



NOISE AND VIBRATION REPORT





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BIG VEIN SOUTH GOLD PROJECT ACOUSTIC REPORT

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GLOSSARY AND ABBREVIATIONS

The following acoustical terms and abbreviations are used in this report:

- **Sound Pressure** Small air pressure variations above and below normal atmospheric pressure that are perceived by human ears as sound;
- **Frequency** The rate of sound pressure fluctuations per second, expressed as cycles per second or hertz (Hz). Human ears in good condition can typically detect sound in the frequency range 20 Hz to 20,000 Hz (20 kHz), depending on sound level;
- **Decibels, dB** A noise level unit based on a logarithmic scale of pascals of sound pressure above and below atmospheric pressure. Human ears in good condition can typically detect sound pressures from the threshold of perception at 0 dB (20 uPa) to the threshold of pain at 140 dB (200 Pa). An increase of 10 dB is perceived as an approximate doubling of sound level by an average human ear;
- **dB** Linear decibels, the same as dB but used to explicitly define a decibel scale in the absence of any frequency weighting;
- **dBA** A-weighted decibels, where the A weighting means frequencies below 500Hz and above 10kHz are artificially reduced to approximate the frequency response of an average human ear. Most sound monitoring instruments include an A-weighting option, enabling direct measurement of noise levels in dBA;
- **LA90** The A-weighted noise level exceeded 90% of the time (which can be thought of as the quietest 10% of the time) over a defined measurement period, usually 15 minutes or one hour, and widely accepted as the background noise level;
- **LAeq** The A-weighted equivalent continuous, or logarithmic average, noise level over a defined time period either measured or predicted at a specific location;
- **Sound Power** Sound energy emitted by a source, measured in watts (W) or expressed on a decibel scale with 0 dB representing 1 picowatt (1 pW) of sound power. While both sound pressure and sound power can be expressed on a decibel scale, the two are not interchangeable or directly comparable. Sound power levels are most commonly expressed as unweighted decibels (dBL) but can be expressed as A-weighted decibels (dBA);
- **AS1055** Australian Standard 1055:2018 Acoustics – Description and measurement of environmental noise;
- **AS2021** Australian Standard 2021:2015 Acoustics – Aircraft noise intrusion, Building siting and construction;
- **DETSI** Qld Department of Environment, Tourism, Science and Innovation;
- **EAR** Environmental Assessment Report;
- **ENM** RTA Technology's Environmental Noise Model software;
- **EP Act 1994** Environmental Protection Act 1994 (Qld);
- **EPA** NSW Environment Protection Authority;
- **EPP Noise 2019** Environmental Protection (Noise) Policy 2019 (Qld);
- **Mtpa** million tonnes per annum;
- **PNCG** Qld Planning for Noise Control Guideline;
- **ROM** Run-of-mine.

1 INTRODUCTION

Bridges Acoustics was commissioned by Strategic Minerals Corporation to complete an Acoustic Assessment as part of the environmental Assessment Report (EAR) for the Big Vein South Gold Project (the project).

The project involves the construction and operation of an open cut gold mine on a greenfield site in North Queensland, as shown in Figure 1. The project site covers an area of approximately 2,281 ha and is located approximately 100 km north of Richmond and 380 km west of Townsville.

Open cut mining will be conducted using excavators and trucks. Gold ore will be processed on site to produce gold dore (solid bars containing gold alloy). The mine's peak production rate will be up to 1.95 million tonnes per annum (Mtpa) of run-of-mine (ROM) gold ore, yielding up to approximately 100,000 ounces of gold dore per annum. The mine life will be approximately 11 years.

The following mining and ore processing activities will be undertaken as part of the project:

- Developing three open cut pits, as follows:
 - The main Big Vein South Pit (BVS Pit) located in the centre of the project site as shown in Figure 2. Waste rock from this pit will be hauled by truck and stored in the Central and Southern Waste Rock Dumps (WRDs).
 - Two small satellite pits, BV1 Pit and BV2 Pit, located in the northern part of the project site. Waste rock from these pits will be stored in the Northern WRD.
- Transporting mined ore in haul trucks from the open cut pits to the ROM area ore stockpiles located near the mine processing facilities at the southern end of the project site.
- Processing ore from the BV1 and BV2 Pits in the first 2 years of mining using Heap Leach Pads and gold elution. Processing ore mined from the BVS Pit in an on-site Carbon In-Leach (CIL) Plant from Year 3 onwards. The heap leaching process will generate spent heap leach residues. These residues will be reprocessed in the CIL Plant over the life of the mine. The CIL Plant will generate wet tailings and dewatered tailings. Wet tailings will be pumped to a Tailings Storage Cell. Dewatered tailings will be stored with waste rock in the Central and Southern WRDs.
- Transporting dore bars from the site via plane to a refinery.

The majority of the mine infrastructure will be located at the southern end of the project site (Figure 2). Key mine infrastructure will include ore processing facilities, workshop, warehouse, administration buildings, haul roads and access roads, vehicle servicing, refuelling and wash down facilities, fuel storage facilities, diesel and solar power station, water supply and water management infrastructure. Workforce accommodation and a private airstrip will also be located at the southern end of the project site.

Figure 1: Location Plan

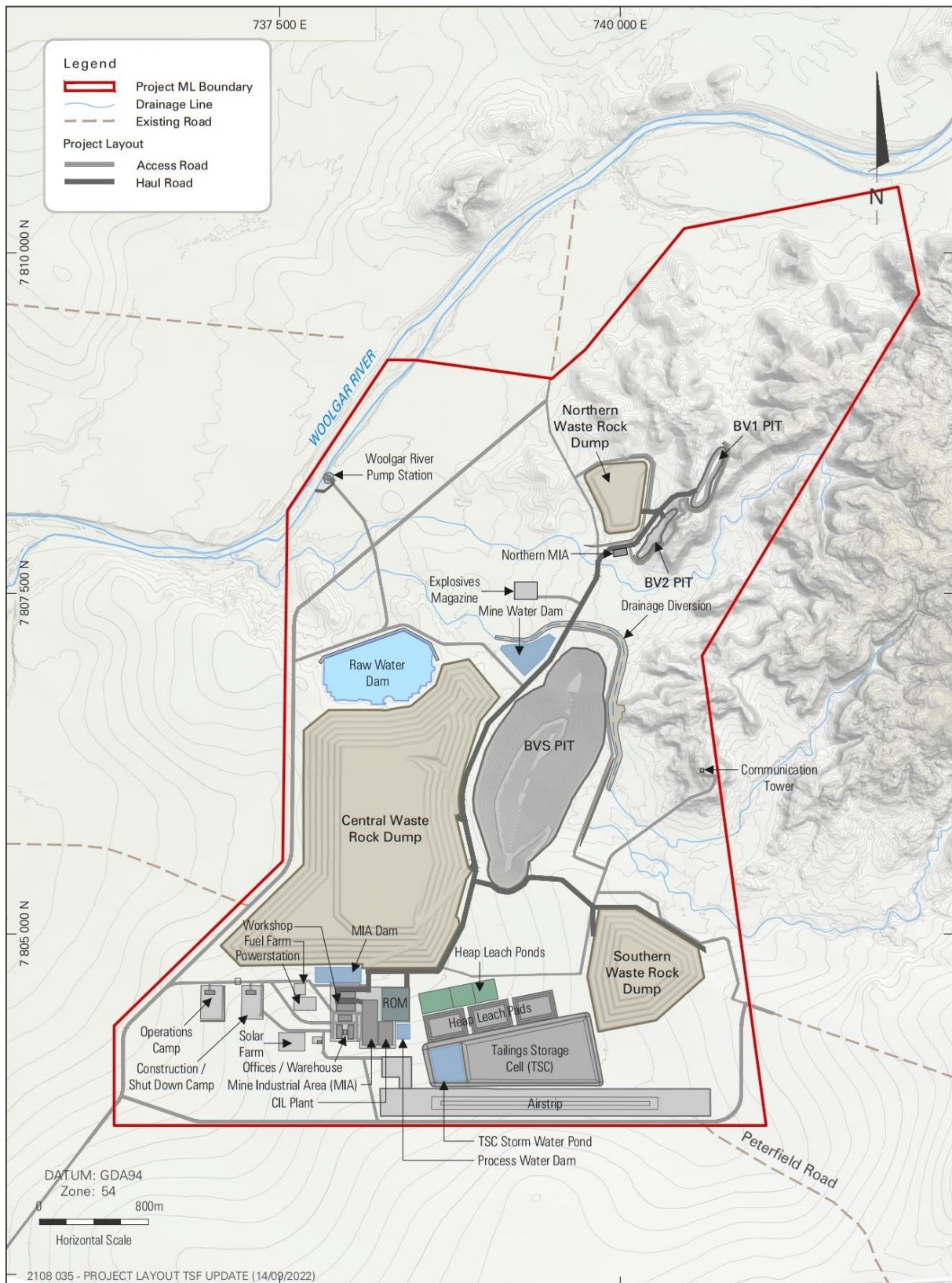


BIG VEIN SOUTH GOLD PROJECT



Location Plan

Figure 2: Conceptual Project Layout Plan



BIG VEIN SOUTH GOLD PROJECT



Project Layout

1.1 Environmental Noise Policies and References

The Department of Environment, Tourism, Science and Innovation (DETSI) has developed or adopted policies and recommended procedures to assess environmental noise levels from various noise source categories including industrial and mining developments in Queensland. The following policy and guidance documents are relevant to this assessment, listed in chronological order:

- *Environmental Protection Act 1994* (Qld, 1994) (EP Act 1994);
- *Planning for Noise Control Guideline* (EPA now DETSI, July 2004) (PNCG);
- *Draft Ecoaccess Guideline for the Assessment of Low Frequency Noise* (EPA now DETSI, November 2004) (Low Frequency Noise Guideline);
- *Noise Measurement Manual* (EHP now DETSI, 2013);
- *Australian Standard 1055:2018 Acoustics – Description and measurement of environmental noise* (Standards Australia, 2018) (AS1055);
- *The health effects of environmental noise* (Commonwealth of Australia, 2018);
- *The Environmental Protection (Noise) Policy 2019* (Qld, August 2019) (EPP Noise 2019);
- *Environmental Protection Regulation 2019* (Qld, September 2019);
- *Model mining conditions* (ESR/2016/1936 DETSI, 2016 [last revised 2024]); and
- *Noise and vibration from blasting* (Qld Department of Environment and Science now DETSI, January 2016).

The PNCG is currently being reviewed, however the guideline is referred to in the more recent Noise Measurement Manual and it therefore remains relevant to this assessment.

1.2 Sensitive Receptors

Noise criteria apply to sensitive places, which primarily include residences and other locations where people regularly sleep such as motels, caravan parks, camping grounds and other accommodation units, and commercial places which include relatively quiet non-residential premises such as shops and offices. Potential noise levels from the project at residential receptors is the focus of this assessment as there are no known shops and offices close to the project site.

The project is located in a relatively remote area. The town of Richmond contains the closest commercial district and is located approximately 100 km south of the project site. Middle Park and Mt Norman rural homesteads are located approximately 1.1 km north and 8.4 km south-west of the project site, respectively. Barnes' House, a homestead that is only occupied intermittently, is located approximately 3 km north-east of the project site.

The project includes on-site accommodation camps west of the Mine Industrial Area (MIA) which will include sleeping, food preparation and related facilities for the workforce and visitors. The accommodation camps would normally be considered sensitive places, however they would be owned and managed by the proponent and are therefore not considered sensitive places in this assessment.

All other receptors are located over 10 km from the project site and are therefore too remote to be potentially affected by noise and vibration from the project.

2 EXISTING ENVIRONMENT

Existing environmental noise levels at closest receptors were not measured during preparation of this report. Nearest receptors are remote rural homesteads far from significant sources of background noise such as main roads or railways. Based on noise measurements previously taken and observations made at other remote locations in central Queensland, sources of background noise would include:

- Insects and frogs, particularly in the wet season when surface water is more consistently available to them;
- Wind, including the effect of wind in trees and other foliage, which occurs intermittently and varies substantially from time to time; and
- Equipment such as ventilation fans, air conditioners, power generators and similar machines associated with each homestead, which in many cases operate intermittently as required.

Background noise levels would therefore vary from less than 20 LA90,15min during a quiet period with no significant wind and insect/frog noise, to over 40 LA90,15min. Background noise levels would generally be lower during the dry season due to less insect and frog noise and would typically be lower during the night due to lower average wind speeds.

Noise criteria relevant to this assessment, as further discussed in Section 3.1, are based on a minimum background noise level of 30 LA90,15min during all time periods. If background noise levels were measured at closest receptors, it is considered likely that relatively quiet periods with low wind speeds would occur for at least part of the measurement period, therefore any noise survey would indicate a background noise level equal to or below 30 LA90,15min. This minimum background noise level has therefore been adopted for this assessment.

3 CRITERIA

3.1 Mining Noise

3.1.1 EPP Noise 2019

The Environmental Protection (Noise) Policy 2019 (EPP Noise 2019), made under the EP Act 1994, defines acoustic quality objectives to protect health, wellbeing and amenity for residents and the occupants of other public and private premises including parks and gardens. The acoustic quality objectives in Schedule 1 of the EPP Noise 2019 applicable to residences are reproduced below.

Schedule 1 Acoustic Quality Objectives

<i>Sensitive receptor</i>	<i>Time of day</i>	<i>Acoustic quality objectives (measured at the receptor) dBA</i>			<i>Environmental value</i>
		<i>LAeq,adj,1hr</i>	<i>LA10,adj,1hr</i>	<i>LA1,adj,1hr</i>	
<i>residence (outdoors)</i>	<i>day and evening</i>	50	55	65	<i>health and wellbeing</i>
<i>residence (indoors)</i>	<i>day and evening</i>	35	40	45	<i>health and wellbeing</i>
	<i>night</i>	30	35	40	<i>health and wellbeing in relation to sleep</i>

Both outdoor and indoor acoustic quality objectives are recommended for residential receptors during the day and evening, with a 15 dBA difference between indoor and outdoor levels for both LAeq,1hr and LA10,1hr acoustic quality objectives and a 20 dBA difference for LA1,1hr. Applying a much more conservative 5 dBA difference from indoor to outdoor noise levels results in outdoor acoustic quality objectives of 35 LAeq,1hr, 40 LA10,1hr and 45 LA1,1hr for the night period.

3.1.2 Health Effects of Environmental Noise

Section 7.4 of The Health Effects of Environmental Noise concludes the following health based limits on environmental noise are warranted at residences:

- A limit of 55 dBA at the external façade of a residence during the night; and

- A limit of 60 LAeq,16hr at the external façade during the day.

The recommended limits are intended to minimise adverse health effects, not to protect amenity.

3.1.3 Model Mining Conditions

The model mining conditions include recommended EA conditions for mining developments. Schedule D Condition D1 includes recommended conditions to control noise impacts at sensitive places and commercial places. Table D1 is reproduced below.

Table D1 – Noise limits

Sensitive place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	9am to 6pm	6pm to 10pm	10pm to 9am
LAeq,adj,15 mins	CV = 50 AV = 5	CV = 45 AV = 5	CV = 40 AV = 0	CV = 45 AV = 5	CV = 40 AV = 5	CV = 35 AV = 0
LA1,adj,15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5
Commercial place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	7am to 6pm	6pm to 10pm	10pm to 7am
LAeq,adj,15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5

Table D1 – Noise limits notes:

1. CV = Critical Value
2. AV = Adjustment Value
3. bg = background noise level (LA90, adj, 15 mins) measured over 3-5 days at the nearest sensitive receptor
4. To calculate noise limits in Table D1:
 If $bg \leq (CV - AV)$: Noise limit = $bg + AV$
 If $(CV - AV) < bg \leq CV$: Noise limit = CV
 If $bg > CV$: Noise limit = $bg + 0$
5. In the event that measured bg (LA90, adj, 15 mins) is less than 30 dB(A), then 30 dB(A) can be substituted for the measured background level
6. If the project is unable to meet the noise limits as calculated above alternative limits may be calculated using the processes outlined in the "Planning for Noise Control" guideline.

Noise limits calculated according to the model mining conditions depend on existing background noise levels. Background noise levels are generally lower in rural areas than in suburban or urban areas. Note 5 recommends a minimum background noise level of 30 dBA where existing background noise levels are below this minimum threshold. This recommendation is consistent with equivalent noise policies in other Australian states and territories such as NSW and the Northern Territory, at least for the most sensitive evening and night periods.

The recommended Adjustment Value (AV) of 5 dBA to determine LAeq,adj,15min noise limits at sensitive places is considered appropriate, however the recommended AV of 0 dBA for the night period

is unusually stringent when compared to equivalent noise policies in other states and territories. This assessment adopts $AV = 5$ for $L_{Aeq,qadj,15min}$ noise levels at sensitive places for all time periods.

3.1.4 Adopted Noise Criteria

The EPP Noise 2019, Health Effects of Environmental Noise and model mining conditions noise criteria can be referred to when determining noise criteria for the assessment. As the model mining conditions criteria are lower than the other two sets of criteria, compliance with the model mining conditions criteria will ensure compliance with the other sets of criteria. The model mining conditions criteria have therefore been adopted for this assessment.

The L_{Aeq} criteria are used to control average noise levels in each of the day, evening and night time periods, while the $LA1$ criteria are used to limit the potential for sleep disturbance for residential receptors and primarily apply to the night period. Table 1 shows outdoor noise criteria for the project, assessed at all residential (sensitive place) receptors.

Table 1: Adopted Mining Noise Criteria, dBA

Criteria	Time Period	Noise Criteria	
		L_{Aeq}	$LA1$
EPP Noise 2019	Day and Evening	50	65
	Night	35	45
Health Effects of Environmental Noise	Day and Evening	60	-
	Night	-	55
Model Mining Conditions	Day, Evening and Night	35	40
Adopted Noise Criteria	Day, Evening and Night	35	40

The $LA_{10,1hr}$ noise criteria recommended in the EPP Noise 2019 for residences are not specifically considered in this assessment, as these criteria are 5 dBA higher than the L_{Aeq} criteria and experience with other mining projects has indicated a less than 5 dBA difference between L_{Aeq} and LA_{10} mine noise levels typically occurs. Compliance with the L_{Aeq} model mining conditions criteria would therefore result in automatic compliance with the EPP Noise 2019 LA_{10} criteria.

3.2 Low Frequency Noise

The Low Frequency Noise Guideline suggests a criterion of 50 dBL inside a residence for the frequency range 10 Hz to 200 Hz to minimise the potential for impacts on noise sensitive receivers such as residences. This includes frequencies in the ranges 20 Hz to 80 Hz that can be produced by material processing and similar industrial equipment and approximately 100 Hz to 200 Hz which are produced by heavy vehicle engine exhausts, which are likely to be the main sources of low frequency noise from the project.

It should be noted that dBL means unweighted decibels, without the usual A-weighting correction that is normally applied to approximate the frequency response of an average human ear. There is no standard dBA equivalent to the suggested criterion of 50 dBL.

The Low Frequency Noise Guideline requires an assessment of low frequency noise to assume windows and doors are closed to reduce background noise levels and to avoid contamination of the noise measurement with wind noise or other extraneous external noise sources. This approach is adopted because low frequency noise inside a dwelling is more audible when windows and doors are closed, thereby lowering background noise levels in the dwelling. Table 7 of the PNCG shows a difference of 20 dBA between outside and inside a dwelling where windows and doors are closed, however a much

lower attenuation of 10 dBA has been conservatively adopted for the low frequency assessment as the walls and roof of typical homesteads would provide less attenuation of low frequency noise compared to typical audible noise.

The 50 dBL indoor criterion would be approximately equivalent to an external criterion of 60 dBL with windows and doors closed.

3.3 Construction Noise

Construction works associated with the project, particularly works associated with construction of the Mining Infrastructure Area (MIA) including ore crushing and processing equipment and the power station, have the potential to be audible at receptors depending on the particular construction activity and weather conditions occurring at the time. The Queensland Government has not developed a specific construction noise policy, therefore the EPP Noise 2019 acoustic quality objectives described in Section 3.1.1 are adopted for the construction noise assessment.

Other jurisdictions such as NSW have also adopted less stringent construction noise criteria compared to operational noise criteria, consistent with the acoustic quality objectives, acknowledging the inherently noisy nature of construction work and the limited duration of work which limits any noise impacts.

3.4 Blasting

Blasting is proposed within the project site to loosen both waste rock and ore for removal by excavator and truck. Blast effects include ground vibration which can sometimes be perceptible as a brief shaking of the ground surface, typically expressed in mm/s Peak Particle Velocity (PPV), and low frequency noise known as overpressure which is typically expressed as dBL Peak and is subjectively similar to distant thunder. Overpressure levels measured in dBL Peak are quite different and cannot be compared to more common noise levels expressed in dBA.

3.4.1 Residential Disturbance Criteria

The *Noise and vibration from blasting* guideline (blasting guideline) recommends residential ground vibration and overpressure limits and time restrictions for blast effects to residences, from quarries and mines, to minimise disturbance to occupants as listed below.

Overpressure	115 dBLpk for 9 out of 10 consecutive blasts; 120 dBLpk for all blasts;
Ground vibration	5 mm/s PPV for 9 out of 10 consecutive blasts; and 10 mm/s PPV for all blast events.

The blasting guideline recommends blasting criteria apply, for mining projects, during the hours 7 am to 6 pm, 7 days per week.

3.4.2 Building Damage Criteria

The overpressure and ground vibration limits in the blasting guideline, although designed to minimise disturbance to occupants, would also prevent any damage to residences and other buildings and structures. The majority of occupied buildings such as residences can withstand much greater vibration levels, typically well over 20 mm/s, before the onset of superficial or cosmetic damage. Vibration levels over 25 mm/s and often over 50 mm/s would typically be required to cause structural damage to these buildings. Steel structures such as farm sheds can typically withstand vibration levels over 100 mm/s without damage.

Appendix J4 of *Australian Standard 2187.2-2006 Explosives – Storage and use, Part 2: Use of explosives* suggests a vibration criterion of 15 mm/s at 4 Hz, rising to 50 mm/s at 40 Hz and above, would protect occupied buildings constructed of lightweight materials such as timber frames with plasterboard lining. AS2187 also recommends a vibration criterion of 50 mm/s for industrial and heavy commercial buildings, including large farm sheds. The residential disturbance vibration criterion of 5 mm/s and upper limit of 10 mm/s for occupied buildings is therefore adequate to protect these buildings from even superficial or cosmetic damage.

Similarly, occupied buildings routinely withstand wind pressures, including strong wind gusts, so are not particularly sensitive to overpressure. Appendix J5 of AS2187 states “*From Australian and overseas research, damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133 dBL. Windows are the building element currently regarded as most sensitive to airblast, and damage to windows is considered improbable below 140 dBL*”. The recommended criterion of 115 dBL, and upper limit of 120 dBL, is therefore adequate to protect buildings including windows from damage due to overpressure.

3.5 Aircraft Noise

Aircraft noise criteria have been determined based on of *Australian Standard 2021:2015 Acoustics – Aircraft noise intrusion, Building siting and construction* (AS2021) which includes recommended noise criteria and methods to calculate aircraft noise levels to receptors. Aircraft noise from large or busy airports is typically assessed using the Aircraft Noise Exposure Forecast (ANEF) rating system, however the ANEF system is not generally applied to small airports with relatively few aircraft movements per day.

Appendix E of AS2021 provides alternative noise criteria for aircraft movements for small airports, based on average maximum noise levels. An extract from Table E1 in AS2021, applicable to residences and similar receptors, is presented in Table 2 below.

Table 2: Recommended Aircraft Noise Criteria, Residences, Average Maximum dBA

Number of Flights per Day	Aircraft Noise Level, Average Maximum dBA		
	Acceptable	Conditionally Acceptable	Unacceptable
> 30	< 70	70 – 75	> 75
15 – 30	< 80	80 – 85	> 85
< 15	< 90	90 - 95	> 95

Appendix E of AS2021 recommends night flights, between the hours of 7 pm and 7 am, should count as four flights for the purposes of determining relevant noise criteria.

Flights are expected to arrive and depart at shift change times, expected to be around 7 am and 7 pm. Flights are therefore expected to land before 7 am and depart after 7 am, or to land before 7 pm and depart after 7 pm, with an average of 4 flights per week expected to be required. While the morning and evening flights are expected to be more evenly distributed throughout the week, a worst case situation may include an evening flight, with a departure after 7 pm, followed by a morning flight with a landing before 7 am. This worst case situation would include one day flight and 2 night flights for an effective total of 9 flights in a 24 hour period when counting the night flights four times.

For less than 15 flights per day, an average maximum noise level of less than 90 dBA is considered acceptable.

4 ASSESSMENT

4.1 Calculation Procedure

Environmental noise levels expected to be produced by the project have been calculated using RTA Technology's Environmental Noise Model (ENM) software. ENM is a general purpose noise modelling package that combines terrain and noise source information with other input parameters such as weather conditions to predict noise levels at specific receiver locations or as contours over a specified receiver area. It is recognised as one of the most appropriate choices of model software for situations involving complex topography and a large number of individual noise sources, and where a detailed assessment of the effects of atmospheric conditions on noise propagation is required.

The standard ENM package includes data input modules to allow terrain and noise source information to be entered and amended, plus an initial setup page containing terrain and source lists and modelled weather conditions for each scenario. All terrain and source files were prepared for this assessment using a combination of AutoCad and Excel based data then automatically converted to ENM format terrain and source files using custom software. All outputs were obtained using ENM's standard sectioning and contouring algorithms and are presented on a base plan after minor tidying such as closing gaps in the contour lines. Figures in Appendix B indicate the terrain models and noise source locations for each assessed year. Noise contour figures are presented in Appendix B.

The noise model was initially set up to calculate LAeq,15min noise levels from the project from all modelled sources operating together. The model was then amended to replace average workshop noise with reasonable maximum levels for this source and noise levels recalculated to determine LA1,15min noise levels during the night.

4.2 Atmospheric Conditions

4.2.1 General Discussion

A review of atmospheric conditions that occur in the vicinity of the project site is required to determine the effect of such conditions on noise propagation from the project. Parameters such as air temperature, relative humidity, wind speed profile and vertical temperature gradient can significantly influence noise levels at distances of a few kilometres from a source, with wind and vertical temperature gradient being the dominant factors.

The PNCG recommends the following default weather conditions should be modelled:

- A 3°C/100m inversion during the night where inversions occur for at least 30% of the time during winter evenings and nights plus a 2m/s drainage flow from source to receiver where the source is on higher ground than the receiver with no intervening hills; or
- A gradient wind of up to 3 m/s from source to receiver where such a wind occurs for at least 30% of the time in any season or time period.

The closest weather station is near Richmond, approximately 115 km south of the project site. Given this distance, and differences in topography between the project site and Richmond, weather data from Richmond are not directly applicable to the project. The project air quality consultants have therefore calculated atmospheric parameters for a representative 12 month period for the project site, based on 2020 data, using The Air Pollution Model (TAPM) and CALMET to estimate hourly wind speed, wind direction and stability class. Further information regarding this calculation process is provided in the air quality and greenhouse gas assessment report.

4.2.2 Prevailing Winds

Analysis of the CALMET output file to determine the occurrence and direction of prevailing winds was completed by:

- Sorting the data by season and time period (day, evening and night);

- For each season and time period, separating the data into 16 compass directions;
- For each direction, summing the hours in which wind speeds remain in the range 0.5 to 3 m/s and expressing these hours as a percentage of the total time in that season and time period; and
- Reporting the sum of each direction and the four adjoining directions (two either side), as a wind in a particular direction also affects noise propagation to receptors in adjacent directions.

The result of this process is the percentage occurrence of potentially noise enhancing winds in each season, time period and direction, as presented in Table 3. As each reported value is the sum over five adjacent directions, winds in each direction are effectively included in the table five times and the total over all directions per season and time period greatly exceeds 100%. Shaded values exceed 30% and are therefore considered significant enough to require consideration in this assessment.

Values in bold font in Table 3 indicate the wind directions included in the noise model. As a modelled wind direction also affects receptors in adjacent directions, the modelled wind directions adequately cover all shaded values in the table.

Table 3: Percentage Occurrence of Prevailing Winds, CALMET 2020 Data.

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Day				Evening				Night			
	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr
N	27	8	7	11	40	11	9	17	45	16	7	14
NNE	22	15	10	13	57	30	23	38	59	45	21	33
NE	19	20	15	17	57	49	38	52	63	63	33	46
ENE	20	28	21	21	51	61	54	54	67	75	54	49
E	22	36	32	26	51	69	64	56	61	82	73	54
ESE	22	41	39	28	41	69	64	52	27	67	68	45
SE	21	37	36	26	24	48	53	31	13	39	54	26
SSE	19	33	32	23	17	30	39	17	9	21	42	14
S	19	26	26	18	13	16	23	14	4	9	20	10
SSW	15	17	15	14	8	8	11	11	2	2	1	4
SW	12	10	7	9	7	4	6	9	0	1	0	1
WSW	14	7	4	9	5	4	3	6	0	0	0	0
W	22	7	4	10	7	5	1	7	0	0	0	0
WNW	25	6	4	10	15	5	2	8	0	0	0	0
NW	25	6	4	9	25	6	2	9	1	0	0	1
NNW	26	6	4	9	28	7	4	11	9	0	0	2

Further analysis of wind data has been completed to determine the maximum representative wind speed associated with each season, time period and prevailing wind direction. The maximum wind speed is selected as the speed at which the 30% threshold is reached, and is taken as the maximum in all seasons rounded to the nearest 0.5 m/s. Maximum wind speeds at which the 30% threshold is reached are shown in Table 4 for north-easterly and east-south-easterly winds which are considered significant. Shaded values highlight the maximum wind speeds for each time period and wind direction.

Table 4: Representative Maximum Prevailing Wind Speeds, CALMET 2020 Data.

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Day				Evening				Night			
	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr
NE	-	-	-	-	2	2.5	2	2.5	2	2.5	1.5	2
ESE	-	2	2	-	1.5	3	2.5	2.5	-	2.5	2.5	2

For the day period, an east-south-easterly wind is significant in autumn and winter with the 30% occurrence threshold occurring at a wind speed of 2 m/s in both seasons. For the evening period, north-east winds up to 2.5 m/s occur in the autumn and spring seasons while east-south-easterly winds occur up to 3 m/s in autumn. For the night period, north-east winds up to 2.5 m/s occur in autumn and east-south-easterly winds up to 2.5 m/s occur in autumn and winter. These maximum acoustically significant wind directions have been considered in the noise model.

4.2.3 Temperature Inversions

The project air quality consultants provided a summary of the occurrence of stability classes A (extremely unstable) to F (stable) at the project site, indicating stable F class conditions occur for an estimated 37% of the time at the project site. It is therefore apparent that temperature inversion conditions, represented by the F stability class, occur regularly in this area.

Results from further analysis to determine the occurrence of each class during the combined evening and night, in each season, are presented in Table 5.

Table 5: Percentage Occurrence of Stability Class, CALMET 2020 Data.

Season	Summer	Autumn	Winter	Spring	Year
Stability Class	Occurrence of Stability Class, % of Evening and Night Combined				
A	8	4	1	6	5
B	16	18	14	20	17
C	15	17	22	15	17
D	21	11	11	14	14
E	14	8	8	11	10
F	26	43	44	33	37

Table 5 indicates F stability class occurs from 26% of the time in summer to 44% of the time in winter, with an annual average of 37% as reported by the air quality consultants. As F stability class occurs more than 30% of the time in at least one season as indicated by shading in Table 5, temperature inversions occur for a significant percentage of the time and are considered in this assessment.

Stability class F is approximately equivalent to a temperature inversion in the range 2 to 4 °C/100m. Stronger temperature inversions can occur at times, particularly in relatively dry areas such as the project site in the dry season, however would only occur intermittently depending on wind conditions, cloud cover and other factors. A modelled 4 °C/100m temperature inversion is considered representative of atmospheric conditions in this region for the purposes of noise assessment.

A temperature inversion consists of a cold air layer below a layer of warmer air, which causes sound waves to refract down towards the ground which in turn increases received noise levels at distant receptors. The cold air layer can be dissipated by wind and cannot form during the day with the sun heating the ground surface. As cold air is more dense than warm air, the cold air tends to flow towards lower ground and would form a 'drainage flow' following the average direction of the Woolgar River, generally from the north-east. However, as a significant drainage flow height and speed develops, this

flow tends to remove the cold air and causes turbulence which mixes cold air with warmer air. Both of these effects partly inhibit further accumulation of the cold air layer, although the temperature inversion strength and drainage flow depth and speed does tend to increase during the course of an average night.

4.2.4 Weather Conditions Summary

The analysis of weather conditions in this area resulted in the weather parameters shown in Table 6 being considered in this assessment. Representative annual average parameters for air temperature and relative humidity have been included based on summary data supplied by the air quality consultants, although calculated noise levels are not as significantly affected by these parameters.

Table 6: Modelled Weather Conditions, CALMET 2020 Data.

Time	Scenario	Temp, °C	Rel. Humid.	Wind Speed	Wind Dir.	Inversion	Reported
Day	Calm	30	40	0	-	-2	Day Calm
	Wind			2	ESE	-2	Day
Evening	Neutral	25	50	0	-	-	Evening
	Wind			2.5	NE	-	
				3	ESE	-	
				Inversion+Wind	2	NE	
Night	Inversion	15	60	1	NE	4	Night
	Inversion+Wind			2	NE	3	
	Wind			2.5	NE	0	
				2.5	ESE	0	

Predicted noise levels presented in the noise contours in Appendix B and in the results section of this report represent:

- Calm, or neutral, weather conditions for the day;
- Prevailing weather conditions for the day, determined by the outer envelope or maximum noise level of both calm and wind conditions during the day;
- Prevailing conditions for the evening, determined by the outer envelope or maximum noise level of all four sets of conditions during the evening; and
- Prevailing conditions for the night, determined by the outer envelope or maximum noise level of all four sets of conditions during the night.

4.3 Noise Mitigation Measures

Initial noise calculation results indicated the need for noise mitigation measures to achieve compliance with adopted noise criteria at R2 Middle Park, the closest receptor to the project site, particularly in Year 1. The other assessed receptors are located at greater distances from the project site and do not require noise mitigation measures to achieve compliance with the noise criteria. Various mitigation measures were considered including:

- Modifications to individual mining machines to reduce the sound power level produced by each machine;
- Noise barriers, generally in the form of earth bunds, between mining areas and a receptor;
- Management measures including changes to mining methods; and
- Changes to the mining sequence, either within the pits or within the WRDs.

The acoustic effect of each mitigation option was considered along with the practicality and estimated cost of the option. The following noise mitigation strategy has been adopted as the most practical and cost effective set of options:

- Fit effective engine exhaust silencers to all haul trucks, drills and water carts;
- Replace tracked dozers on all WRDs by wheeled dozers, or alternatively operate tracked dozers at moderate engine speed in first gear in reverse during the night period to avoid generating significant track noise at night; and
- Deposit waste rock along the northern and western sides of the northern WRD during the day periods and deposit the waste rock on lower, acoustically shielded ground behind the day-time deposits during the evening and night. The evening and night area must be at least 8 m lower than the day area in the direction of R2 Middle Park to form an effective noise barrier. This strategy will provide a noise barrier for evening and night operation of the northern WRD and will maintain the barrier as the WRD increases in height. This strategy is not required for the central or southern WRDs which will be located significantly further from all receptors.

Predicted noise levels in the following sections were calculated with these mitigation measures in place.

4.4 Operational Noise Sources

Sound power levels produced by proposed mining, ore processing and ancillary noise sources associated with the project are assumed to be similar to noise levels currently produced by equivalent sources on other mine sites in Queensland, with lower sound power levels for trucks, water carts and dozers due to the noise mitigation measures described above. Sound power levels for proposed sources are shown in Table 7, with more detailed spectral data attached to this report in Appendix C. Table 7 also presents the number of sources included in the noise model in each assessed year.

Table 7: Modelled Sound Power Levels.

Source Type		dBL	dBA	Modelled Equipment Numbers		
Description	Height, m			Year 1	Year 5	Year 11
Excavator	4	129	118	3	2	1
Loader	3	127	116	1	1	1
Truck (exhaust silencer)	4	129	116	9	8	5
Dozer D10 (slow reverse)	2	120	117	4	3	2
Dozer D9	2	122	120	1	2	1
Drill (exhaust silencer)	3	126	117	3	2	1
Grader	2	116	109	2	2	1
Water cart (exhaust silencer)	3	121	117	1	1	1
Crusher	3	137	116	1	1	1
MIA	5	135	116	1	1	1
Power generators	2	95	94	1	1	1
Pump (Woolgar River)	1	111	104	1	1	1
Workshop (LAeq,15min) ¹	2	107	108	1	1	1
Workshop (LA1,15min) ²		125	123			

1. The LAeq,15min workshop source sound power level is included for all reported LAeq,15min levels, including noise contour figures B1 to B12 inclusive.
2. The LA1,15min workshop source sound power level is included for all reported LA1,15min levels.

Noise sources were modelled at representative operating locations, with highly mobile sources such as haul trucks distributed over haul roads and mining areas with a focus on sections of road with a significant gradient. Truck sources are therefore primarily located on ramps into and out of the pits and ramps leading to the WRDs, where the trucks travel slowly under full power uphill while loaded. Trucks travelling along relatively flat sections of haul road travel faster, with moderate engine power, therefore produce significantly less noise for a lower proportion of the time from these sections.

Modelled noise source locations are shown on the figures in Appendix A, with the actual source located at the lower left corner of the code text as indicated by a small cross, at a representative height above the ground indicated by the source heights in Table 7.

4.5 Mining Noise Levels

4.5.1 Calculated Noise Levels

Noise levels from the project have been calculated with all noise sources operating normally. The noise model considers three operating years, which were selected for the following reasons:

- Year 1 in which mining is active in the northern BV1 pit and Northern WRD closest to Receptors R1 Barnes' House and R2 Middle Park;
- Year 5 in which mining and waste rock dumping continues in the central section of the project site, representing most of the project's life; and
- Year 11 which includes waste rock dumping to the south-east, albeit with fewer mobile machines towards the end of the project life.

The assessed years include normal operation of the ore processing plant and mining in all pits, therefore collectively representing the worst-case acoustic situation to all receptors near the project.

Noise contour figures B1 to B12 in Appendix B show calculated LAeq,15min noise levels for the day, evening and night periods for each assessed year. A summary of calculated noise levels is shown in Table 8, along with the adopted noise criteria from Table 1.

Table 8: Predicted Project Noise Levels and Noise Criteria, LAeq,15min.

Year	Time Period, Weather Conditions	Receptor			Noise Criteria	Noise Contour Figure
		R1 Barnes' House	R2 Middle Park	R3 Mt Norman		
1	Day Calm	15	28	8	35	B1
	Day Prevailing	15	32	17		B2
	Evening Prevailing	19	34	20		B3
	Night Prevailing	26	35	20		B4
5	Day Calm	12	24	9		B5
	Day Prevailing	12	25	19		B6
	Evening Prevailing	14	30	23		B7
	Night Prevailing	25	31	23		B8
11	Day Calm	8	18	7		B9
	Day Prevailing	8	21	15		B10
	Evening Prevailing	10	26	17		B11
	Night Prevailing	20	26	17		B12

Table 8 indicates predicted noise levels comply with the noise criteria at all receptors and in all time periods.

4.6 Sleep Disturbance

The recommended LA1,15min noise criterion is intended to minimise the potential for sleep disturbance to sensitive places such as residential receptors. The procedure adopted to calculate representative LA1,15min noise levels is described in Section 4.1, with workshop noise levels being the primary difference between LAeq,15min and LA1,15min predicted levels given all other noise sources are assumed to produce maximum noise in the LAeq,15min calculations.

LA1,15min noise contours were calculated for each of the three assessed years, for the most critical night period in which sleep disturbance requires assessment. However, there was little difference in the closest noise contours to the workshop and no appreciable difference to the contours in the vicinity of any receptor, therefore no additional figures have been included in the report. LA1,15min noise levels are predicted to exceed LAeq,15min levels by less than 0.2 dBA at all receptors based on the adopted assessment methodology.

In reality, differences between LAeq,15min and LA1,15min levels would typically be higher than indicated due to the following factors:

- Variations in wind or other atmospheric conditions throughout a typical 15 minute period; and
- Variations in equipment operating locations during a typical 15 minute period. For example, occasional truck bunching on a haul road may result in an increase of a few dBA for part of a period, followed by lower noise levels until the next group of trucks is audible. Truck bunching and other short term variations in mining equipment operation are unlikely to affect average LAeq,15min levels, however can affect LA1,15min levels.

There are a large number of possible variations in equipment operating locations and other factors that may affect LA1,15min noise levels at each receptor, therefore it is impractical to investigate all reasonable possibilities in a noise model. Experience at other mine sites in Queensland indicates LA1,15min levels are typically less than 3 dBA and rarely more than 5 dBA above LAeq,15min levels, within the recommended LA1,15min criterion which is 5 dBA above the LAeq,15min criterion. Therefore, as predicted LAeq,15min noise levels meet the criterion, LA1,15min noise levels would also meet the criterion.

4.7 Low Frequency Noise

Low frequency noise levels, defined in the Low Frequency Noise Guideline as all project noise in the frequency range 10 Hz to 200 Hz, have been assessed using the project noise model in the following configuration:

- Include source sound power levels up to and including the 200 Hz 1/3 octave band, with noise levels in all other frequency bands set to zero. As the noise model itself is limited to the range 25 Hz to 20 kHz, all source noise below the 25 Hz band was included in the 25 Hz band;
- Calculate dBL noise levels to the receptor, rather than the usual dBA noise levels, for comparison with relevant criteria. Calculations were completed for the most critical night period in all assessed years.

Calculated low frequency noise levels in 1/3 octave bands and total levels are presented in Table 9 for the most critical night period. Results are presented for the worst case set of weather conditions indicated in Table 8 for each receptor, which are strong inversion and light wind conditions for all receptors.

Table 9: Predicted Project Noise Levels, Low Frequency, Leq.

Frequency Band, Hz		<25	31	40	50	63	80	100	125	160	200	Total	External Noise Limit
Receptor	Year	Predicted Noise Level, dBL											
R1 Barnes' House	1	41	43	34	33	34	32	37	39	30	26	47	60
	5	41	43	33	32	34	32	37	37	30	26	47	
	11	39	40	29	29	32	29	32	29	25	22	44	
R2 Middle Park	1	48	51	44	44	39	35	38	40	38	39	55	
	5	44	46	39	41	39	34	38	41	34	32	51	
	11	39	42	33	33	30	29	33	36	31	28	46	
R3 Mt Norman	1	44	46	37	34	26	27	31	29	23	23	49	
	5	44	46	36	33	29	33	37	34	26	25	49	
	11	44	46	36	33	24	23	27	27	23	19	48	

Results in Table 9 indicate total low frequency noise levels would remain within the 60 dBL external noise criterion in all assessed years and at all receptors.

4.8 Cumulative Noise

The receptor area around the project site is currently occupied by large rural properties typical of north Queensland. No other industrial developments are known to exist in the area. Predicted cumulative noise levels for all industrial developments are therefore equal to predicted noise levels from the project, as presented in Table 7.

Predicted industrial noise levels would therefore remain below the EPP Noise 2019 acoustic quality objectives and well below the 55 LAeq,15min external criterion recommended in the Health Effects of Environmental Noise for the night period, indicating total industrial noise levels from the project are unlikely to significantly affect the health of the occupants of any receptor near the project.

4.9 Construction Noise

Construction of the project would include earthmoving and other construction activity, primarily associated with ore processing and other infrastructure in the southern section of the project area. Other areas of the project site that would require significant construction work include various surface water control structures and internal haul roads.

4.9.1 Mine Infrastructure Area

Construction of the MIA would include a number of separate phases such as earthmoving to prepare the site, civil work to prepare foundations for buildings, the crusher and similar major items of equipment and mechanical work to install building and ore processing equipment. Other construction phases such as electrical installation rarely produce significant environmental noise compared to prior phases.

The earthmoving fleet is expected to include a number of diesel powered machines including excavators, trucks, loaders, a dozer, graders, rollers and water carts, plus smaller and quieter equipment such as compressors and hand tools. Sound power levels produced by a typical construction fleet include:

Two excavators in the 15 to 30 tonne range	108 dBA each
Two 40 tonne off-highway articulated trucks;	113 dBA each
One backhoe;	106 dBA
One grader;	106 dBA

One sheepfoot roller;	102 dBA
One smooth drum roller;	102 dBA
One road-type water cart	104 dBA
Two skid-steer loaders	102 dBA each
Various smaller machines including light vehicles	110 dBA total
Total assumed construction sound power level	119 dBA

The assumed construction sound power level of 119 dBA for the MIA is equal to the combined sound power level of the crusher and MIA presented in Table 7. Construction noise levels from this section of the project site are therefore unlikely to exceed predicted operational noise levels described in Section 4.4.

Later construction stages for the MIA, such as installation of ore processing equipment and construction of buildings, are expected to require a crane, trucks, compressor and various hand tools including air powered wrenches and angle grinders. The total sound power level of these sources would not exceed 119 dBA as estimated for the earthmoving fleet, therefore this phase of construction is unlikely to produce more noise at receivers than predicted for the operational phase of the project.

4.9.2 Surface Water Control Structures

Surface water control structures include the raw water dam immediately north of the central WRD, various sediment dams adjacent to pits and WRDs and drainage diversions north of the BVS pit and leading to each sediment dam. These structures generally require a small fleet of earthmoving machines such as an excavator, grader and roller. Trucks and a dozer may be required to construct the raw water dam.

A combined sound power level of 116 dBA is expected for this fleet which is less than the sound power level produced by nearby mining equipment during the later operational phase. For example, a mining dozer on the central WRD adjacent to the raw water dam, producing a sound power level of up to 117 dBA including minor track noise, would produce a higher noise level at all receptors than the raw water dam construction fleet. Construction noise levels from this section of the project site are therefore unlikely to exceed predicted operational noise levels described in Section 4.4.

4.9.3 Roads

Haul roads would be constructed between the ore processing area and each pit, and between pits and WRDs. Road construction is expected to require an excavator, dozer, truck, grader and water cart for a combined sound power level of approximately 118 dBA distributed over each road being constructed.

Road construction work would therefore produce less noise than later mining and ore processing.

4.10 Blasting

Blasting is proposed to loosen sections of waste rock and ore for removal by excavator and truck. An average of three to four blasts per week are expected to be required, or one blast every two days on average. Blasts would generally occur on benches below the natural surface and therefore shielded from receptors by the pit walls, although initial mining in each pit would require blasts close to the natural surface after removal of topsoil.

4.10.1 Blast Parameters

A hole diameter in the range 150 to 200 mm and a depth of approximately 10 m is assumed, requiring approximately 200 to 300 kg of explosive material per hole. Each blast event is assumed to include

rows of up to 30 holes fired simultaneously, with delays added to the blast pattern between rows. The Maximum Instantaneous Charge (MIC) would therefore be up to 9000 kg per delay. A range of 4500 to 9000 kg MIC in 1500 kg steps has been considered in this section.

Sufficient stemming material is assumed to be provided above each explosive charge to adequately confine the charge, preventing blowouts and a consequent increase in overpressure and rock size.

4.10.2 Predicted Blast Effects

Blast effects at receptors, including ground vibration and overpressure, depend on the following factors:

- Ground conditions including rock types and layers;
- Groundwater conditions including extent and depth;
- Distance from the blast site to a receptor;
- How well the explosive charges are confined in the holes with stemming material;
- MIC for each blast event;
- Topography between the blast site and receptors; and
- Atmospheric conditions including wind speed, wind direction and vertical temperature gradient at the time of the blast event.

Acoustic blast effects have been calculated using the equations in Appendix J of AS 2187.2:2006. Values of $K = 1000$ and $B = 1.6$ are assumed for the type of rock expected to be encountered in a gold bearing area, although different rock types can have a significantly different effect on ground vibration levels at a receptor. These parameters can be adjusted as site specific blast monitoring results are accumulated during initial mining operations.

Predicted blast effects have been calculated from the closest mining area to each receptor and are shown in Table 10, assuming a well confined charge in each hole with effective stemming material. Calculations include an overpressure correction factor of -5 dB to R1 Barnes' House due to the set of ridgelines existing between all pits and this receptor.

Table 10: Predicted Blast Impacts to Receptors

Receptor	Closest Distance, m	MIC, kg								Residential Criteria, mm/s, dBL
		4500	6000	7500	9000	4500	6000	7500	9000	
		Ground Vibration mm/s				Overpressure dBLpk				
R1	5.3 km	0.9	1.2	1.4	1.6	97 ¹	98 ¹	99 ¹	100 ¹	5, 115
R2	2.5 km	3.6	3.9	N/R ²	N/R ²	112	113	N/R ²	N/R ²	5, 115
R3	11.7 km	0.3	0.3	0.4	0.5	92	93	94	95	5, 115

1 Overpressure levels at R1 have been reduced by 5 dBL to account for topographical shielding.

2 A MIC over 6000 kg is not recommended for the northern pits due to blast impacts to Receptor R2 approaching the criteria.

Table 10 indicates an MIC of up to 6000 kg is expected to produce acceptable blast impacts at all receptors. An MIC above 7500 kg in the northern pits is not recommended as this is predicted to result in blast impacts closely approaching or exceeding the ground vibration criterion of 5 mm/s PPV at R2 Middle Park and to just meet the overpressure criterion of 115 dBLpk at this receptor.

Blasts in the BVS pit, significantly further from R2 Middle Park, are expected to result in lower blast effects and compliance with both ground vibration and overpressure criteria for all assessed MIC values.

A lower MIC can be achieved by one or more of the following methods:

- Reducing the number of holes per delay, either by reducing the total number of holes per blast event or adding additional delays into the blast pattern; or
- Reducing the charge weight per hole, either by reducing the burden and spacing which permits smaller holes or by deck loading the larger holes.

4.11 Aircraft Noise

Given the project site is relatively remote from large population centres, the majority of construction and operational staff are expected to travel to the project site by air. A regular air service is proposed to and from Townsville, which is itself readily accessible by air from other large centres including Cairns and Brisbane.

A new on-site airstrip is proposed to be constructed at the southern end of the project site. The airstrip is proposed to include a runway aligned approximately east to west and approximately 1500 m long, with an aircraft parking and passenger transfer area at the western end of the runway close to the MIA. The following sections describe an assessment of noise from aircraft using the proposed airstrip.

4.11.1 Aircraft and Flight Details

The assessment of aircraft noise levels to identified receptors is based on the following factors:

- The direction of landing and take-off. As all aircraft are expected to fly to and from Townsville which is located directly east of the project site, aircraft are expected to land from the east and take-off to the east. These landing and take-off directions are consistent with the passenger transfer area being located at the western end of the runway;
- Aircraft types. Detailed data regarding exact aircraft types are not currently available, as such details will depend on aircraft available for charter and may vary from time to time. The largest aircraft expected to use the airstrip would be a twin engine turboprop airliner with a capacity of approximately 78 passengers, such as an ATR-72, which is the assumed aircraft type for this assessment;
- The location of each receptor in relation to the runway and the landing and take-off directions, which have been determined from project plans; and
- The aircraft's landing and take-off profiles which affect its height above the ground at various distances from the airstrip. Standard profiles are assumed for the assumed aircraft type.

The factors described above are expected to result in worst case predicted noise levels, as smaller aircraft generally produce less noise per flight.

4.11.2 Aircraft Noise Assessment

This assessment of aircraft noise is based on the relevant sections of AS2021 which includes a large database of aircraft noise levels based on aircraft type and receptor location. Table 3.1(b) in AS2021 includes a detailed list of non-jet aircraft, by manufacturer and model, and indicate equivalent noise level table to consult for each aircraft type. An ATR72-212A is included in this table and indicates the noise data in Table 3.45 on a later page in AS2021 are the most appropriate noise data for this aircraft type.

Table 3.45(a) in AS2021 includes noise levels for this aircraft type during a landing, while Table 3.45(b) includes equivalent data for take-off. The tables require the following information for each receptor:

- The distance along the centreline, labelled *DL* in AS2021, under the aircraft while landing. This distance is measured from the end of the runway on which the aircraft lands, which in this case is the eastern end of the runway;

- The distance along the centreline, labelled *DT* in AS2021, under the aircraft while taking-off. This distance is measured from the end of the runway where the aircraft starts the take-off manoeuvre, which in this case is the western end of the runway. The distances *DL* and *DT* therefore differ by the total length of the runway; and
- The side distance between the receptor and the runway centreline, labelled *DS* in AS2021.

AS2021 generally assumes noise levels are required for receptors that are near to the aircraft flightpaths. For receptors that are beyond the runway, which for this assessment includes receptors generally west of the runway away from the aircraft flightpaths, the noise level tables in AS2021 do not provide data. Noise levels for these receptors will be determined by adopting a *DL* or *DT* distance of zero, assuming noise levels at the receptor would be similar to the noise levels received perpendicular to the runway.

Table 11 presents relevant distances, determined from project plans, and noise levels extrapolated from the relevant tables in AS2021. Where the tables do not extend to the sideline *DS* distance applicable to each receptor, the tabulated noise levels for the appropriate *DL* and *DT* distance were extrapolated based on hemispherical propagation of sound as for an industrial source. For Receptors R2 and R3, as the tables do not extend to negative *DL* and *DT* values, the estimated noise levels were determined by assuming the residence is located perpendicular to the runway and extrapolating the *DS* distance at zero *DL* and *DT* distances.

Table 11: Aircraft Noise Levels, Average Maximum dBA

Receptor	Receptor Distances			Average LA _{max} Noise Level	
	Landing <i>DL</i>	Take-off <i>DT</i>	Sideline <i>DS</i>	Landing	Take-off
R1	4.4 km	6.0 km	8.3 km	33	40
R2	-0.8 km	0.8 km	6.9 km	28	38
R3	-12.2 km	-10.6 km	1.9 km	23	32

Table 11 indicates an average maximum noise level of 33 LA_{max} during a landing and 40 LA_{max} during a take-off at Receptor R1 Barnes' House, with lower noise levels at the other receptors. Predicted aircraft noise levels are therefore well below the recommended average maximum noise level of 90 dBA determined in Section 3.5 of this report.

5 CONCLUSION

The results of this assessment indicate the project would produce acceptable environmental noise levels at all receptors during all time periods provided relatively minor noise and blasting mitigation measures are included in the project. Noise mitigation measures including engine exhaust silencers for trucks, drills and water carts, slow dozer reverse speed at night and different day and evening/night waste rock dumping areas within the northern WRD are discussed in Section 4.3.

Noise levels during the construction phase are predicted to be acceptable at all receptors, particularly during the day but also during the evening and night if construction work continues into these time periods.

Blast impacts are predicted to be acceptable and well below relevant ground vibration and overpressure criteria at all receptors. A limit of 6000 kg MIC is recommended for blasting in the northern pits close to R2 Middle Park to minimise the chance of exceeding relevant ground vibration and overpressure criteria, as discussed in Section 4.10.

Aircraft noise levels are predicted to remain well below relevant criteria.

Based on the results of this assessment, the project can operate within relevant criteria with relatively minor noise and blasting mitigation and management measures in place.

6 REFERENCES

- Environmental Protection Act 1994* (Qld, 1994) (EP Act 1994);
- Planning for Noise Control Guideline* (EPA now DETSI, July 2004) (PNCG);
- Draft Ecoaccess Guideline for the Assessment of Low Frequency Noise* (EPA now DETSI, November 2004) (Low Frequency Noise Guideline);
- Noise Measurement Manual* (EHP now DETSI, 2013);
- Australian Standard 1055:2018 Acoustics – Description and measurement of environmental noise* (Standards Australia, 2018) (AS1055);
- The health effects of environmental noise* (Commonwealth of Australia, 2018);
- The Environmental Protection (Noise) Policy 2019* (Qld, August 2019) (EPP Noise 2019);
- Environmental Protection Regulation 2019* (Qld, September 2019);
- Model mining conditions* (ESR/2016/1936 DETSI, 2016 [last revised 2024]);
- Noise and vibration from blasting* (Qld Department of Environment and Science now DETSI, January 2016).
- Australian Standard 2021:2015 Acoustics – Aircraft noise intrusion, Building siting and construction* (Standards Australia, 2015).

APPENDIX A – NOISE SOURCE LOCATION FIGURES

FIGURE	DESCRIPTION
A1	Entire modelled area (including mining area in year 1)
A2	Noise source locations, year 1
A3	Noise source locations, year 5
A4	Noise source locations, year 11

A description of noise sources represented by each code shown with the noise source location figures. Source sound power levels and elevation above ground are presented in Appendix C.

Figure A1: Entire Noise Model Calculation Area

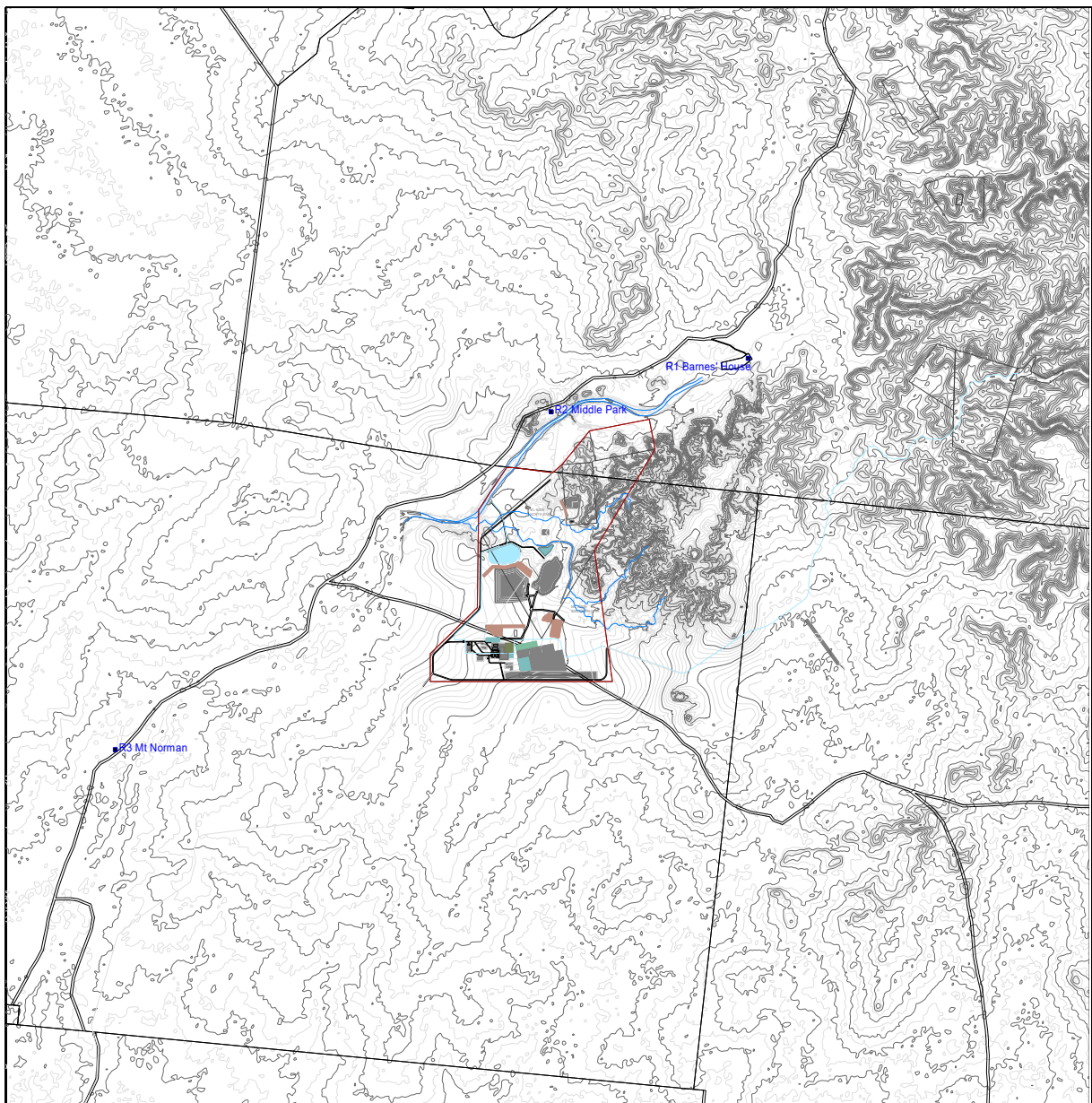


Figure A1 indicates the entire calculation area, approximately centred on the project area. The calculation area is 28.8 km east to west and 28.5 km north to south and includes all potentially affected receptors.

Figure A2: Noise Source Locations, Year 1

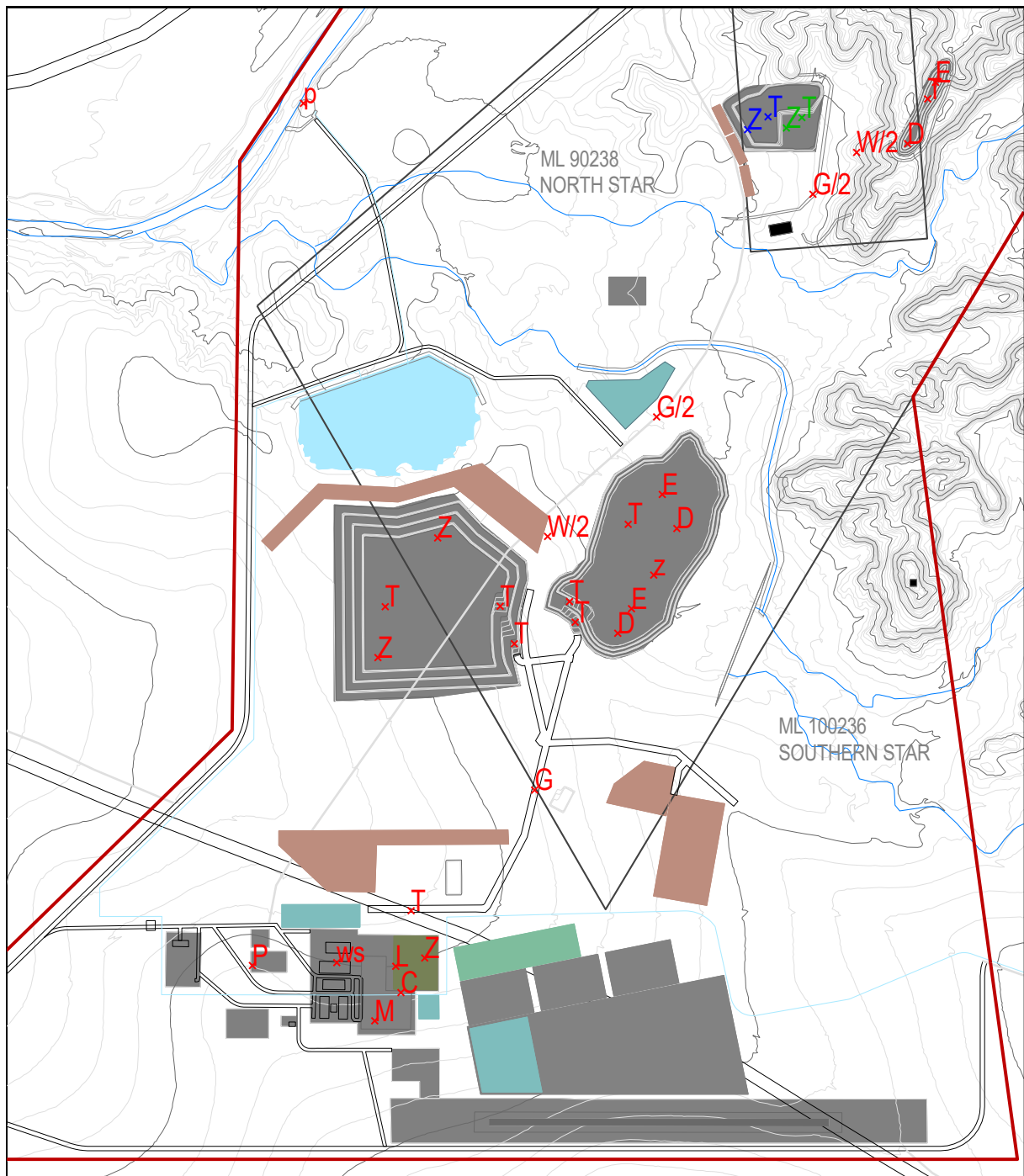


Figure A2 indicates the modelled locations of all noise sources in Year 1, with the small cross at the lower left corner of each source text indicating the exact location of the source. The source codes indicate:

E	Excavator	G	Grader	ws	Workshop
L	Loader	W	Water cart	/2	50% of noise at that location
T	Truck	C	Crusher	Red	Day/evening/night
Z	Dozer (D10)	M	Process equipment	Blue	Day only
z	Dozer (D9)	P	Power generators	Green	Evening/Night only
D	Drill	p	Pump (Woolgar River)		

Figure A3: Noise Source Locations, Year 5

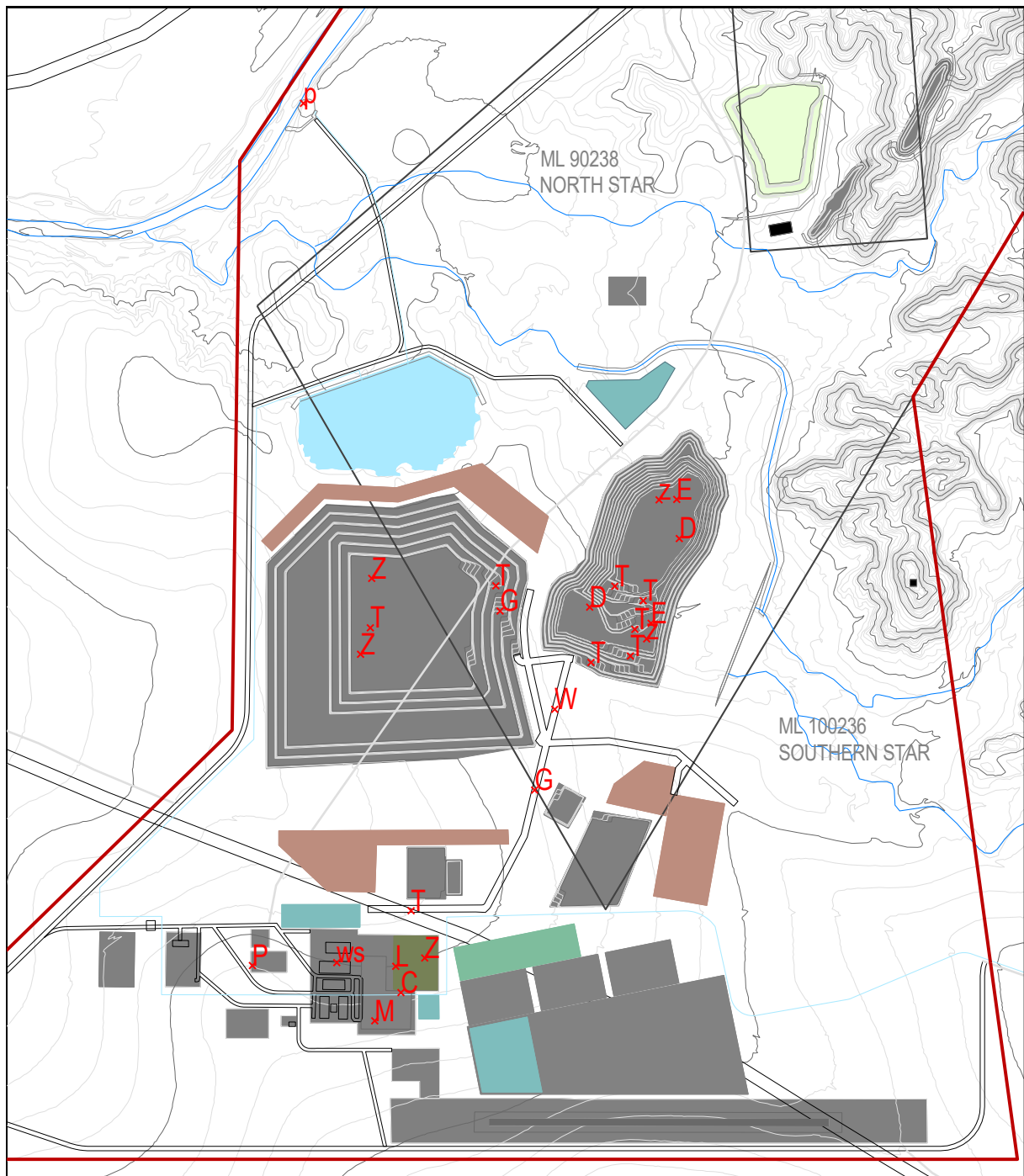


Figure A3 indicates the modelled locations of all noise sources in Year 5, with the small cross at the lower left corner of each source text indicating the exact location of the source. The source codes indicate:

E	Excavator	D	Drill	M	Process equipment
L	Loader	G	Grader	P	Power generators
T	Truck	W	Water cart	p	Pump (Woolgar River)
Z	Dozer (D10)	C	Crusher	ws	Workshop
z	Dozer (D9)				

Figure A4: Noise Source Locations, Year 11

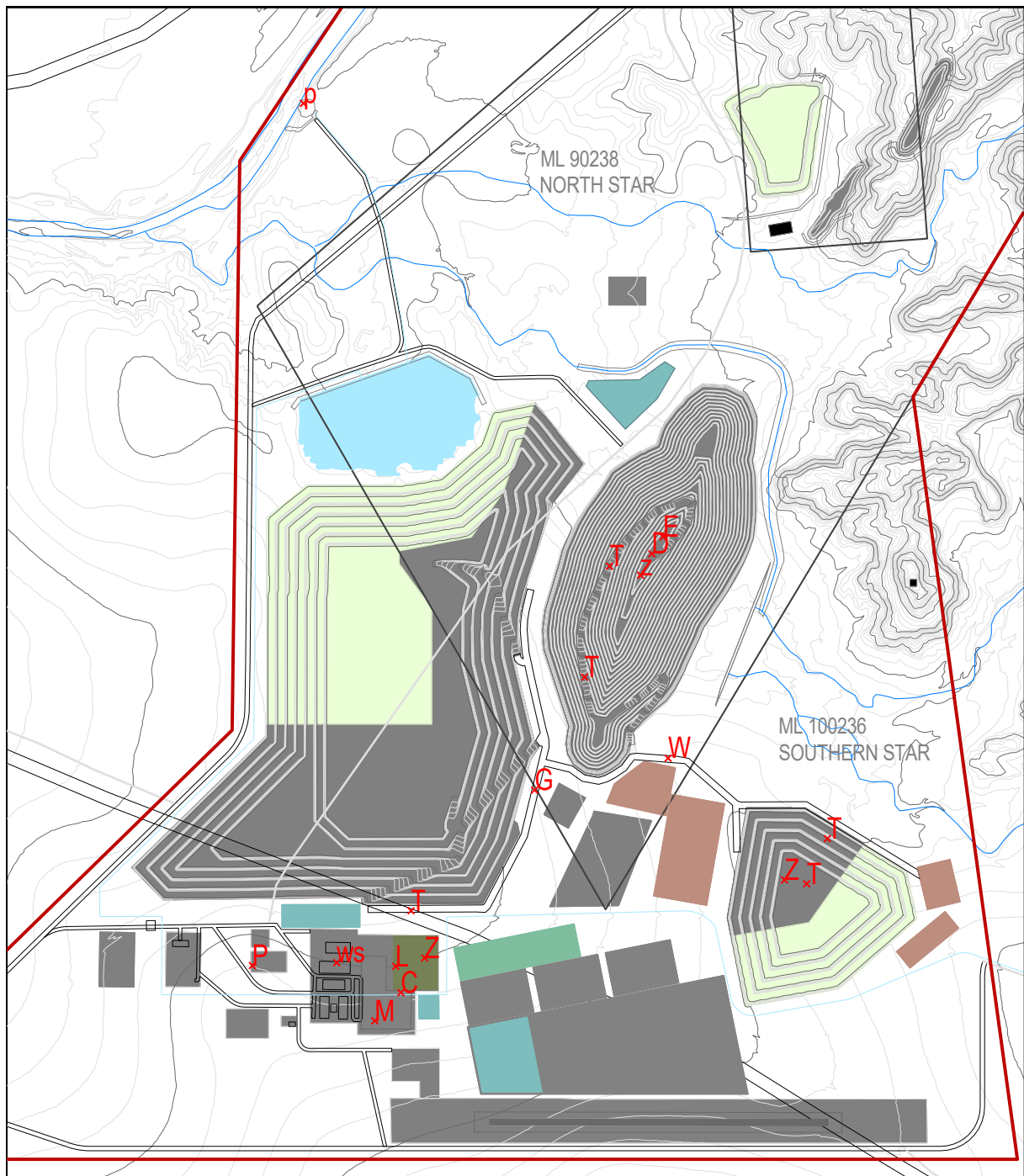
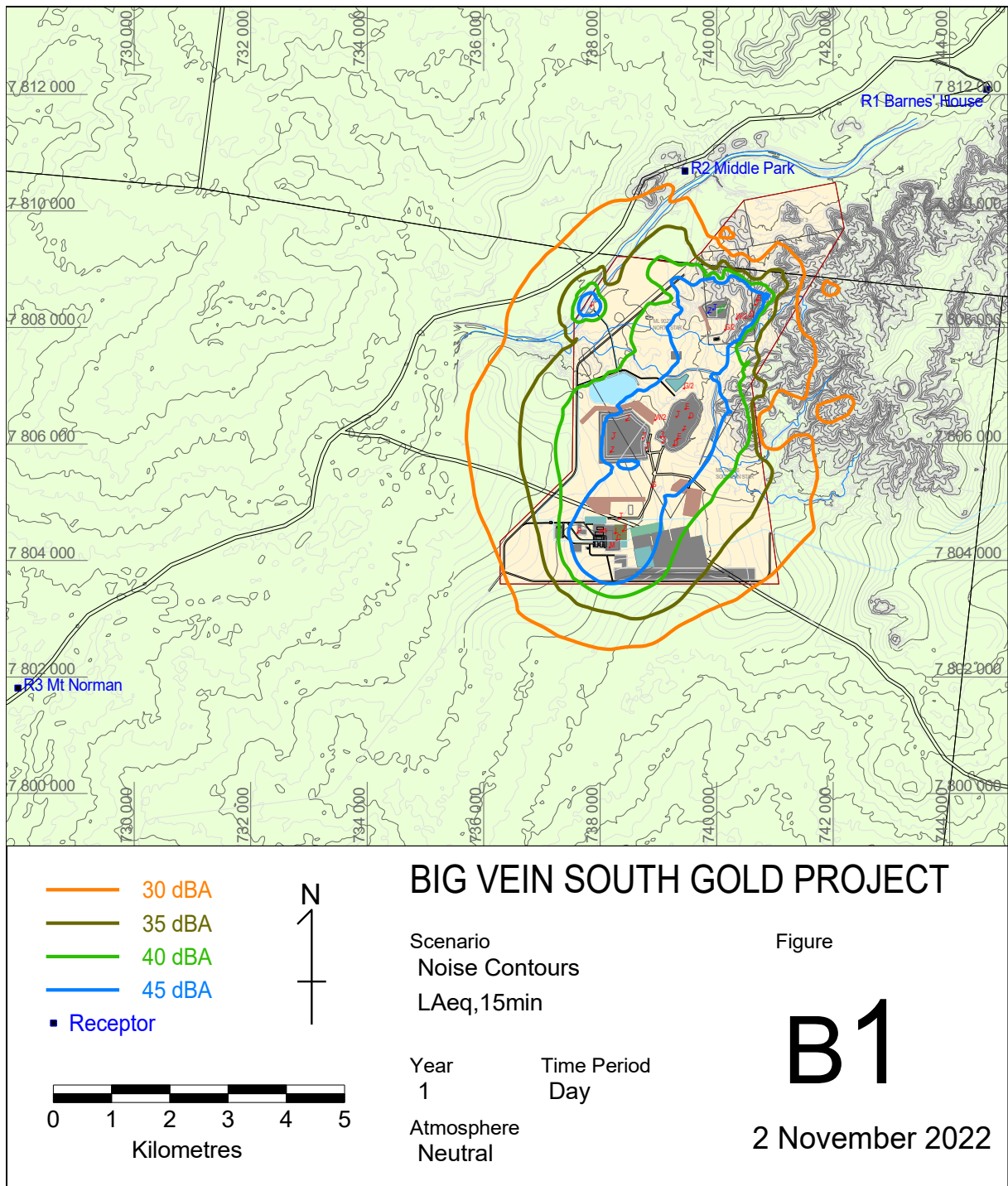


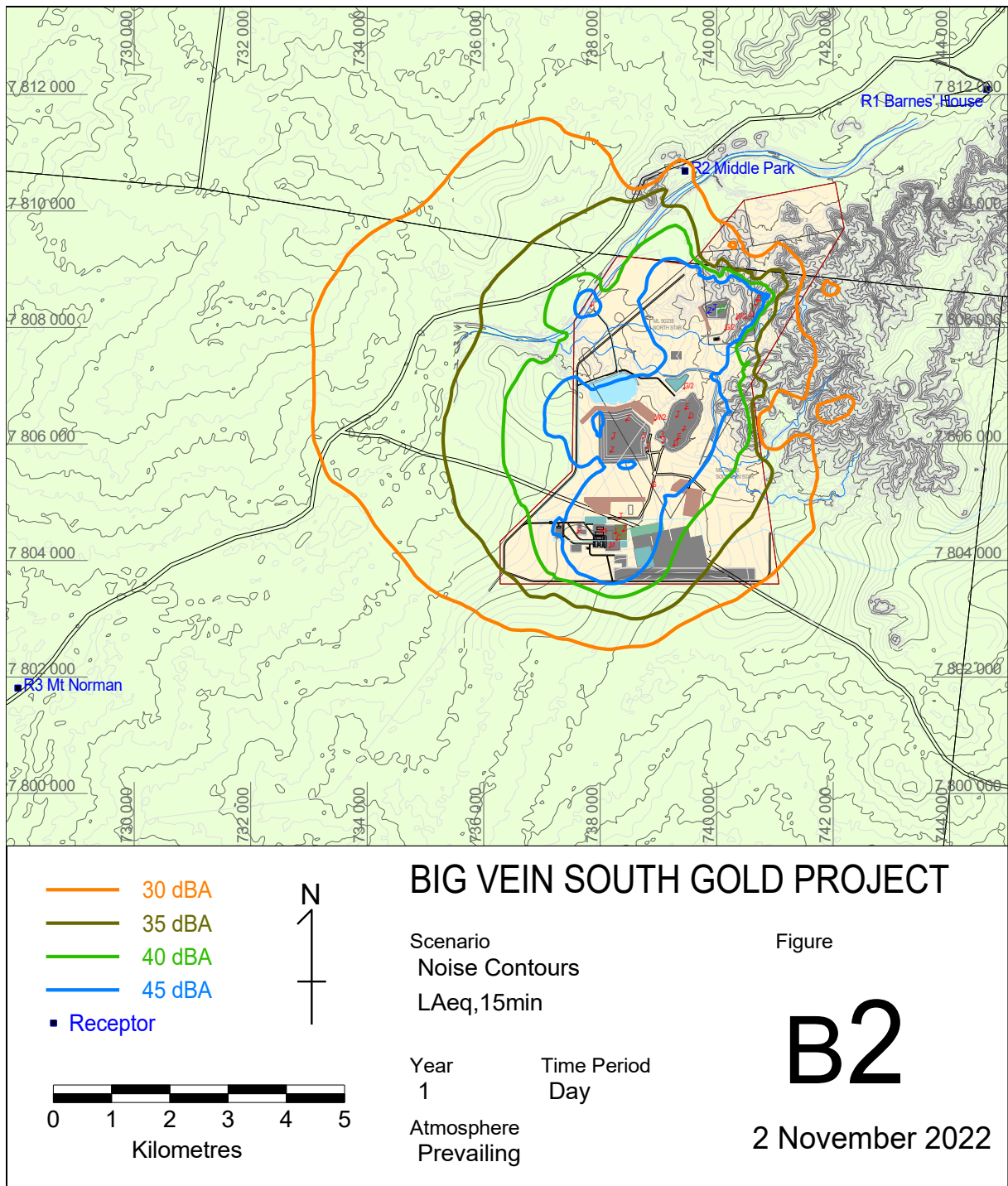
Figure A4 indicates the modelled locations of all noise sources in Year 11, with the small cross at the lower left corner of each source text indicating the exact location of the source. The source codes indicate:

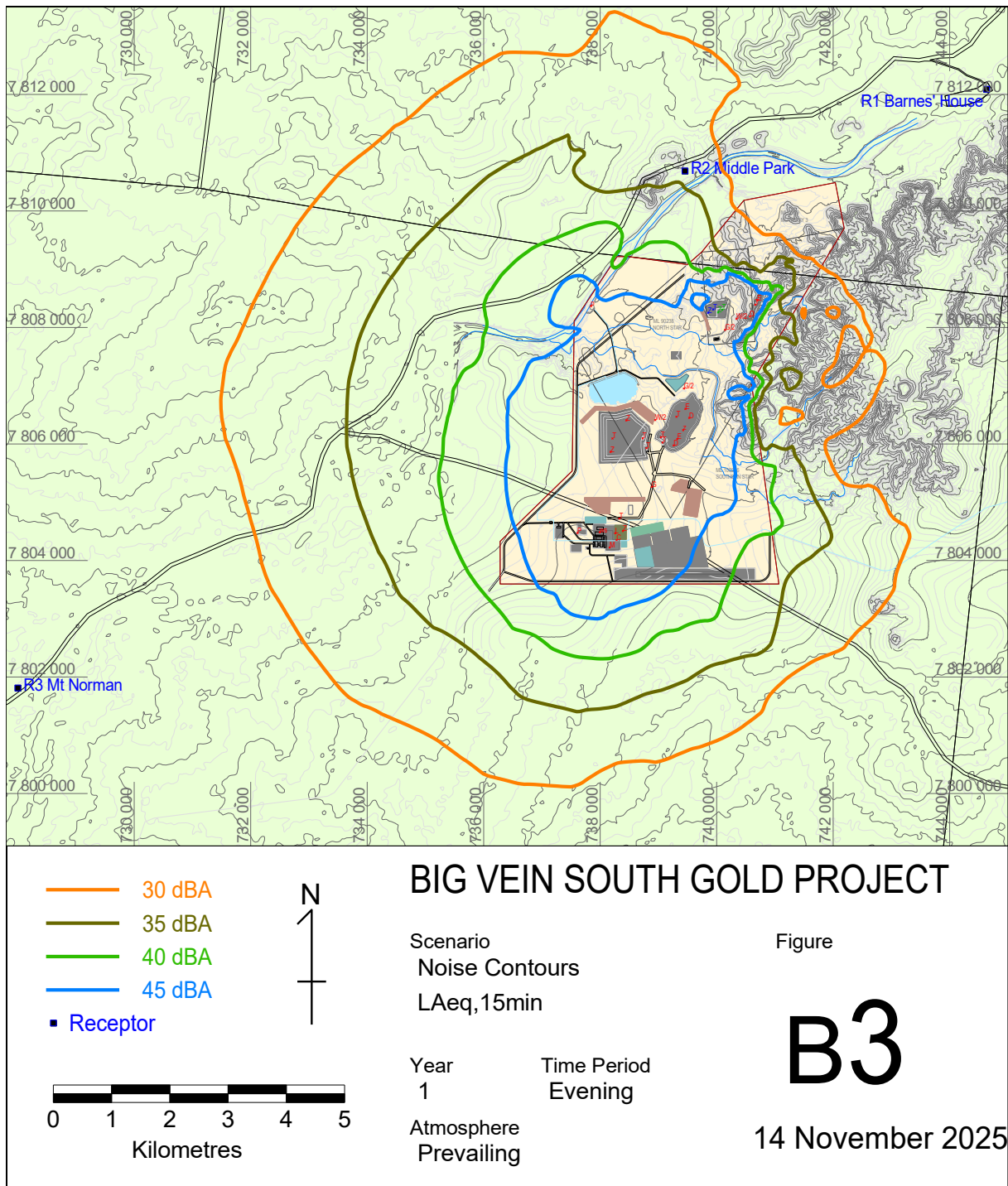
E	Excavator	D	Drill	M	Process equipment
L	Loader	G	Grader	P	Power generators
T	Truck	W	Water cart	p	Pump (Woolgar River)
Z	Dozer (D10)	C	Crusher	ws	Workshop
z	Dozer (D9)				

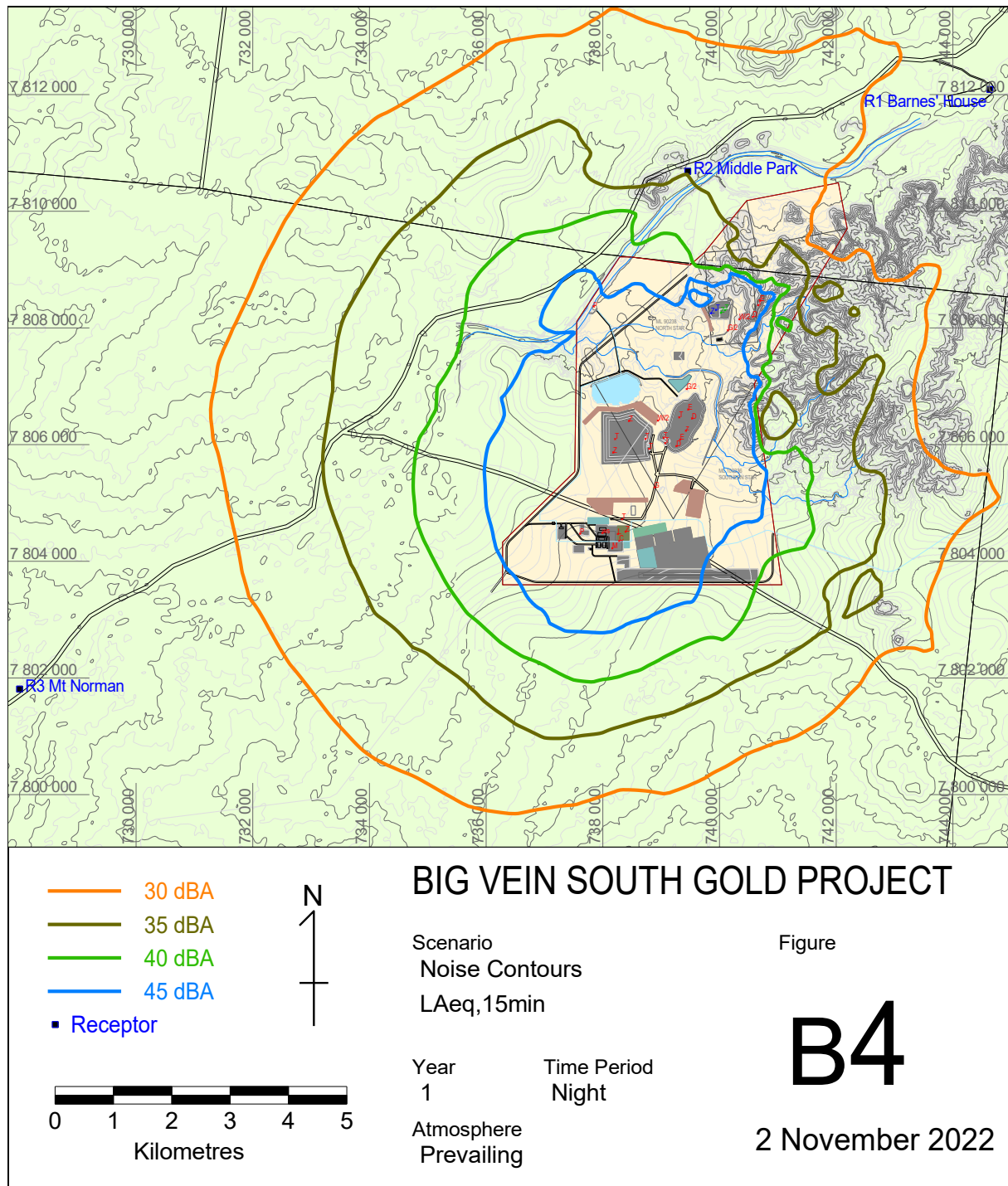
APPENDIX B – NOISE CONTOUR FIGURES

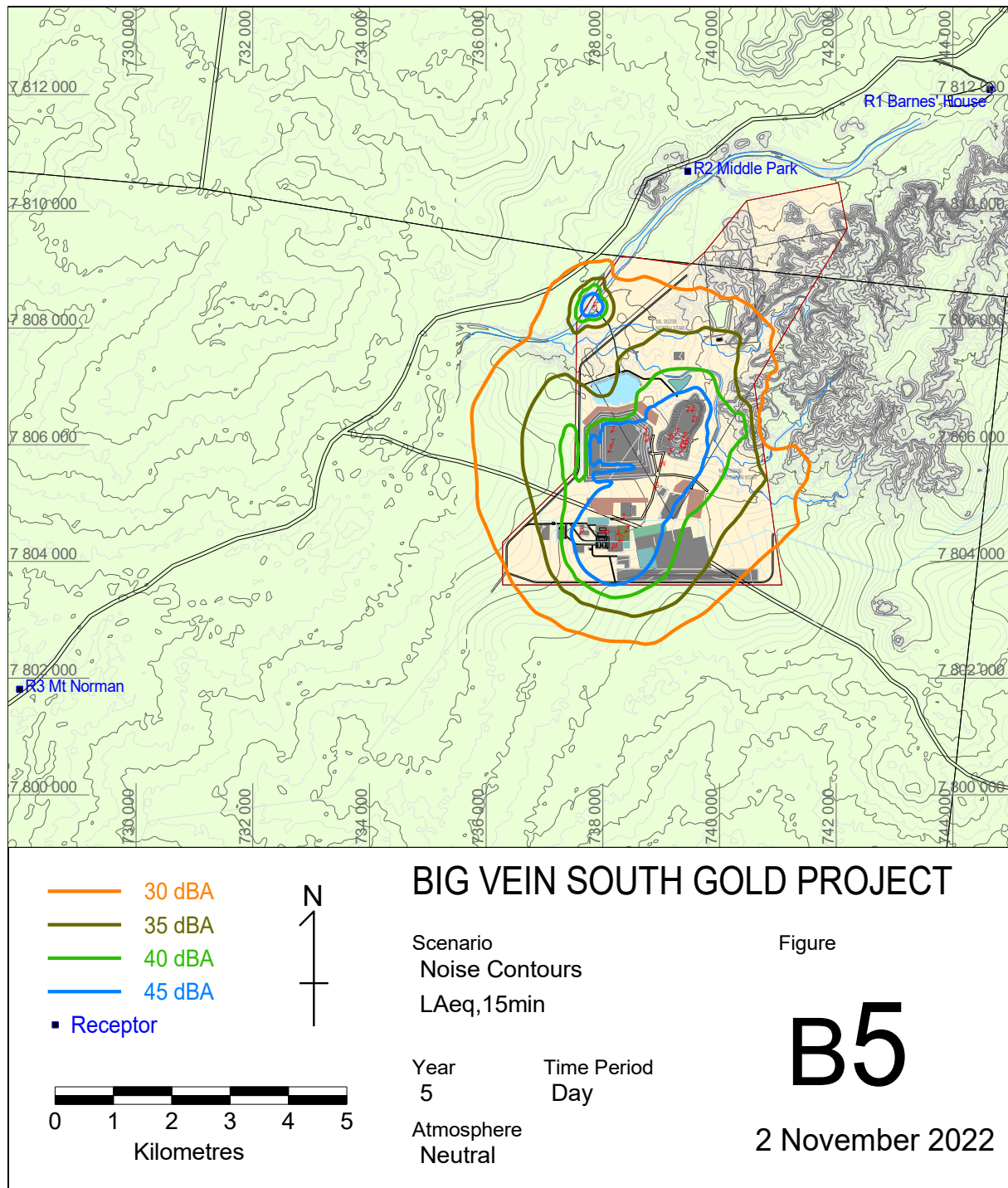
FIGURE	DESCRIPTION
B1	Noise contours, Year 1, Day, Calm conditions
B2	Noise contours, Year 1, Day, Prevailing conditions
B3	Noise contours, Year 1, Evening, Prevailing conditions
B4	Noise contours, Year 1, Night, Prevailing conditions
B5	Noise contours, Year 5, Day, Calm conditions
B6	Noise contours, Year 5, Day, Prevailing conditions
B7	Noise contours, Year 5, Evening, Prevailing conditions
B8	Noise contours, Year 5, Night, Prevailing conditions
B9	Noise contours, Year 11, Day, Calm conditions
B10	Noise contours, Year 11, Day, Prevailing conditions
B11	Noise contours, Year 11, Evening, Prevailing conditions
B12	Noise contours, Year 11, Night, Prevailing conditions

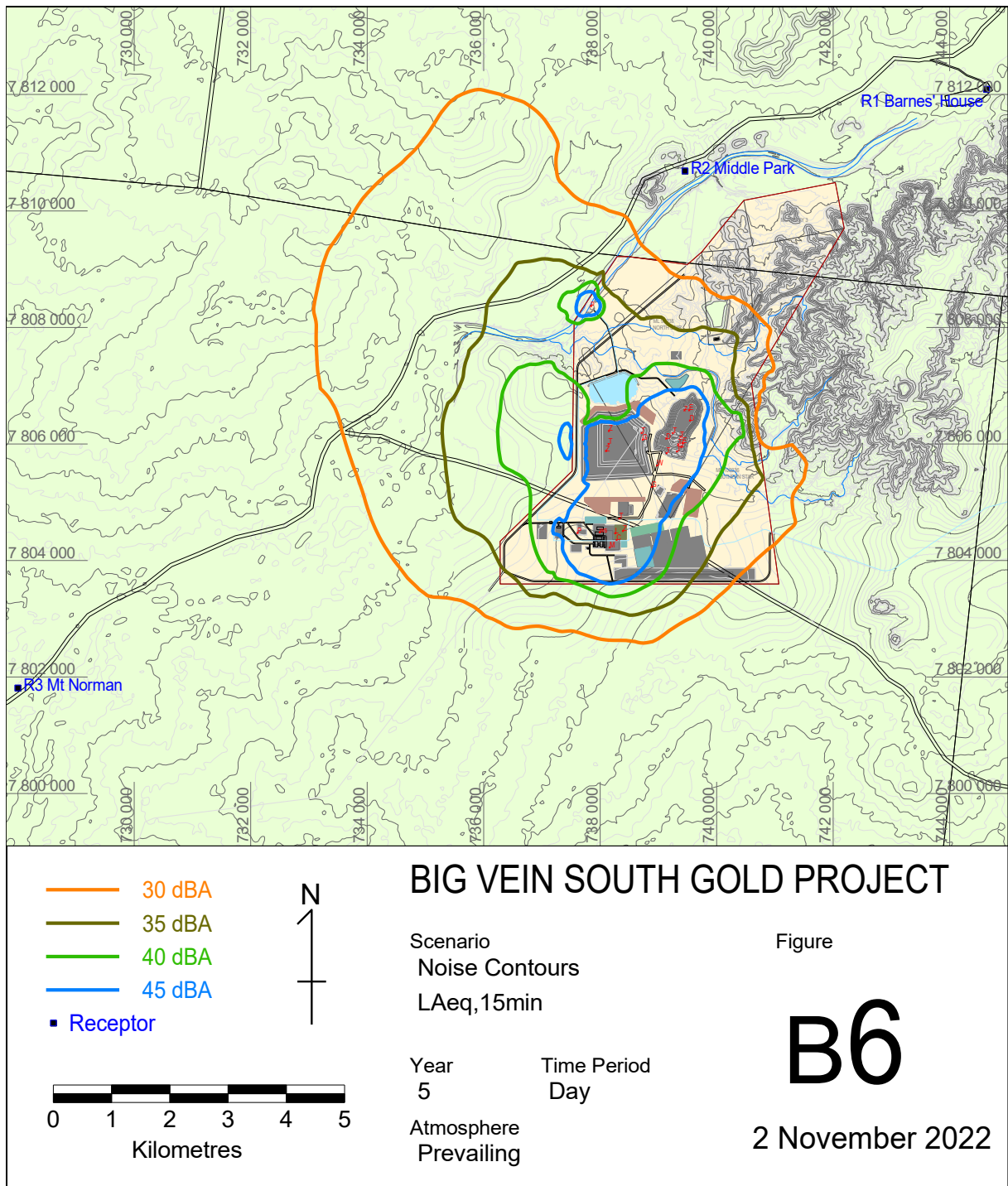


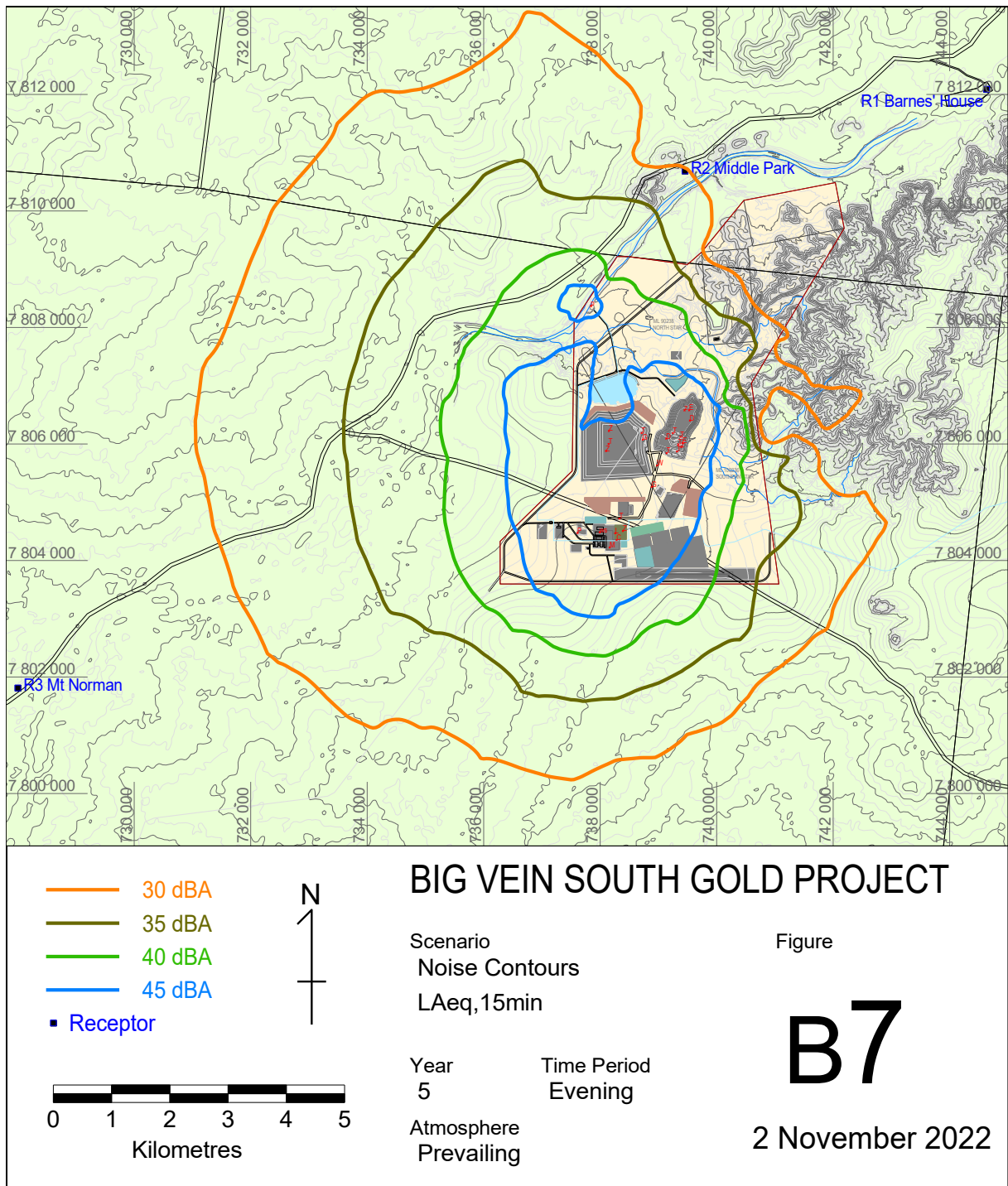


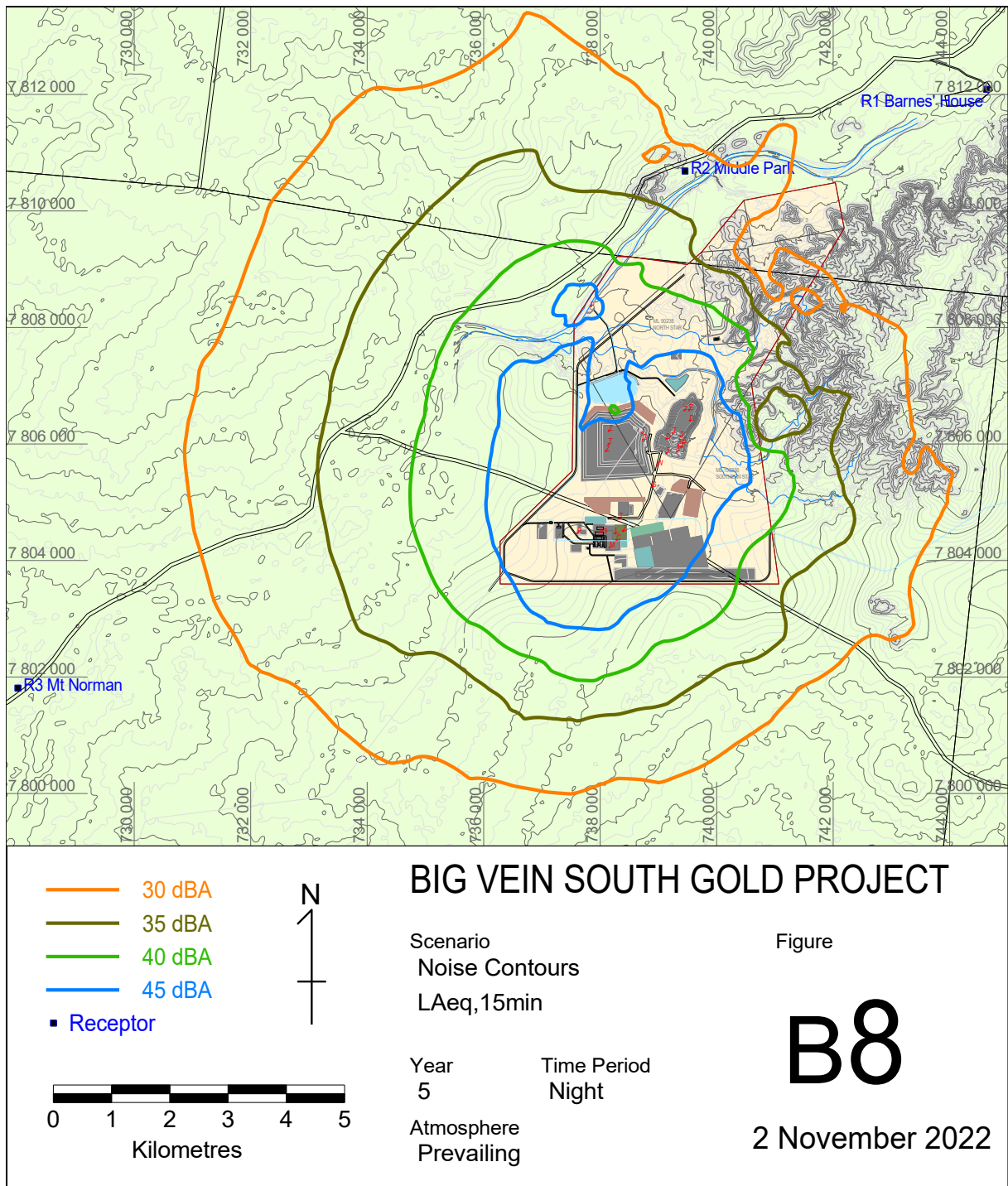


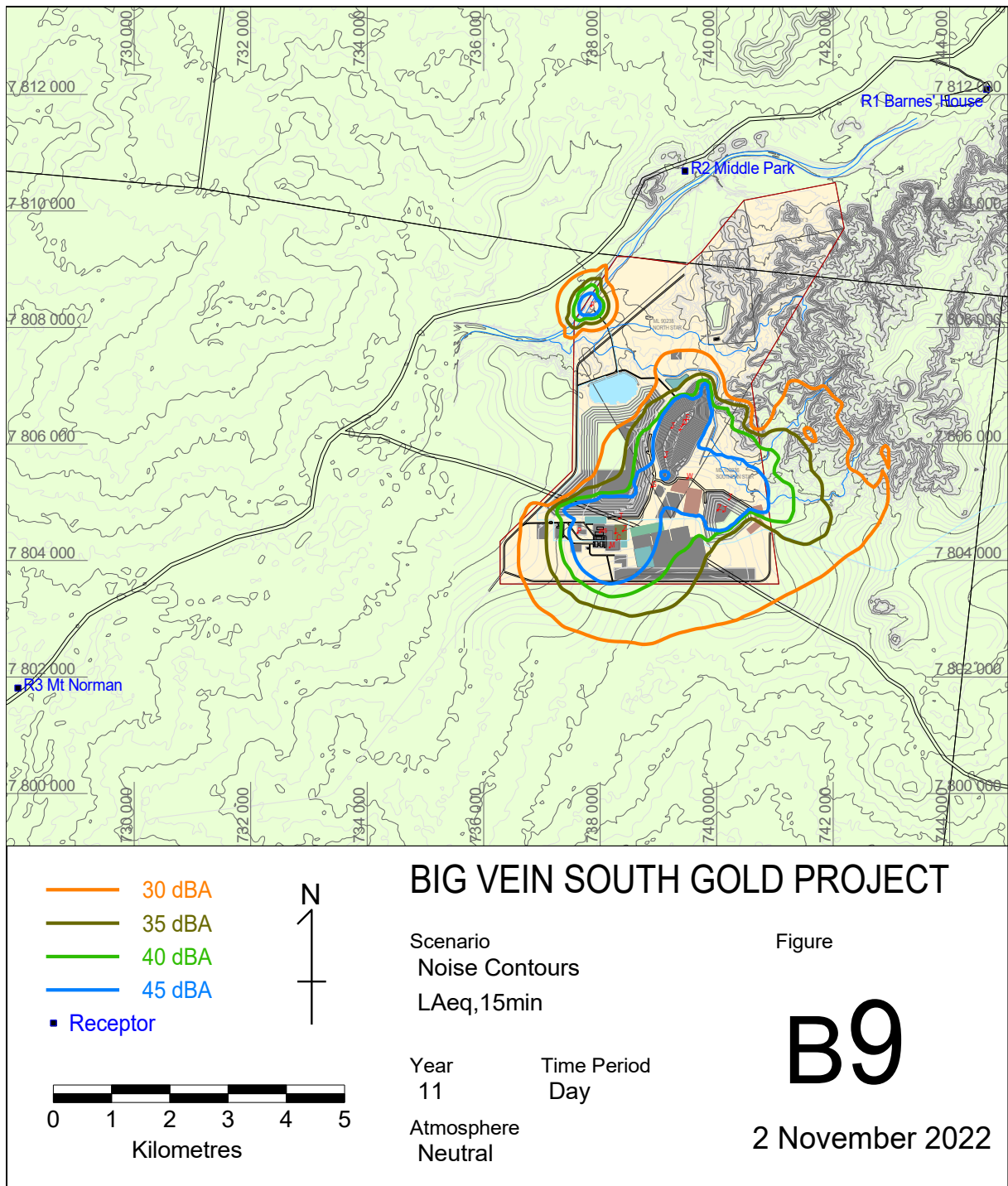


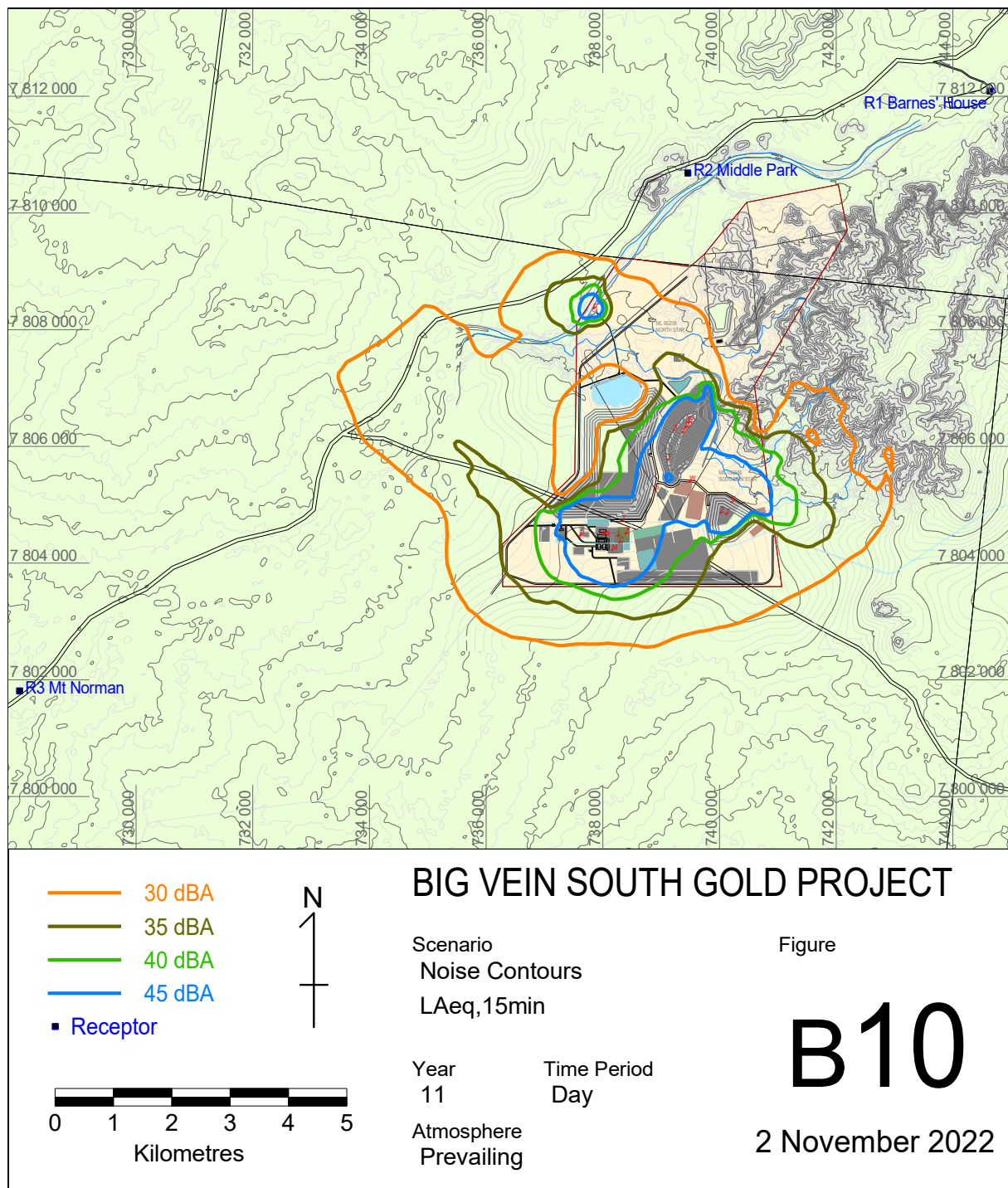


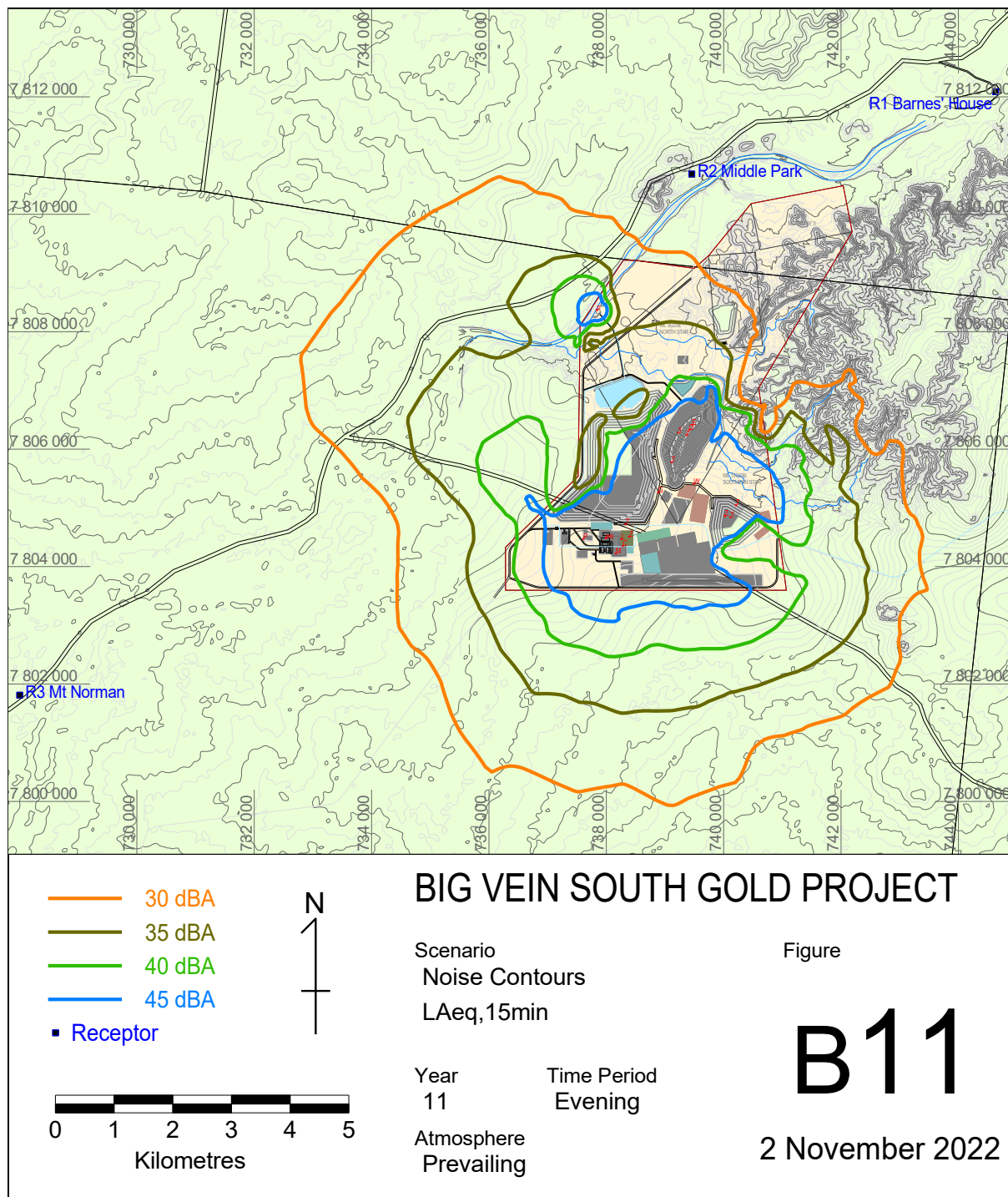


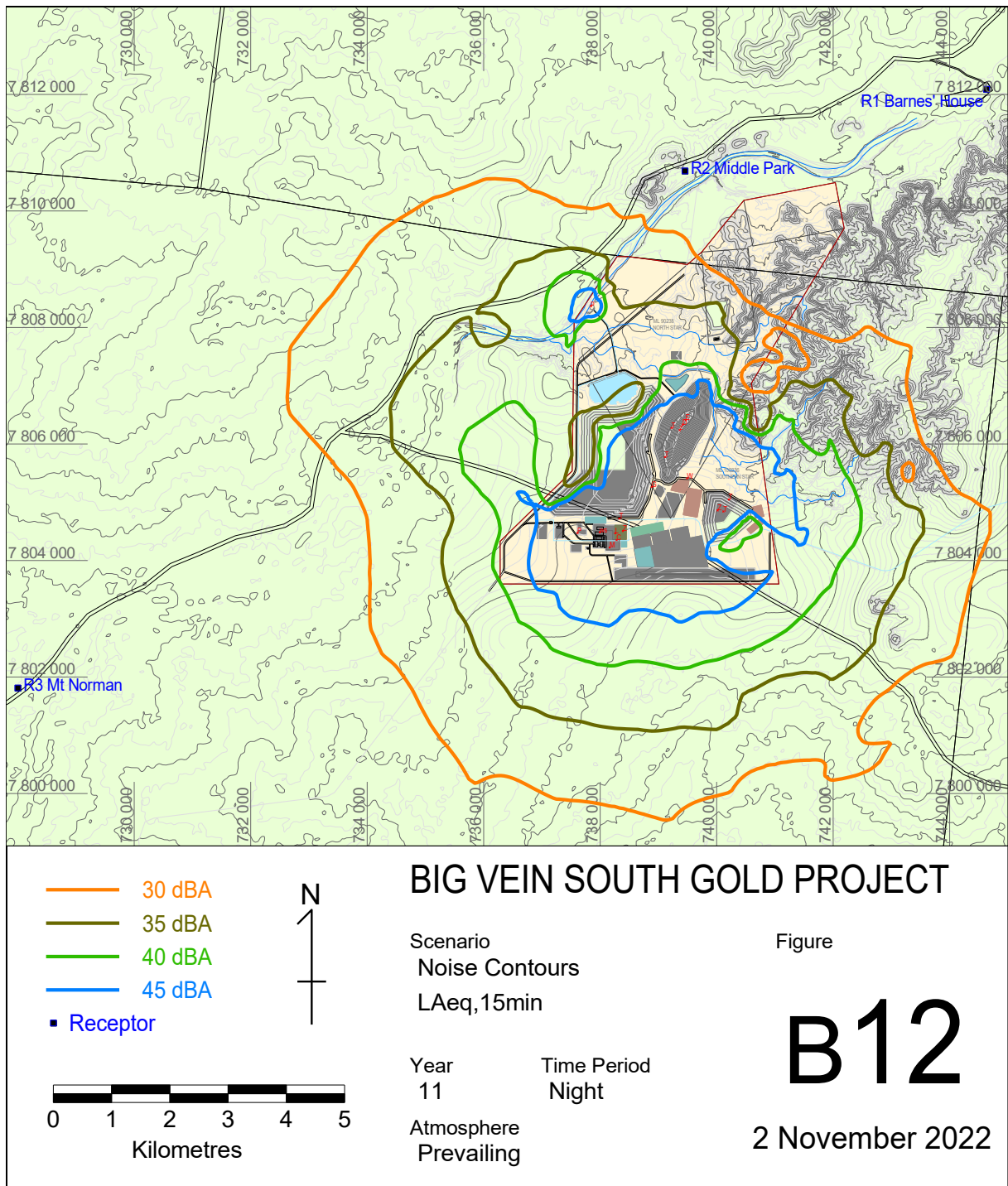












APPENDIX C – SOURCE SOUND POWER LEVELS

Code, Description	Elev, m	1/3 Octave Band Centre Frequency, Hz									Total	
		25 31.5 40	50 63 80	100 125 160	200 250 315	400 500 630	800 1000 1250	1600 2000 2500	3150 4000 5000	6000 8000 10000		
		Sound Power Level, dBL, per 1/3 Octave Band									dBL	dBA
E, Excavator	4	115 117 122	120 118 123	122 109 109	105 104 110	112 110 108	107 108 107	110 106 105	102 100 98	94 90 84	129	118
L, Loader	3	104 107 107	108 109 114	120 118 120	119 114 115	106 102 104	102 102 103	102 100 100	97 95 94	90 90 85	127	116
T, Truck	4	118 123 117	121 120 111	116 121 113	110 111 108	109 108 107	106 106 105	104 103 102	101 98 96	93 90 88	129	116
Z, Dozer D10	2	95 95 95	96 96 99	111 101 103	113 100 100	111 108 112	109 106 105	105 104 102	102 101 102	96 94 93	120	117
Z, Dozer D9	2	98 99 98	99 101 102	112 104 105	114 103 105	112 111 113	110 109 107	109 108 106	107 104 105	99 96 95	122	120
D, Drill	3	107 104 102	103 110 117	122 112 111	118 106 104	107 106 107	107 107 107	107 105 103	100 100 98	94 92 89	126	117
G, Grader	2	93 94 92	97 101 105	111 101 101	109 102 102	101 100 100	101 99 98	97 97 96	94 92 88	86 82 79	116	109
W, Water Cart	3	102 102 101	103 101 111	112 104 114	111 107 102	105 109 105	106 107 106	110 104 102	102 98 96	96 97 90	121	117
C, Crusher	3	126 130 123	120 116 116	116 114 114	110 108 109	109 111 109	108 106 105	104 103 101	100 97 94	91 88 85	137	116
M, MIA	5	123 123 114	118 110 114	111 111 111	111 109 108	108 107 107	107 107 106	105 104 103	102 100 98	96 93 90	135	116
P, Power Generators	2	47 49 59	62 66 70	75 77 83	81 79 82	83 81 85	86 86 87	86 83 80	76 74 71	70 67 60	95	94
P, Pump	1	88 89 87	92 96 100	106 96 96	104 97 97	96 95 95	96 94 93	92 92 91	89 87 83	81 77 74	111	104
ws, ¹ Workshop LAeq,15min	2	64 70 70	71 73 71	71 73 73	75 77 81	85 86 85	89 89 95	96 96 99	101 97 97	93 90 89	107	108
ws, ² Workshop LA1,15min	2	77 77 79	80 80 93	95 96 104	107 114 114	118 117 116	115 113 114	112 110 109	105 102 98	95 93 92	125	123

1. The LAeq,15min workshop source sound power level is included for all reported LAeq,15min levels, including noise contour figures B1 to B12 inclusive.
2. The LA1,15min workshop source sound power level is included for all reported LA1,15min levels.