest sensitive receivers. Mitigation measures in the form of a hold in operations after completion of Stage 2 to verify onsite noise sources and conduct additional assessments of the future stages before they commence are expected to minimise exceedances as the quarry progresses. In addition to this, the implementation of a Construction and Operational Noise and Vibration Management Plan will be required.

Traffic noise levels were predicted to account for the additional heavy vehicle traffic the quarry is expected to introduce onto Nelson Bay Road, with the results predicted to comply with the relevant criteria.

10 Bibliography

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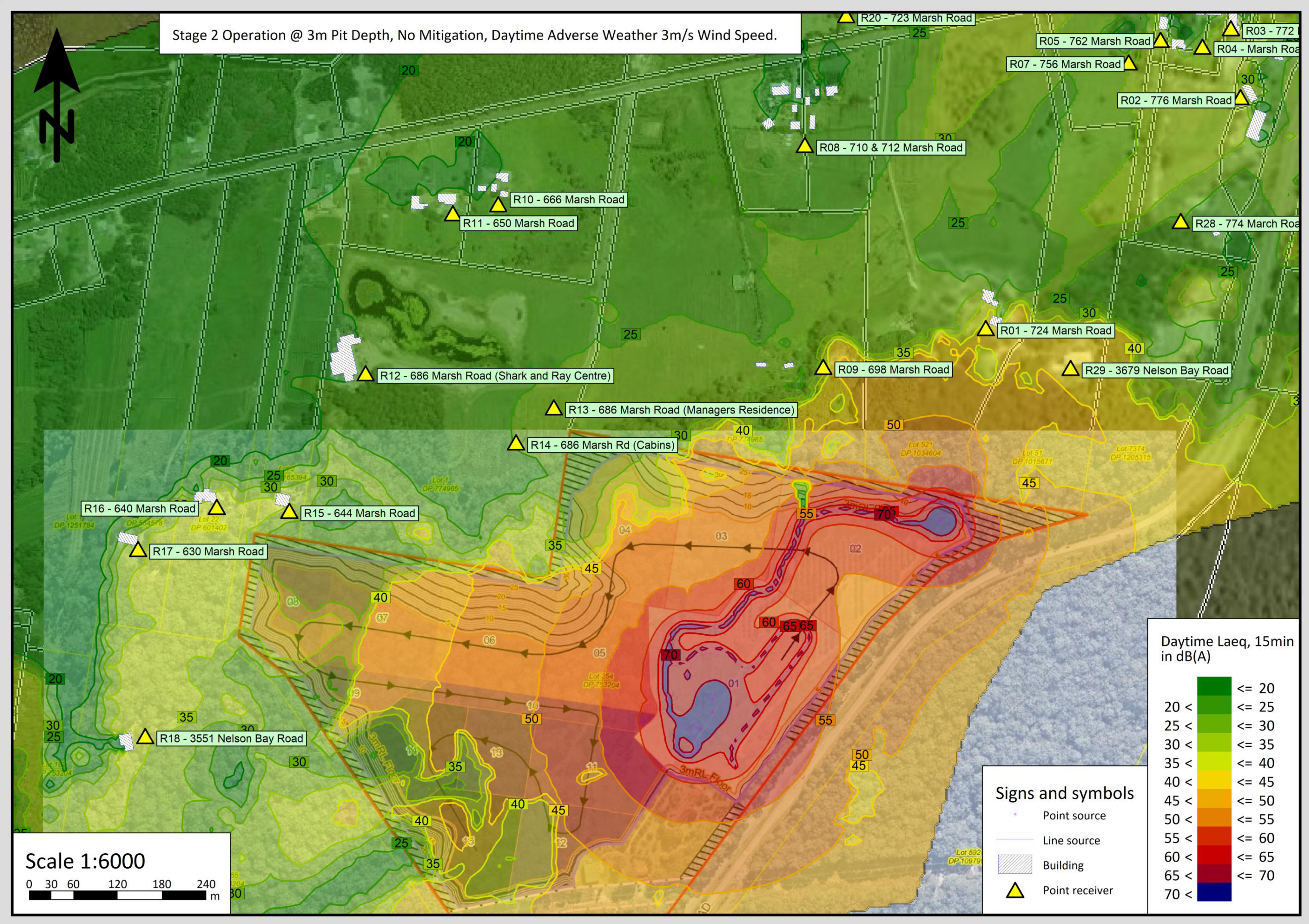
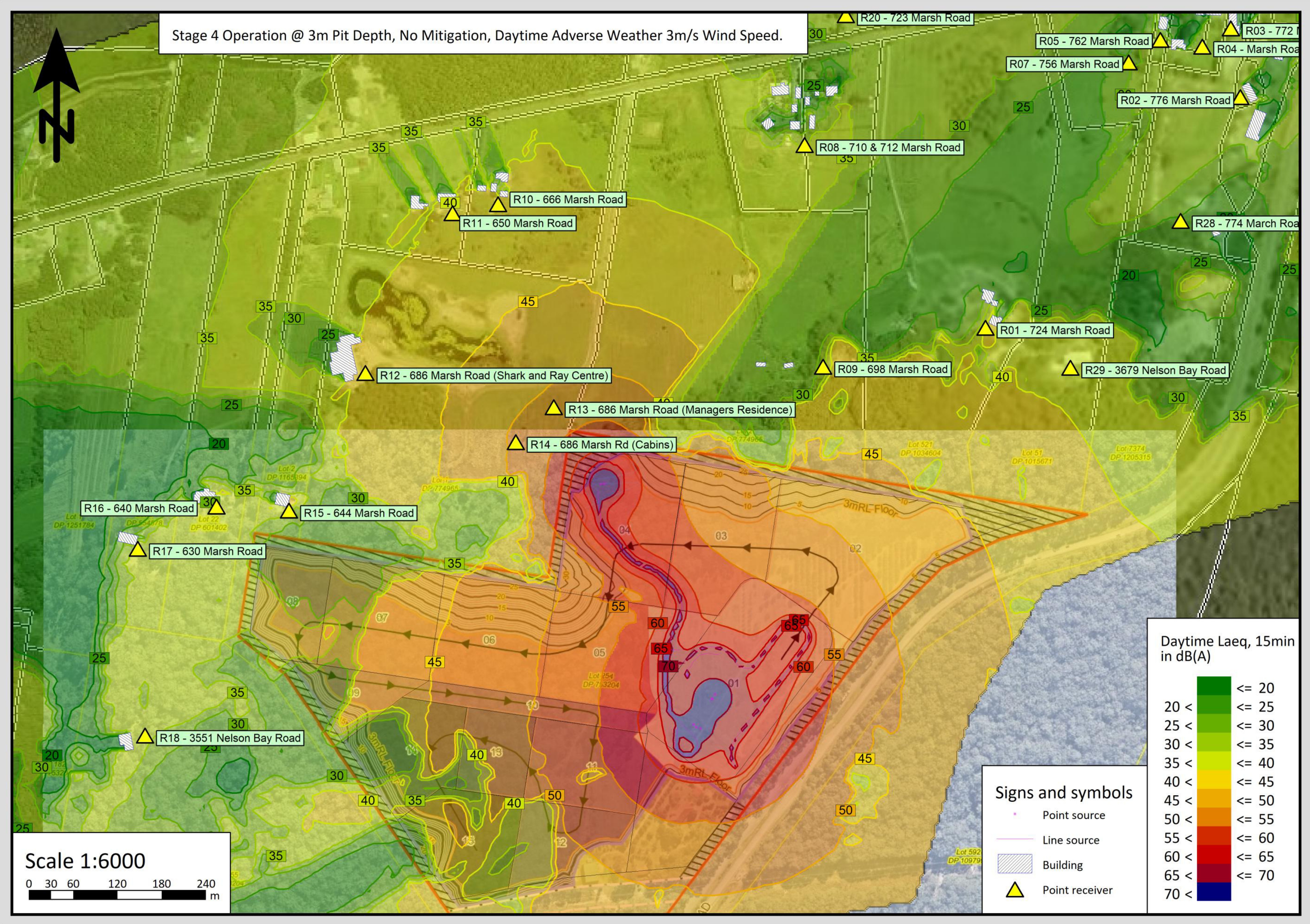
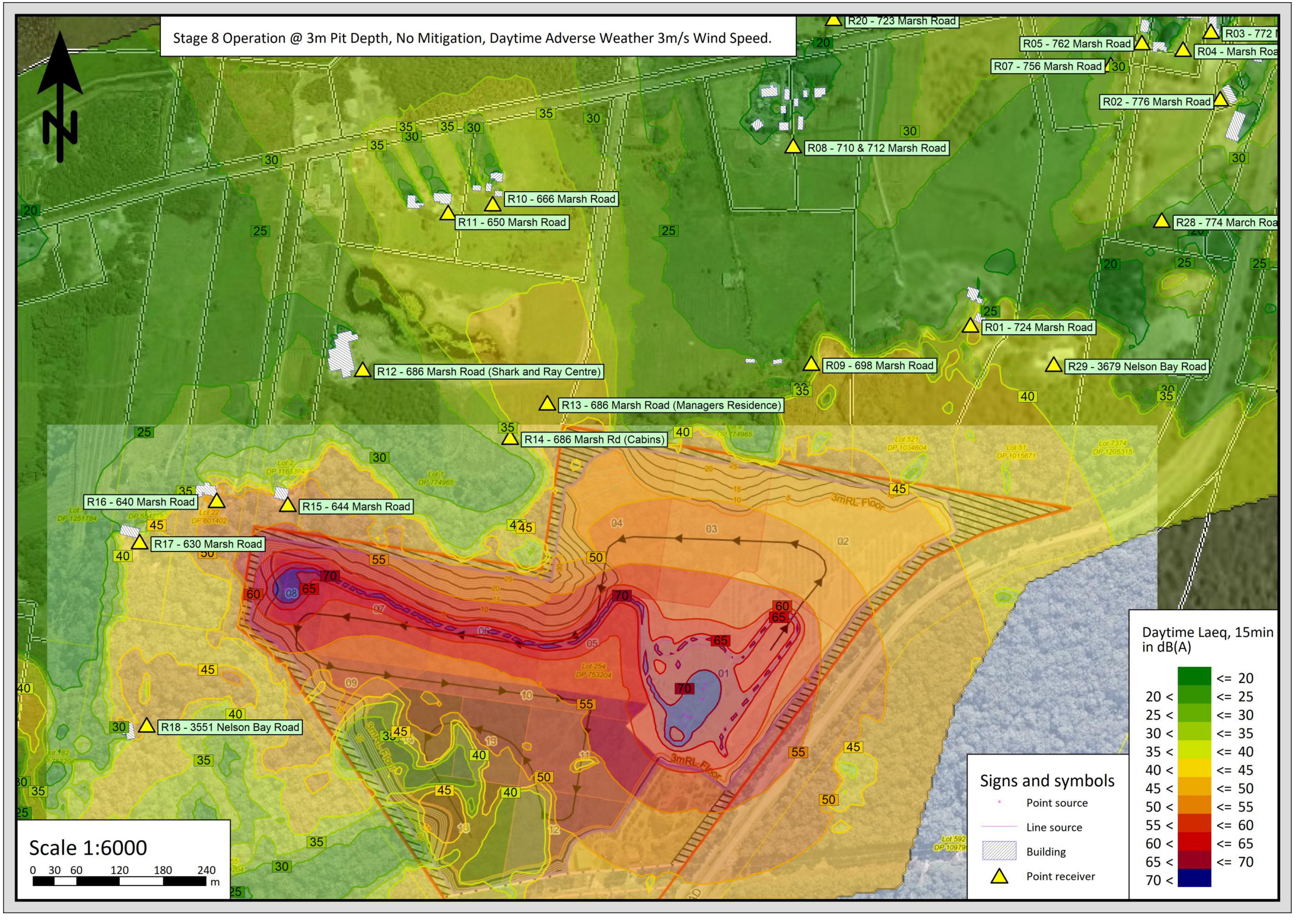
Appendix A Noise Contour Maps


Stage 2 Operation @ 3m Pit Depth, No Mitigation, Daytime Adverse Weather 3m/s Wind Speed.
R20 - 723 Marsh Road
R03 - 772
R05 - 762 Marsh Road
R04 - Marsh Roa
R07 - 756 Marsh Road
R02 - 776 Marsh Road
R08 - 710 & 712 Marsh Road
R10 - 666 Marsh Road
R11 - 650 Marsh Road
R28 - 774 March Roa
R01 - 724 Marsh Road
R09 - 698 Marsh Road
R29 - 3679 Nelson Bay Road
R12 - 686 Marsh Road (Shark and Ray Centre)
R13 - 686 Marsh Road (Managers Residence)
R14 - 686 Marsh Rd (Cabins)
R16 - 640 Marsh Road
R15 - 644 Marsh Road
R17 - 630 Marsh Road
R18 - 3551 Nelson Bay Road
3mRL Floor
Scale 1:6000
0 30 60 120 180 240
m
Signs and symbols
Point source
Line source
Building
Point receiver
Daytime Laeq, 15min in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <


Stage 4 Operation @ 3m Pit Depth, No Mitigation, Daytime Adverse Weather 3m/s Wind Speed.
R20 - 723 Marsh Road
R05 - 762 Marsh Road
R07 - 756 Marsh Road
R02 - 776 Marsh Road
R08 - 710 & 712 Marsh Road
R10 - 666 Marsh Road
R11 - 650 Marsh Road
R28 - 774 March Roa
R01 - 724 Marsh Road
R12 - 686 Marsh Road (Shark and Ray Centre)
R09 - 698 Marsh Road
R29 - 3679 Nelson Bay Road
R13 - 686 Marsh Road (Managers Residence)
R14 - 686 Marsh Rd (Cabins)
R16 - 640 Marsh Road
R15 - 644 Marsh Road
R17 - 630 Marsh Road
R18 - 3551 Nelson Bay Road
3mRL Floor
Scale 1:6000
0 30 60 120 180 240 m
Signs and symbols
Point source
Line source
Building
Point receiver
Daytime Laeq, 15min in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <


Stage 8 Operation @ 3m Pit Depth, No Mitigation, Daytime Adverse Weather 3m/s Wind Speed.
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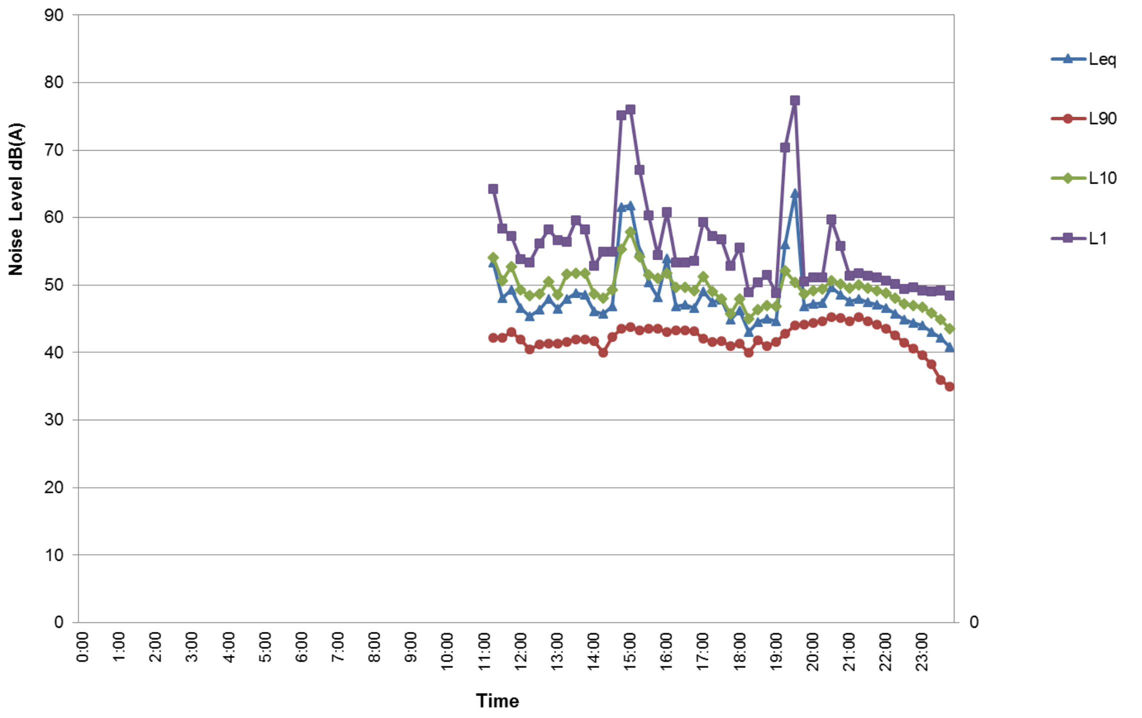
R05 - 762 Marsh Road
R07 - 756 Marsh Road
R02 - 776 Marsh Road
R08 - 710 & 712 Marsh Road
R10 - 666 Marsh Road
R11 - 650 Marsh Road
R28 - 774 March Roa
R01 - 724 Marsh Road
R09 - 698 Marsh Road
R29 - 3679 Nelson Bay Road
R12 - 686 Marsh Road (Shark and Ray Centre)
R13 - 686 Marsh Road (Managers Residence)
R14 - 686 Marsh Rd (Cabins)
R16 - 640 Marsh Road
R15 - 644 Marsh Road
R17 - 630 Marsh Road
R18 - 3551 Nelson Bay Road
3mRL Floor
Scale 1:6000
0 30 60 120 180 240 m
Signs and symbols
Point source
Line source
Building
Point receiver
Daytime Laeq, 15min in dB(A)
<= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <

Appendix B Noise Monitoring Results

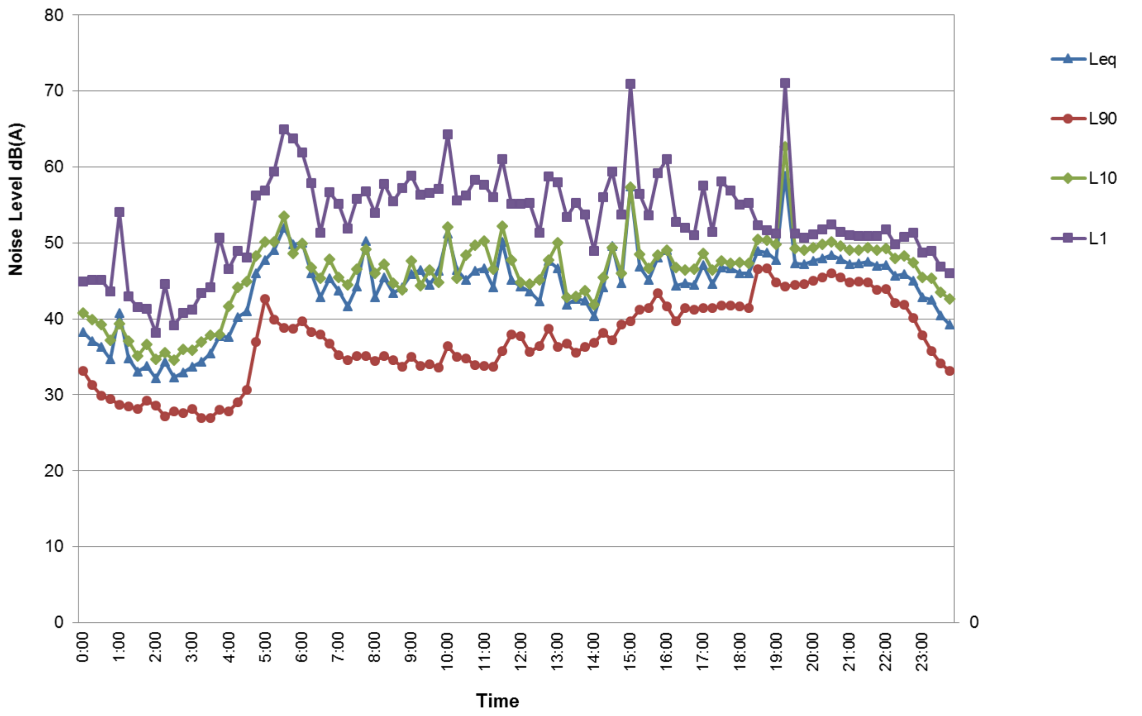
Noise Monitoring Graph

Location: 686 Marsh Road, Bobs Farm **Date:** 01/10/2019



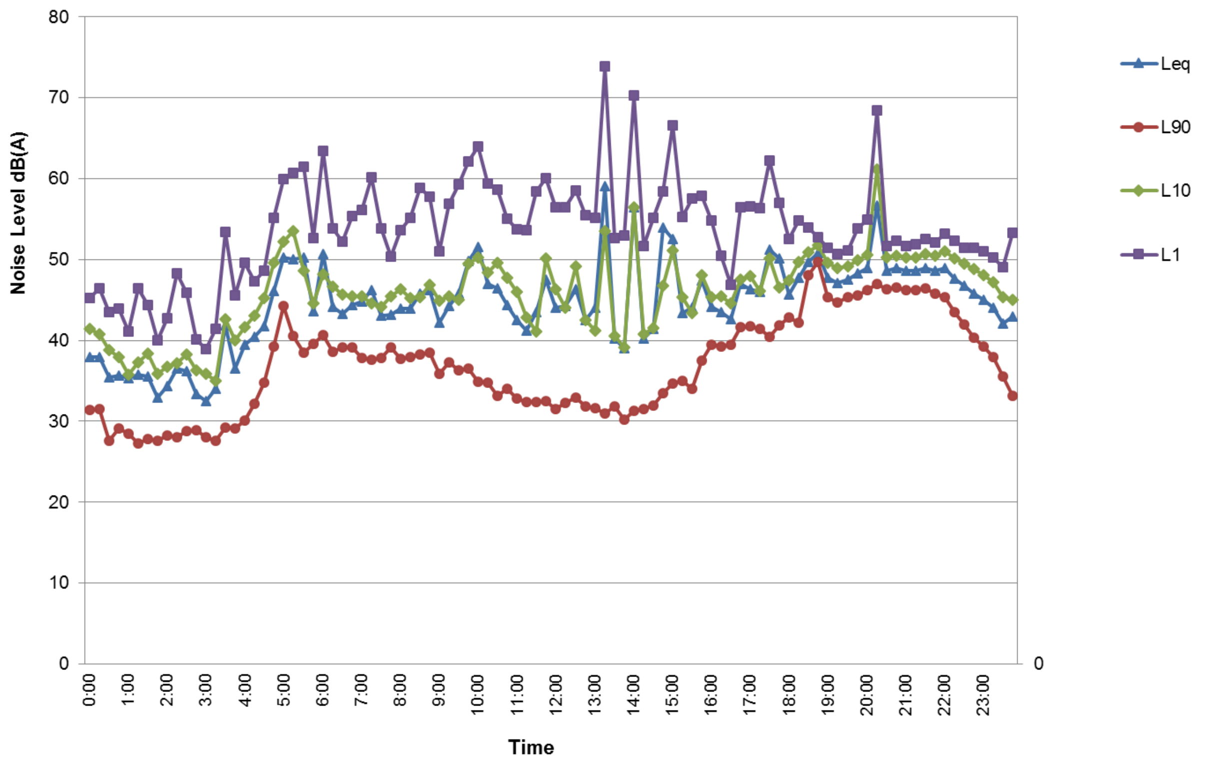
Noise Monitoring Graph

Location: 686 Marsh Road, Bobs Farm **Date:** 02/10/2019



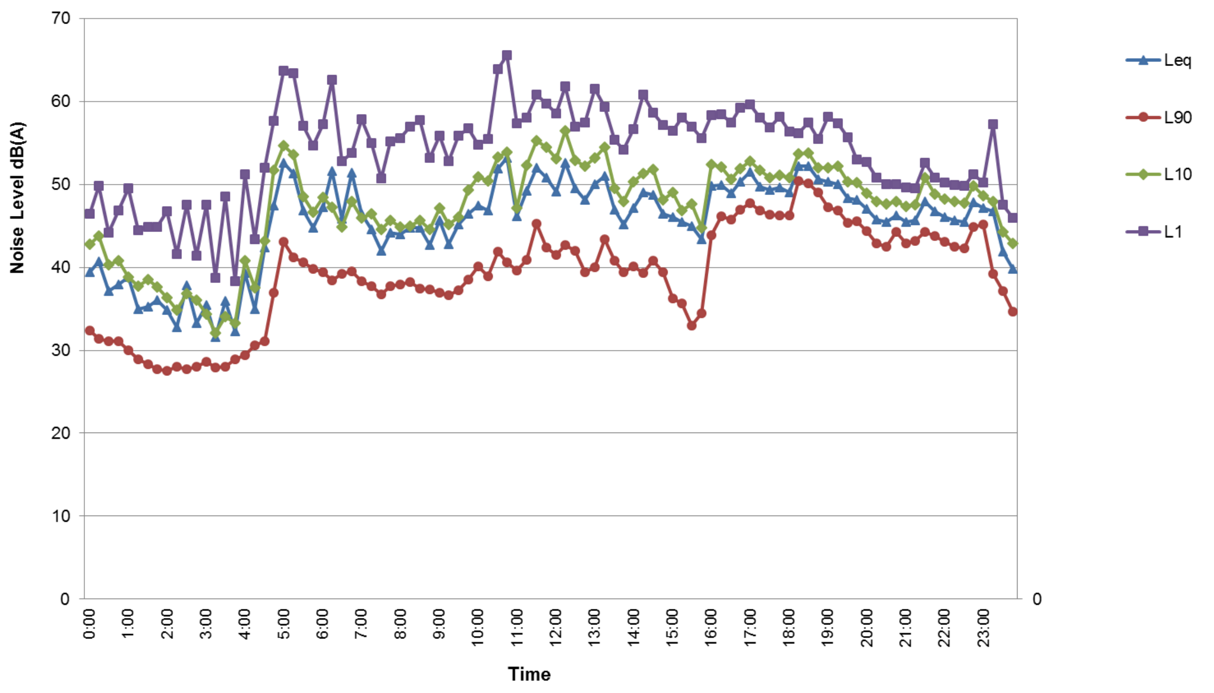
Noise Monitoring Graph

Location: 686 Marsh Road, Bobs Farm **Date:** 03/10/2019



Noise Monitoring Graph

Location: 686 Marsh Road, Bobs Farm **Date:** 04/10/2019



Noise Monitoring Graph

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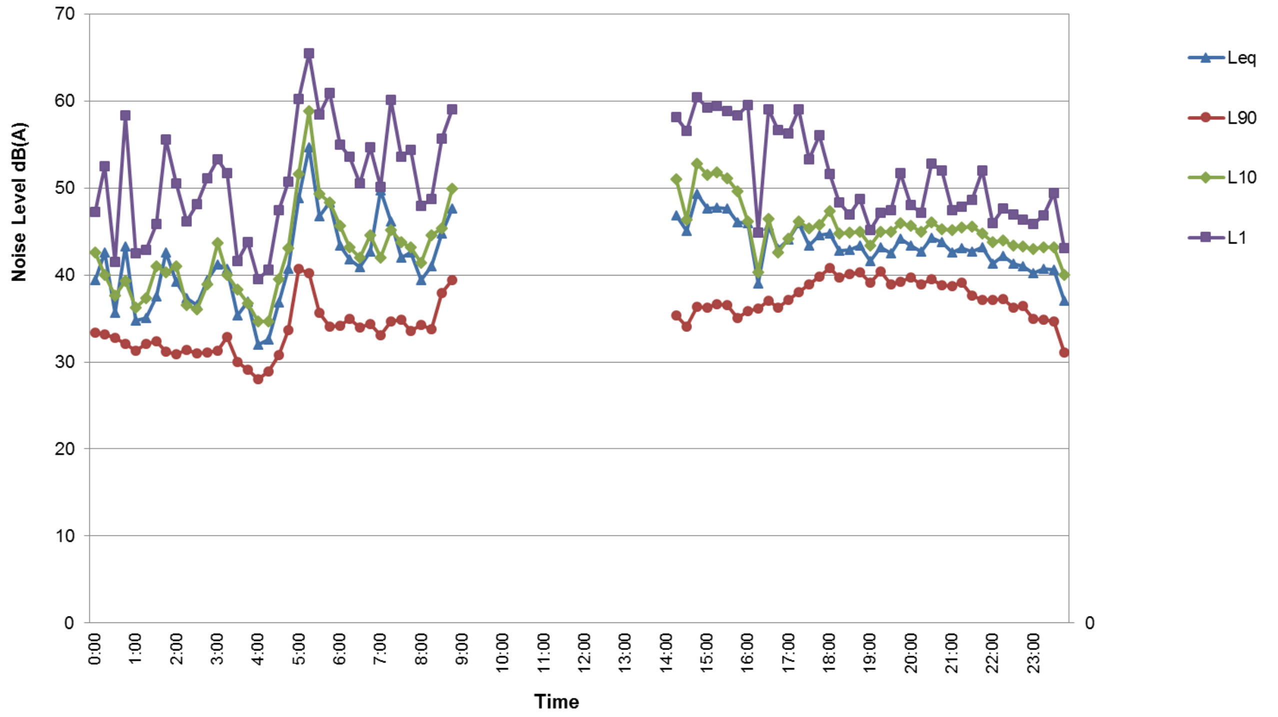
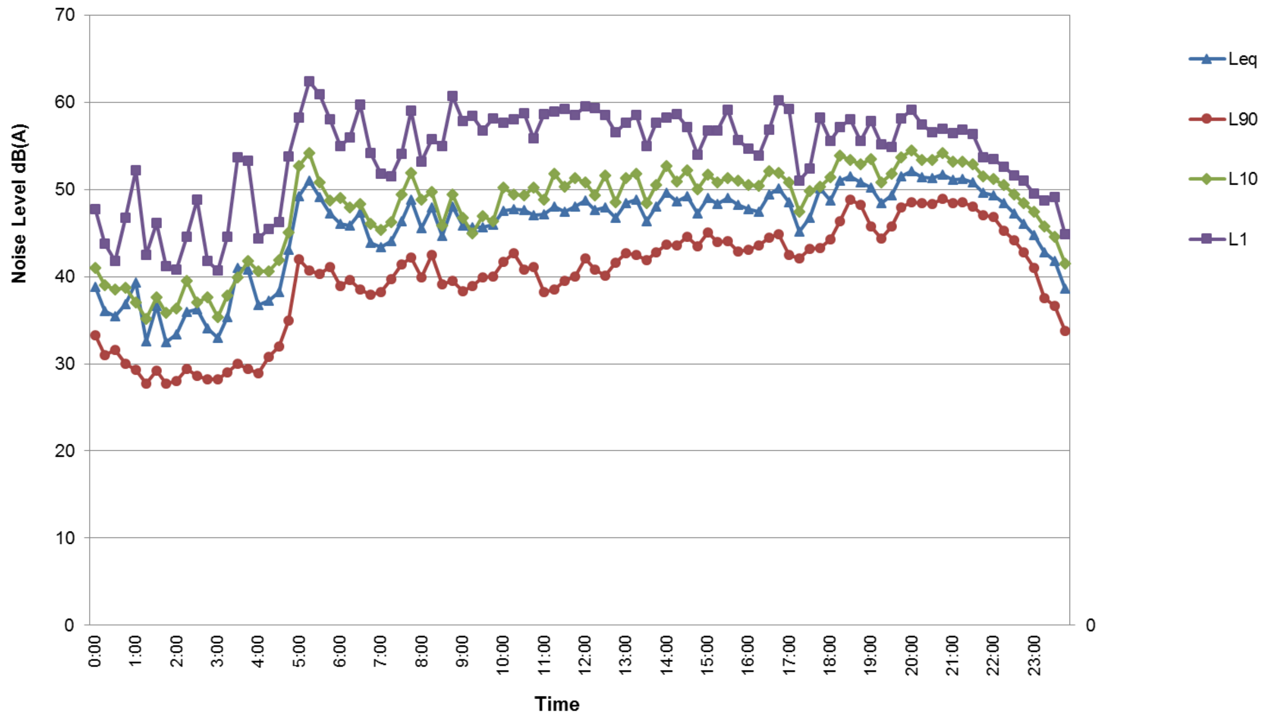
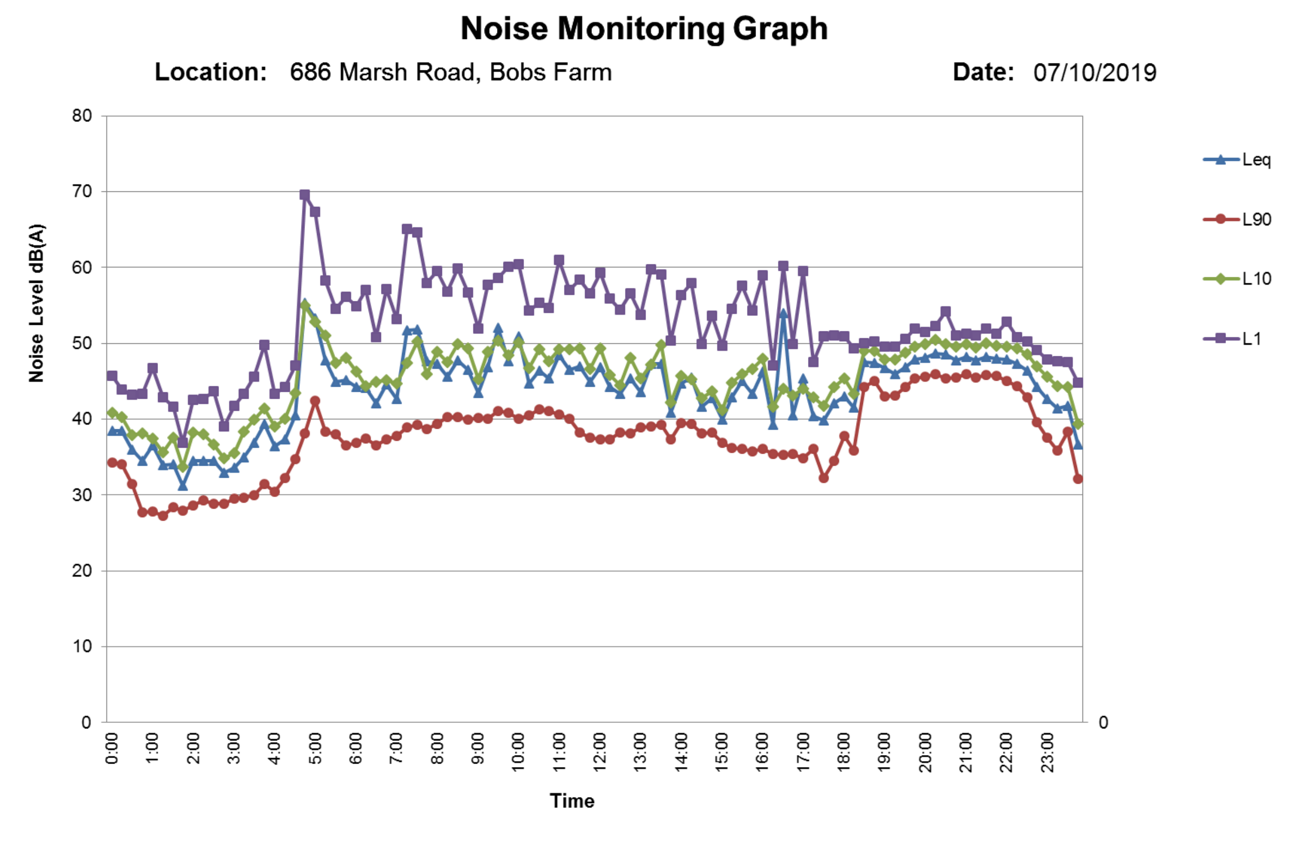


Noise Monitoring Graph

Location: 686 Marsh Road, Bobs Farm **Date:** 06/10/2019




Noise Monitoring Graph
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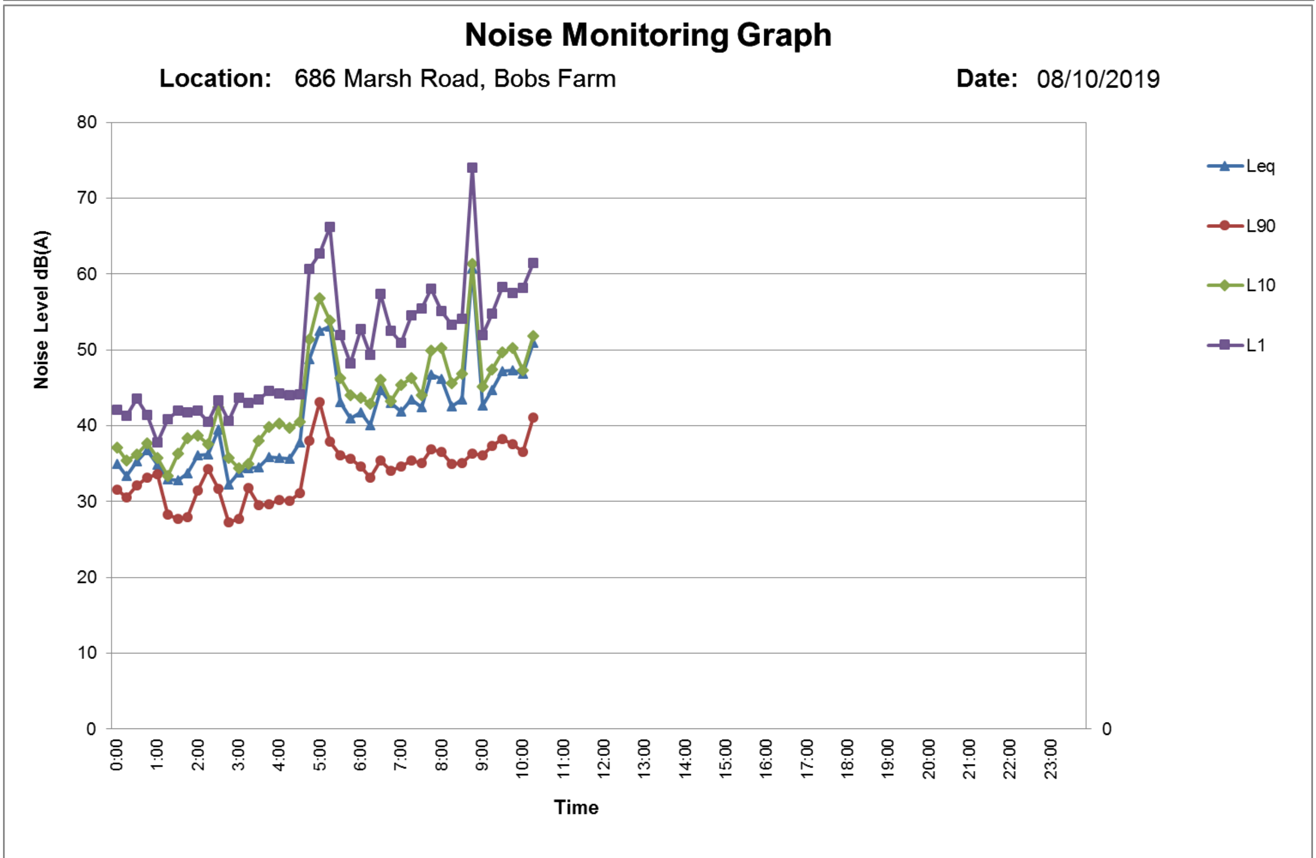
Date: 07/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1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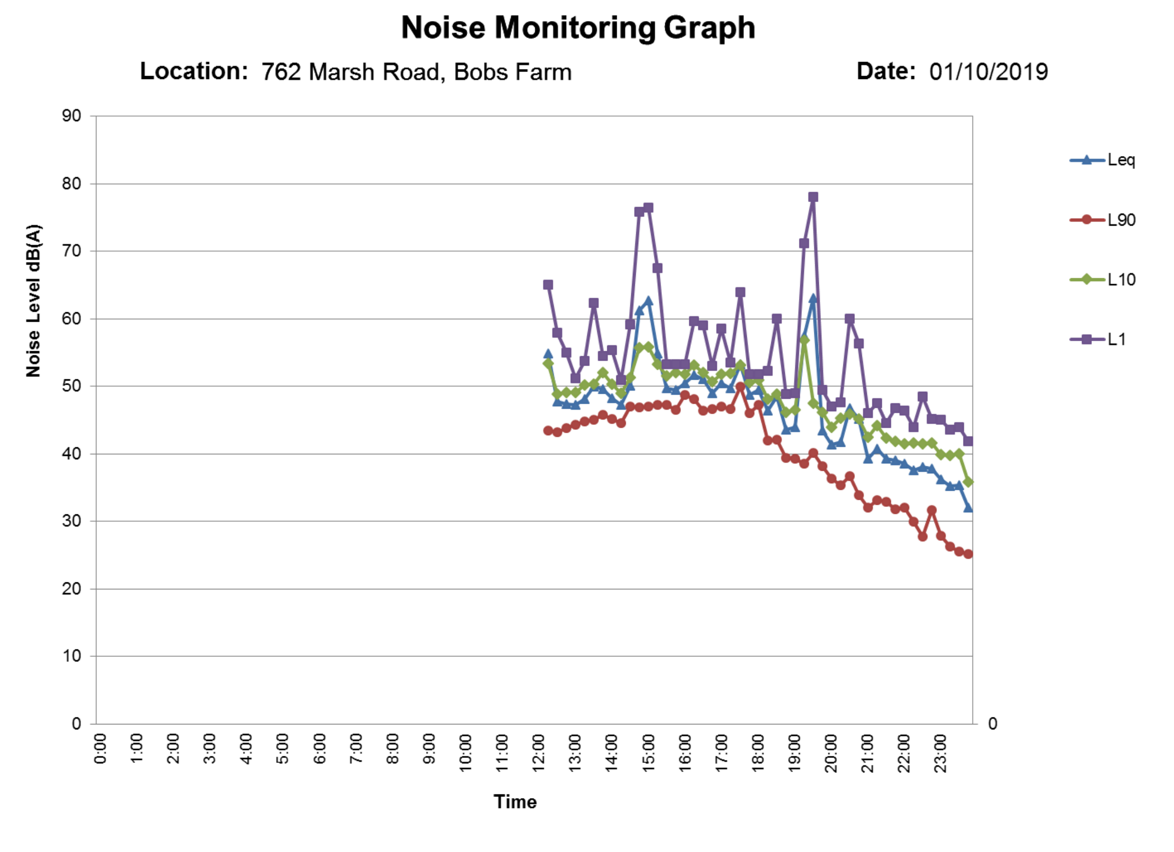
Date: 08/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1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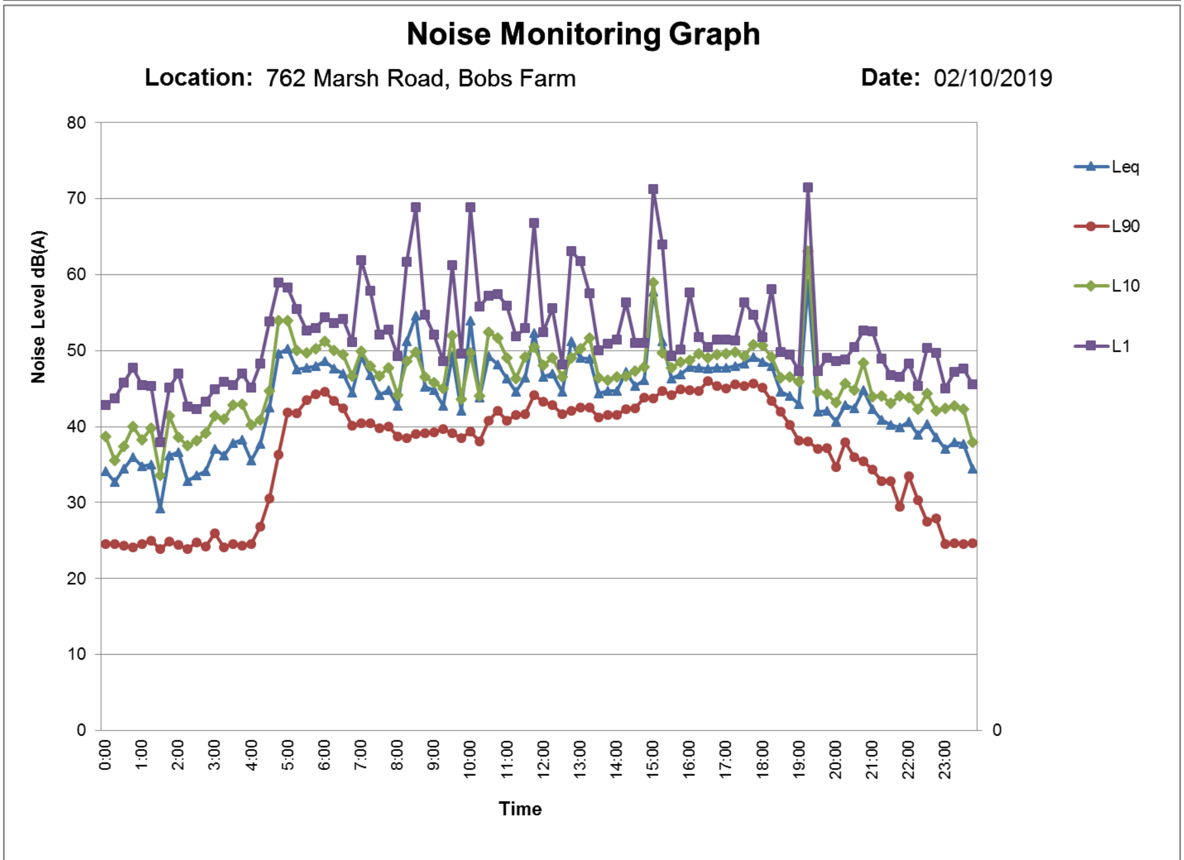
Date: 01/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1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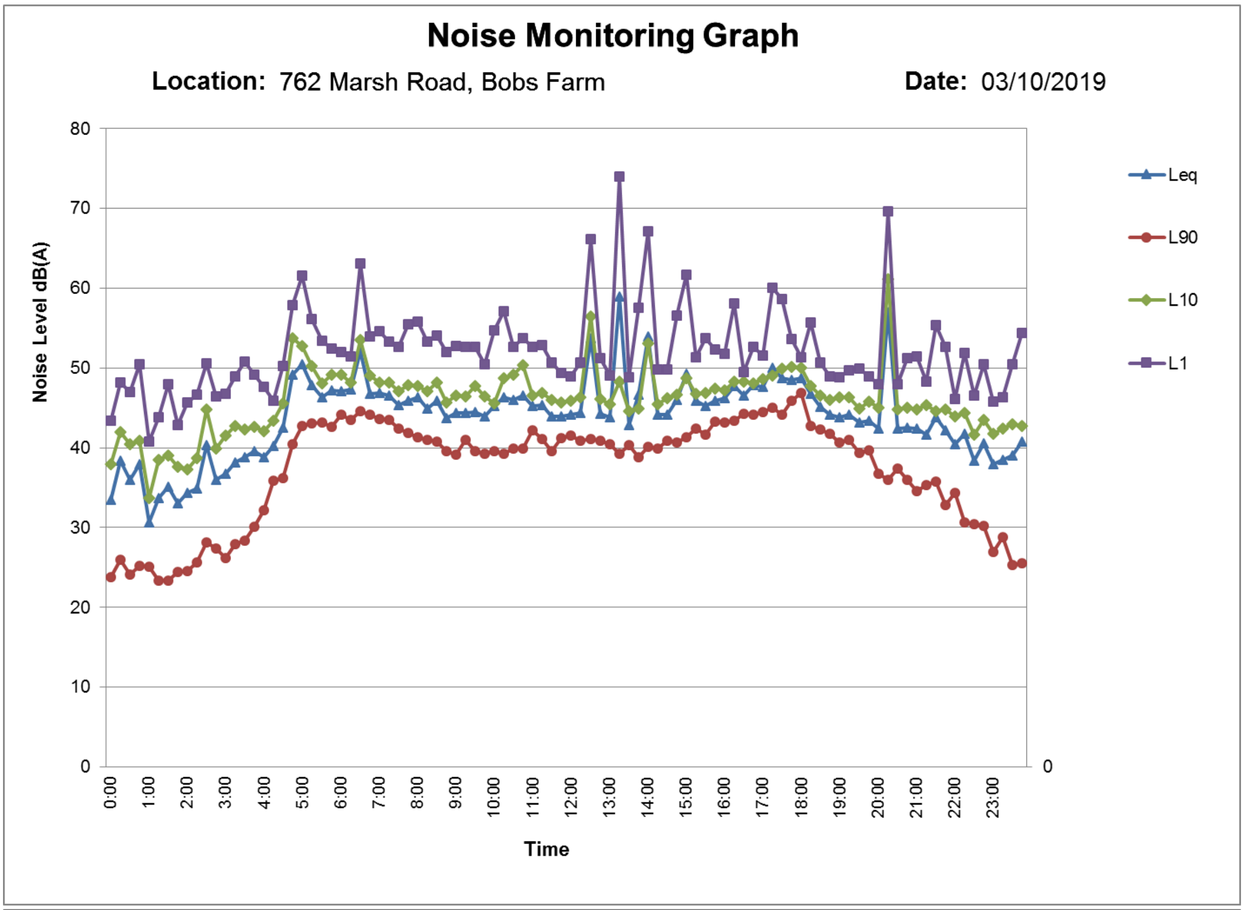
Noise Level dB(A)
Time
Leq
L90
L10
L1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Date: 03/10/2019
Noise Level dB(A)
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50
40
30
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0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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Leq
L90
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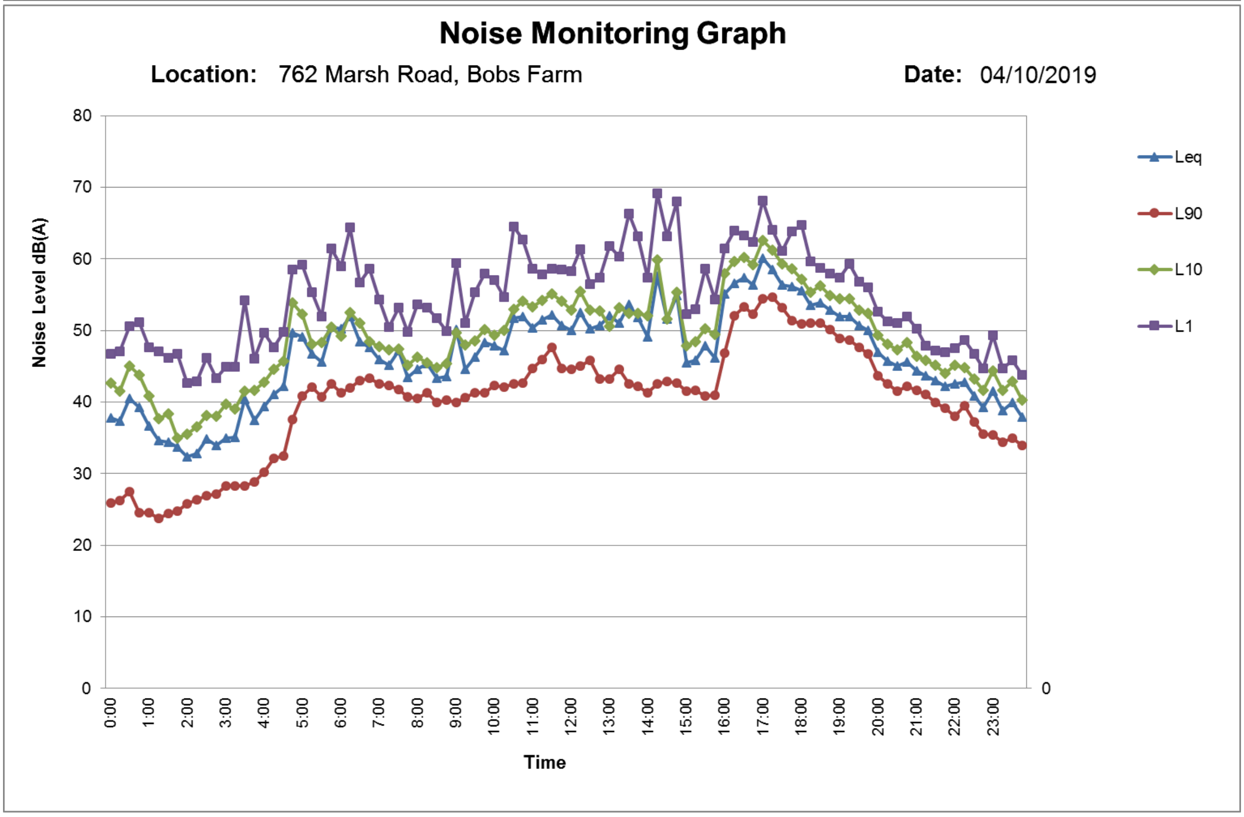
L1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Noise Level dB(A)
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60
50
40
30
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4:00
5:00
6:00
7:00
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11:00
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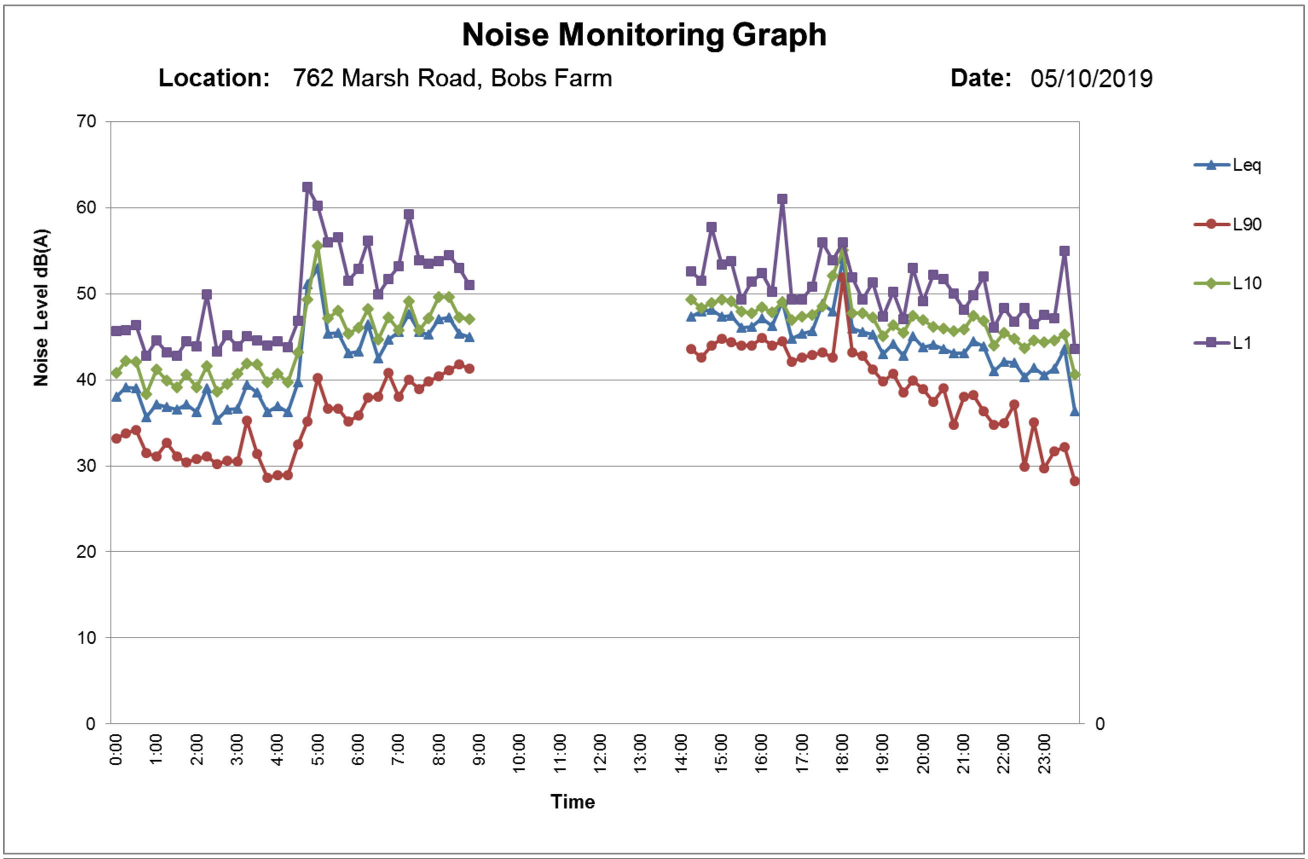
Leq
L90
L10
L1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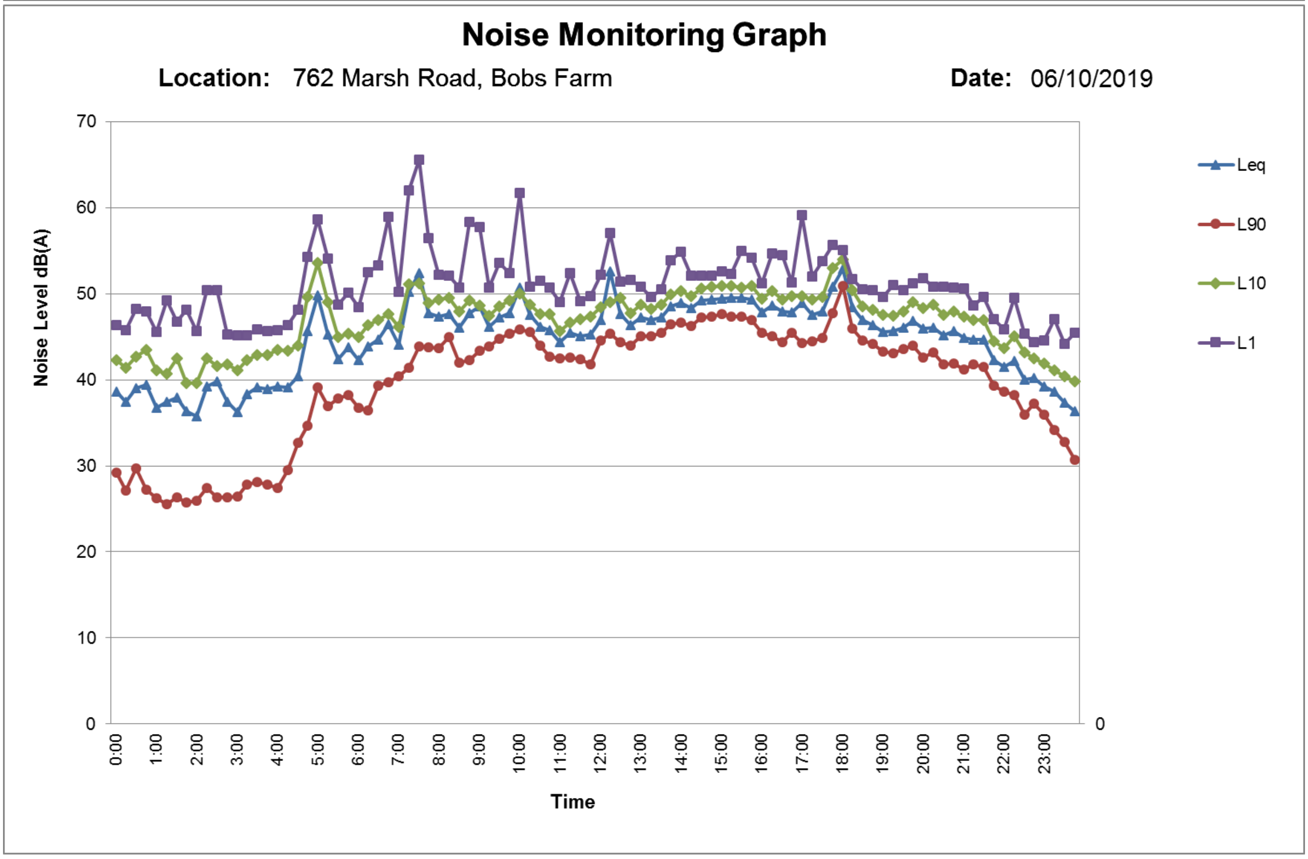
Date: 05/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1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Date: 06/10/2019
Noise Level dB(A)
Time
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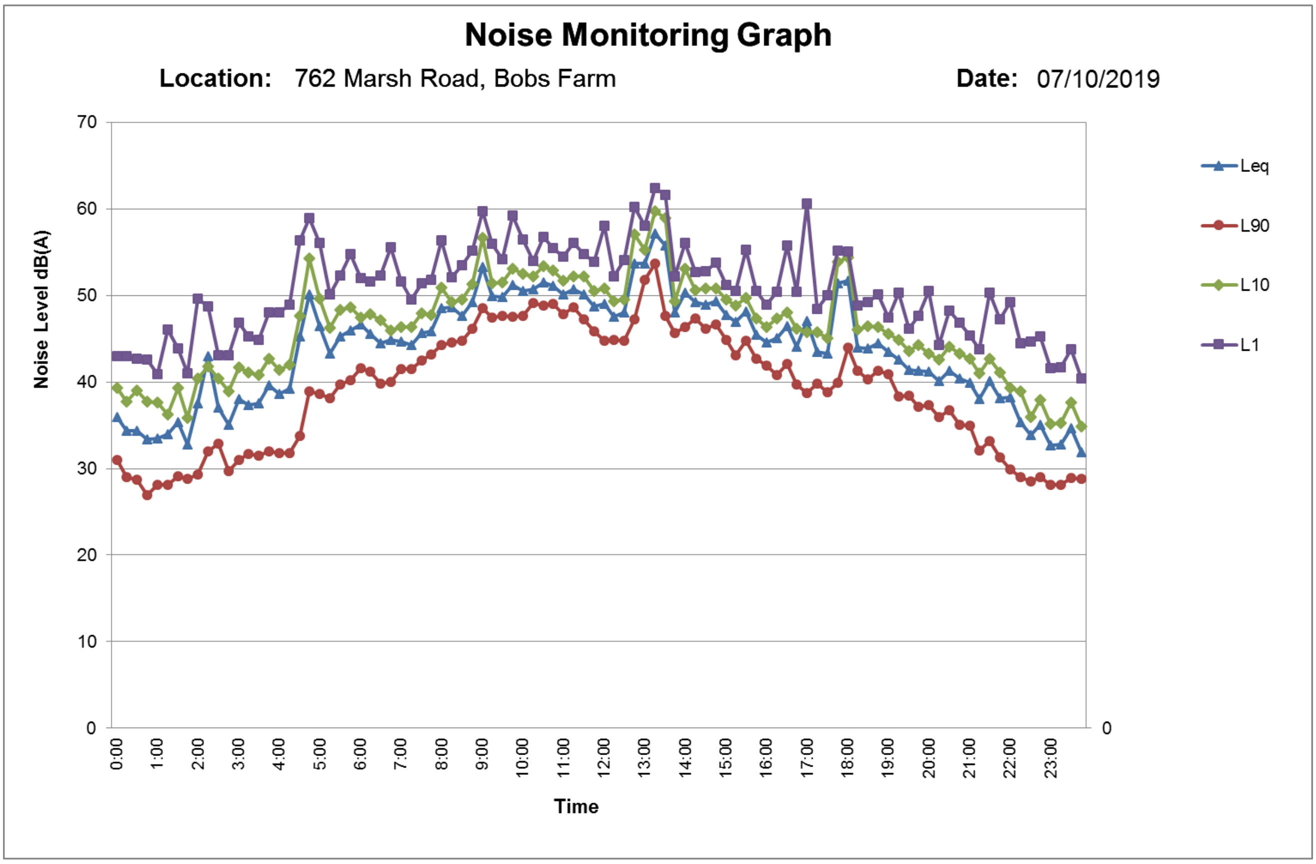
L10
L1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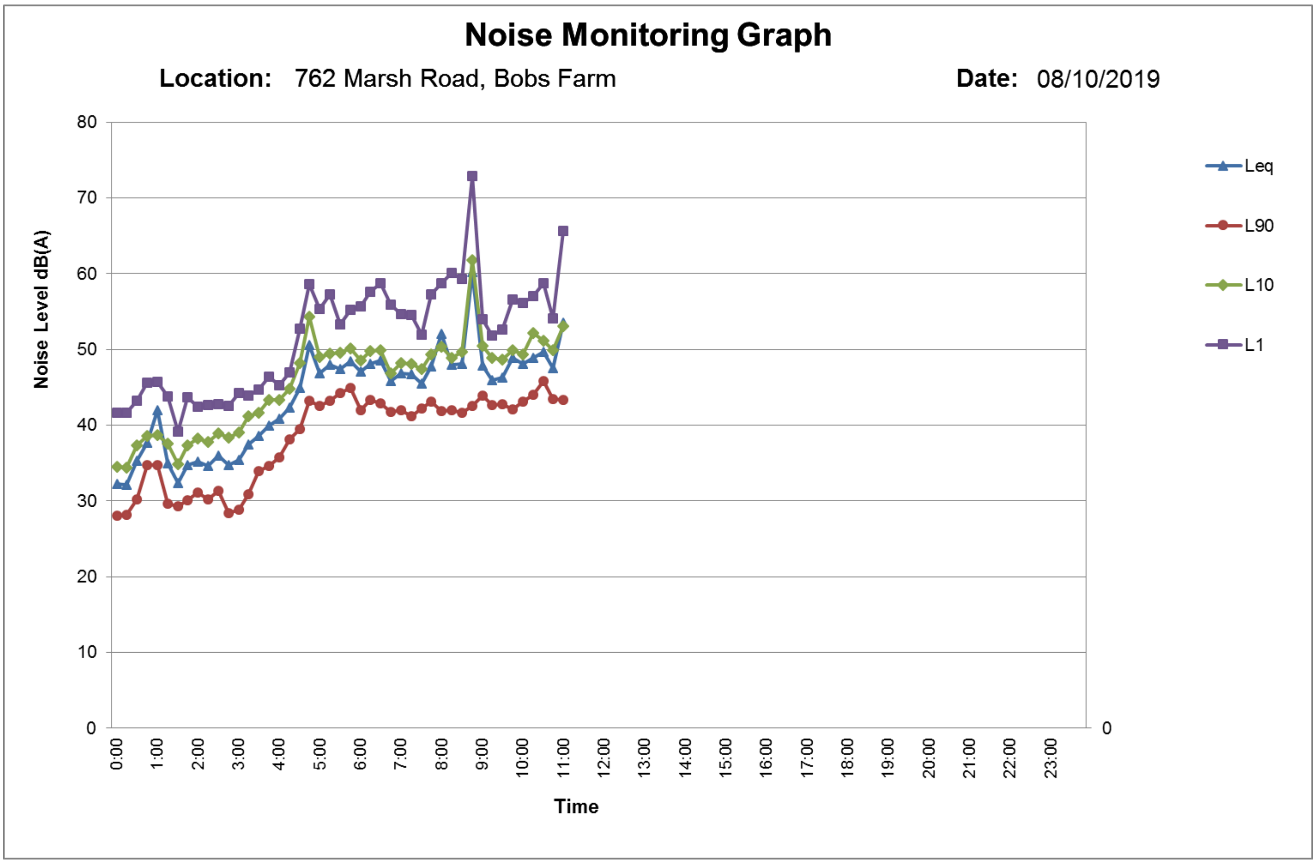
L10
L1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