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Gemini Project

Noise Impact Assessment

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Appendices

1. Introduction

Trinity Consultants Australia (T/A ASK Consulting Engineers) was commissioned by Magnetic South Pty Ltd to provide a noise and vibration impact assessment for the Gemini Project.

The Gemini Project consists of a greenfield open cut mine to produce Pulverised Coal Injection (PCI) coal and Coking Coal products for export for steel production. The Project is located within EPC 881 and the proposed Mining Lease Application (MLA) boundary in the Bowen Basin, Central Queensland. The site is located approximately 15 km east of Bluff and 10 km west of Dingo. The site location and surrounds are shown in **Figure 1.1**.

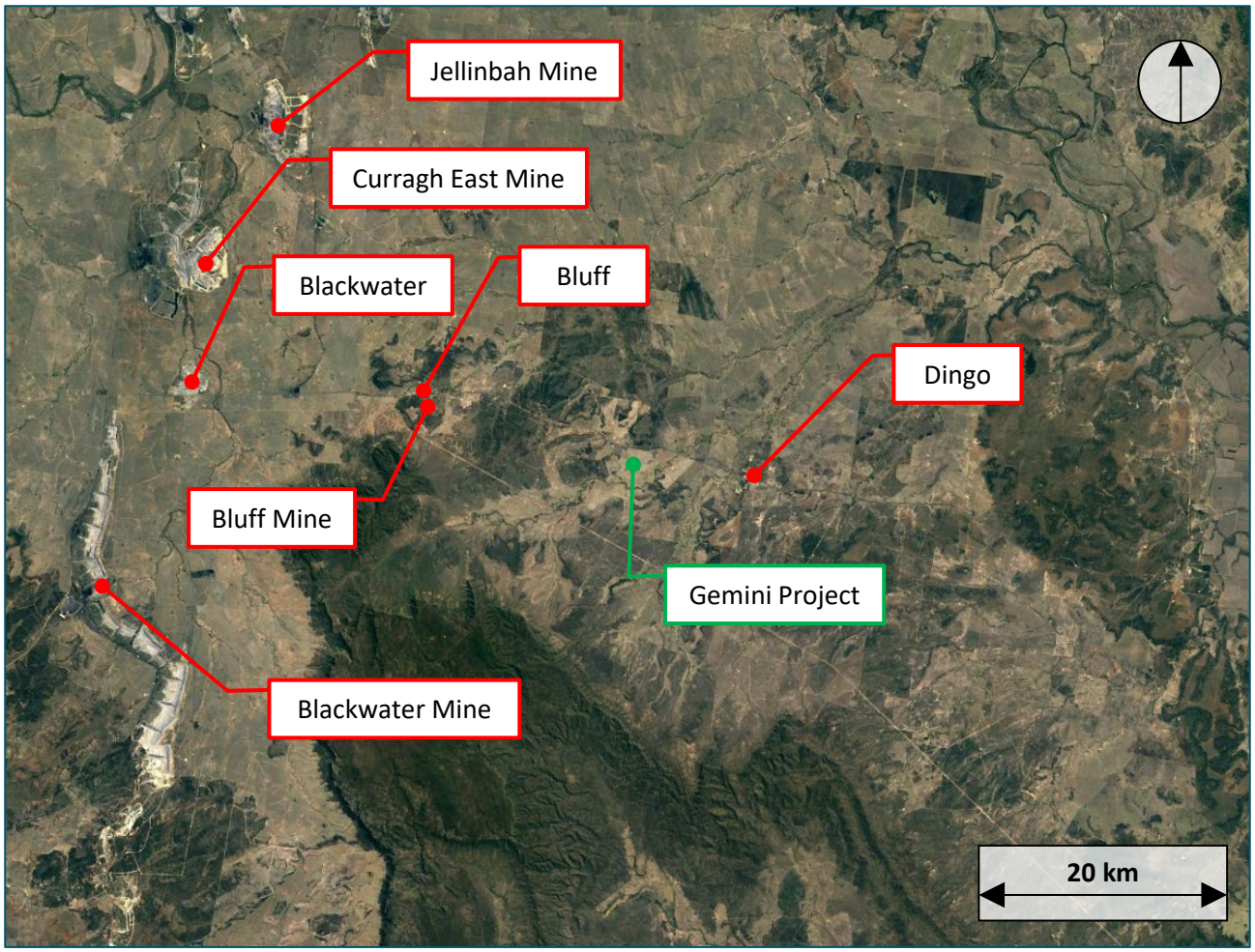


Figure 1.1 Site Location and Surrounds

The purpose of this report is as follows:

- Present the results of noise monitoring data of the existing environment at selected sensitive receptors.
- Propose appropriate noise and vibration criteria.
- Determine noise emission levels from the proposed fixed and mobile plant.
- Determine airblast and vibration levels due to blasting operations.
- Assess noise and vibration impacts for three scenarios of mining operations under adverse and neutral meteorological conditions in accordance with the nominated noise and vibration criteria.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

The previous noise report 197401.0181.R01V06 was submitted, and a second further information request was issued by Department of Environment and Science (DES). This revised assessment has been prepared with the aim of addressing the latest information request and a summary of the response is shown in **Table 1.1**.

Table 1.1 Further Information Request and Trinity Responses

Section	Comment	Requirement	Trinity Response
Volume 4 / Appendix M: Noise Impact Assessment / Section 3.1	The list of main activities associated with Gemini Project does not include "workers' accommodation and associated infrastructure (camp access road, sewage treatment plant, sewage pipeline and effluent irrigation management area)" as proposed by the written notice of changed application and the revised conceptual mine layout. It is noted that these activities were not considered as a source in noise quality modelling and assessment in the original EA application submission. However, given the changed application, it is not clear how the revised mine layout has the potential to impact the EVs of noise at nearby sensitive receptors.	Provide justification for why workers' accommodation and associated infrastructure, which includes camp access road, sewage treatment plant, sewage pipeline and effluent irrigation management area, has been excluded as sources from the noise modelling and assessment. Demonstrate how the EVs of noise will be enhanced or protected given the change to the conceptual mine layout.	The following additional noise sources have been added: • vehicles on the camp access road • sewage treatment plant • pump at irrigation management area • people talking and air-conditioning units at camp The additional sound power level information is in **Table 6.2**. These noise sources have been added to all models. The calculated noise levels are in **Tables 6.6 to 6.8**. The noise contribution from these new sources is minor but sufficient to require alterations to the mitigation scenarios in the noise management plan. A number of operational scenarios have been modelled to demonstrate that changes to mining operations (i.e. reduction in the number of machines in operation) can be implemented to prevent exceedances and ensure compliance can be achieved at all sensitive receivers.
Volume 4 / Appendix M: Noise Impact Assessment / Section 2 / Table 2.1	Table 2.1 lists sensitive receptors surrounding the project. The real property description for SR31 and SR32 is not provided. It is not clear if the revised conceptual mine layout affects and alters the impacts to noise at these sensitive receptors from the original application.	Provide more information about SR31 and SR32 and the potential impacts to the EVs of noise at these locations given the change to the conceptual mine layout.	SR31 and SR32 are private homesteads on 1RP61678. The real property description has been added to **Table 2.1**.

2. Study Area Description

The Gemini Project is located approximately 3 km west of Dingo.

The nearest residential sensitive receptors are summarised in **Table 2.1**.

Table 2.1 Sensitive Receptors

Sensitive Receptor ID	Receptor type	Real Property Description	Easting (m)	Northing (m)	Location
SR01	Residential	3SP165527	721380	7386940	4.9 km W
SR03	Residential	6SP152759	737915	7382328	3.2 km E
SR05	Residential	2HT388	721937	7382077	4.3 km W
SR07	Residential, facilities (sports oval, tennis court, school) & businesses (Post Office, hotel, shops, sawmills, etc.)	Dingo Township	737777	7383220	3.0 km E
SR08	Residential	1RP801280	722022	7384327	4.2 km W
SR09	Residential	2RP904099	731988	7385624	Within MLA
SR10	Residential	28HT87	736181	7382995	1.4 km E
SR13	Residential	29HT489	737113	7382802	2.4 km E
SR14	Residential	3HT139	728569	7374873	2.5 km S
SR15	Residential	4HT165	729144	7388750	0.3 km N
SR16	Residential	8HT536	735273	7388705	3.0 km NE
SR17	Residential	2RP616780	722415	7384928	3.8 km W
SR18	Residential	1HT424	729626	7384531	Within MLA
SR19	Residential	2HT138	732684	7377515	1.4 km SE
SR20	Residential	2HT138	732671	7377581	1.4 km SE
SR21	Residential	2HT138	732614	7377700	1.4 km SE
SR22	Residential and Camp Accommodation	100RP882349	726499	7386357	Within MLA
SR23	Residential	47H406	734446	7383534	Within MLA
SR24	Residential	20H4017	735824	7384500	1.2 km NE
SR26	Residential	20SP217269	739747	7382306	5.1 km E
SR27	Residential	20SP217269	739278	7383145	4.5 km E
SR28	Residential	21SP217269	739157	7383337	4.4 km E
SR30	Residential	25SP217269	739319	7383894	4.6 km E
SR31	Residential	1RP61678	725109	7385743	1.1 km NW
SR32	Residential	1RP61678	725075	7386813	1.2 km NW

It is noted that SR07 represents the Dingo township. The following sensitive receptors are located within the Mining Lease Application (MLA) Area:

- SR09
- SR18
- SR23

At the time of report preparation, receptors SR09, SR14, SR15, SR18, SR19, SR20, SR21, SR23 and SR24 are owned or under purchase by Magnetic South, and will be excluded from the assessment.

The Capricorn Highway and the Blackwater-Gladstone rail network extend through the northern section of the MLA. A number of the sensitive receptors are located within 1 km of the highway and rail line.

The site location and sensitive receptors are shown in **Figure 2.1**.

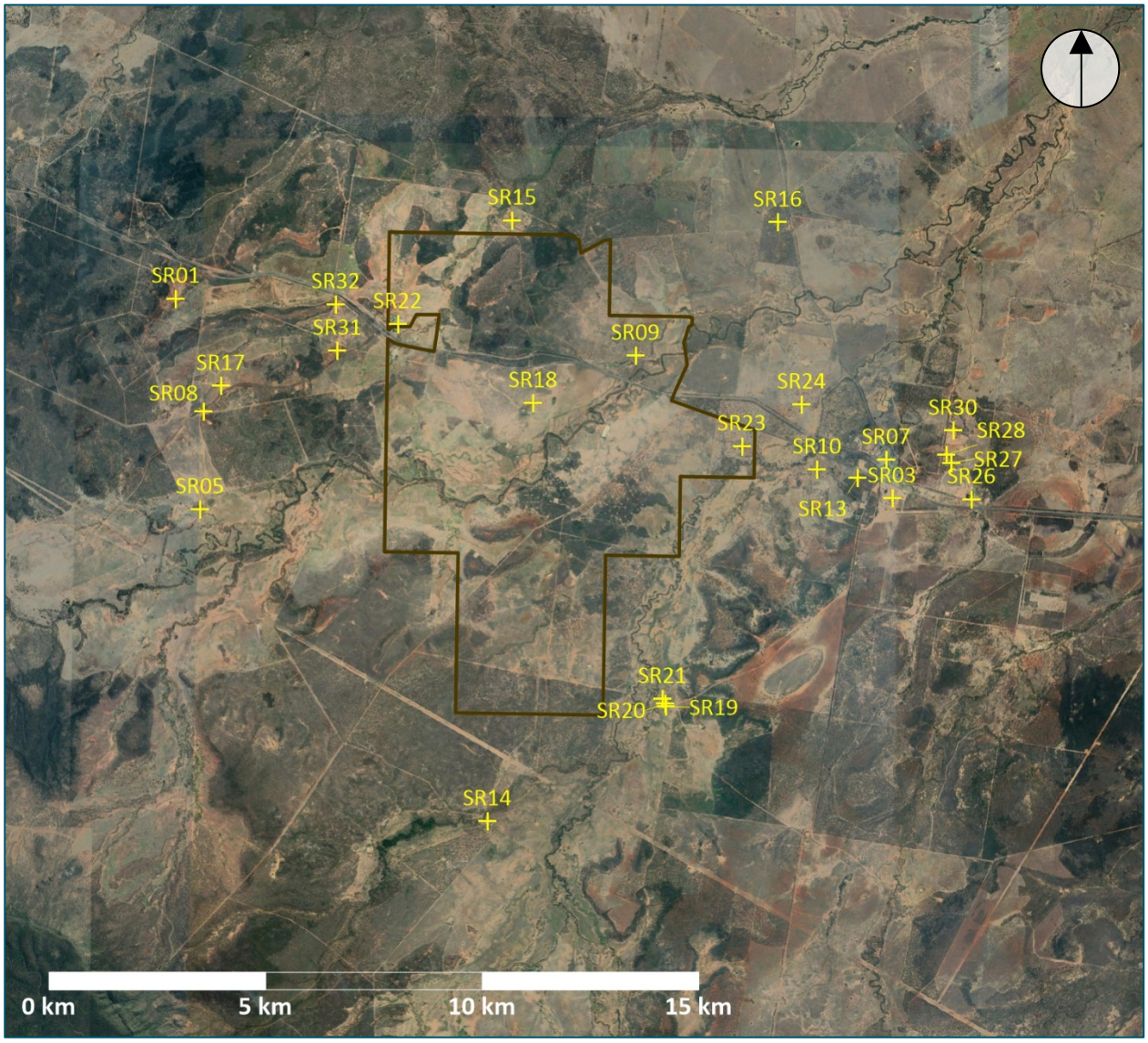


Figure 2.1 Site Location (MLA shown with brown line) & Sensitive Receptors

According to the Department of Natural Resources, Mines and Energy's MinesOnlineMaps system, the nearest mine to the Gemini Project is Bluff Mine, which is located approximately 15 km west of the Gemini Project's proposed ROM pad. There are a number of other mines further to the west, but no other mines within 50 km to the north, south or east.

3. Proposed Development

3.1 Project Description

The Gemini Project is a greenfield, open-cut metallurgical coal mine producing Pulverised Coal Injection (PCI) coal and coking coal for export to the international steel making industry. The Project term is anticipated to be 25 years from grant of the Mining Lease (ML) with this term including initial construction, mine operation and rehabilitation activities.

Mine construction activities are scheduled to commence in 2022 subject to granting of the Project ML and EA. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production.

The main activities associated with the Project include:

- Exploration activities continuing in order to support mine planning.
- Development of a Mine Infrastructure Area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, wash bay, laydown area, sewage, effluent and liquid waste storage, and a heli-pad.
- Construction and operation of a Coal Handling Preparation Plant (CHPP) and coal handling facilities adjacent to the MIA (including Run-of-Mine (ROM) coal and product stockpiles and rejects bin/overflow [coarse and fine rejects]).
- Construction and operation of a surface conveyor from the product stockpiles to a Train Load Out (TLO) facility and rail loop connecting to the Blackwater-Gladstone Branch Rail to transport product coal to coal terminals at Gladstone for export.
- Construction of an access road from the Capricorn Highway to the MIA and accommodation facility, and an access road to the TLO.
- Installation of a raw water supply pipeline to connect to the Blackwater Pipeline network.
- Construction of a 66 kV transmission line and switching/substation to connect to the existing regional network.
- Other associated minor infrastructure, plant, equipment and activities.
- Development of mine areas (open cut pits) and out-of-pit waste rock emplacements.
- Drilling and blasting of competent waste material.
- Mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers).
- Mining up to 1.9 Mtpa ROM Coal – average 1.8 Mtpa for a construction/production period of approximately 20 years.
- Progressive placement of waste rock in:
- Emplacements, adjacent to and near the open cut voids.
- Mine voids, behind the advancing open cut mining operations.
- Progressive rehabilitation of waste rock emplacement areas and mined voids.
- Progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works). Material will be sourced from local quarries where required.
- Disposal of CHPP rejects (coarse and fine rejects) in out of pit spoil dumps, and in-pit behind the mining void.
- Progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access.
- Development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

The proposed mine layout is shown in **Figure 3.1**.

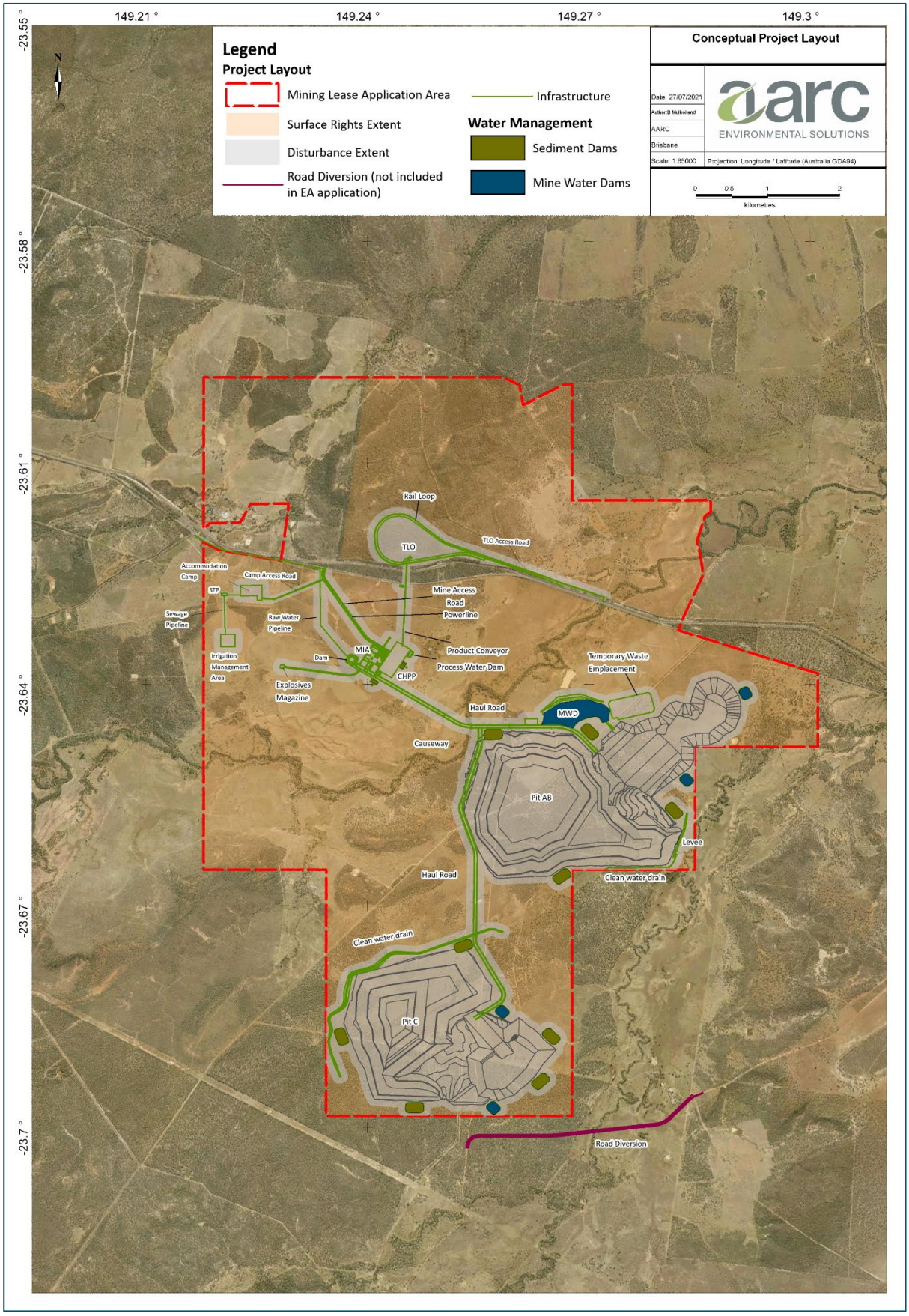


Figure 3.1 Proposed Mine Layout

3.2 Projected Equipment Numbers

To give an indication of the amount of equipment used, the proposed haul truck numbers for the open cut mining operations are presented in **Table 3.1**.

Table 3.1 Haul Truck Fleet in Each Mining Year

Mining Year	Waste Haul Trucks	Coal Haul Trucks
1	6	0
2	12	1
3	12	2
4	13	2
5	14	2
6	15	2
7	15	2
8	15	2
9	15	2
10	15	2
11	15	2
12	15	2
13	15	2
14	15	2
15	17	3
16	17	3
17	17	3
18	17	3
19	10	3

It is noted that these haul truck numbers are the actual number of trucks in use at any one time, with an additional number of trucks being out of operation for maintenance etc. Further details on the types and numbers of equipment are provided in **Section 6**.

The major items of equipment at the ROM pad include a Coal Handling Preparation Plant (CHPP) and a front end loader (FEL). The rail loadout facility is also included in the model, including conveyors, conveyor drives, rail loadout bin and train locomotives. Support equipment/activities are also included in the model, i.e. sewage treatment plant (STP), activities at the accommodation camp, and vehicle movements to the camp.

4. Existing Noise Environment

4.1 Overview and Locations

Attended noise measurements and noise logging were undertaken at the following locations:

- Location A – Accommodation Facility: Located in an open-field, approximately 360 metres northeast of the railway line and 440 metres northeast of the Capricorn highway (726505.61 E, 7386445.61 N). This is the same location as SR22 (refer **Figure 2.1**).
- Location B – Roadhouse: Located in an open-field location, approximately 220 metres southwest of the Capricorn Highway (738095.59 E, 7382329.42 N). This is approximately the same location as SR03 (refer **Figure 2.1**).
- Location C – Residence: Located in an open-field position, approximately 200 metres northeast of the homestead (732865.98 E, 7377627.44 N). This is approximately the same location as sensitive receptors S19, SR20 and SR21 (refer **Figure 2.1**).

Aerial photos of the measurement locations are included in **Figures B.1**, **B.2** and **B.3** in **Appendix B**.

The noise monitoring was undertaken in general accordance with Australian Standard AS1055 *Acoustics – Description and measurement of environmental noise* and the DES Noise Measurement Manual 2013.

4.2 Weather

Data from the Bureau of Meteorology (Blackwater Airport) indicates that weather for the duration of the noise monitoring period was generally fine and warm with rainfall only recorded for Saturday 08/06/2019 (16.6 mm), Sunday 09/06/2019 (5.4 mm) and Tuesday 11/06/2019 (0.2 mm). Overall, the noise monitoring data has been deemed acceptable for use in this report.

4.3 Attended Noise Measurements

Attended noise measurements were undertaken at Locations A, B and C. The measurements were undertaken over separate 15-minute periods using a field and laboratory calibrated Larson Davis LD831 sound level meter. The microphone height was approximately 1.5m above natural ground level and was located in the free field at each location. Weather during the time of monitoring was generally cool, calm and clear. The conditions were as follows:

- Daytime: Approximately 11 to 15°C with a 2 to 3 m/s breeze and 1/8 cloud cover.
- Night time: Approximately 8 to 10°C, with a 0 to 3 m/s breeze and 1/8 cloud cover.

The measured noise levels are summarised in **Table 4.1**.

Table 4.1 Attended Noise Measurement Results

Location	Date & Time	Period (Minutes)	Results & Notes
A	19/06/2019 11:39pm	15	Statistical noise levels: L_{10} 61 dBA, L_{eq} 55 dBA, L_{90} 21 dBA Coal trains: 54 to 66 dBA Train horn: 58 dBA Distant cattle noise: 24 to 27 dBA Capricorn highway traffic: 45 to 52 dBA
B	19/06/2019 10:03pm	15	Statistical noise levels: L_{10} 61 dBA, L_{eq} 56 dBA, L_{90} 36 dBA Coal trains: 53 to 64 dBA Train horn: 78 to 79 dBA Capricorn highway traffic: 30 to 61 dBA
C	19/06/2019 10:52pm	15	Statistical noise levels: L_{10} 27 dBA, L_{eq} 27 dBA, L_{90} 19 dBA Cattle noise (Distant): 21 to 33 dBA Cattle noise (Closer): 37 to 43 dBA Birds: 33 dBA
A	20/06/2019 08:16am	15	Statistical noise levels: L_{10} 53 dBA, L_{eq} 50 dBA, L_{90} 41 dBA Birds: 39 to 42 dBA Highway trucks: 47 to 56 dBA Capricorn highway traffic: 37 to 50 dBA
B	20/06/2019 09:38am	15	Statistical noise levels: L_{10} 51 dBA, L_{eq} 49 dBA, L_{90} 46 dBA Wind through trees/rustling leaves: 47 to 48 dBA Crows: 54 to 58 dBA Birds: 46 to 51 dBA Truck leaving parking area: 47 to 55 dBA Capricorn highway traffic: 45 to 53 dBA

Note: * The reported noise levels, excluding the statistical noise levels, are the instantaneous levels read from the sound level meter, and generally represent the range in noise levels or maximum noise levels for a particular noise source.

4.4 Noise Logging

Noise logging was undertaken over the following time periods:

- Location A – Accommodation Facility: The measurement period was Friday 7th to Wednesday 19th June 2019.
- Location B – Roadhouse: The measurement period was Friday 7th to Wednesday 19th June 2019.
- Location C – Residence: The measurement period was Friday 7th to Monday 17th June 2019.

Logging was undertaken using field and laboratory calibrated Larson Davis LD831 environmental noise loggers. Noise logging was undertaken in the free-field at each location.

The measured noise levels at Locations A, B and C are shown in **Figure C.1** to **C.6** in **Appendix C**. The statistical results from the noise logging have been summarised in **Tables C.1**, **C.2** and **C.3** in **Appendix C**.

The noise logger at Location C had its wind protector removed when the logger was collected. This could have adversely affected the results with wind noise resulting in increased noise levels. However, the background noise levels remained consistently low throughout the measurement period, including

background noise levels below 20 dBA L_{90}, and therefore the background noise data is still considered to be of use for this review.

The background noise levels were affected by insect noise at Locations A and C. At Location B, insect noise was minimal. As the insect noise is likely a seasonal influence, the noise level data has been filtered to remove the insect noise from Location A and C. The resulting background noise levels, calculated using the lowest 10th percentile method, are shown in **Table 4.2**.

Table 4.2 Background Noise Level with Insect Noise Removed

Period	Background Noise Level (Less Insect Noise) L_{90} dBA		
	Location A	Location B	Location C
Day (7am to 6pm)	33	35	25
Evening (6pm to 10pm)	23	37	29
Night (10pm to 7am)	20	27	22

5. Acoustic Criteria

5.1 Overview

Noise and vibration criteria are required to assess the potential impacts of the proposed Gemini Project operations on sensitive receptors.

The relevant Department of Environment and Science (DES) noise and vibration criteria have been considered and are listed as follows:

- Environmental Protection Act 1994
- Environmental Protection (Noise) Policy 2019
- Guideline "Planning For Noise Control"
- Guideline "Noise and Vibration from Blasting"

5.2 Environmental Protection Act

In Queensland, the environment is protected under the *Environmental Protection Act 1994* (EP Act).

Section 3 of the EP Act states that the object of the Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

Section 12 of the EP Act defines noise as including *"vibration of any frequency, whether emitted through air or another medium"* and thus includes underwater noise.

Section 319 of the EP Act relates to General Environmental Duty and states that a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm.

Section 14(1) of the EP Act defines environmental harm as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Section 15 of the EP Act defines environmental nuisance as an unreasonable interference or likely interference with an environmental value caused by (a) ... noise.

Section 440 of the EP Act relates to the offence of causing a nuisance, and section 440Q relates to the offence of contravening a noise standard. In both cases, the sections state it does not apply to an environmental nuisance of the variety mentioned in schedule 1, part 1 of the EP Act.

The EP Act refers to the Environmental Protection Policies as being subordinate legislation to the Act.

5.3 Environmental Protection (Noise) Policy

5.3.1 Overview

In respect of the acoustic environment, the object of the Act is achieved by the Environmental Protection (Noise) Policy 2019 (EPP (Noise)). This policy identifies environmental values to be enhanced or protected, states acoustic quality objectives, and provides a framework for making decisions about the acoustic environment.

5.3.2 Acoustic Quality Objectives

The EPP (Noise) contains a range of acoustic quality objectives for a range of receptors. The objectives are in the form of noise levels, and are defined for various periods of the day, and use a number of acoustic parameters.

Schedule 1 of the EPP(Noise) includes the following acoustic quality objectives to be met at residential dwellings:

- Outdoors
  - Daytime and Evening: 50 dBA $L_{Aeq,adj,1hr}$, 55 dBA $L_{A10,adj,1hr}$ and 65 dBA $L_{A1,adj,1hr}$
- Indoors
  - Daytime and Evening: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$
  - Night: 30 dBA $L_{Aeq,adj,1hr}$, 35 dBA $L_{A10,adj,1hr}$ and 40 dBA $L_{A1,adj,1hr}$

Based on the previously published DES Guideline "Planning For Noise Control" (refer **Section 5.4**) the noise reduction provided by a typical residential building façade is 7 dBA with windows open.

Based on a façade reduction of 5 dBA (5 dBA reduction in noise levels from outside a house to inside a house when windows are fully open), the indoor noise objectives noted above could be converted to the following external objectives (with windows open) for monitoring:

- Daytime and Evening: 40 dBA $L_{Aeq,adj,1hr}$, 45 dBA $L_{A10,adj,1hr}$ and 50 dBA $L_{A1,adj,1hr}$
- Night: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$

A sensitive receptor is defined as "an area or place where noise is measured".

5.3.3 Background Creep

The current 2019 version of the EPP(Noise) no longer contains criteria for background creep, but states that background creep should be prevented or minimised, to the extent that it is reasonable to do so.

Background creep is defined as "a gradual increase in the total amount of background noise in the area or place as measured under the document called the 'Noise measurement manual' published on the department's website". This is understood to require consideration of cumulative impacts, including other developments.

5.4 Guideline – Planning for Noise Control

DES had previously published a guideline titled "Planning for Noise Control". The Planning for Noise Control guideline is currently listed as being "under review" according to the DES website. As such, it is not proposed to utilise the noise criteria contained within the document.

The document did contain some guidance on noise assessment, measurement and modelling, including the following:

- "Noise levels are calculated at the noise sensitive places for a range of typical operating scenarios and conditions that are representative of the proposed activity, including worst-case meteorological conditions."
- A method for determining the minimum background noise level using the lowest tenth percentile methodology is provided.

5.5 Guideline – Noise & Vibration from Blasting

The DES Guideline "Noise and vibration from blasting" contains criteria and procedures that are applicable to noise and vibration emitted from blasting. It applies to activities such as mining, quarries, construction and other operations which involve the use of explosives for fragmenting rock.

The criteria address human comfort and are below typical limits for prevention of structural damage. The criteria apply at residential and commercial receivers. The criteria are presented in **Table 5.1**.

Table 5.1 Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Air blast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

5.6 Proposed Criteria

5.6.1 Noise Emissions

In accordance with the EPP(Noise) and based on the calculated external limits as discussed in **Section 5.3.2**, the resulting noise limits are presented in **Table 5.2**.

Table 5.2 Proposed Noise Limits

Period	Noise Limit $L_{Aeq,adj,1hr}$ dBA
Day (7am to 6pm)	40
Evening (6pm to 10pm)	40
Night (10pm to 7am)	35

5.6.2 Blasting

It is proposed to adopt the blasting criteria from the Guideline "Noise and vibration from blasting". The criteria are presented in **Table 5.3**.

Table 5.3 Proposed Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Air blast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

6. Noise Assessment

6.1 Model Description

Noise modelling was carried out using the SoundPLAN v8.2 computer program using the CONCAWE algorithms, which is widely used and accepted for noise modelling and is approved by DES.

The SoundPLAN program was used to develop a three-dimensional digital terrain noise model of the Gemini Project and the surrounding area including the location of sensitive receptors. The model incorporates terrain data for the proposed Gemini Project mine and the surrounding natural topography.

6.2 Meteorology

The mining noise levels at residential receptors can vary significantly depending upon the meteorology and the mining activities. Meteorology has a significant effect on the noise levels, particularly due to wind speed and direction and vertical temperature gradients, which include temperature inversions.

It is possible to measure noise variations of the order of 15 to 20 dBA due to changes in meteorology. Assessment is required under worst-case meteorological conditions according to the Planning for Noise Control guideline.

As per the air quality report (D16063-3_AQ_Gemini_V1.0, dated 02/10/2019), the winds are generally light to moderate and occur almost exclusively from the eastern quadrants with an average wind speed of 2.02 m/s. The distribution of winds is predominantly from the south-east. Winds are weaker during evening hours (6 pm to 6 am), and stronger during daylight hours (6 am to 6 pm).

The SoundPLAN model can model with a wind direction towards every receiver simultaneously, i.e. a worst-case scenario. However, in this instance, DES has requested modelling with specific wind directions, and thus Trinity has modelled with wind from the south-east (SE) and west (W) directions.

The SoundPLAN model has been setup to predict noise levels under adverse day and night meteorological conditions. The conditions used in the noise model are shown in **Table 6.1**. It should be noted that noise emissions are not modelled under neutral (i.e. calm) or favourable (i.e. wind blowing towards the mine) conditions.

Table 6.1 Meteorological Scenarios

Parameter	Day Meteorological Scenarios			Night Meteorological Scenarios		
	Scenario D1	Scenario D2	Scenario D3	Scenario N1	Scenario N2	Scenario N3
Pasquill Stability Class	D	D	D	F	F	F
Temperature (°C)	25	25	25	10	10	10
Wind Speed (m/s)	2	2	2	2	2	2
Wind direction	Towards receivers	SE	W	Towards receivers	SE	W
Relative Humidity (%)	40	40	40	70	70	70

6.3 Noise Source Data

The model uses the sound power level (L_w) of each noise source to predict noise emissions. The sound power levels used in the model were based on noise source data obtained from previous mining projects or

published sources. The sound power levels for the mobile and fixed equipment proposed for the Gemini Project are presented in **Table 6.2**.

Table 6.2 Noise Source Sound Power Levels

Equipment	Data Source	Octave Band Sound Power Level $L_{W,eq}$ dBZ								Overall $L_{W,eq}$	
		63	125	250	500	1k	2k	4k	8k	dBZ	dBA
Hitachi EX5600	1	129	124	114	119	111	106	104	99	131	118
Hitachi EX1900	1,2	127	121	112	116	109	103	101	97	128	116
CAT 793	1,2	115	125	120	118	113	111	104	96	127	120
CAT 777	1,2	110	112	110	111	111	109	101	96	118	115
D11	3	111	119	117	119	113	114	105	93	124	120
D10	3	111	119	117	119	113	114	105	93	124	120
CAT 994 (FEL)	1	103	110	113	109	109	104	98	94	117	113
CAT 777 (Water Cart)	1,2	110	112	110	111	111	109	101	96	119	115
CAT 16M (Grader)	1,2	108	115	112	104	104	102	98	90	118	110
Drill MD6420	2	109	111	111	110	110	109	106	101	118	115
CHPP	1,2	125	119	113	113	110	107	101	93	127	115
Conveyor Drive	2	98	97	98	100	99	94	87	78	106	102
Conveyor per 1m	2	75	74	75	77	76	71	64	55	83	79
Rail Loadout Bin	2	105	102	104	105	105	107	104	95	113	112
Train Slow Travel whilst Loading	2	110	105	104	103	104	104	101	94	114	110
Sewage Treatment Plant (STP)	4	76	77	72	76	78	75	76	72	85	83
Pump at Irrigation Management Area	5	64	61	63	69	66	63	65	61	74	72
Camp	6	101	98	97	95	88	82	77	72	105	91
Car on Camp access road	1	88	88	91	86	83	81	76	73	95	89
Bus on Camp access road	1	95	93	91	91	91	88	81	76	100	95

The sources of data used to compile the sound power level data in **Table 6.2** are presented in **Table 6.3**.

Table 6.3 Source of Data for Sound Power Levels

Source #	Data Source
1	Trinity database, based on sound power level calculated from measurements used for other projects.
2	Data for these sources was extracted from another similar coal mine project. Generally this data is similar to noise data for similar equipment at other mine sites and is considered suitable for noise modelling purposes.
3	Data for the tracked dozers was based on measurements at another coal mine and decreased by 5 dBA based the tracked dozers being limited to first gear only in reverse.
4	Trinity database, based on sound power level determined for a 1500 EP sewage treatment plant in Childers (Trinity ref: 9776).
5	Trinity database, based on sound power level of a typical pump determined for a 1500 EP sewage treatment plant in Childers (Trinity ref: 9776).
6	The camp sound power level includes 280 small air-conditioner units (each 65 dBA sound power level, with assumption that 100% operating at any one time, and 50% of operating units are under load at any one time) plus a group of 50 people conversing (e.g. outdoor café style) with a sound power level of 89 dBA[1], for a total sound power level of 91 dBA.

6.4 Modelling Scenarios

Mining noise emissions from the Gemini Project have been predicted for the following three mine year scenarios:

- Year 2
- Year 8
- Year 15

These years were selected to give a representation of mine noise levels near the beginning, middle and end of the project.

Modelling of the nominated mine year scenarios has included mine ground elevations, equipment numbers and equipment locations for each mine year based on information provided by Magnetic South Pty Ltd.

The mobile equipment numbers for the modelled mine years are presented in **Table 6.4**.

Table 6.4 Mobile Equipment Fleet in Modelled Mining Years

Equipment Type	Model #	Number of Items		
		Year 2	Year 8	Year 15
Excavator	EX5600	3	3	3
Excavator	EX1900	1	1	1
OB haul trucks	Cat 793	12	15	17
Coal haul trucks	Cat 777	1	2	3
Track Dozer	Cat D11	4	6	4
Track Dozer	Cat D10	3	3	3
Grader	Cat 16M	2	2	2

[1] Calculated using patron noise formula by Hayne et al.

Equipment Type	Model #	Number of Items		
		Year 2	Year 8	Year 15
Water Cart	Cat 777	2	2	2
Drill	Cat MD6420	2	2	2
Front end loader	Cat 994	1	1	1

All three scenarios include the following peak usage of the camp access road:

- 39 trips/day for local commuters
- 83 trips/day for one day a week for DIDO
- 5 trips/day for workforce shift change from camp to mine (bus)

It is assumed that 50% of the above movements (rounded upwards) occur in one hour.

The locations of the equipment included in noise modelling as advised by Magnetic South Pty Ltd are provided in **Appendix D**. The location of equipment in the noise model has generally been located where it will spend the majority of time operating. Overburden trucks and dozers have generally been placed at or near the top of the dumps, except for Year 8, when waste will predominantly be dumped in-pit.

The following additional notes are provided regarding the modelled scenarios:

- Coal haul trucks will not operate during the night (10pm to 7am), and as such, have only been modelled during the day scenarios, not the night scenarios.
- The rail loadout facility will only operate when a train is being loaded, which is expected to occur on average four times per week. As such, the rail loadout facility noise sources, including conveyor system, rail loadout bin and slow-moving train being loaded, is modelled as part of a separate scenario, i.e. models of the mine only and the mine with the rail loadout facility.

The overall sound power levels of the equipment modelled in the night scenarios, excluding the rail loadout sources, are presented in **Table 6.5**.

Table 6.5 Total Scenario Sound Power Levels

Mining Year	Total Octave Band Sound Power Level $L_{W,eq}$ dBA
Year 2	133
Year 8	134
Year 15	134

6.5 Predicted Noise Levels & Assessment

6.5.1 L_{Aeq} Noise Levels

The predicted noise levels at nearby sensitive receptors for the three mining year scenarios are presented in **Table 6.6**, **Table 6.7** and **Table 6.8** for the Year 2, 8 and 15 mining years.

The results are compared against the proposed noise limits of 35 dBA L_{eq} and 40 dBA L_{eq} for the night and daytime/evening respectively, as per **Table 5.2**. Where the result exceeds the limit, the cell is shaded pink. Where the result does not exceed, the level below the criterion is included in brackets.

The predicted noise levels are also shown graphically as noise contours in **Appendix E**, as follows:

- **Figure E.1** Year 2 Scenario D1 Mine and Rail Loadout Noise Levels
- **Figure E.2** Year 8 Scenario D1 Mine and Rail Loadout Noise Levels
- **Figure E.3** Year 15 Scenario D1 Mine and Rail Loadout Noise Levels

- **Figure E.4** Year 2 Scenario N1 Mine and Rail Loadout Noise Levels
- **Figure E.5** Year 8 Scenario N1 Mine and Rail Loadout Noise Levels
- **Figure E.6** Year 15 Scenario N1 Mine and Rail Loadout Noise Levels

Note: Noise contours have not been prepared for the D2, D3, N2 and N3 scenarios, or for scenarios without the rail loadout, as they would have less noise impact than the results included in the figures.

Based on the tabulated results, no exceedances are recorded during day/evening operations, but the following night exceedances are predicted:

- Year 2:
  - SR 10: 2 dBA
  - SR 22: 1 dBA
- Year 8:
  - SR 10: 4 dBA

It is noted that receptor SR10 is located to the east of the Gemini Project, whilst receptor SR22 is located within the MLA.

Overall, the maximum predicted exceedance is 4 dBA at receptor SR10.

6.5.2 L_{Amax}, L_{A01} and L_{A10} Noise Levels

Noise levels have not been predicted in terms of L_{Amax}, L_{A01} and L_{A10} noise parameters because most mine noise source data is available in terms of the L_{Aeq} parameter. Were L_{Amax}, L_{A01} and L_{A10} noise limits to be specified for the project, they would be 15, 10 and 5 dBA higher than the L_{Aeq} noise limits respectively, as per the Sleep disturbance limit of 50 dBA L_{Amax} (equating to an indoor limit of 45 dBA L_{Amax} plus 5 dBA), and the Acoustic Quality Objectives in **Section 5.3.2**.

It is Trinity's experience that L_{Amax}, L_{A01} and L_{A10} noise emissions from a coal mine would generally comply with the L_{Amax}, L_{A01} and L_{A10} noise limits if the L_{Aeq} noise level complies with the L_{Aeq} noise limit, and therefore no further assessment is proposed for the L_{Amax}, L_{A01} and L_{A10} parameters.

It is noted that L_{A01} and L_{A10} noise limits cannot be accurately used for compliance during warmer months because the L_{A01} and L_{A10} noise levels are generally dominated by insect noise. It is not strictly possible to remove insect noise from the measured L_{A01} and L_{A10} noise levels, and therefore these parameters are not as useful for compliance monitoring as the L_{Aeq} parameter.

The L_{Amax} parameter can also be challenging for compliance monitoring as extraneous L_{Amax} events (e.g. birds, animals, farm activities) need to be removed from the noise monitoring data.

6.6 Cumulative Noise Impacts

As described in **Section 2**, the nearest other existing mine is Bluff Mine to the west. The sensitive receptors that have the most potential to be impacted by the Gemini Project to the west are SR22, SR31 and SR32 with noise levels of up to 36 dBA, 33 dBA and 31 dBA L_{Aeq} respectively.

The Bluff Mine is over 12 km from these receptors (SR22, SR31 and SR32) and only 1 km from the township of Bluff. Given the requirement to comply with noise criteria in the township, it would be expected that Bluff mine noise levels at the receptors would be well below the 35 dBA noise limit and would not significantly contribute to exceedances at these locations.

Table 6.6 Predicted Year 2 Noise Levels

Receptor	Predicted Noise Emission Levels, L_{eq} dBA																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Exceedance of 40 dBA Day Criterion			Mine Only			Mine & Rail Loadout			Exceedance of 35 dBA Night Criterion		
Scenario	D1	D2	D3	D1	D2	D3	D1	D2	D3	N1	N2	N3	N1	N2	N3	N1	N2	N3
SR01	23	24	15	24	24	15	(-16)	(-16)	(-25)	24	24	18	24	24	19	(-11)	(-11)	(-16)
SR03	31	23	31	31	23	31	(-9)	(-17)	(-9)	32	30	32	32	30	32	(-3)	(-5)	(-3)
SR05	26	25	17	26	25	17	(-14)	(-15)	(-23)	26	27	20	26	28	20	(-9)	(-7)	(-15)
SR07	31	24	31	31	24	31	(-9)	(-16)	(-9)	32	32	32	32	32	32	(-3)	(-3)	(-3)
SR08	24	25	15	24	25	15	(-16)	(-15)	(-25)	25	25	19	25	26	19	(-10)	(-9)	(-16)
SR10	36	29	36	36	29	36	(-4)	(-11)	(-4)	37	37	37	37	37	37	2	2	2
SR13	33	25	33	33	25	33	(-7)	(-15)	(-7)	34	33	34	34	33	34	(-1)	(-2)	(-1)
SR16	29	30	29	29	30	29	(-11)	(-10)	(-11)	30	30	30	30	30	30	(-5)	(-5)	(-5)
SR17	26	27	17	26	27	17	(-14)	(-13)	(-23)	27	27	21	27	27	21	(-8)	(-8)	(-14)
SR22	34	34	24	35	35	25	(-5)	(-5)	(-15)	35	35	29	36	36	30	1	1	(-5)
SR26	26	18	26	26	18	26	(-14)	(-22)	(-14)	27	25	27	27	25	27	(-8)	(-10)	(-8)
SR27	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	28	28	28	28	28	(-7)	(-7)	(-7)
SR28	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	28	28	28	28	28	(-7)	(-7)	(-7)
SR30	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	29	28	28	29	28	(-7)	(-6)	(-7)
SR31	31	32	21	32	32	22	(-8)	(-8)	(-18)	32	32	26	33	33	26	(-2)	(-2)	(-9)
SR32	29	30	20	30	30	20	(-10)	(-10)	(-20)	30	30	24	31	31	25	(-4)	(-4)	(-10)

Table 6.7 Predicted Year 8 Noise Levels

Receptor	Predicted Noise Emission Levels, L_{eq} dBA																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Exceedance of 40 dBA Day Criterion			Mine Only			Mine & Rail Loadout			Exceedance of 35 dBA Night Criterion		
Scenario	D1	D2	D3	D1	D2	D3	D1	D2	D3	N1	N2	N3	N1	N2	N3	N1	N2	N3
SR01	21	22	12	21	22	12	(-19)	(-18)	(-28)	22	22	16	22	22	16	(-13)	(-13)	(-19)
SR03	32	24	32	32	24	32	(-8)	(-16)	(-8)	33	31	33	33	31	33	(-2)	(-4)	(-2)
SR05	24	23	15	24	23	15	(-16)	(-17)	(-25)	25	26	18	25	26	18	(-10)	(-9)	(-17)
SR07	32	24	32	32	24	32	(-8)	(-16)	(-8)	33	33	33	33	33	33	(-2)	(-2)	(-2)
SR08	23	23	13	23	23	13	(-17)	(-17)	(-27)	23	24	17	24	24	17	(-11)	(-11)	(-18)
SR10	37	30	37	37	30	37	(-3)	(-10)	(-3)	38	38	38	39	38	39	4	3	4
SR13	34	26	34	34	26	34	(-6)	(-14)	(-6)	35	35	35	35	35	35	(0)	(0)	(0)
SR16	28	29	28	28	29	28	(-12)	(-11)	(-12)	29	29	30	29	29	30	(-6)	(-6)	(-5)
SR17	24	25	15	24	25	15	(-16)	(-15)	(-25)	25	25	19	25	25	19	(-10)	(-10)	(-16)
SR22	33	33	23	34	34	24	(-6)	(-6)	(-16)	34	34	28	35	35	29	(0)	(0)	(-6)
SR26	27	18	27	27	18	27	(-13)	(-22)	(-13)	28	26	28	28	26	28	(-7)	(-9)	(-7)
SR27	28	20	28	28	20	28	(-12)	(-20)	(-12)	29	29	29	29	29	29	(-6)	(-6)	(-6)
SR28	28	20	28	28	20	28	(-12)	(-20)	(-12)	29	29	29	29	29	29	(-6)	(-6)	(-6)
SR30	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	30	28	28	30	28	(-7)	(-5)	(-7)
SR31	30	30	20	30	31	20	(-10)	(-9)	(-20)	31	31	24	32	32	25	(-3)	(-3)	(-10)
SR32	28	28	18	28	29	18	(-12)	(-11)	(-22)	29	29	22	30	30	23	(-5)	(-5)	(-12)

Table 6.8 Predicted Year 15 Noise Levels

Receptor	Predicted Noise Emission Levels, L_{eq} dBA																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Exceedance of 40 dBA Day Criterion			Mine Only			Mine & Rail Loadout			Exceedance of 35 dBA Night Criterion		
Scenario	D1	D2	D3	D1	D2	D3	D1	D2	D3	N1	N2	N3	N1	N2	N3	N1	N2	N3
SR01	22	23	13	23	23	13	(-17)	(-17)	(-27)	23	23	18	23	23	18	(-12)	(-12)	(-17)
SR03	24	18	24	24	18	25	(-16)	(-22)	(-15)	25	28	25	25	28	25	(-10)	(-7)	(-10)
SR05	28	28	18	28	28	18	(-12)	(-12)	(-22)	28	29	22	29	29	22	(-6)	(-6)	(-13)
SR07	24	19	24	24	19	24	(-16)	(-21)	(-16)	25	27	25	25	27	25	(-10)	(-8)	(-10)
SR08	24	24	14	24	24	14	(-16)	(-16)	(-26)	25	25	19	25	25	19	(-10)	(-10)	(-16)
SR10	27	23	27	27	23	27	(-13)	(-17)	(-13)	28	29	28	28	29	28	(-7)	(-6)	(-7)
SR13	25	21	26	25	21	26	(-15)	(-19)	(-14)	26	28	26	26	28	26	(-9)	(-7)	(-9)
SR16	20	21	21	21	21	22	(-19)	(-19)	(-18)	21	21	21	21	22	21	(-14)	(-13)	(-14)
SR17	26	26	16	26	26	16	(-14)	(-14)	(-24)	27	27	21	27	27	21	(-8)	(-8)	(-14)
SR22	32	32	24	34	34	25	(-6)	(-6)	(-15)	34	34	30	35	35	31	(0)	(0)	(-4)
SR26	21	15	21	21	15	21	(-19)	(-25)	(-19)	21	24	21	22	24	22	(-13)	(-11)	(-13)
SR27	22	16	22	22	16	22	(-18)	(-24)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR28	22	16	22	22	16	22	(-18)	(-24)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR30	22	17	22	22	17	22	(-18)	(-23)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR31	30	30	21	31	31	21	(-9)	(-9)	(-19)	31	31	26	32	32	26	(-3)	(-3)	(-9)
SR32	28	28	19	29	29	19	(-11)	(-11)	(-21)	29	29	25	30	30	25	(-5)	(-5)	(-10)

7. Blasting Assessment

7.1 Overview

It is anticipated that the existing vibration levels around the mine site and at the location of sensitive receptors will generally be negligible, except at locations which are close to roads, rail lines or near major items of fixed plant.

The only vibration source of significance from the mining of the Gemini Project would be blasting. Blasting activities within the pits have been assessed for both ground vibration and airblast. The relevant criteria for ground vibration and airblast have been presented and discussed in **Section 5.6.2**.

7.2 Predictions

Ground vibration and airblast levels caused by blasting activities have been predicted based on the formulas and methodology of Australian Standard AS2187.2 "Explosives - Storage Transport and Use - Use of Explosives", which predicts the peak particles velocity (PPV) in mm/s and the airblast over pressure (peak pressure) in dB.

7.2.1 Ground Vibration

In accordance with the criteria presented in **Section 5.6.2**, ground vibration levels are to achieve 5mm/s PPV for nine out of ten blasts and not greater than 10mm/s PPV at any time. Ground vibration can be calculated at various distances from a blast using the following formula from AS2187.2:

$$V = K (R / Q^{1/2})^{-B}$$

where: V = ground vibration as peak particle velocity (PPV) (mm/s)
K = site constant
R = distance between charge and point of measurement (m)
Q = effective charge mass per delay or maximum instantaneous charge (kg)
B = site exponent or attenuation rate

Ground vibration from blasting generally increases with an increase in charge mass and reduces with distance.

A site exponent (-B) (attenuation rate) of –1.6 has been estimated for the site based on Trinity's experience with similar mining projects. The site constant (K) was assumed to be in the range 800 to 1600. The maximum instantaneous charge mass will be 900 kg as advised by Magnetic South Pty Ltd.

Table 7.1 contains the calculated ground vibration levels (mm/s) at various distances from the blast.

Table 7.1 Ground Vibration Levels at Various Distances from the Blast

Distance from Blast km	Vibration Level mm/s	
	K = 800	K = 1600
1.0	2.9	5.9
1.5	1.5	3.1
2.0	1.0	1.9
2.5	0.7	1.4
3.0	0.5	1.0
3.5	0.4	0.8
4.0	0.3	0.6
4.5	0.3	0.5
5.0	0.2	0.4
5.5	0.2	0.4
6.0	0.2	0.3
6.5	0.1	0.3
7.0	0.1	0.3
7.5	0.1	0.2
8.0	0.1	0.2
8.5	0.1	0.2
9.0	0.1	0.2
9.5	0.1	0.2
10.0	0.1	0.1

Table 7.1 shows that the 10 mm/s PPV criterion would not be exceeded at distances greater than 1.0 kilometre from the blast. The 5 mm/s PPV criterion would not be exceeded at distances greater than 1.5 kilometres from the blast.

The nearest sensitive receptor is approximately 1.9 kilometres away from the nearest pit within the proposed Gemini Project area. Therefore, ground vibration due to blasting is predicted to be compliant with the nominated criteria at all sensitive receptors.

Blast parameters will need to be reviewed to ensure that the nominated vibration criteria are met at all locations.

7.2.2 Airblast

In accordance with the criteria presented in **Section 5.6.2**, airblast pressure levels are to achieve 115 dBZ for nine out of ten blasts and not greater than 120 dBZ at any time. For blasting in an open-cut mine, the distance to the 120 dBZ L_{peak} contour line from the blast can be calculated using the following formula:

$$D_{120} = (k * h / \text{maximum } (B, S))^{2.5} * m^{1/3}$$

Where: D_{120} = distance to the 120 dBZ L_{peak} contour (m)
k = a site constant determined from the ratio S/B and S/h which requires local calibration
h = hole diameter (mm)
B = burden (mm)
S = stemming height (mm)
m = charge mass (kg)

The site constant, k, has been assumed to be equal to 180 based on Trinity's experience with other mining projects.

The following blast information has been provided by Magnetic South Pty Ltd:

- h = 270 mm
- S = 8000 mm
- B = 8000 mm
- m = 900 kg

Table 7.2 contains the separation distances and the reduction of noise levels due to distance.

Table 7.2 Airblast Noise Levels at Various Distances from the Blast

Distance from Blast km	Airblast Level, dBZ
1.0	118.3
1.5	113.0
2.0	109.3
2.5	106.4
3.0	104.0
3.5	102.0
4.0	100.3
4.5	98.8
5.0	97.4
5.5	96.2
6.0	95.0
6.5	94.0
7.0	93.0
7.5	92.2
8.0	91.3
8.5	90.5
9.0	89.8
9.5	89.1
10.0	88.4

The distance to the 120 dBZ contour line is calculated to be 880 metres. The distance to the 115 dBZ contour line is calculated to be 1,290 metres.

Based on these calculations and blast parameters, the airblast criteria would not be exceeded at any sensitive receptors.

7.3 Assessment

Based on the blasting calculations presented within this section, the ground vibration and airblast levels from open cut operations within the Gemini Project are predicted to be acceptable at the nearest sensitive receptors based on the nominated criteria.

8. Noise Management Plan

8.1 Overview

Noise modelling has predicted noise level exceedances at some receptors as outlined in **Section 6**. The predicted noise levels are therefore expected to result in noise levels exceeding the EPP(Noise) Acoustic Quality Objectives inside these receptors.

To achieve the Acoustic Quality Objectives inside the receptors, the following opportunities are considered:

- Ceasing operations at times of the day that are predicted to result in exceedances.
- Ceasing operations under meteorological conditions that are predicted to result in exceedances.
- Moving mine equipment further from the receptors.
- Reducing quantity of mine equipment, i.e. lower production.
- Incorporating noise mitigation measures to equipment, particularly the mobile fleet.
- Providing acoustic or ventilation upgrades to the receptors.
- Relocating the receptors further from the mine.

The first four of the above opportunities could be considered by the mine, whereas the last two opportunities would require acceptance from the residents.

As disused in **Section 6.6**, receivers SR09, SR14, SR15, SR18, SR19, SR20, SR21, SR23 and SR24 are owned or are to be purchased by Magnetic South at the time of report preparation. The results in **Table 6.6**, **Table 6.7** and **Table 6.8** indicate there are no day/evening exceedances but the following night exceedances:

- Year 2:
  - SR 10: 2 dBA
  - SR 22: 1 dBA
- Year 8:
  - SR 10: 4 dBA

Noise management opportunities are discussed in the following sections of the report to achieve night time compliance.

8.2 Review of Noise Management Opportunities

8.2.1 Ceasing Operations in Various Time Periods

Based on the predictions noise level exceedances are only predict at night time scenarios for most of the receptors. Therefore, ceasing operations in particular time periods (e.g. night) can be considered in this assessment.

8.2.2 Ceasing Operations under Particular Meteorological Conditions

From **Table 6.6** to **Table 6.8,** it can be seen that modelled meteorological conditions affect the noise levels at the residence.

It would be possible to setup a real time noise monitors at highly affected receptors, so that the mine can alter operations according to measured noise levels, and thus react to meteorological conditions. However, it is Trinity's experience that this form of reactive operation is difficult to plan for, and it is preferable to have operations that meet noise limits under most, if not all, meteorological conditions.

8.2.3 Moving Mine Equipment Further from the Receptors

Moving noisy equipment away from the most affected sensitive receptors can be considered to minimize noise effects.

8.2.4 Reduce Quantity of Mine Equipment, i.e. Lower Mine Output

If mine output was reduced, then the quantity of mine equipment could also be reduced, thereby resulting in lower noise emission levels.

A halving of equipment would be expected to provide a reduction of 3 dBA, assuming the shutdown equipment was spread around the mine operations. Similarly, reducing to a quarter of the equipment would be expected to provide a reduction of 6 dBA. If the equipment to be shutdown was the equipment located closest to the receptor, then the reduction could be greater.

8.2.5 Noise Mitigation of Equipment

Noise mitigation measures can be applied to equipment, including all the mobile equipment which is located near to the receptors. The noise reductions can be of the order of 3 to 8 dBA, and the costs can be of the order of a $250,000 to $750,000 per item of equipment.

8.2.6 Noise Mitigation between Equipment and Receptors

Noise mitigation measures can include bunding constructed between equipment and the receptors. Noise bunding is generally most effective when constructed near the source, e.g. adjacent a haul road, or near the receptors. Noise reduction via this technique is likely to be limited to less than 5 dBA even with quite significant bunding heights.

8.3 Mitigation Scenarios

Based on the results discussed in **Section 6.5** noise affected receptors are SR10 and SR22. The noise mitigation scenarios are outlined in **Table 8.1** for these receptors and focus on removing or relocating equipment.

Table 8.1 Example Mitigated Scenarios

Year	Scenario	Examples Scenarios and Resulting Noise Levels Under Adverse Conditions for Each Time Period	
		Day and Evening (7am to 10pm) **Limit: 40 dBA L_{Aeq}**	**Night (10pm to 7am)** **Limit: 35 dBA L_{Aeq}**
Year 2	Original	36 dBA at SR10 and 35 dBA at SR22, as per **Table 6.6**.	37 dBA at SR10 and 36 dBA at SR22, as per **Table 6.6**.
	Option 2A	No change to day/evening operations. Results as per Original scenario.	35 dBA at SR10 and 35 dBA at SR22, i.e. compliance achieved when 7 of 12 x OB haul trucks are removed.
Year 8	Original	37 dBA at SR10, as per **Table 6.7.**	39 dBA at SR10, as per **Table 6.7**.
	Option 8A	No change to day/evening operations. Results as per Original scenario.	35 dBA at SR10, i.e. compliance achieved when 1 of 6 x D11 dozers are removed from dump and 6 of 15 x OB haul trucks are removed.

It is proposed that the mine could operate compliantly by selecting operating to the optional scenarios in **Table 8.1**. The optional scenarios presented in **Table 8.1** should be considered examples only, and other acoustically equivalent scenarios could be developed.

8.4 Noise Monitoring

It is recommended that noise level compliance be confirmed by real time noise monitoring at the most noise affected receptor/s (e.g. SR10 and SR22), and that monitoring be commenced prior to mine operation.

The real time noise monitoring system should report one-third octave band noise levels (including L_{eq}, L_1, L_{10} and L_{90}) over 15 minute periods, and should also provide audio recording/snapshots and 1 second time period noise levels. The system should have the capability to email, sms or otherwise transmit alerts to mine operators to enable the mine to react to potential exceedances, and should ideally also provide a web portal interface where mine operators can track the noise trends during night periods.

9. Recommendations and Conclusions

A noise and vibration impact assessment has been conducted for the proposed Gemini Project. Noise monitoring was conducted at three sensitive receptor locations. A noise model has been developed for proposed mining activities for mining years 2, 8 and 15 to predict noise emission levels at nearby sensitive receptors. Calculations have also been made to predict noise and vibration levels due to blasting.

From this assessment, the following conclusions are made:

- Noise criteria for the mine have been proposed in **Section 5.6**, which includes noise limits of 40 dBA $L_{Aeq,adj,1hr}$ in the day and evening and 35 dBA $L_{Aeq,adj,1hr}$ in the night. These limits are consistent with other coal mining projects.
- From the predicted noise levels in **Section 6.5**, no exceedances are predicted during the day and evening periods, but minor night-time exceedances are predicted as follows:
  - Receptor 10: 2 dBA In Year 2 and 4 dBA in Year 8.
  - Receptor 22: 1 dBA in Year 2.
- Cumulative noise impacts are discussed in **Section 6.6**. Cumulative impacts from other mines are not expected to be an issue.
- Based on the blasting parameters and calculations in **Section 7**, the ground vibration and airblast levels from blasting are predicted to be acceptable at the nearest sensitive receptors.
- A number of operational scenarios have been modelled to demonstrate that changes to mining operations (i.e. reduction in the number of machines in operation) can be implemented to prevent exceedances and ensure compliance can be achieved at all sensitive receivers.
- Given there are exceedances predicted, a noise management plan is included in **Section 8**. The noise management plan includes potential operational changes to enable compliance during day, evening and night periods.

Appendix A Glossary

Parameter or Term	Description
dB	The decibel (dB) is the unit measure of sound. Most noises occur in a range of 20 dB (quiet rural area at night) to 120 dB (nightclub dance floor or concert).
dBA	Noise levels are most commonly expressed in terms of the 'A' weighted decibel scale, dBA. This scale closely approximates the response of the human ear, thus providing a measure of the subjective loudness of noise and enabling the intensity of noises with different frequency characteristics (e.g. pitch and tone) to be compared.
Frequency	The number of vibrations, or complete cycles, that take place in one second. Measured in hertz (Hz), where one Hz equals one cycle per second. A young person with normal hearing will be able to perceive frequencies between approximately 20 and 20,000 Hz. With increasing age, the upper frequency limit tends to decrease.
dB, dB(linear) or dBZ	Noise levels are sometimes expressed in terms of the linear, Z or un-weighted decibel scale – they all take the same meaning. The value has no weighting applied to it and is the same as the dB level.
dBC	Noise levels are sometimes expressed in terms of the 'C' weighted decibel scale, dB(C). This scale is very similar to the dB, dB, dB(linear), dBZ un-weighted scale. The difference being that some negative weighting is applied below 250Hz and above 1kHz. The magnitude of the weighting is significantly less than the dBA scale.
Octave band	Ranges of frequencies where the highest frequency of the band is double the lowest frequency of the band. The band is usually specified by the centre frequency, i.e. 31.5, 63, 125, 250, 500 Hz, etc.
Day	The period between 7am and 6pm.
Evening	The period between 6pm and 10pm.
Night	The period between 10pm and 7am.
Free-field	The description of a noise receiver or source location which is away from any significantly reflective objects (e.g. buildings, walls).
Noise sensitive receiver or Noise sensitive receptor	The definition can vary depending on the project type or location, but generally defines a building or land area which is sensitive to noise. Generally it includes residential dwellings (e.g. houses, units, caravans, marina), medical buildings (e.g. hospitals, health clinics, medical centres), educational facilities (e.g. schools, universities, colleges),
L_1	The noise level exceeded for 1% of the measurement period.
L_{10}	The noise level exceeded for 10% of the measurement period. It is sometimes referred to as the average maximum noise level.
L_{90}	The noise level exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.
minL_{90}	The background noise levels calculated using the 'lowest 10th percentile' of the L_{90} levels in each period of the day. This 'lowest 10th percentile' method is defined in the Queensland Department of Environment and Heritage Protection (EHP) guidelines.
L_{eq}	The equivalent continuous sound level, which is the constant sound level over a given time period, which is equivalent in total sound energy to the time-varying sound level, measured over the same time period.
$L_{eq,1hr}$	As for L_{eq} except the measurement intervals are defined as 1 hour duration.
$L_{eq,adj,T}$	The L_{eq} adjusted for tonal or impulsive noise characteristics and with a measurement interval of 'T' duration (e.g. 15 minutes, 1 hour).

Parameter or Term	Description
L_{Amax} or max L_{pA}	Maximum A-weighted sound pressure level.
Sound power level (L_W)	The sound power level of a noise source is its inherent noise, which does not vary with distance from the noise source. It is not directly measured with a sound level meter, but rather is calculated from the measured noise level and the distance at which the measurement was undertaken.

Appendix B Noise Monitoring Photos

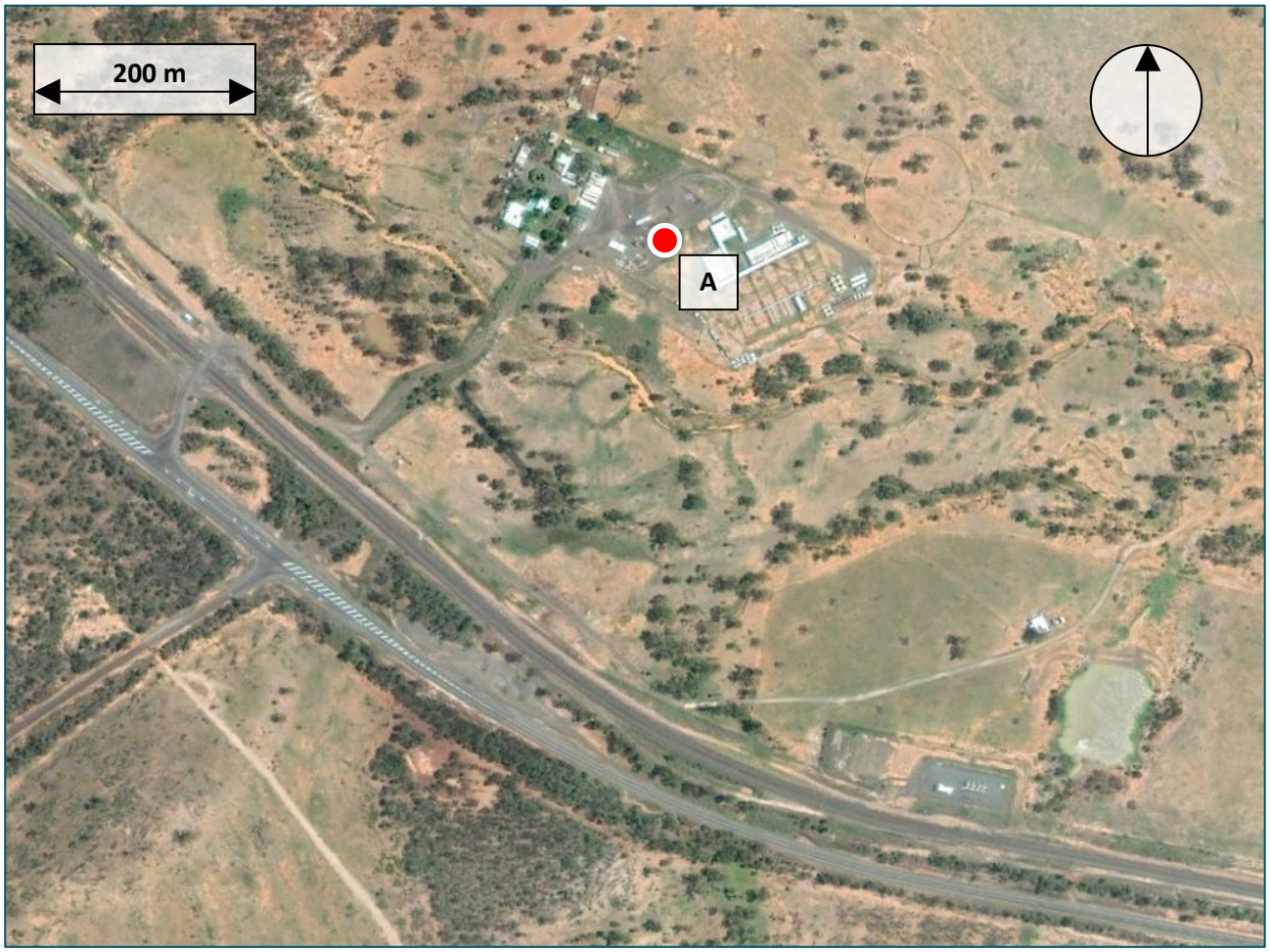


Figure B.1 Aerial Photo of Noise Monitoring Location A – Accommodation Facility

Figure B.2 Aerial Photo of Noise Monitoring Location B – Roadhouse

Figure B.3 Aerial Photo of Noise Monitoring Location C – Residence

Appendix C Noise Monitoring Results

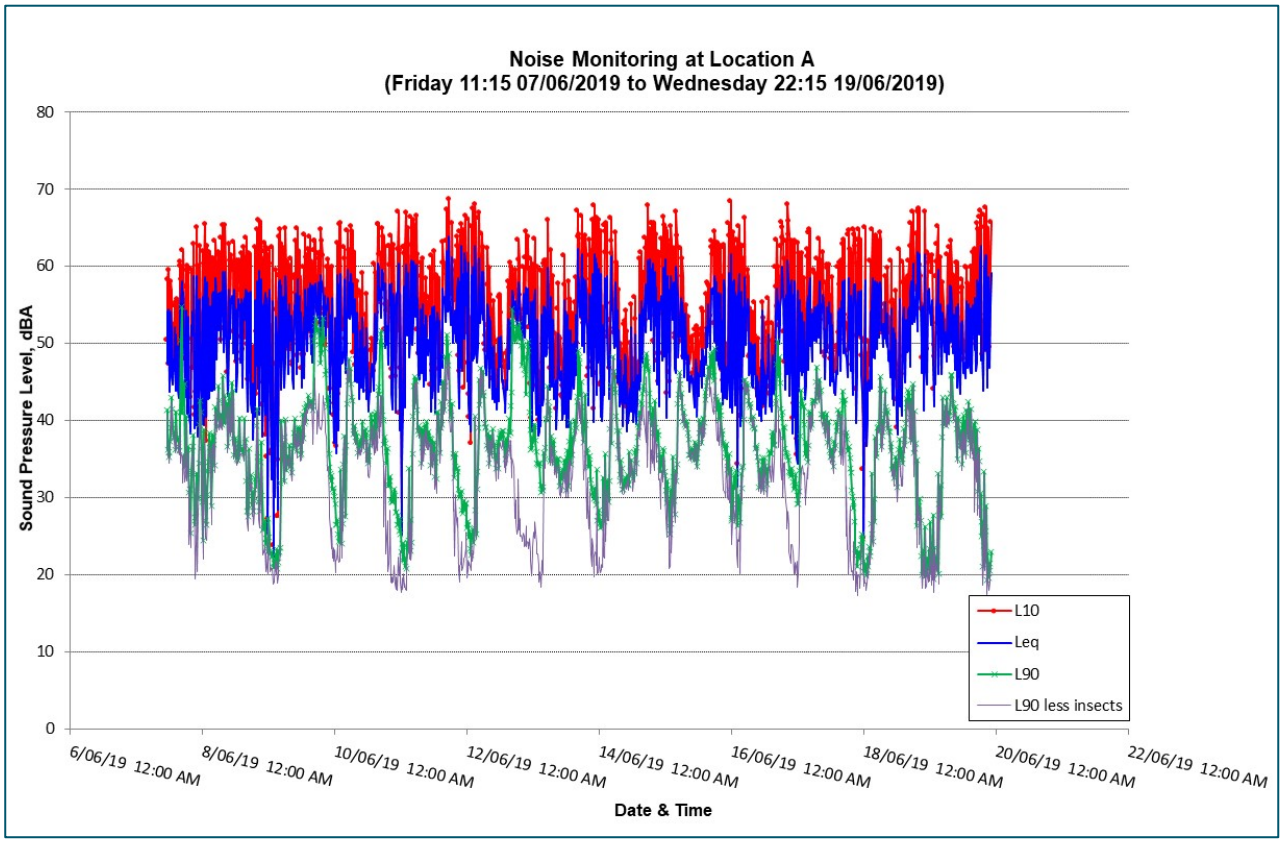


Figure C.1 Noise Monitoring Results at Location A – Accommodation Facility

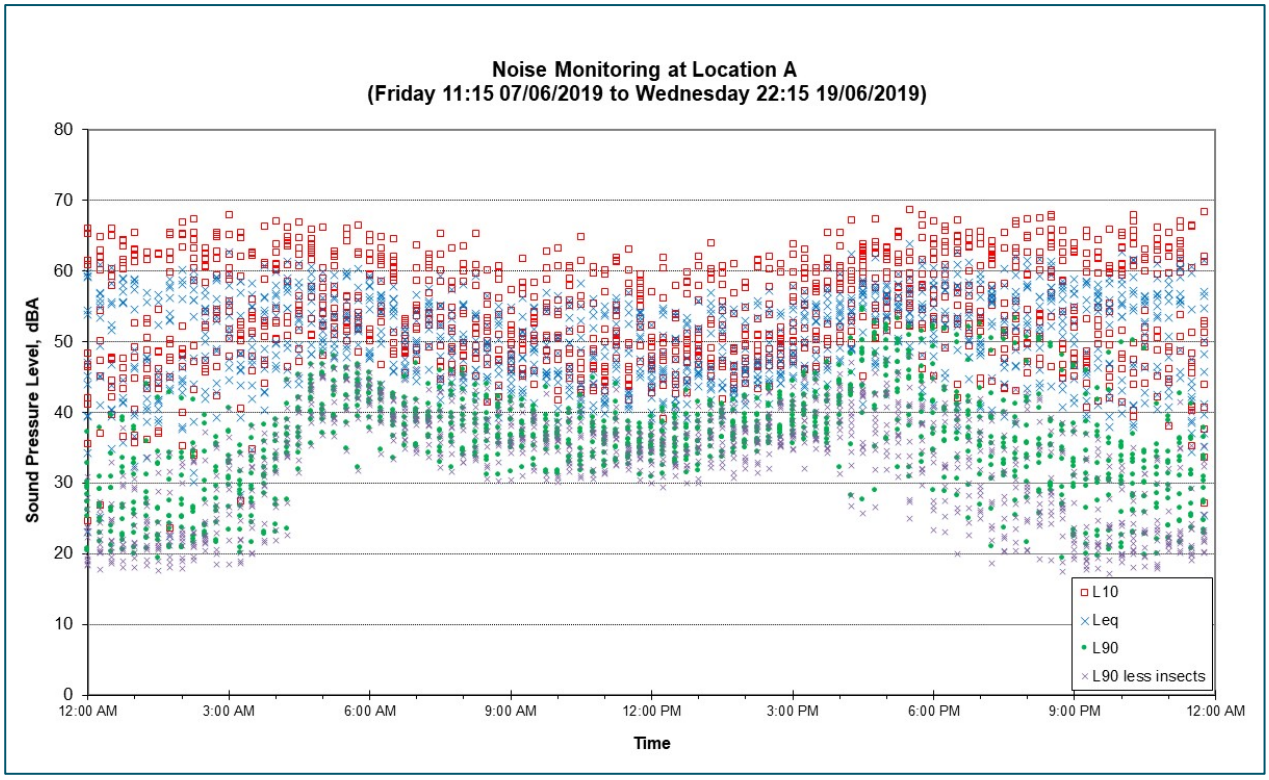


Figure C.2 24 Hour Noise Monitoring Results at Location A – Accommodation Facility

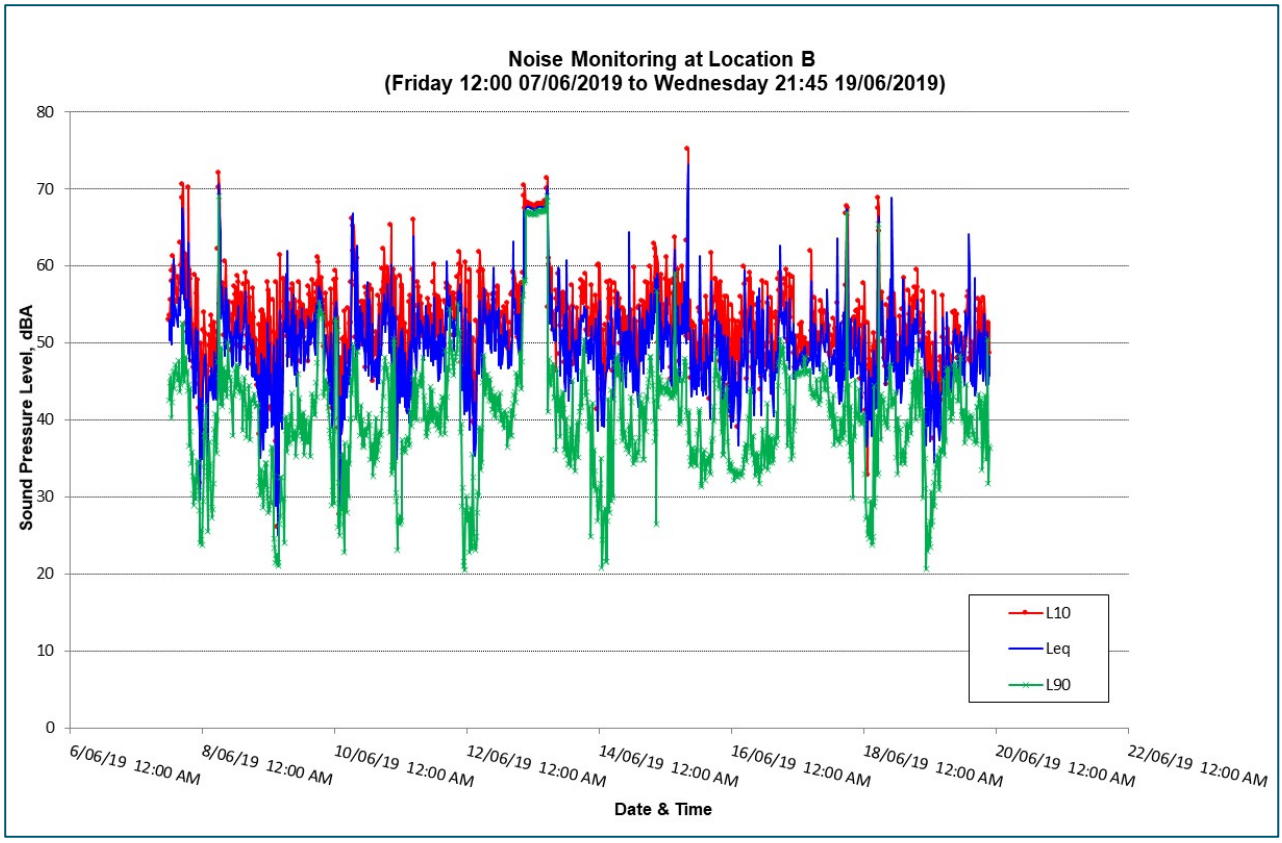


Figure C.3 Noise Monitoring Results at Location B – Roadhouse

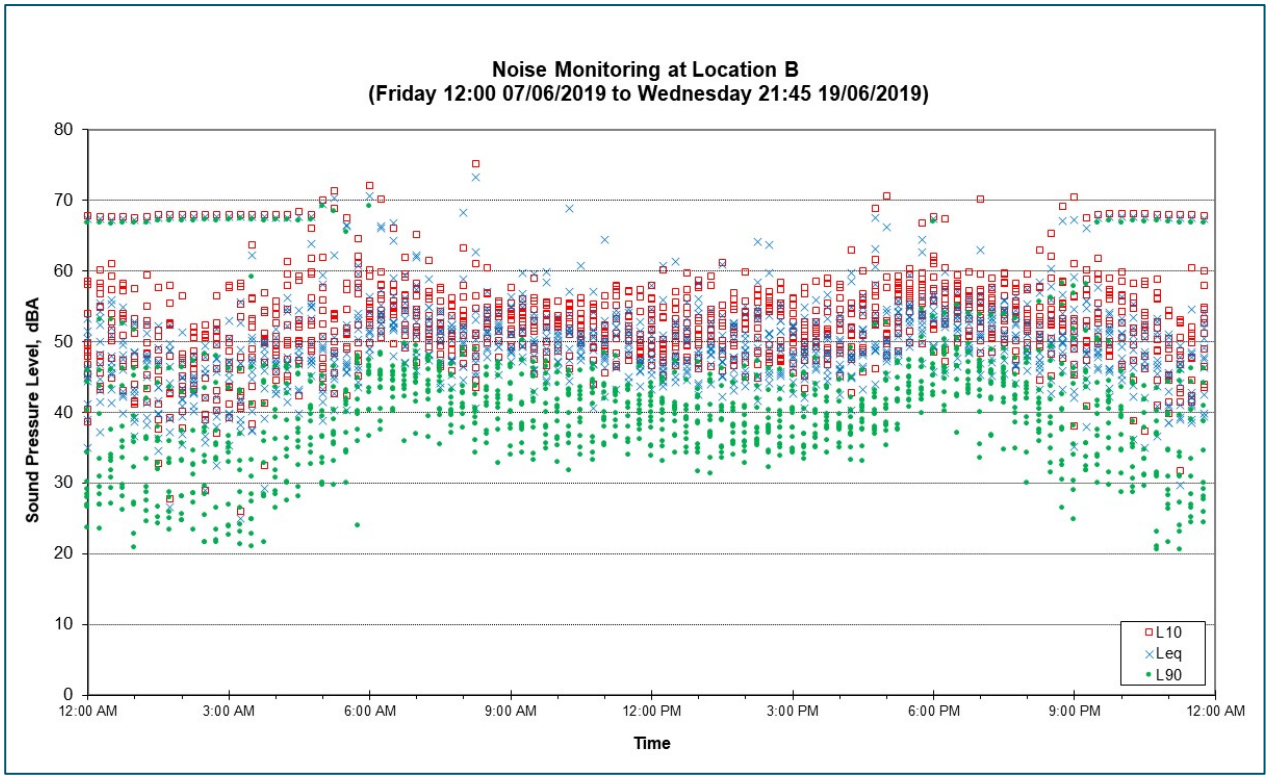


Figure C.4 24 Hour Noise Monitoring Results at Location B – Roadhouse

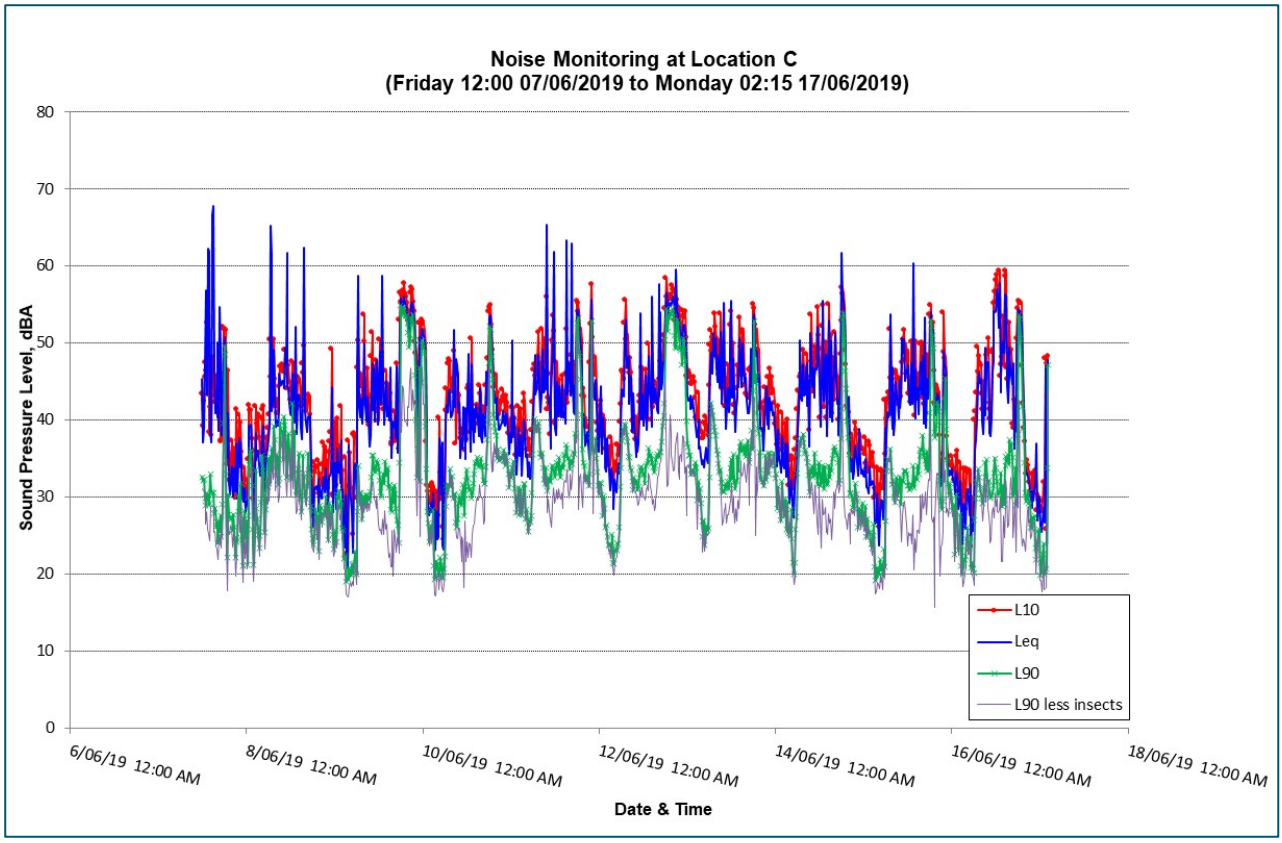


Figure C.5 Noise Monitoring Results at Location C – Residence

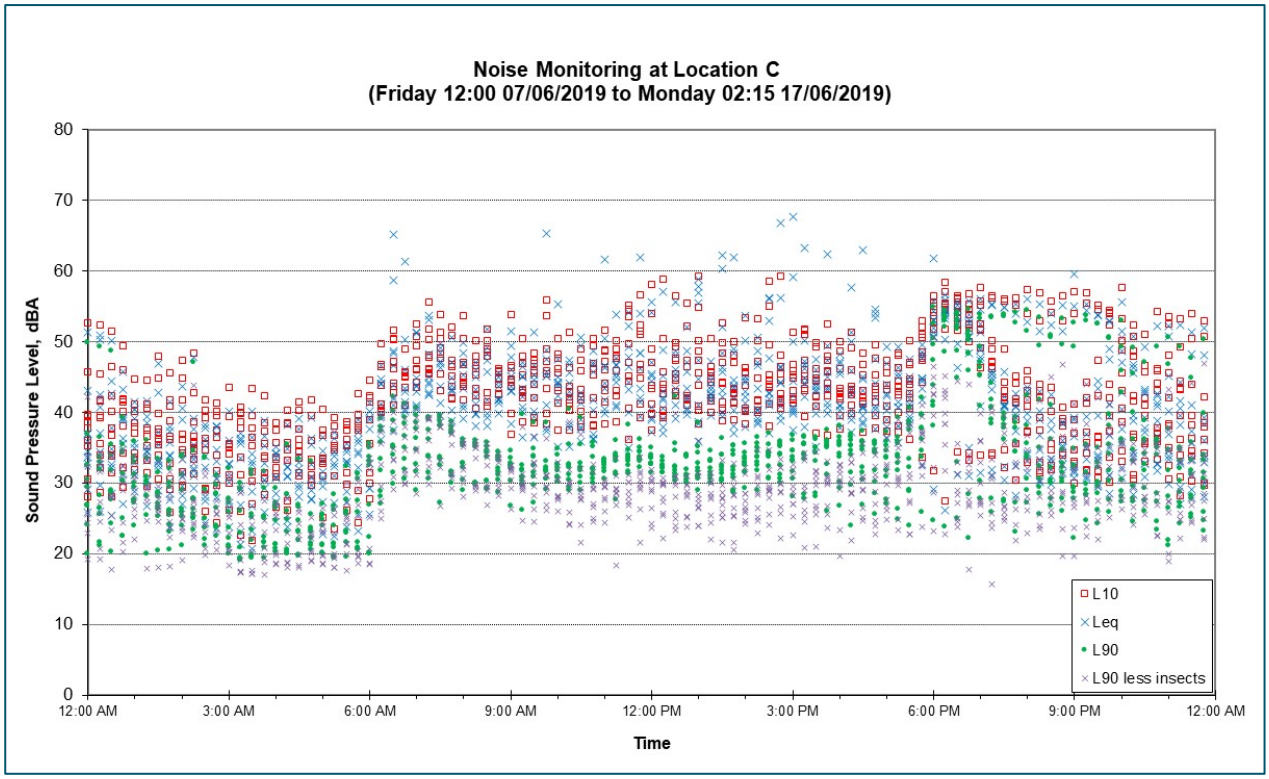


Figure C.6 24 Hour Noise Monitoring Results at Location C – Residence

Table C.1 Noise Monitoring Results at Location A – Accommodation Facility

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	82-71-(64)-58-51	80-72-(65)-56-48	83-72-(65)-56-34
L_1	73-66-(58)-51-46	73-69-(62)-52-46	74-69-(61)-51-25
L_{10}	69-62-(53)-46-39	68-65-(56)-46-41	68-65-(55)-44-24
L_{eq}	64-56-(49)-43-38	63-59-(52)-43-38	63-59-(51)-41-22
L_{90}	55-45-(39)-34-28	53-48-(36)-27-19	50-43-(33)-23-19

Table C.2 Noise Monitoring Results at Location B – Roadhouse

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	95-78-(68)-59-53	87-74-(65)-57-50	91-72-(62)-53-33
L_1	87-67-(60)-53-48	76-64-(58)-53-44	82-68-(56)-49-29
L_{10}	75-57-(53)-48-43	70-60-(55)-49-38	72-61-(52)-42-26
L_{eq}	73-55-(50)-45-40	68-57-(51)-46-35	71-59-(49)-39-25
L_{90}	55-46-(40)-35-31	67-51-(43)-34-25	69-47-(38)-26-21

Table C.3 Noise Monitoring Results at Location C – Residence

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	94-76-(65)-56-48	93-60-(54)-44-38	89-61-(50)-39-29
L_1	82-63-(55)-48-42	62-57-(48)-37-31	80-52-(43)-33-25
L_{10}	59-51-(45)-40-34	58-56-(45)-33-27	58-47-(38)-30-22
L_{eq}	68-51-(44)-39-33	62-55-(43)-31-26	65-45-(36)-28-21
L_{90}	42-37-(33)-30-24	55-53-(39)-27-22	53-37-(29)-21-19

Appendix D Mining Equipment Locations

Figure D.1 Year 2 Equipment Locations

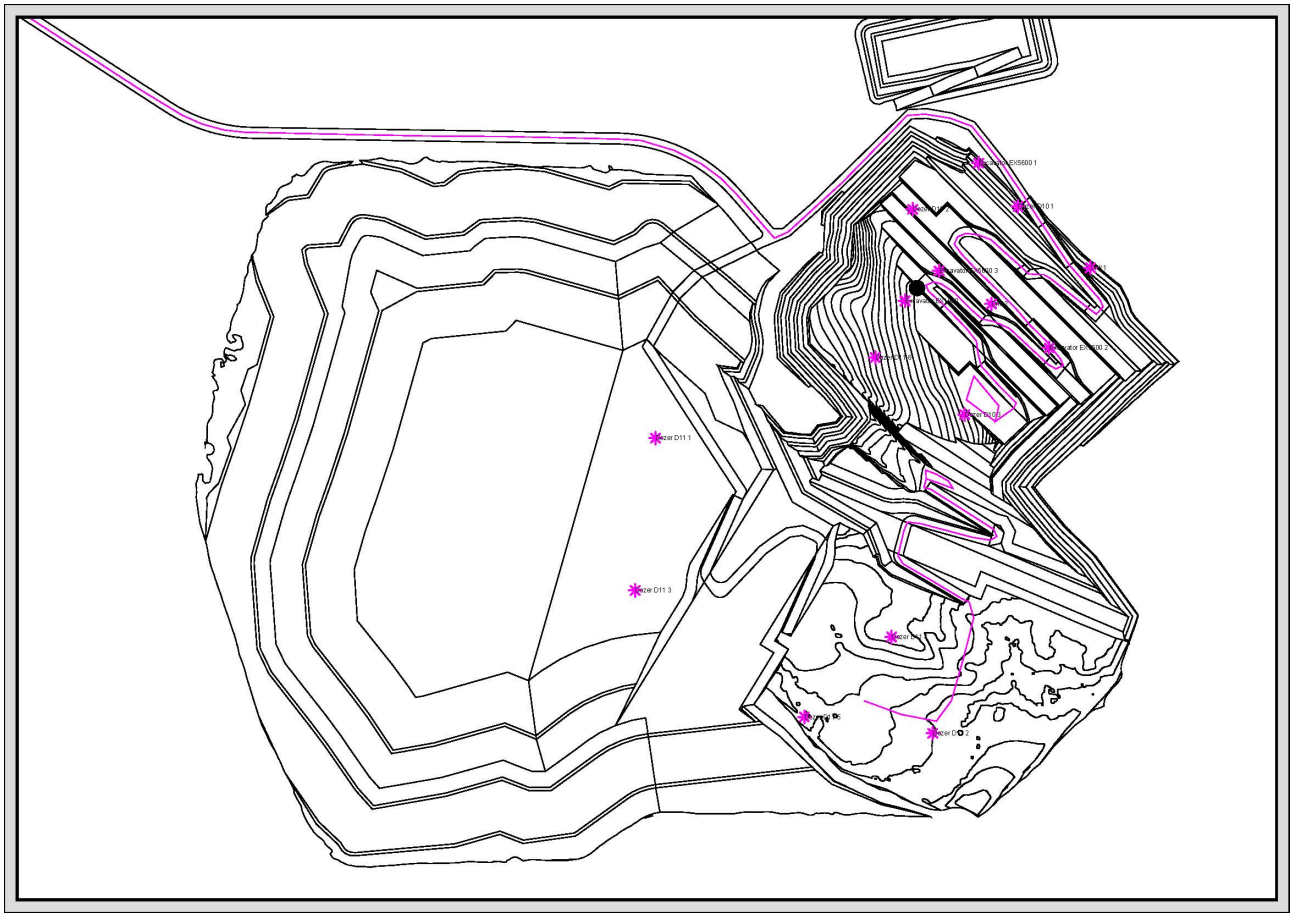


Figure D.2 Year 8 Equipment Locations

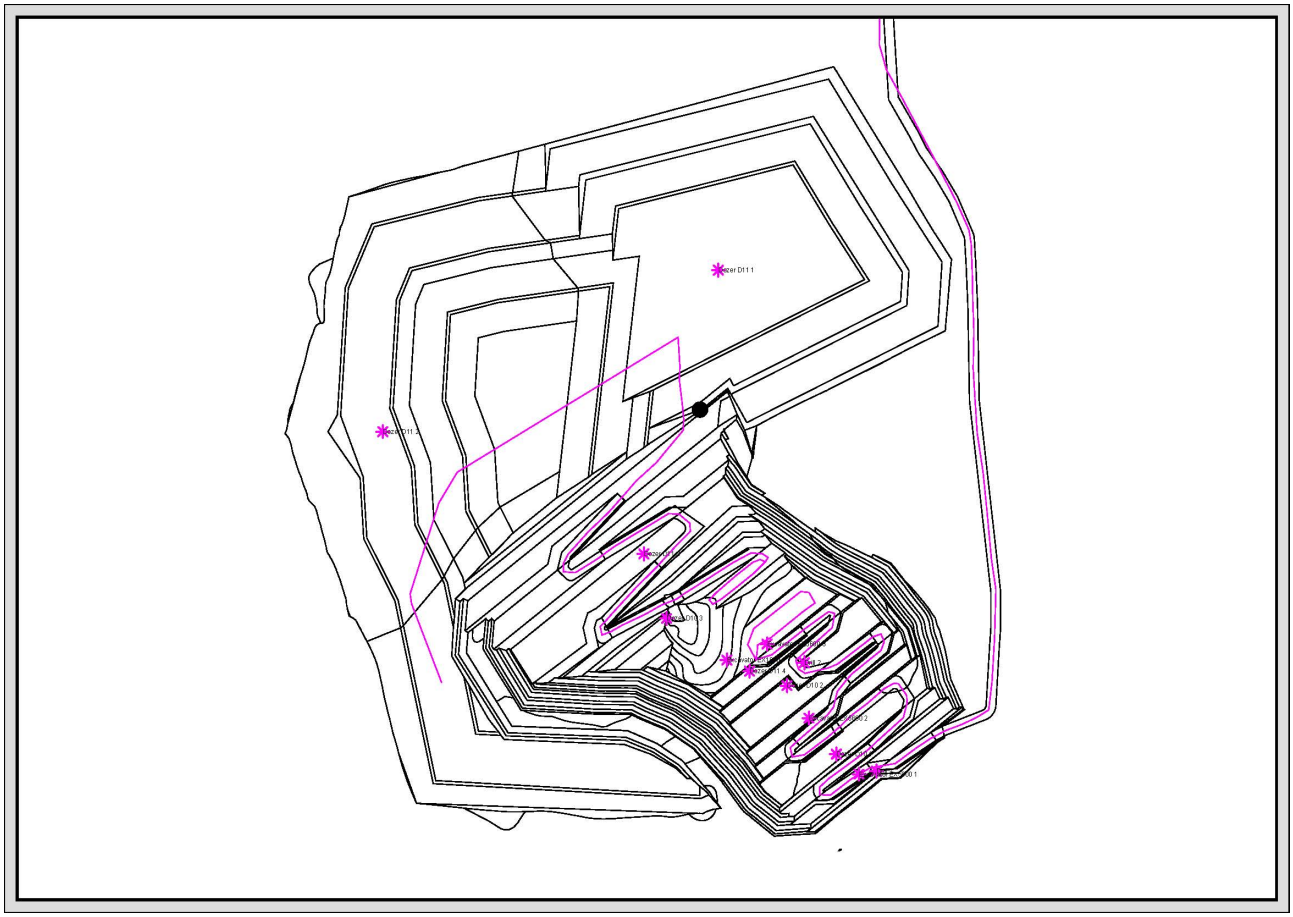
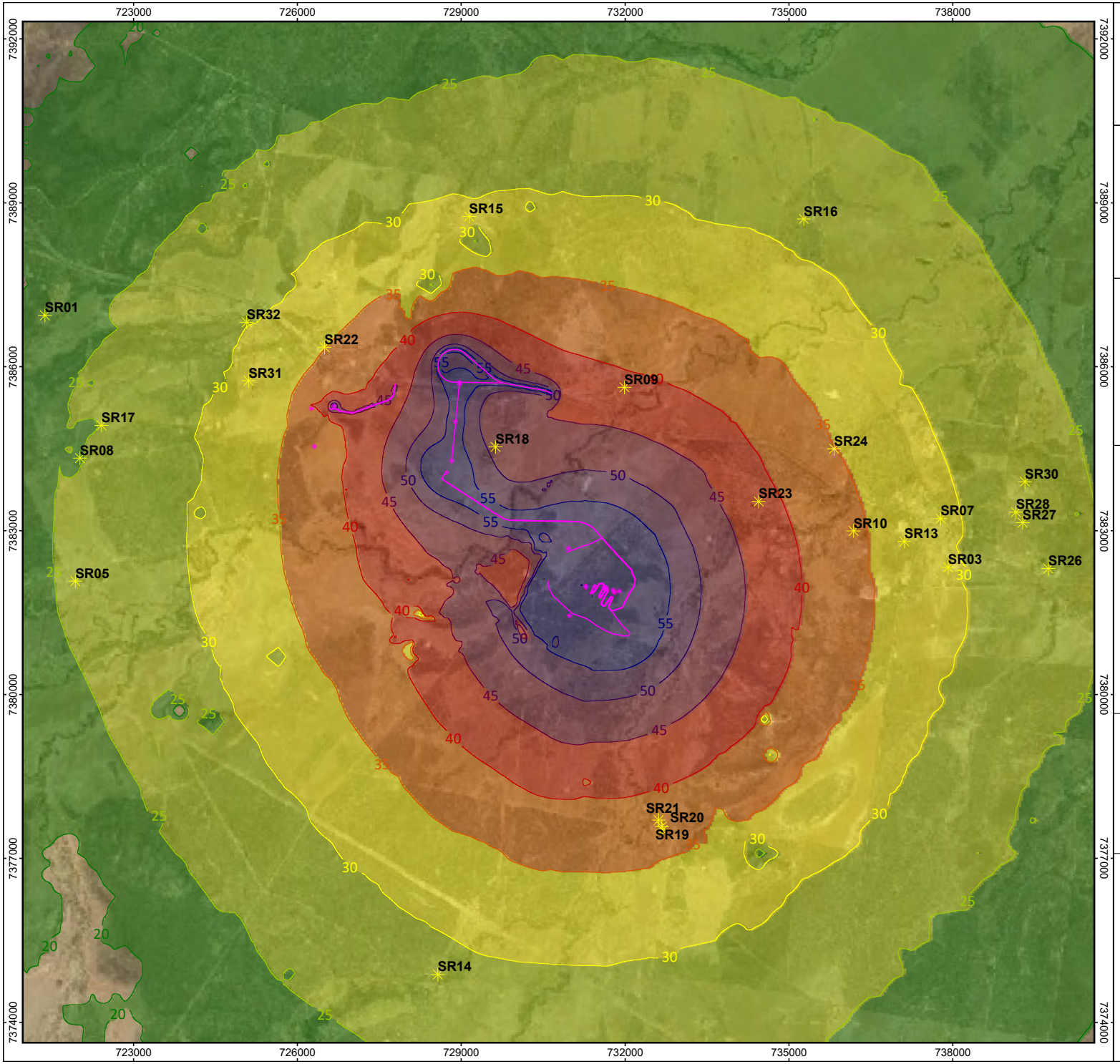


Figure D.3 Year 15 Equipment Locations

Appendix E Predicted Mining Noise Contours

The predicted mining noise level contour figures are as follows:

- **Figure E.1** Year 2 Scenario D1 Mine and Rail Loadout Noise Levels
- **Figure E.2** Year 8 Scenario D1 Mine and Rail Loadout Noise Levels
- **Figure E.3** Year 15 Scenario D1 Mine and Rail Loadout Noise Levels
- **Figure E.4** Year 2 Scenario N1 Mine and Rail Loadout Noise Levels
- **Figure E.5** Year 8 Scenario N1 Mine and Rail Loadout Noise Levels
- **Figure E.6** Year 15 Scenario N1 Mine and Rail Loadout Noise Levels



Gemini Project
Project Number: 197401.0181

Figure

E.1

Year 2 Mine and Rail Loadout Noise Contours
Meteorology Scenario D1 (Day)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point receiver
- Point source
- Line source

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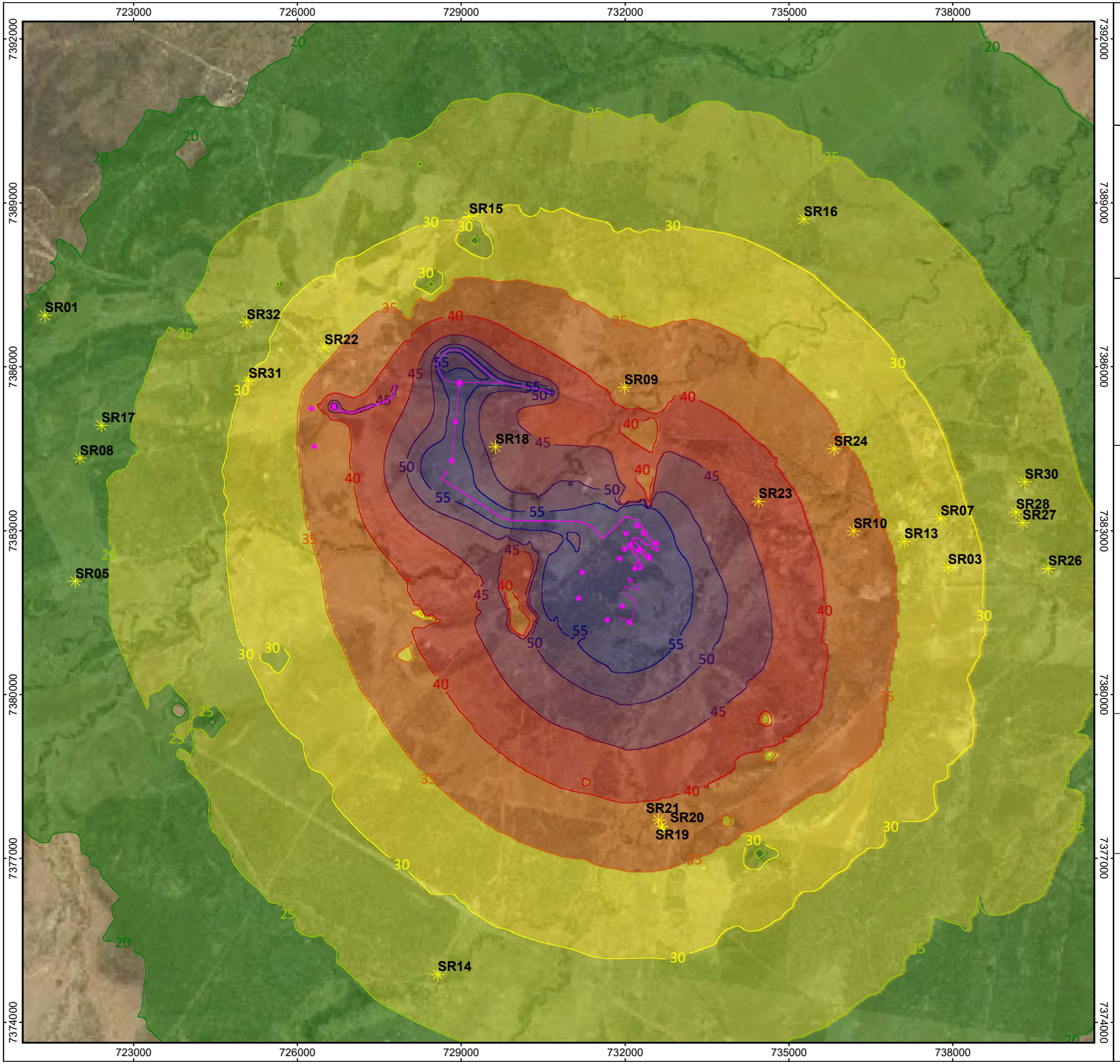

Gemini Project
Project Number: 197401.0181

Figure

E.2

Year 8 Mine and Rail Loadout Noise Contours
Meteorology Scenario D1 (Day)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point receiver
- Point source
- Line source

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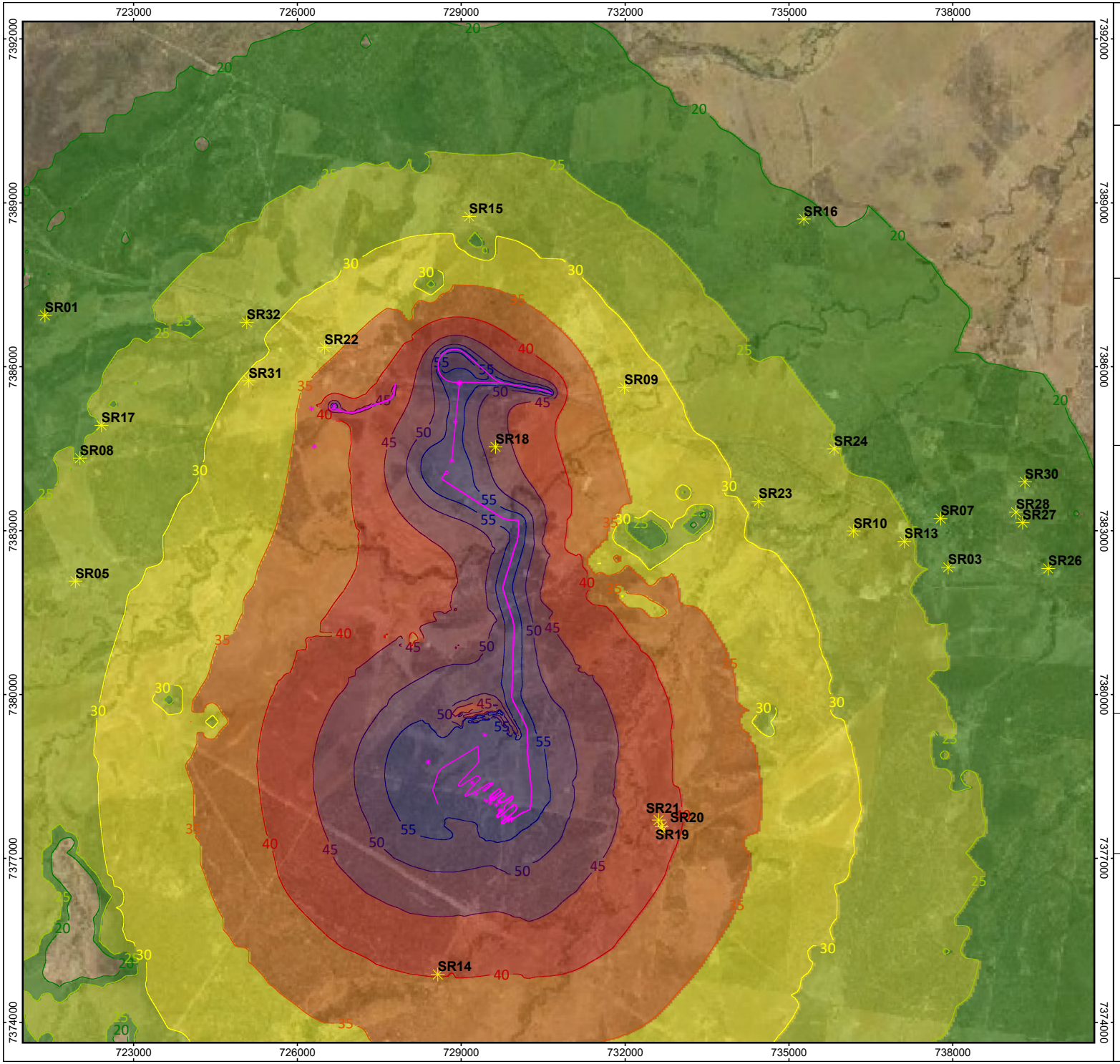

Gemini Project
Project Number: 197401.0181

Figure

E.3

Year 15 Mine and Rail Loadout Noise Contours
Meteorology Scenario D1 (Day)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point receiver
- Point source
- Line source

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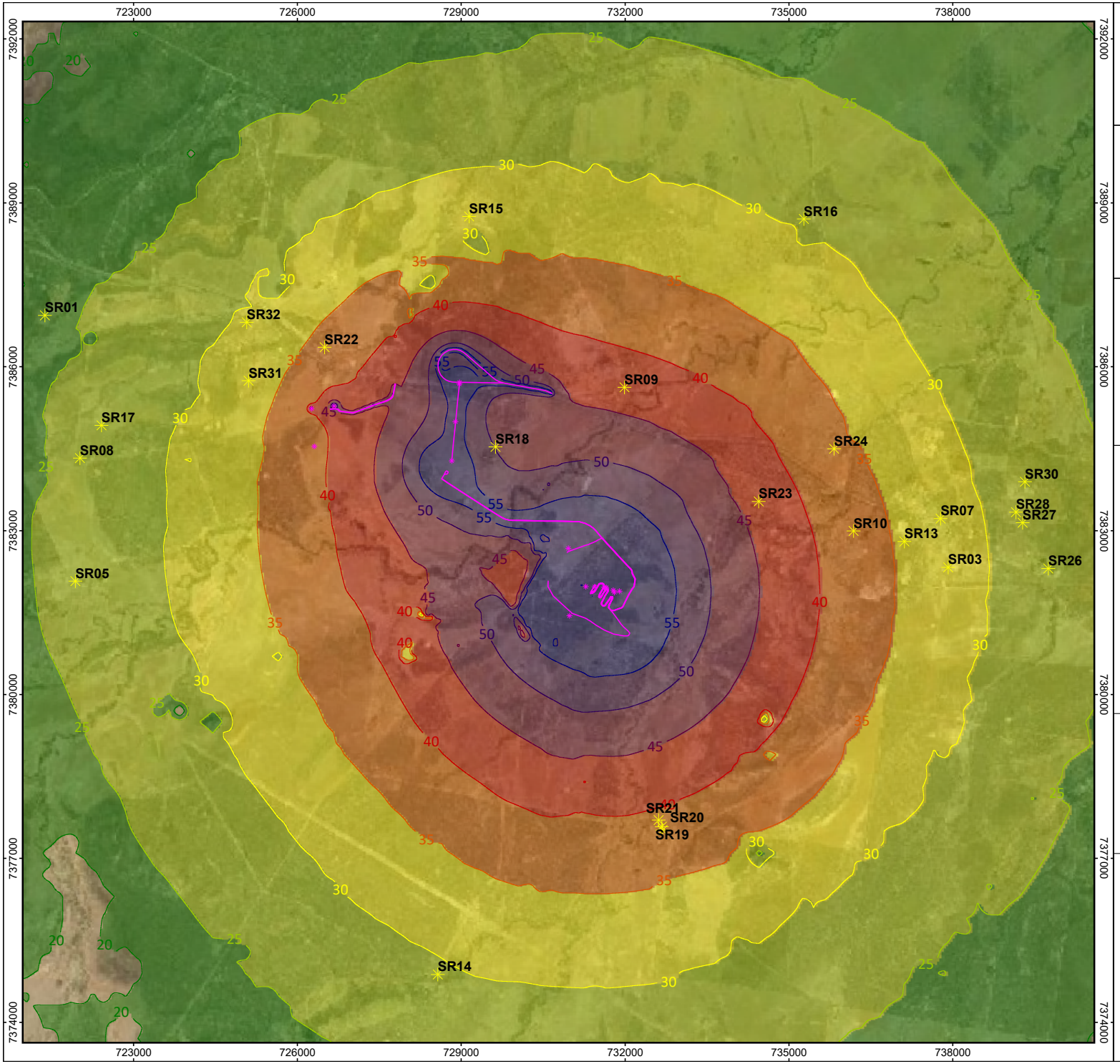

Gemini Project
Project Number: 197401.0181

Figure

E.4

Year 2 Mine and Rail Loadout Noise Contours
Meteorology Scenario N1 (Night)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point source
- Line source
- Point receiver

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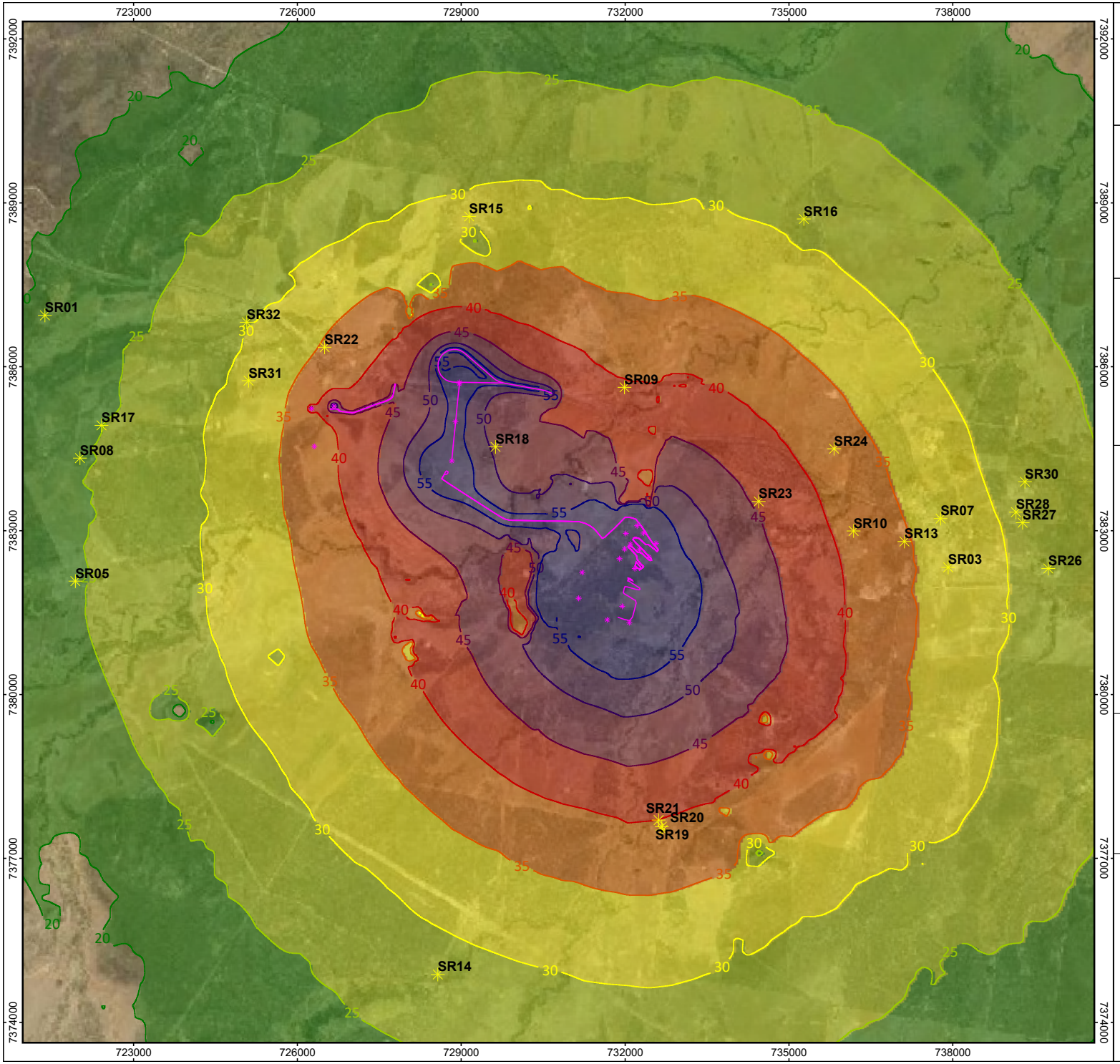

Gemini Project
Project Number: 197401.0181

Figure

E.5

Year 8 Mine and Rail Loadout Noise Contours Meteorology Scenario N1 (Night)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point receiver
- Point source
- Line source

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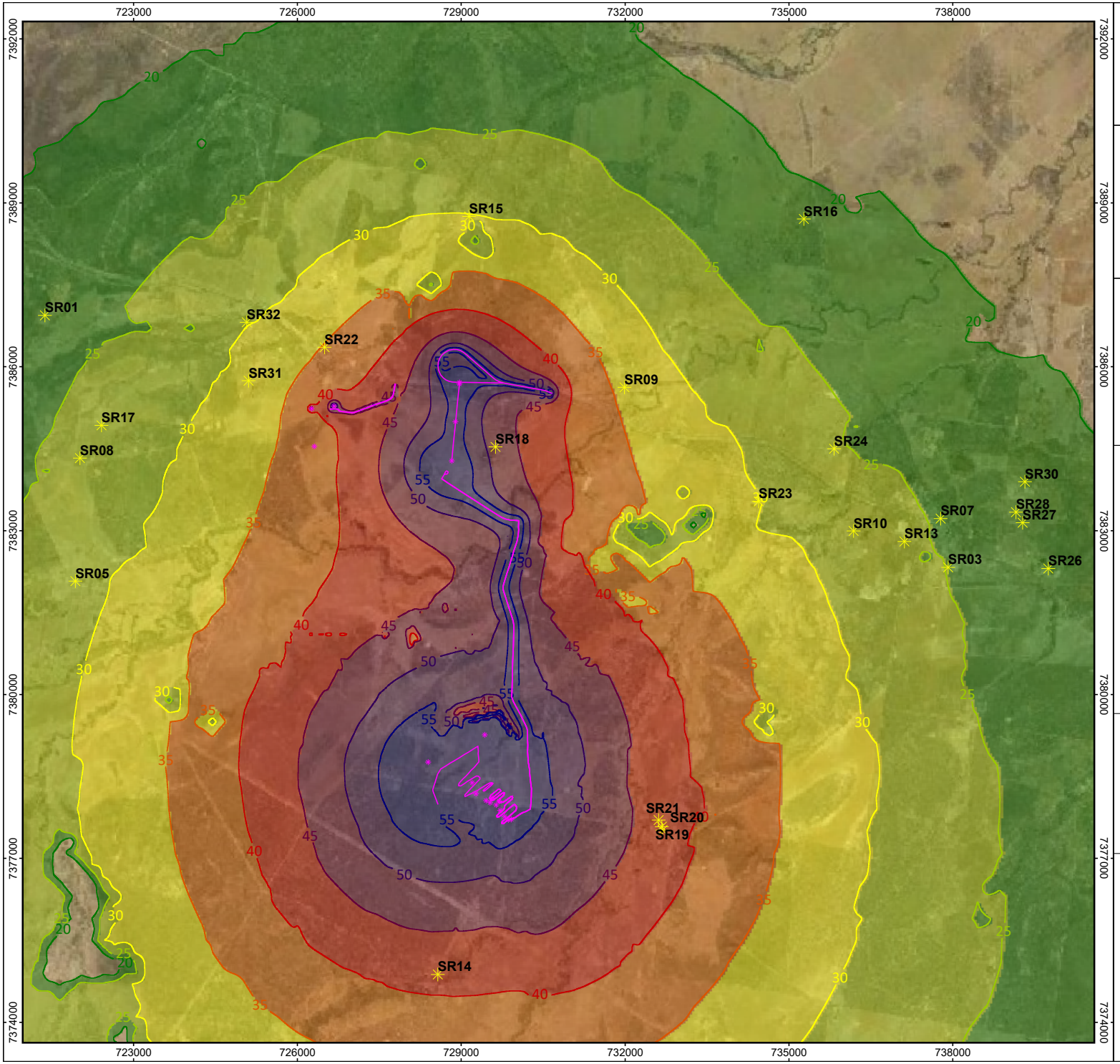

Gemini Project
Project Number: 197401.0181

Figure

E.6

Year 15 Mine and Rail Loadout Noise Contours Meteorology Scenario N1 (Night)

Date: 21/07/2021
Drawn By: PJ
Prepared For: Magnetic South Pty Ltd

Noise Levels Leq (1 hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and symbols

- Point receiver
- Point source
- Line source

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