BARALABA SOUTH PROJECT

NOISE and VIBRATION IMPACT ASSESSMENT

PREPARED FOR
Baralaba South Pty Ltd

21 November 2023

aarc
ENVIRONMENTAL SOLUTIONS

BRISBANE OFFICE
164 Wharf Street
Spring Hill QLD 4000
P +61 7 3217 8772

E info@aarc.net.au
AARC.NET.AU

ABN. 71 620 818 920
ACN. 620 818 920

Document Control

Project Name:	**Baralaba South Project**
Report Title:	Noise and vibration impact assessment
Client:	Baralaba South Pty Ltd
Project Manager:	Stephen Pugh

Version	Comments	Author	Reviewer	Date
Draft issued for client review		SP	EB	23 October 2023
Revised draft issued for client review		SP	EB	2 November 2023
Final issued to client		SP	EB	21 November 2023

Table of Contents

List of Figures

List of Tables

1 Introduction

The proponent for the Baralaba South Project (the Project) is Baralaba South Pty Ltd (ACN 603 037 065) (formerly Mount Ramsay Coal Company Pty Ltd and Wonbindi TLO Holdings Pty Limited). The proponent is a privately owned Australian metallurgical coal company; and a wholly owned subsidiary of Baralaba Coal Pty Ltd (Baralaba Coal Company). Baralaba Coal Pty Ltd is majority owned by the AMCI Group.

The proposed Project will be a transition of the existing operations at nearby Baralaba Coal Mine. The Project is located to the south of the Baralaba township, within the Bowen Basin in central Queensland.

The purpose of this report is to assess potential noise and vibration impacts of the Project. This report addresses noise and vibration from the Project in accordance with the Terms of Reference (ToR) (dated 19 July 2017), and relevant regulatory requirements, guidelines and Australian Standards.

The requirements of the ToR are included in Table 1 along with the relevant report sections. This report is to be included in the Environmental Impact Statement (EIS) for consideration by Queensland Department of Environment and Science (DES).

Table 1: Baralaba South Project Terms of Reference review

Relevant Terms of Reference	**Section of this report**
8.6.1 Fully describe the characteristics of the noise and vibration sources that would be emitted when carrying out the activity (point source and general emissions). Noise and vibration emissions (including fugitive sources) that may occur during construction, commissioning, upset conditions, operation and closure should be described.	Section 2.3 – Construction, commissioning, upset conditions and closure are reviewed. Sections 6.3 to 6.6 – Operational noise sources and equipment numbers are detailed. Section 7 – Vibration sources (blasting) are addressed.
8.6.2 Predict the impacts of the noise emissions from the activity on the environmental values of the receiving environment, with reference to sensitive receptors, using recognised quality assured methods. Taking into account the practices and procedures that would be used to avoid or minimise impacts, the impact prediction must address the: • activity's consistency with the objectives; • cumulative impact of the noise with other emissions of noise associated with existing development and possible future development (as described by approved plans); and • potential impacts of any low-frequency (<200 Hz) noise emissions.	Sections 6.4 to 6.7 – Noise modelling and assessment Section 6.7 – Low frequency noise assessment Section 6.8.2 – Cumulative noise impacts Section 7 – Vibration calculations and assessment
8.6.3 Describe how the proposed activity would be managed to be consistent with best practice environmental management for the activity. Where a government plan is relevant to the activity, or the site where the activity is proposed, describe the activity's consistency with that plan	Sections 6.3 to 6.6 – Describes how equipment noise levels and quantities are to be managed Section 6.8.1 – Describes how noise levels are to be managed through noise monitoring and noise mitigation.
8.6.4 Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed.	Section 6.8.1 – Describes noise monitoring and management requirements.

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

2 Project background

The Project represents a greenfield coal mine development opportunity, located approximately 8 km south of Baralaba and 115 km inland from Rockhampton, in the lower Bowen Basin region of Central Queensland. The site location is shown in Figure 1. The Project objective is to develop an open cut, metallurgical coal resource for export of a low volatile pulverised coal injection (PCI) product to the steel production industry.

North of Baralaba town is the existing operating Baralaba Coal Mine. It is proposed that Baralaba Coal Mine will be winding down when the Project is ramping up, such that total annual coal production of the two mines is similar to the peak annual coal production of either individual mine, and therefore coal production remains relatively steady across this time period.

The Project would extract up to 2.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal to produce pulverised coal injection (PCI) coal for international export to the steel production industry over a life of approximately 23 years. Mining activities are to be undertaken within the area of Mining Lease Application (MLA) 700057, which covers a total of 2,214 ha.

Open-cut coal mining activities would target the Baralaba Coal Measures, including the basal sub-unit Kaloola Member, where the structural dip of the Permian geology brings them to or near the surface within MLA 700057. The total resource targeted comprises approximately 49 Mt of ROM coal estimated to produce approximately 36 Mt of PCI product coal over the 23 year operating life of the Project. Overburden and interburden will be disposed of in out-of-pit dumps located contiguous with the pit excavation, and in-pit dumps as part of ongoing progressive rehabilitation behind the advancing operations.

A conventional Coal Handling and Preparation Plant (CHPP) would be constructed at the Project site for coal washing. Dry disposal of tailings and reject material is proposed within the dumps. Process waste water will be recovered for recycling through the plant. Other associated infrastructure would include offices, crib rooms, warehouse, workshops, wash down bay, refuelling facility, electricity transmission lines (ETLs) and communication facilities.

Coal would be transported via road trains along the existing Baralaba Mine Coal haul route, approximately 40 km by public road south to the existing train load-out (TLO) facility located 2 km east of Moura. Noise emissions from this haul route are assessed in a separate noise report provided with the EIS. Product coal would then be transported by rail to the Port of Gladstone for export to international markets.

Project development requires realignment of a 4.5 km section of the Moura Baralaba Road from within the ML application area. The preferred route for the Banana Shire Council road is directly east of the MLA boundary, selected to minimise impacts to landholders, road users and the environment.

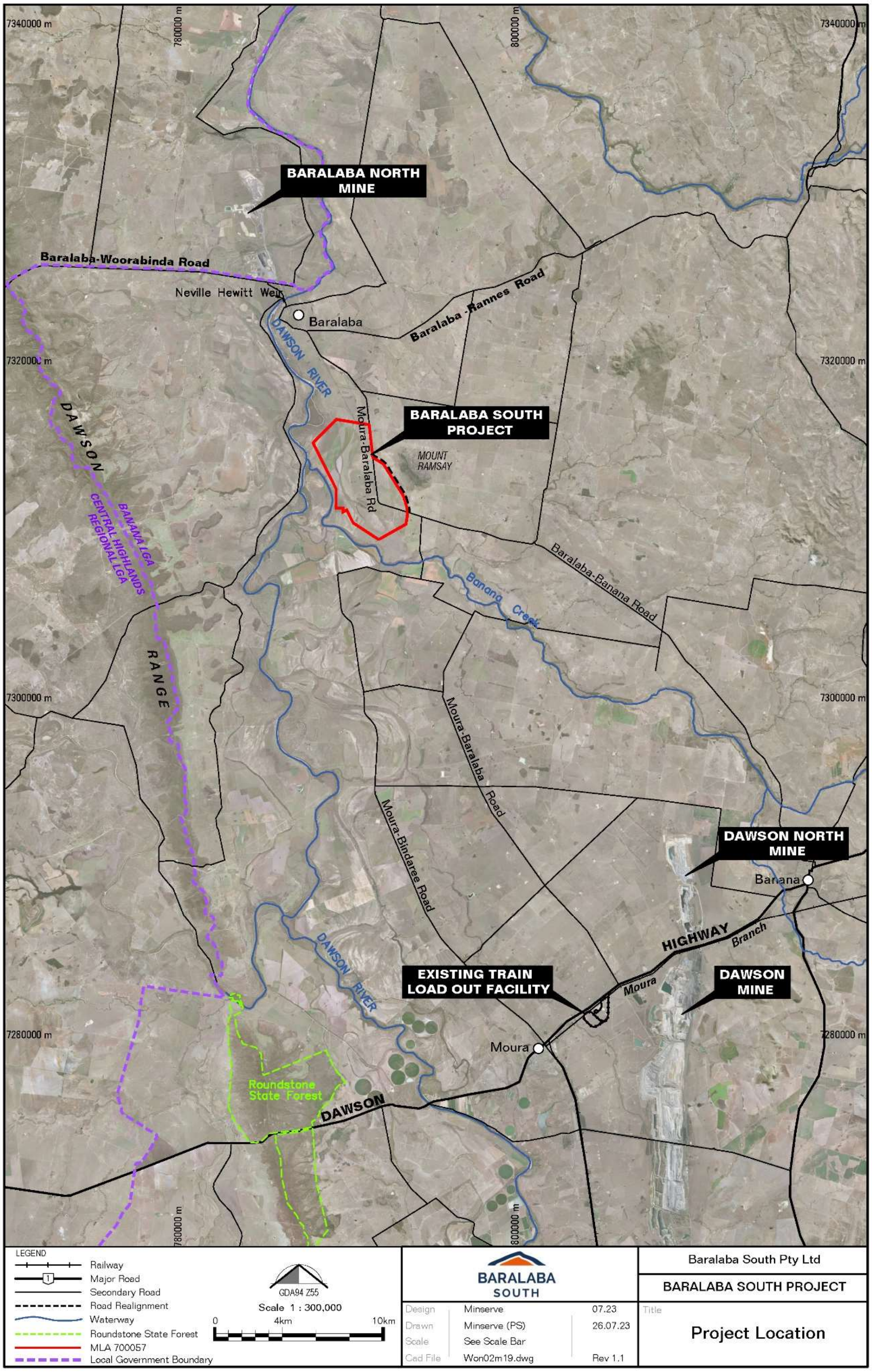

Figure 1: Baralaba South Project location

2.1 Proposed activity

The mine plan is based on conventional truck and excavator operations, operating as a terrace mine configuration. Rehabilitation will be undertaken progressively as land becomes available.

The open-cut operations are described as follows:

- Felling timber and vegetaion.
- Topsoil will be removed and hauled to topsoil stockpile or establishing rehabilitated areas.
- Drilling and blasting will be undertaken.
- Excavators will load trucks with overburden, which will then be hauled to overburden dumps in earlier years or dumped inpit in later years.
- Dozers will be used to shape the dumps.
- Excavators will load the exposed coal into coal haul trucks to be transported from the pit to the ROM pad.
- The coal haul trucks will then unload the coal at the ROM pad.
- The ROM coal will be fed into the CHPP crushed, washed and screened. The product coal will be stockpiled and trucked off lease to the TLO (a rail loading point to the east of Moura).
- The CHPP reject material will be dried in belt press filters and returned to the pit for disposal in dumps.
- The CHPP will operate 24 hours per day throughout the year.
- Mine construction is expected to be undertaken in Year 2029, followed by 23 years of mining commencing in Year 2030, and additional closure and rehabilitation activities at the end of mining.

2.2 Production quantities

Mining will be carried out sequentially from the north of the site progressing towards the south. Estimated coal and waste production quantities over the life of the mine are provided in Table 2.

The maximum annual ROM coal is 2.5 Mt of coal in multiple years. Maximum product coal is approximately 1.8 Mt while the remainder (0.7 Mt) consists of rejects, which will be hauled back from the CHPP belt press filter system to the dumps for disposal. The maximum overburden removal is 37 Mbcm in years 3, 5 and 6.

Table 2: Coal and waste production quantities

Year	ROM coal (t)	ROM waste (bcm)	Product (t)	CHPP rejects (t)
1	1,251,073	29,917,134	947,374	329,444
2	2,141,756	36,470,360	1,578,896	605,767
3	2,030,053	37,146,816	1,469,714	600,280
4	2,100,000	35,182,411	1,548,821	593,269
5	2,200,000	37,018,878	1,608,699	635,019
6	2,300,000	36,725,699	1,694,116	651,923
7	2,400,000	26,950,122	1,769,800	678,296
8	2,500,000	26,894,981	1,789,793	758,846
9	2,500,000	26,880,500	1,806,014	743,065
10	2,317,103	27,095,057	1,666,441	695,949

Year	ROM coal (t)	ROM waste (bcm)	Product (t)	CHPP rejects (t)
11	2,250,000	27,048,859	1,662,594	632,588
12	2,250,000	27,061,516	1,618,978	675,019
13	2,250,000	27,071,849	1,620,640	673,402
14	2,189,267	27,150,196	1,595,225	637,394
15	2,416,509	26,948,916	1,750,293	713,781
16	2,500,000	26,877,465	1,833,437	716,388
17	2,500,000	26,877,027	1,848,062	702,160
18	2,182,084	27,179,947	1,613,811	612,130
19	2,100,000	27,178,118	1,528,349	613,185
20	2,019,095	27,229,113	1,489,877	569,707
21	2,142,522	24,557,634	1,579,192	606,245
22	1,309,976	15,258,017	942,255	393,327
23	750,948	5,662,948	563,484	202,777

A list of major mobile equipment quantities is included in Table 3. Specific equipment types are included later in this report.

Table 3: Mining equipment quantities

Year	Excavators	Haul trucks	Loader	Dozers	Graders and water trucks
1	5	39	1	6	7
2	5	31	1	8	6
3	5	39	1	8	7
4	5	41	1	8	7
5	5	41	1	8	7
6	5	42	1	8	7
7	4	26	1	6	4
8	4	24	1	6	4
9	4	31	1	6	6
10	4	32	1	6	6
11	4	34	1	6	6
12	4	23	1	6	4
13	4	23	1	6	4
14	4	30	1	6	6

Year	Excavators	Haul trucks	Loader	Dozers	Graders and water trucks
15	4	34	1	6	6
16	4	36	1	6	6
17	4	27	1	6	5
18	4	33	1	6	6
19	4	26	1	6	5
20	4	29	1	6	6
21	4	34	1	6	6

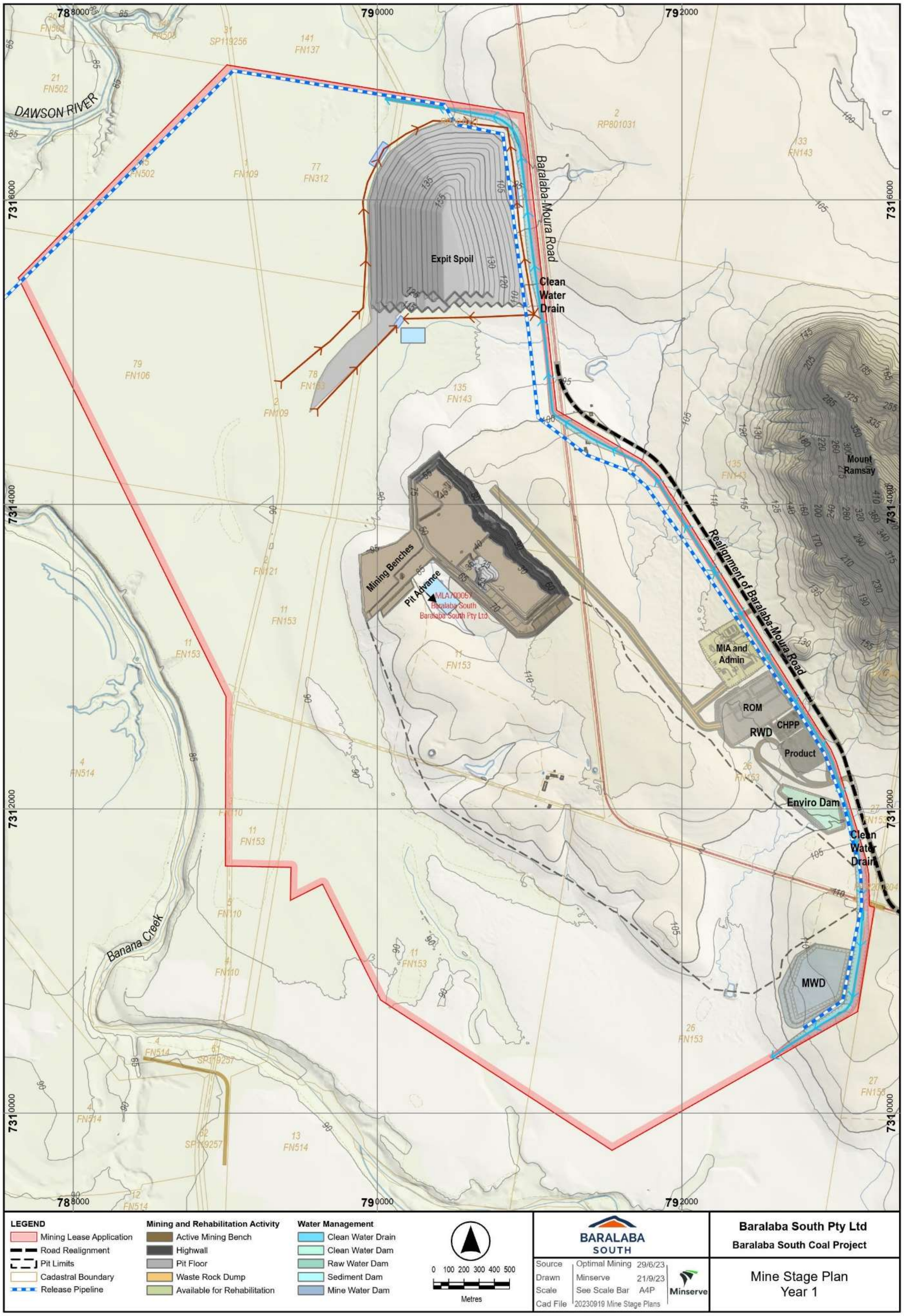

Figure 2: Year 1 Mine plan

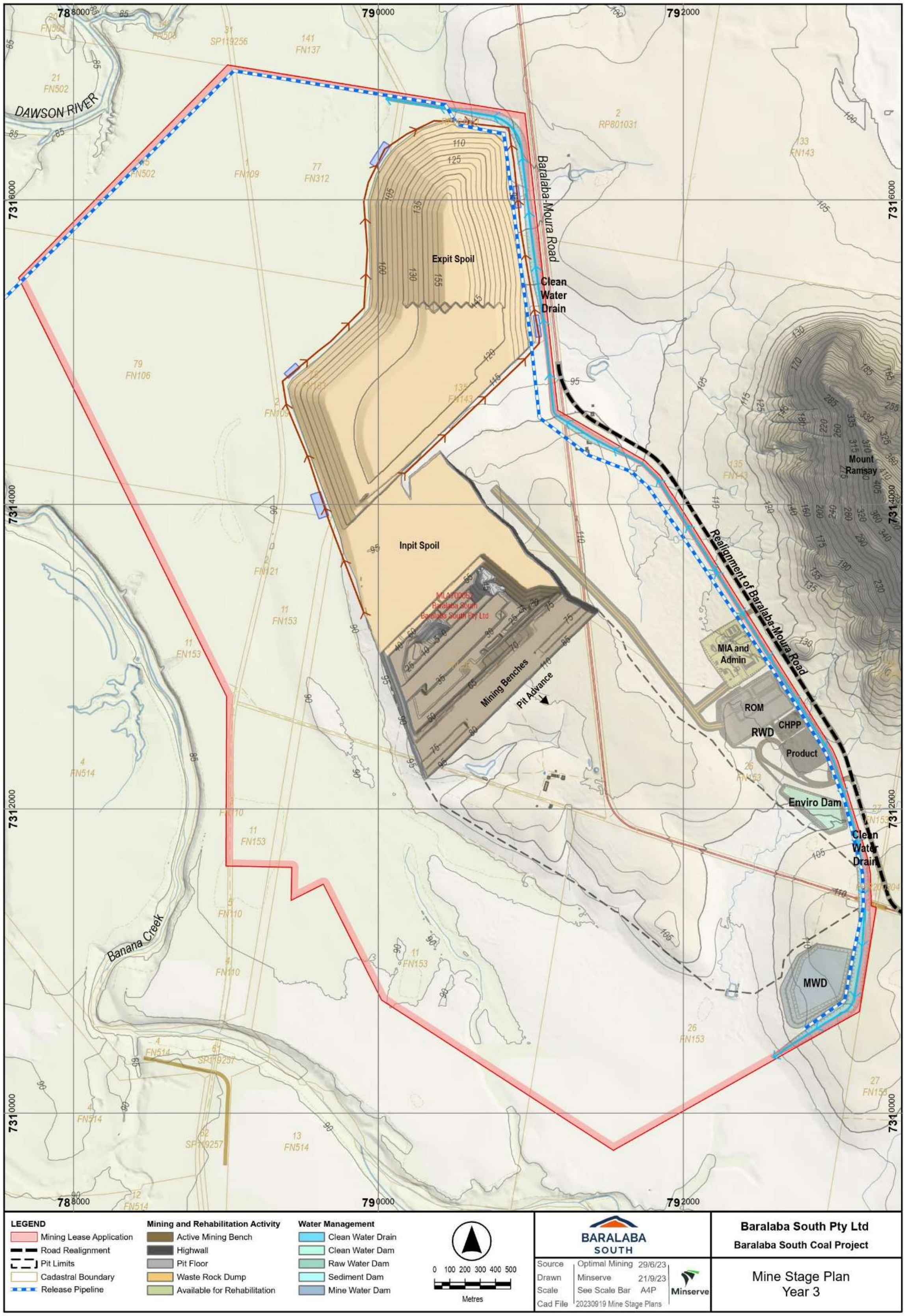

Figure 3: Year 3 Mine plan

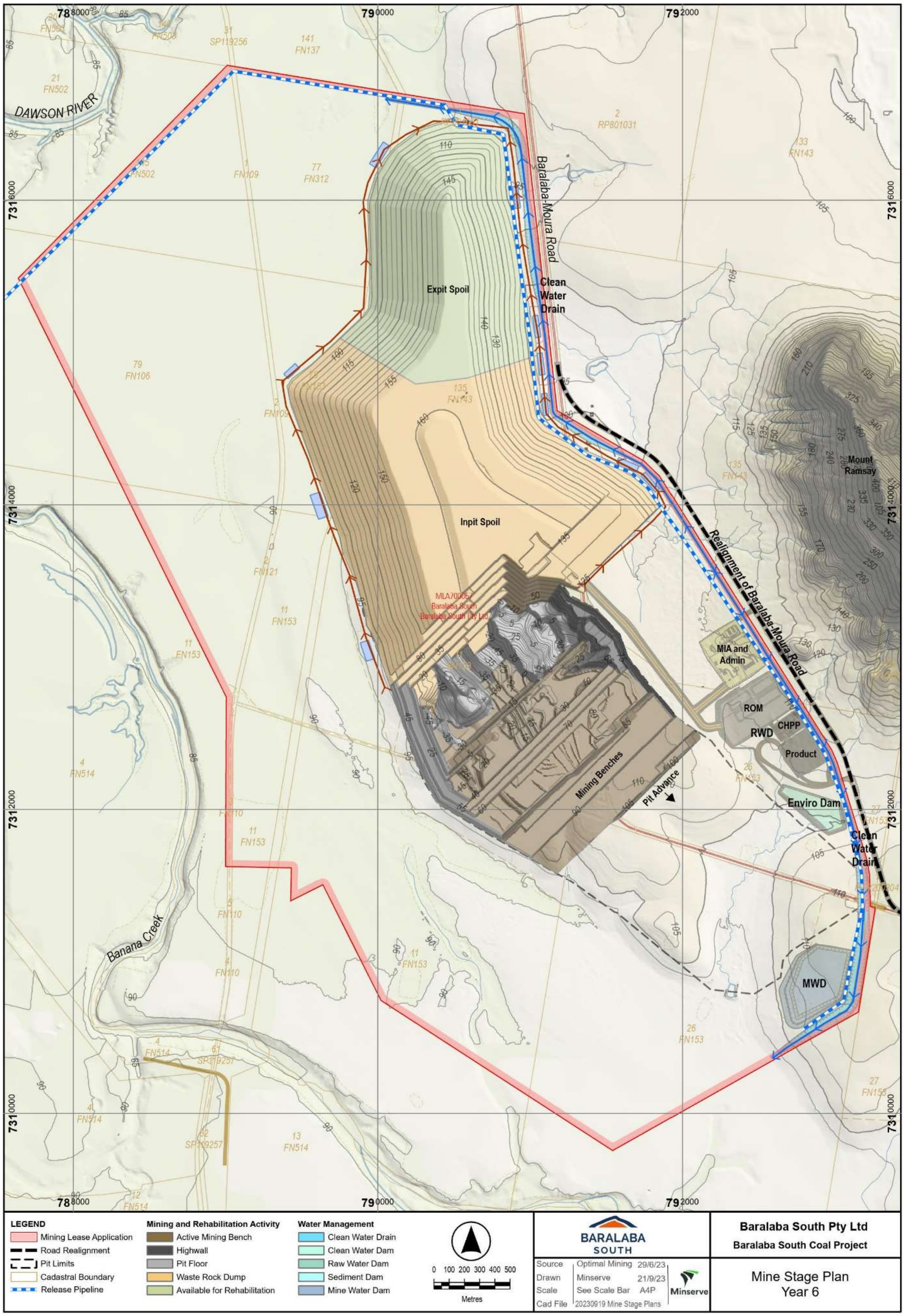

Figure 4: Year 6 Mine plan

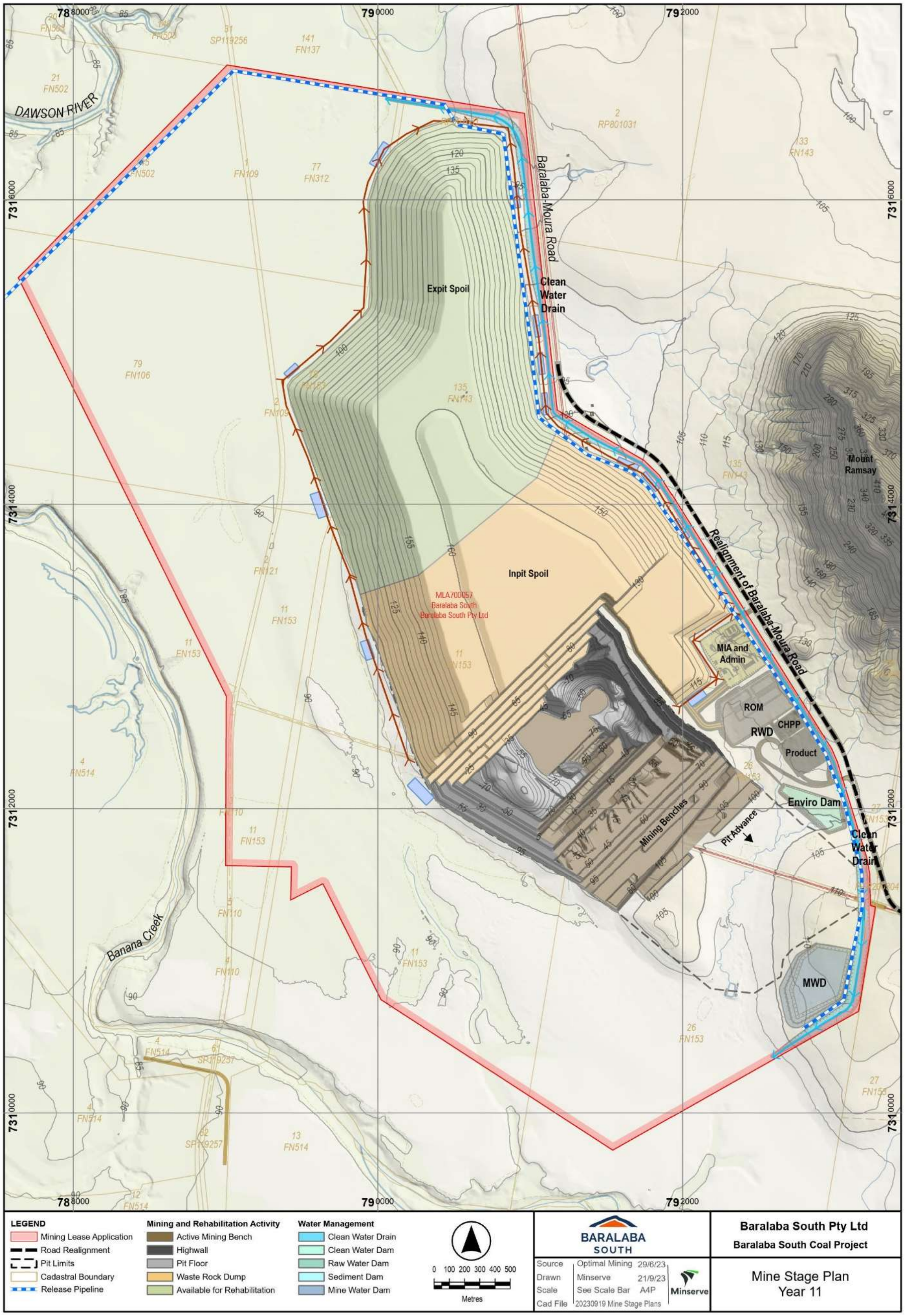

Figure 5: Year 11 Mine plan

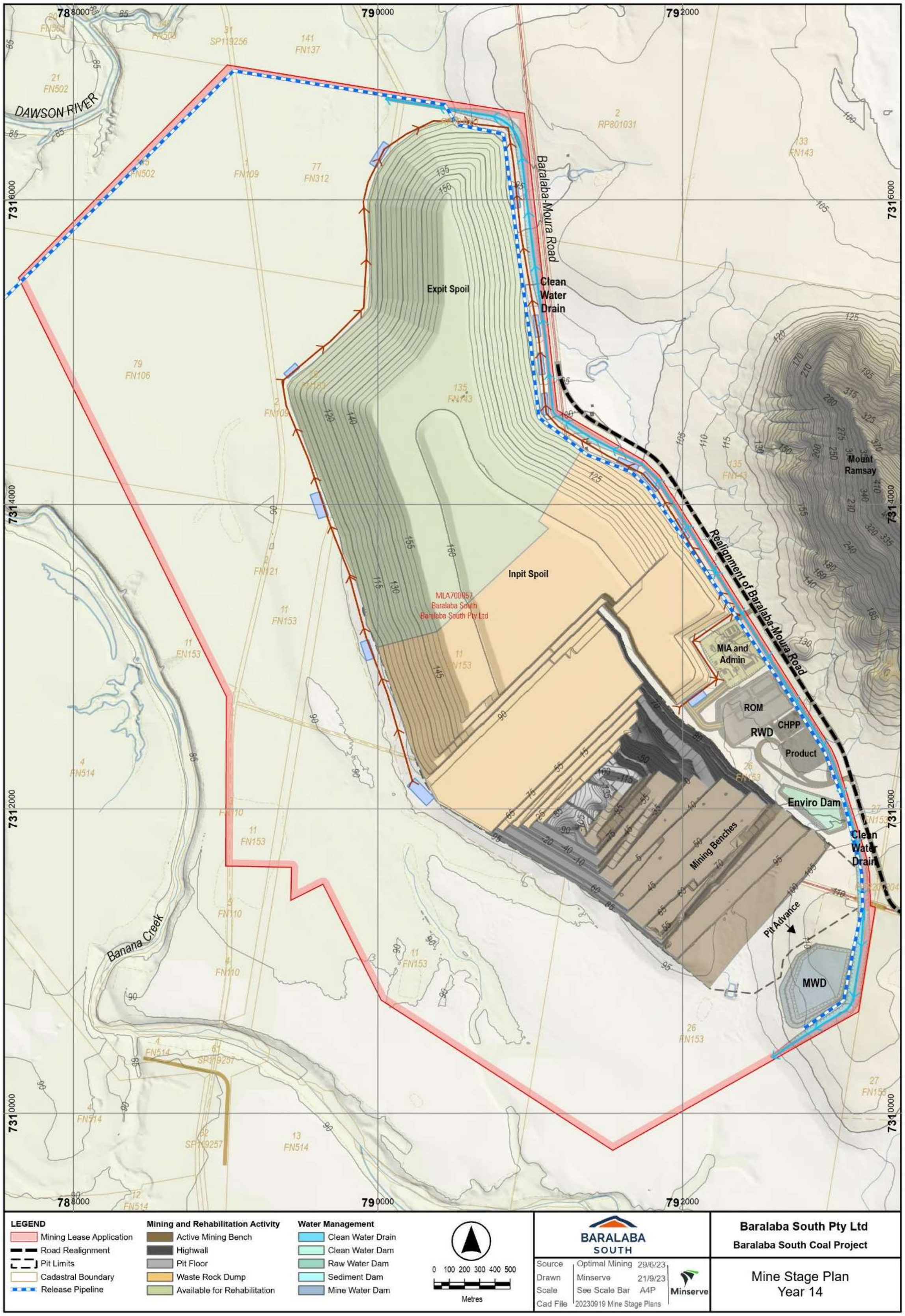

Figure 6: Year 14 Mine plan

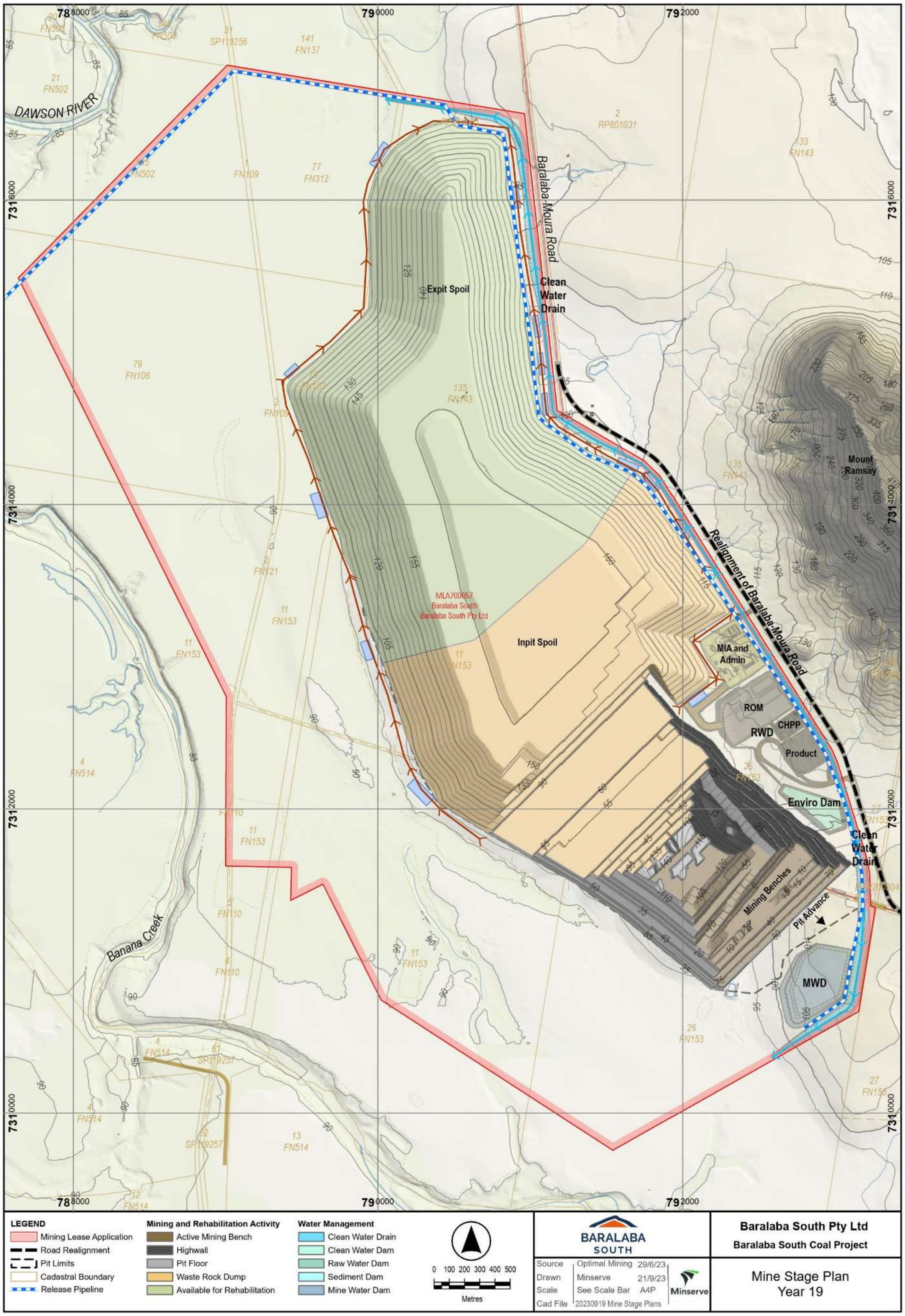

Figure 7: Year 19 Mine plan

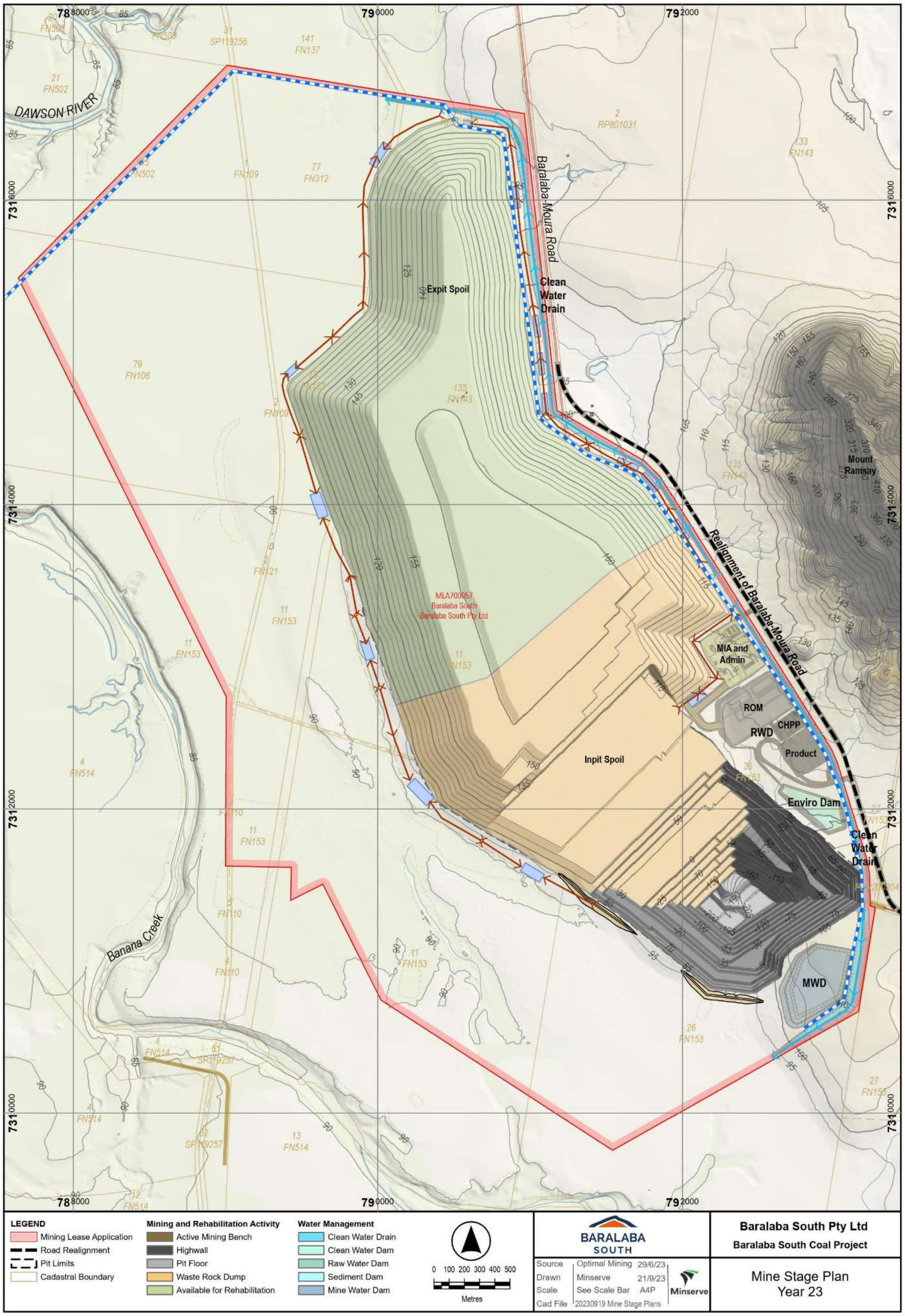

Figure 8: Year 23 Mine plan

Figure 9: Final landform

2.3 Other activities

2.3.1 Construction phase

The construction of the necessary infrastructure to commence mining is to occur in the year prior to mining operations commencing.

The on-site infrastructure that will be constructed includes:

- site access road(s) from Moura Baralaba Road;
- light vehicle access roads;
- heavy vehicle haul roads;
- communications infrastructure (i.e. towers, cabling);
- CHPP;
- mine infrastructure areas;
- sediment dams;
- water infrastructure (dams, diversion drains);
- ROM transfer pads;
- coal stockpiling and blending facility;
- topsoil stockpiles;
- equipment laydown areas;
- offices and administration facilities;
- ablutions and crib room facilities;
- sewage treatment facilities;
- fuel and oil storage facilities; and
- high voltage transmission lines/poles and reticulation.

The off-site infrastructure that will be constructed is the re-alignment of the Moura Baralaba Road, which is currently within the mining lease boundary, and will be constructed east of the mining lease boundary.

The noise emissions due to the construction activities are expected to be less than noise emissions from mining operations based on the operating equipment and nature of the activities. The activities will also be short-lived. Hence, noise emissions from these sources were not modelled in this assessment.

2.3.2 Closure phase

Closure of the Project will include decommissioning and rehabilitation of the facilities onsite. As with the construction activities, noise emissions are likely to be minimal in comparison to mining operations and will include a small amount of equipment operating. Noise emissions from this phase were not modelled in this assessment.

2.3.3 Upset conditions

Potential upset conditions and their effect on noise emissions are discussed as follows:

- If a piece of equipment malfunctions, this could result in an increased noise level for that item of equipment, although the overall effect on noise emissions from the whole site would likely be minor.

- When equipment malfunctions, it will be quickly taken out of operation, and adverse noise impacts are not expected to occur. In addition, all equipment will be maintained routinely, and malfunctions that increase noise levels are expected to be rare.
- Severe weather conditions could cause mining activities to reduce or stop. This would result in lower noise emission levels.
- Strong winds blowing away from the mine would have a lowering effect on sensitive receptors. However, strong winds blowing from the direction of the mine towards sensitive receivers could increase the mining noise levels. However in both cases the likely increase in the background noise levels would significantly mask any such mining noises, and the noise modelling in this report considers the worst-case scenario of low to moderate wind speeds.

Overall it is not expected that upset conditions pose a risk of additional noise impact and further assessment of such cases is not considered warranted.

2.4 Train load out (TLO)

The mine TLO is an existing facility located 2 km east of Moura and approximately 40 km by public road south of the mine. The environmental authority (EA) for the TLO is EPPR02011714. Schedule D of the EA includes noise limits based on the L_{Aeq} and L_{Amax} noise parameters, which represent the average noise emission level and maximum noise level, both measured over 15-minute periods.

As a result of the Project there will be an increased amount of coal transported via the TLO, and therefore an increased number of trains will use the facility. There is not proposed to be any significant changes to the operational hours, train types, mobile equipment or fixed equipment at the TLO.

The proposed increase in train numbers will result in additional periods of noise emissions during the day, evening and/or night. However, as the onsite equipment remains the same, the average noise emission level and maximum noise level, measured over 15-minute periods, would not increase above the current noise emission levels. Therefore, noise emissions from the TLO will remain unchanged.

3 Sensitive receptors

The Project is located in a rural area surrounded by agricultural land. There are isolated residences around and within the proposed mining lease boundary. The closest town is Baralaba which is located approximately 8 km north of the mine (refer Figure 1).

3.1 Selection of receptors

According to DES (2022) a sensitive place includes a sensitive receptor for the purposes of the Environmental Protection (Noise) Policy 2019 (EPP Noise). Sensitive receptors are listed in Schedule 1 of the EPP (Noise) as follows:

- residences (including a building, or part of building, capable of being used as a dwelling);
- library and educational institution (including a school, college and university);
- childcare centre or kindergarten;
- school or playground;
- hospital, surgery or other medical institution;
- commercial and retail activity;
- protected area (see Nature Conservation Act 1992, schedule) or critical area (means an area identified in a conservation plan under the Nature Conservation Act 1992, section 120H as, or as including, a critical habitat or an area of major interest);
- marine park (see Marine Parks Act 2004, schedule); and
- park or garden that is open to the public (whether or not on payment of an amount) for use other than for sport or organised entertainment.

According to DES (2017), *the terms 'sensitive place' and 'commercial place' … do not include places that are within the boundaries of the mining lease, nor places that are owned or leased by the holder of the authority or its related companies. For example, a mining camp operated by the EA holder would not be a sensitive place.*

It is noted that according to DES (2017) sensitive places are considered separately to commercial places, though the EPP (Noise) includes a place of commercial activity as a sensitive receptor. For the purpose of this report, commercial places may be considered sensitive, though may also be subject to different noise requirements than other sensitive places (e.g. residences).

3.2 Existing receptors

The nearest receptors for potential noise, vibration and/or airblast emissions from the Project are listed in Table 4 and shown in Figure 10. It is noted that Receptors 1 to 3 and 14 are located within the MLA and are therefore not considered sensitive receptors. The tabled receptors are the nearest to the Project in their respective directions and have the potential to be impacted by the Project.

Table 4: List of nearest receptors and distance from activities

ID	Property	Name / address	Real property description	Approximate distance to proposed activities (km)	Easting (GDA94 Z55)	Northing (GDA94 Z55)
1	'Broadmeadow'	Moura Baralaba Rd	11/FN153	Within the MLA	791210	7312217
2	'Broadmeadow'	Moura Baralaba Rd	11/FN153	Within the MLA	791130	7312026
3	'Mount Ramsay'	Moura Baralaba Rd	26/FN153	Within the MLA	792701	7310779

ID	Property	Name / address	Real property description	Approximate distance to proposed activities (km)	Easting (GDA94 Z55)	Northing (GDA94 Z55)
4	’Belvedere’	Bindaree Harcourt Rd	35/FN141	4.8 km south-west	789817	7306551
5	’Tingle Hill’	Moura Baralaba Rd	141/FN137	4.5 km north-west	788105	7320494
6	’Alberta Vale’	Alberta Rd, Alberta	5/RP856832	4.1 km north-west	786668	7318708
7	‘Riverside’	Alberta Rd, Alberta	3/RP856832	6.1 km north-west	785609	7320451
8	‘Lucerne Park’	Baralaba Rannes Rd, Baralaba	110/FN103	5.9 km north-west	786247	7320822
9	’Mount Ramsay’	Moura Baralaba Rd	1/RP801031	0.9 km north	790694	7317563
10	’Murrindindi’	Remfreys Rd	126/FN148	3.2 km north-east	793686	7318245
11	’Nonda’	Moura Baralaba Rd	102/SP107139	2.9 km north	790328	7319625
12	’Brahmleigh’	Baralaba Rannes Rd	80/SP131479	4.9 km north	790405	7321578
13	’Woodlands’	Remfreys Rd	133/FN143	3.1 km east	794051	7317045
14	’Mount Ramsay’	Moura Baralaba Rd	135/FN143	Within the MLA	791300	7314361
15	’Alberta’	Alberta Rd, Alberta	6/KM50	5.2 km west	784262	7314555
16	’Riverland’	Harcourt Baralaba Rd	4/FN514	3.2 km south-west	787625	7310449
17	’Bauhinia Park’	Baralaba Banana Rd	28/FN154	4.1 km south-east	796940	7309124
18	’Airedale’	Baralaba Banana Rd	30/FN154	4.5 km south-east	797418	7309218
19	‘Alberta Vale’	Alberta Rd, Alberta	5/RP856832	4.5 km north-west	786010	7318462
20	’Harcourt’	Harcourt Baralaba Rd	12/FN514	3.5 km south-west	788702	7308881
21	’Harcourt’	Harcourt Baralaba Rd	12/FN514	6.0 km south-west	785139	7309128

The nearest receptors outside the mining lease, are Receptor 9 to the north and Receptor 16 to the south-west at approximately 0.9 km and 3.2 km from the proposed mining activities respectively.

Receptor 9 is located on a parcel of land that underlies the MLA and will required a compensation agreement. It is considered part of the Mount Ramsay/McLaughlins agreement that will be required to address Receptors 3 and 14, which are located within the MLA. Regardless, Receptor 9 is considered as a sensitive receptor for noise assessment purposes.

3.3 Other receptors

The noise from the mine is expected to be relatively continuous and steady. Short-term impulsive type noises are expected to be minimal and therefore impacts onto fauna, including livestock, are not expected and no fauna receptors are included.

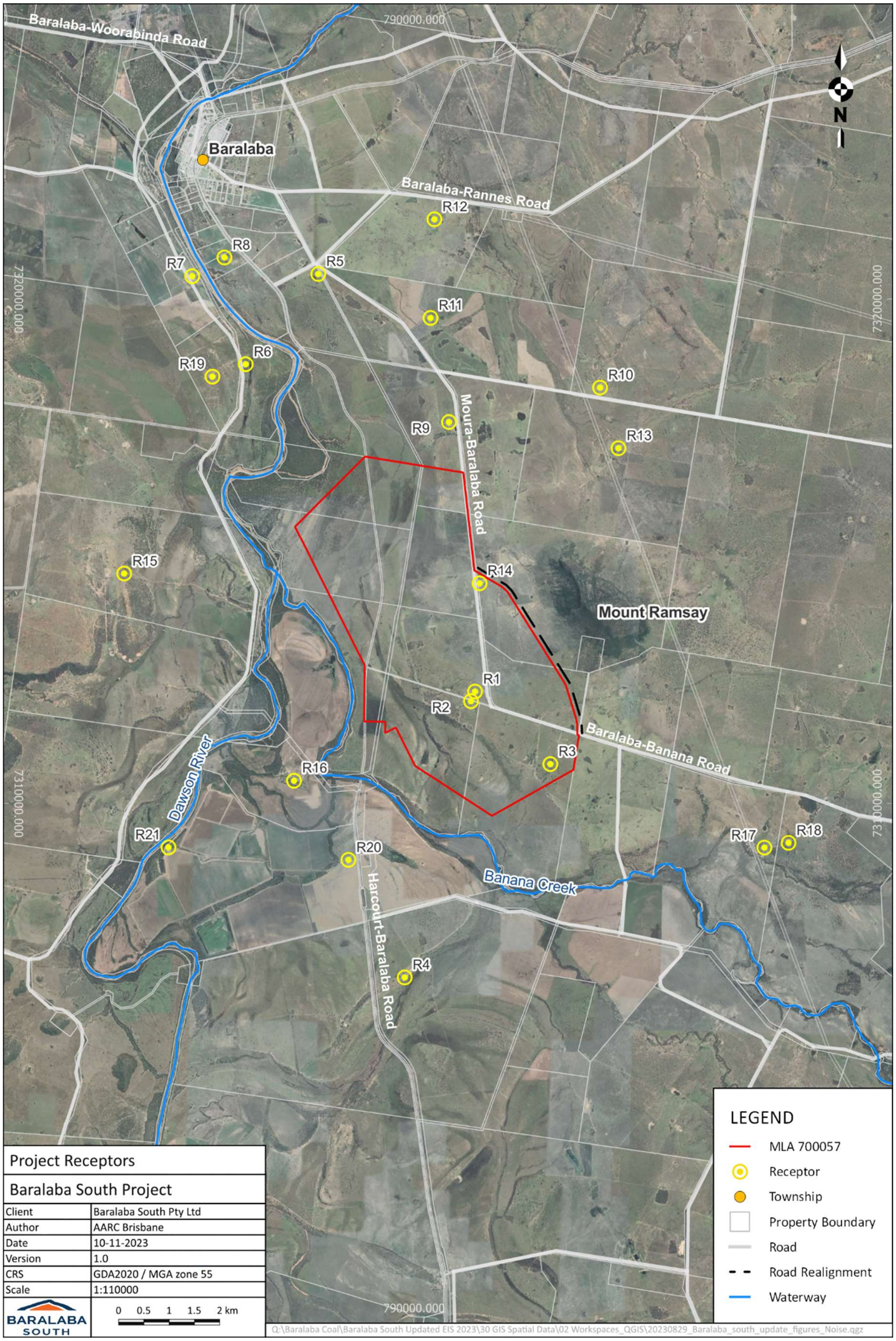

Figure 10: Baralaba South Project mining lease and nearby receptors

4 Existing noise environment

The existing noise environment is consistent with the land uses surrounding the Project, which around the area are predominantly rural agricultural land uses. The existing Baralaba North mine is located approximately 10 km north of the Project. The next nearest mines are Baralaba North and another mine near Moura, approximately 25 km south-east of the Project, but at that distance it has minimal impact on the existing noise environment near the Project.

The existing noise environment is dominated by natural noises, such as birds, insects, wind in grass and trees, and road traffic and agricultural activities.

4.1 Noise monitoring

Noise monitoring was conducted in July 2018 during winter and which is typically a quieter part of the year with respect to insect noise. As no change in surrounding land use has been identified since 2018, it is expected that the current noise environment would be the same as measured in 2018, i.e. neither quieter nor noisier. Noise monitoring results were detailed in the previous Baralaba South noise report (ASK 2021), and the results are copied below in Section 4.1.1 to 4.1.3 and Appendix B.

4.1.1 Locations

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

- Location A (Receptor 20) – Located adjacent the fence at the entrance to a property (Lots 3 and 12 on FN514) off Harcourt Baralaba Road (-24.3062, 149.8466). This is adjacent to sensitive Receptor 20 in Figure 10.
- Location B (Receptor 3) – Located adjacent the dirt road/driveway on approach to a property (Lot 26 on FN153) off Moura Baralaba Road (-24.2883, 149.8839). This is adjacent to Receptor 3 in Figure 10.
- Location C (Receptor 9) – Located adjacent the dirt road/driveway on approach to a property (Lot 1 on RP801031) off Moura Baralaba Road (-24.2275, 149.8635). This is adjacent to sensitive Receptor 9 in Figure 10.

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.

4.1.2 Attended noise measurements

Attended noise measurements were undertaken at these Locations A, B and C. The measurements were undertaken over separate 15-minute periods using a field and laboratory calibrated Norsonic NOR140 Type 1 sound level meter. The microphone height was approximately 1.3m above natural ground level and was located in the free field at each location. Weather during the time of monitoring was generally moderate with a light breeze in the daytime, and cold and still at night. The conditions were as follows:

- Day time: Approximately 22 to 24°C with a 0 to 2 m/s breeze and 10 to 20% cloud cover.
- Night time: Cold, calm and approximately 5% cloud cover.

The measured noise levels and associated field notes are summarised in Table 5.

Table 5: Attended noise measurement results

Location (Receptor)	Date and time	Period (minutes)	Noise Levels dBA			Results and notes
			L_{10}	L_{eq}	L_{90}	
Daytime measurements						
A (20)	11/07/2018 2:43pm	15	33	30	24	Noise from distant farm machinery and crows Distant combine harvester 25 to 28 dBA Distant tractor 25 to 36 dBA Bird nearby 36 to 40 dBA Passing car 34 dBA
B (3)	11/07/2018 3:54pm	15	33	31	23	Noise from distant birds and occasional wind gusts in trees Distant crows 27 to 34 dBA Wind in trees 29 to 31 dBA Distant truck 30 dBA
C (9)	11/07/2018 4:40pm	15	46	43	21	Noise from passing cars and birds Birds 38 to 44 dBA Distant small birds 23 to 25 dBA Car passbys 55, 52, 58, 54, 57, 56 dBA
Night measurements						
A (20)	12/07/2018 12:41am	15	27	27	17	Dog barks 30 to 38 dBA Birds 21 dBA
B (3)	12/07/2018 1:14am	15	26	24	17	Birds 20 to 23 dBA Cow 30, 31, 27, 28, 21, 28 dBA
C (9)	12/07/2018 1:40am	15	28	29	17	C w 35, 24 dBA Cars 28 to 35 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.

4.1.3 Noise Logging

Noise logging was undertaken over the period of Wednesday 11th to Tuesday 24th July 2018.

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 12 to Figure 17 in Appendix B. The statistical results from the noise logging have been summarised in Table 25 in Appendix B.

The average $L_{eq,15min}$ noise levels are shown in Table 6.

Table 6: Noise logging results – average $L_{Aeq,15min}$ levels

Period	Average noise levels Leq,15min dBA		
	Location A (Receptor 20)	**Location A (Receptor 3)**	**Location A (Receptor 9)**
Day (7am to 6pm)	41	35	45
Evening (6pm to 10pm)	26	27	40
Night (10pm to 7am)	23	26	35

The rating background noise levels, calculated using the lowest 10th percentile method in accordance with the DES "Planning for Noise Control" guideline, are shown in Table 7.

Table 7: Noise logging results – rating background noise levels

Period	Rating background noise levels L_{90},15min dBA		
	Location A (Receptor 20)	**Location A (Receptor 3)**	**Location A (Receptor 9)**
Day (7am to 6pm)	21	20	23
Evening (6pm to 10pm)	18	16	18
Night (10pm to 7am)	18	16	18

The following comments are provided regarding the noise monitoring and existing noise environment:

- Average L_{eq} noise levels during the daytime were relatively quiet at Location B and moderate at Locations A and C. Birds and wind in trees/grass were a major noise source at all locations. Noise levels were typically highest in the early morning and late afternoon due to birds. Road traffic also contributed at all locations, particularly at Location C, which was near Moura Baralaba Road. Other noise sources included farm machinery and animals, particularly at Location A.
- Average L_{eq} noise levels during the night were low at Locations A and B, and moderate at Location C. Road traffic noise contributed to the night-time noise levels intermittently at Location C, resulting in higher average L_{eq} noise levels than at the other two locations. Animals also contributed at all locations, including dogs at Locations A and C, and cows at Locations B and C. Birds and insects also contributed at all locations, although insect noise levels were very low.
- Background L_{90} noise levels were very quiet, as would be expected in a rural area. The rating background noise levels ranged from 20 to 23 dBA during the day and 16 to 18 dBA at night. Most noise sources that contributed to the noise levels were intermittent, such as birds, wind and road traffic, resulting in very low background noise levels when these sources were not producing noise.

Overall, the measurement results indicate the areas are very quiet, as is typical of a rural environment. The major noise sources are natural (birds, wind in trees), farm related (farm machinery, livestock, dogs) and community related (passing traffic).

5 Legal obligations and criteria

Noise and vibration criteria for the Project are to be determined from a variety of sources, including the following noise legislation and guidelines:

- Environmental Protection Act 1994
- Environmental Protection Regulation 2019
- Environmental Protection (Noise) Policy 2019
- Guideline – Model mining conditions (Department of Environment and Science [DES], 2017)
- Guideline – Noise, Noise and vibration from blasting, 22 January 2016, version 3.02, last reviewed 9 February 2022 (Department of Environment and Science [DES], 2022)
- Guideline – Noise and vibration, EIS information guideline (Department of Environment and Science [DES], 2022)

5.1 Environmental Protection Act 1994

In Queensland, the environment is protected under the Environmental Protection Act 1994 (EP Act). It defines environmental nuisance as inclusive of interference of an environmental value by noise, where noise is inclusive of vibration. Environmental values are identified under an environmental protection policy or regulation.

5.2 Environmental Protection (Noise) Policy 2019

The purpose of the Environmental Protection (Noise) Policy 2019 is to achieve the object of the Act in relation to the acoustic environment. The purpose is achieved by providing environmental values, acoustic quality objectives, and a *"framework for making consistent, equitable and informed decisions that relate to the acoustic environment."*

Acoustic quality objectives are included in Schedule 1 of the EPP (Noise). The objectives for residences are copied below in Table 8.

Table 8: Acoustic quality objectives for residences

Sensitive receptor	Time of Day	Acoustic quality objectives (measured at the receptor) dBA		
		$L_{Aeq,adj,1hour}$	$L_{A10,adj,1hour}$	$L_{A1,adj,1hour}$
Residences (for outdoors)	Daytime and evening	50	55	65
Residences (for indoors)	Daytime and evening	35	40	45
	Night-time	30	35	40

It is preferable not to apply noise criteria at a sensitive receptor based on indoor noise limits, and hence, equivalent outdoor noise limits can be determined based on the typical noise reduction from noise outside a residence to inside a residence.

The EPP (Noise) already includes limits for outdoors, as shown above, but compliance with those outdoor limits will not necessarily result in compliance with the indoor noise limits, as they assume a noise difference of 15 to 20 dBA which is generally not achieved with open windows at a residence.

Noise reductions for the façade of a timber dwelling with open windows are typically reported as 5 to 10 dBA. The DES Noise and vibration—EIS information guideline 2022 recommends to *"use an outdoor to indoor* *attenuation value of 7dB, which is appropriate for typical Queensland buildings with open windows."* Therefore, the indoor noise limits in Table 8 can be recalculated as outdoor noise limits as per Table 9.

Table 9: Calculated outdoor acoustic quality objectives for residences

Sensitive receptor	**Time of Day**	**Acoustic quality objectives (measured at the receptor) dBA**		
		$L_{Aeq,adj,1hour}$	$L_{A10,adj,1hour}$	$L_{A1,adj,1hour}$
Residences (outdoors)	Daytime and evening	42	47	52
	Night-time	37	42	47

The L_{Aeq} parameter is most commonly applied to new mining projects. It corresponds to the average noise level, and extraneous noise (e.g. from insects, birds, cars etc) can readily be mathematically removed from the measured levels for assessment purposes. The L_{A1} parameter is also regularly applied, as a way to contain brief high noise level events. With the use of the L_{Aeq} and L_{A1} parameters, it is not considered necessary to also include an L_{A10} limit.

5.3 Guideline – Model mining conditions

The DES guideline ' Model mining conditions' includes noise criteria that may be used as a basis for proposing noise protection commitments for mining projects.

For noise environments with a background noise level less than 30 dBA L_{90}, as is the case near Baralaba South (refer Table 7) the outdoor noise limits are calculated as per Table 9.

Table 10: Calculated outdoor noise limits from Model mining conditions

Receptor	**Parameter**	**Monday to Saturday**			**Sundays and public holidays**		
		Day 7am to 6pm	**Evening 6pm to 10pm**	**Night 10pm to 7am**	**Day 9am to 6pm**	**Evening 6pm to 10pm**	**Night 10pm to 9am**
Sensitive	$L_{Aeq,adj,15min}$	35	35	30	35	35	30
	$L_{A1,adj,15min}$	40	40	35	40	40	35
Commercial	$L_{Aeq,adj,15min}$	40	40	35	40	40	35

It can be seen that the Model mining condition limits (Table 10) are 7 dB stricter than the Acoustic quality objective derived limits (Table 9) with respect to the L_{eq} parameter, and 12 dB stricter with respect to the L_1 parameter.

This guideline also includes airblast and vibration limits for blasting as per Table 11.

Table 11: Model mining conditions blasting noise and vibration criteria

Blasting effect	Sensitive or commercial place criteria	
	Daytime 7am to 6pm	Evening and night 6pm to 7am
Airblast overpressure	115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time	No blasting
Ground vibration peak particle velocity (PPV) (vector sum)	5 mm/second PPV for 9 out of 10 consecutive blasts and not greater than 10 mm/second PPV at any time	No blasting

5.4 Guideline – Noise and vibration, EIS information guideline

This guideline advises proponents about the information and assessment requirements in relation to noise and vibration when preparing an environmental impact statement (EIS).

The guideline prescribes the use of the acoustic quality objectives within the EPP (Noise) and confirms the use of a 7 dB façade reduction for open windows, as applied when determining the noise limits in Table 9.

5.5 Guideline – Noise and vibration from blasting

The effects of blasting are described as follows[1]:

- Airblast is the pressure wave (sound) produced by the blast and transmitted through the air.
- Ground vibration from blasting is the radiation of mechanical energy within a rock mass or soil.

This guideline includes blasting criteria to minimise the impacts of airblast and ground vibration. The proposed criteria for the mining industry, and specifically surface mining, are the same as the Model mining conditions (refer Table 11).

5.6 Limits imposed at Baralaba North mine

The existing Baralaba North mine operates under the Environmental Authority EPML00223213, which include the noise limits in Table 12, and the same blasting criteria as outlined in Table 11.

Table 12: Baralaba North EA noise limits

Noise parameter	Noise limits at a sensitive or commercial place - Monday to Sunday (including public holidays)		
	Day 7am to 6pm	Evening 6pm to 10pm	Night 10pm to 7am
$L_{Aeq,adj,1hour}$ (dBA)	40	40	35
$L_{A10,adj,1hour}$ (dBA)	45	45	40
$L_{A1,adj,1hour}$ (dBA)	50	50	45
Low frequency noise limit (dB Lin)	-	55	55

[1] AS 2187.2 – 2006 Explosives – Storage and Use, Part 2: Use of Explosives

The EA includes noise limits based on L_{Aeq}, L_{A10} and L_{A1} parameters, adjusted for tonality and/or impulsiveness. It is noted that the above noise limits are based on 1-hour noise levels, which are less stringent than applying the same limits using 15-minute duration noise levels. Equivalent 15-minute limits could be 2 to 3 dB higher than the 1-hour limits in Table 12.

The EA also includes a low frequency noise limit of 55 dB Lin for the evening and night periods. Low frequency noise limits can sometimes be included for a mine. However, when Baralaba North applied the above EA noise limits, it is understood that the L_{Aeq} was the critical parameter rather than the low frequency noise requirement, as would typically be expected for a coal mining operation. Therefore, it is proposed to include low frequency noise as an assessment criteria for this report, but it is not proposed to be included within the EA.

5.7 Proposed noise and vibration criteria

It is proposed to adopt a mix of the Baralaba North limits in Table 12 and the EPP (Noise) derived limits in Table 9, with the exceptions that:

1. the night-time limit is reduced from 37 dBA L_{eq} down to 35 dBA L_{eq} as per the Baralaba North EA; and
2. the day and evening limit is reduced from 42 dBA L_{eq} down to 40 dBA L_{eq} as per the Baralaba North EA; and
3. the measurement period is reduced from 1 hour to 15 minutes.

These changes are to make the criteria more consistent with noise criteria adopted at other mine sites and determined in recent legal case decisions.

The proposed noise criteria are shown below in Table 13.

Table 13: Proposed Project noise limits

Noise level dBA measured as:	All days		
	Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
Sensitive Place			
$L_{Aeq,adj,15min}$	40	40	35
$L_{A1,adj,15min}$	52	52	47
Commercial Place			
$L_{Aeq,adj,15min}$	47	47	42

Further to Table 13 it is noted that:

- The noise limits relate to noise generated by Baralaba South mining activities, and exclude noise from extraneous noise sources such as road traffic, wind, insects, birds, residential activities and other mines.
- The noise limits are to be adjusted ('adj') for tonality and impulsiveness. Generally, the noise from coal mines is not tonal or impulsive when considered over a 15-minute or 1-hour period, however, this will be considered further when results are assessed.

The proposed blasting noise and vibration criteria are shown below in Table 14.

Table 14: Blasting noise and vibration limits

Blasting noise and vibration limits	Sensitive place and commercial place criteria	
	Monday to Friday 7am to 6pm; Saturday, Sunday and Public Holidays 9am – 6pm	**Other times**
Airblast overpressure	115 dB (Linear peak) for 9 out of 10 consecutive blasts and not greater than 120 dB (Linear peak) at any time	No blasting
Ground vibration	5 mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting

Further to Table 14 it is noted that the criteria include consideration of human comfort and are well below levels at which damage to typical residential type buildings is known to occur. It is also noted that vibration can be felt at a much lower level than those that could result in damage to structures, and at lower levels than are included in this table.

6 Noise assessment

6.1 Modelling software

Noise modelling has been undertaken with the SoundPLAN (version 8.2) computer program, which is widely used by Acoustic Consultants for modelling mine noise and is accepted by DES for this purpose.

The noise model takes into account the mine and local topography, noise levels and locations of equipment, distance attenuation, ground and air absorption, natural and artificial barriers, and meteorological effects.

The model has been run using the CONCAWE[2] algorithms, which enables predictions with different meteorological conditions.

6.2 Meteorological effects

Meteorological conditions can have a large impact on noise levels around the noise sources, particularly due to wind speed and direction, and vertical temperature gradients (e.g. temperature inversions). Noise level variations of up to 20 dB can be recorded due to these meteorological effects.

Standard meteorological conditions used for noise modelling are described as neutral (nil wind), adverse daytime (wind), and adverse night (wind and temperature inversion) as shown in Table 15. Each meteorological condition would be expected to be prevalent in a rural location. It is expected that higher noise levels will be predicted under adverse conditions.

Table 15: Noise modelling meteorological conditions

Parameter	Neutral conditions (experienced in the day, evening and night)	Adverse-day conditions (experienced in the day, evening and night)	Adverse-night conditions (mostly experienced in the evening and night)
Temperature (°C)	25	25	10
Relative Humidity (%)	40	40	70
Wind Speed (m/s)	Nil	2	2
Wind direction	NA	Towards receivers	Towards receivers
Pasquill Stability Class	D (neutral conditions)	D (neutral conditions)	F (moderately stable condition, which is typical of a moderate temperature inversion)

6.3 Noise source data

Baralaba South Pty Ltd has provided information on equipment type and locations for the modelling scenarios. Noise source data for the proposed equipment has been obtained from AARC's noise source records, equipment supplier noise specifications, other noise assessment reports and scientific papers.

The noise source level is based on the equipment sound power level (L_w or SWL). The sound power level of a noise source is a fixed number that can be used to determine the sound pressure level at any distance from the source.

Noise sources and locations are listed in Table 16. Equipment is located to represent a typical worst-case scenario for noise levels, e.g. with trucks and dozers atop a dump near a sensitive receptor. Light vehicles and

[2] CONservation of Clean Air and Water in Europe

other lower noise equipment are not included in the noise modelling due to their expected low noise emissions.

Table 16: Mining equipment and locations

Equipment	Location and use in noise model
Komatsu PC5500 and Komatsu PC4000 excavators	Located in pit and assumed to operate continuously. Assumed not to move substantially within the 15-minute assessment period, and therefore modelled as a point source.
Komatsu 830E and 930E haul trucks	Coal and waste (overburden and rejects) trucks operating between the (i) pit and ROM, (ii) pit and dump; and (iii) ROM and dump. Assumed to operate continuously and to move significantly within the 15-minute assessment period, and therefore modelled as a line source.
Caterpillar D11T tracked dozer	Located on dump areas for reshaping the dumps. Assumed not to move substantially within the 15-minute assessment period, and therefore modelled as a point source.
Caterpillar D10T tracked dozer	Located in or out of pit, as required. Assumed not to move substantially within the 15-minute assessment period, and therefore modelled as a point source.
Komatsu WA900 wheel loader	Located at the ROM to load coal into the hopper leading to the CHPP, and to load rejects into trucks. Assumed to operate continuously. Assumed not to move substantially within the 15-minute assessment period, and therefore modelled as a point source.
Caterpillar 777 water cart and Caterpillar 16M grader	To move along all the roads used by haul trucks. Assumed to operate continuously and to move significantly within the 15-minute assessment period, and therefore modelled as a line source.
Drill	Located in upper areas of pit and assumed to operate continuously. Assumed not to move substantially within the 15-minute assessment period.
CHPP, crushers, conveyors	Located on the southern side of the ROM. A fixed location and therefore modelled as a point source.

The octave band sound power level data associated with the above equipment is included in Table 17.

Table 17: Sound power level data for modelled equipment

Item	Source height (metres)	Overall and octave band sound power level ($L_{w,eq,15min}$) dBA (per item)								
		Overall	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Excavator – Komatsu PC5500	5.0	119	103	108	105	116	111	107	105	98
Excavator – Komatsu PC4000	4.0	119	103	108	105	116	111	107	105	98
Haul truck – Komatsu 830E with noise reduction package	3.0	114	93	103	103	107	108	107	103	97
Haul truck – Komatsu 930E with noise reduction package	3.0	114	93	103	103	107	108	107	103	97

Item	Source height (metres)	Overall and octave band sound power level ($L_{w,eq,15min}$) dBA (per item)								
		Overall	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Loader – Komatsu WA900	3.0	113	77	94	104	106	109	105	99	93
Dozer – Caterpillar D11T with noise reduction package	3.0	113	89	91	100	109	106	107	101	91
Dozer – Caterpillar D10T	3.0	116	87	102	105	110	113	108	102	96
Grader – Caterpillar 24	3.0	115	76	102	104	109	110	108	102	94
Water truck – Caterpillar 777	3.0	115	84	96	101	108	111	110	102	95
Drill – SK45	3.0	115	83	95	102	107	110	110	107	100
CHPP, crushers, and conveyors	5.0	119	102	108	110	114	113	113	107	98

From Table 17 it can be seen that the noise model uses haul trucks and D11T dozers with noise reduction packages. Noise reduction packages can be provided as staged options, with increasing performance and costs. To achieve the nominated sound power levels it is expected that comprehensive noise reduction packages will be required.

The equipment modelled has been chosen to most accurately reflect the anticipated mining fleet. However, there is potential for alternate makes and models of equipment to be used in the operating mine. If the equipment model is changed, the sound power level of the alternative model should be reviewed, and if the noise level increases, additional attenuation may be required.

A mine operator may choose to use a different combination of equipment, or use non-attenuated equipment in a different manner (e.g. in-pit activity at night) to achieve the same noise level outcomes.

6.4 Model scenarios

The major determinants of noise impacts over the life of the mining operation are (i) the quantity of equipment used, which is dependent on both the quantity of material handled, and (ii) the location of equipment noise sources relative to the receptors.

Estimated material handling quantities over the life of the mine are provided in Table 2. The location of activities throughout the mine life are shown in Figure 2 to Figure 8, plus the final landform in Figure 9.

Three mine scenarios have been considered as follows:

- Scenario 1: Year 1 mine site layout as shown in Figure 2. Due to the northern dump location, this scenario likely represents a typical worst-case scenario for receptors to the north.
- Scenario 2: Year 3 mine site layout as shown in Figure 3. This scenario represents pit operations located towards the middle of the mine plan.
- Scenario 3: Year 11 mine site layout as shown in Figure 5. Due to the southern pit location and high haul truck numbers, this scenario likely represents a typical worst-case scenario for receptors to the south.

The three scenarios were chosen to represent typical worst case impact scenarios at the nearest sensitive receptors.

Due to the proximity of Year 1 dumping activities to Receptor 9 to the north, two versions of Scenario 1 will be modelled, with Scenario 1a aiming for compliance at all sensitive receptors except Receptor 9, and Scenario 1b aiming for compliance at all sensitive receptors including Receptor 9.

The noise assessment will consider the following four scenarios:

- Scenario 1a: Year 1 mine site layout and equipment numbers.
- Scenario 1b: Year 1 mine site layout with reduced equipment numbers.
- Scenario 2: Year 3 mine site layout and equipment numbers.
- Scenario 3: Year 11 mine site layout and equipment numbers.

6.5 Model equipment quantities

Equipment quantities included in Table 3 were provided by the Project Mining Engineers. Numbers are determined on the basis that major mobile equipment is only operational for approximately 5000 hours per year. Given an approximate mine operation of 8760 hours per year (i.e. 365 days x 24 hours), it can be determined that equipment is utilised for approximately 57% of the time. Therefore, the actual equipment operating simultaneously at any one time, can be estimated as 57% of the numbers in Table 3, and rounded up to the nearest whole number.

The mobile equipment numbers for the four modelled scenarios are presented in Table 18.

Table 18: Mining equipment numbers in noise model

Equipment	Number of items per scenario			
	Scenario 1a Year 1	**Scenario 1b Year 1**	**Scenario 2 Year 3**	**Scenario 2 Year 11**
Excavator – Komatsu PC5500	2	2	2	2[3]
Excavator – Komatsu PC4000	3	2	3	3[3]
Haul truck – Komatsu 830E with noise reduction package	10	5 day, 4 night[1]	12	14
Haul truck – Komatsu 930E with noise reduction package	14	5[2]	11	7
Loader – Komatsu WA900	1	1	1	1
Dozer – Caterpillar D11T with noise reduction package	3	1	3	3
Dozer – Caterpillar D10T	2	2	2	2
Grader – Caterpillar 24	3	2	3	2
Water truck – Caterpillar 777	2	1	2	2
Drill – SK45	2	2	2	2
CHPP, crushers, and conveyors	1	1	1	1

Note: 1:5 x 830E trucks in daytime consists of 2 trucks between pit and dump, 1 truck between pit and ROM, 1 truck between ROM and dump, and 1 truck between pit and topsoil dump. At night, there are 4 trucks as there is no topsoil truck.

2: 5 x 930E trucks consists of 4 trucks between pit and dump, and 1 truck between pit and ROM.

3: A total of 5 excavators was modelled for Year 11, which is conservative, as mining equipment quantities in Table 3 indicates that excavator numbers would have reduced to a total of 4 by Year 7 onwards.

The overall sound power levels of the equipment modelled are presented in Table 19.

Table 19: Total mine scenario sound power levels

Mine scenario	Total sound power level $L_{w,eq,15min}$ dBA
Scenario 1a: Year 1	130
Scenario 1b: Year 1	129
Scenario 2: Year 3	130
Scenario 3: Year 11	130

The total sound power for Scenario 1b is only 1 dB quieter than Scenario 1a, however, due to the reduction in overburden trucks and dump dozers, which are located at the northern end of the MLA near Receptor 9, there is a significant reduction in the sound power level at the northern end of the mine plan near Receptor 9.

6.6 Model mitigation measures and equipment locations

To assist with achieving noise limits, the mitigation measures listed in Table 20 have been included. These mitigation measures are in addition to the equipment noise reduction measures discussed in Section 6.3 and Year 1 equipment reductions in Scenario 1b in Section 6.4.

Table 20: Mine scenario noise mitigation measures

Mine scenario	Day/Night	Mitigation measures
Scenarios 1a and 1b: Year 1	Day	None (it is assumed that the noise bunds included in the Night scenario would be constructed in the day).
	Night	15m high bunds around the northern dump, and 10m high bunds to the haul roads between the pit and northern dump.
Scenario 2: Year 3	Day	None (it is assumed that the noise bunds included in the Night scenario would be constructed in the day).
	Night	15m high bund to eastern side of the northern dump, noting that the northern side of the northern dump is expected to be complete such that it provides shielding to the proposed Year 3 dumping area. A 10m high bund was included to the western side of the pit area.
Scenario 3: Year 11	Day	None (it is assumed that out-of-pit dumping would occur in the day).
	Night	Dumping is to be in-pit (note: out of pit dumping may still be possible, however it could require noise bunding to achieve compliance).

It is noted that the mitigation measures included in Table 20 have not gone through a detailed optimisation process but were selected to achieve compliance with noise limits. A mine operator may choose to use a different combination of mitigation measures in addition to equipment selection and location to achieve the same noise level outcomes.

The locations of the equipment included in noise modelling are provided in Appendix C. The equipment locations were chosen to be representative of equipment locations on a typical worst-case basis during each modelled year, e.g. locations near to receptors and at higher ground levels.

6.7 Predicted noise levels and assessment

The predicted noise levels are shown in Table 21 for all four scenarios and all three meteorological conditions (i.e. a total of 12 sets of results). The predicted noise levels for the day and night adverse meteorological conditions are also shown graphically as noise contours in Appendix D.

The noise shielding effects of Mount Ramsay to the east of the mine are clearly visible in the noise contours in Appendix D.

Noise levels are generally higher under adverse meteorological conditions, and particularly night-time adverse meteorological conditions. The daytime and daytime-adverse meteorological conditions results are assessed against the proposed day time noise limit. The night-adverse meteorological condition results are assessed against the proposed night time noise limit.

The mining noise at receptors is not expected to have tonal or impulsive components, and hence no corresponding penalties are added to the predicted noise levels.

An assessment of low frequency noise emissions has been included in accordance with the 55 dB target, as used at Baralaba North mine. The predicted low frequency noise levels are shown in Table 22.

Table 21: Predicted A-weighted noise levels

Receptor	Predicted A-weighted noise levels																							
	Scenario 1a: Year 1						**Scenario 1b: Year 1**						**Scenario 2: Year 3**						**Scenario 3: Year 11**					
	Noise Level $L_{Aeq,adj,15min}$ dBA			**Exceedance of 40 dBA day and 35 dBA night noise limits**			**Noise Level $L_{Aeq,adj,15min}$ dBA**			**Exceedance of 40 dBA day and 35 dBA night noise limits**			**Noise Level $L_{Aeq,adj,15min}$ dBA**			**Exceedance of 40 dBA day and 35 dBA night noise limits**			**Noise Level $L_{Aeq,adj,15min}$ dBA**			**Exceedance of 40 dBA day and 35 dBA night noise limits**		
Met' condition	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**	**Day-neutral**	**Day-Adverse**	**Night-Adverse**
1 (MLA[1])	45	50	51	NA	NA	NA	45	49	50	NA	NA	NA	45	49	50	NA	NA	NA	65	65	69	NA	NA	NA
2 (MLA[1])	43	48	49	NA	NA	NA	43	46	48	NA	NA	NA	43	48	49	NA	NA	NA	55	58	58	NA	NA	NA
3 (MLA[1])	37	43	44	NA	NA	NA	37	42	44	NA	NA	NA	37	42	44	NA	NA	NA	39	44	44	NA	NA	NA
4	21	26	27	nil	nil	nil	21	25	25	nil	nil	nil	20	26	27	nil	nil	nil	21	27	24	nil	nil	nil
5	24	30	28	nil	nil	nil	24	27	24	nil	nil	nil	19	25	26	nil	nil	nil	15	21	18	nil	nil	nil
6	27	32	30	nil	nil	nil	27	30	27	nil	nil	nil	22	28	29	nil	nil	nil	17	22	19	nil	nil	nil
7	22	27	25	nil	nil	nil	22	25	22	nil	nil	nil	18	24	24	nil	nil	nil	13	19	16	nil	nil	nil
8	22	27	25	nil	nil	nil	22	25	22	nil	nil	nil	18	24	24	nil	nil	nil	13	19	16	nil	nil	nil
9[2]	39	44	40	Nil	4	5	39	40	35	nil	nil	nil	29	36	35	nil	nil	nil	23	28	28	nil	nil	nil
10	25	32	29	nil	nil	nil	25	27	25	nil	nil	nil	26	32	33	nil	nil	nil	18	24	18	nil	nil	nil
11	28	34	33	nil	nil	nil	28	31	28	nil	nil	nil	23	29	30	nil	nil	nil	18	23	22	nil	nil	nil
12	22	28	26	nil	nil	nil	22	25	22	nil	nil	nil	19	25	25	nil	nil	nil	14	20	18	nil	nil	nil

Receptor	Predicted A-weighted noise levels																							
	Scenario 1a: Year 1						Scenario 1b: Year 1						Scenario 2: Year 3						Scenario 3: Year 11					
	Noise Level $L_{Aeq,adj,15min}$ dBA			Exceedance of 40 dBA day and 35 dBA night noise limits			Noise Level $L_{Aeq,adj,15min}$ dBA			Exceedance of 40 dBA day and 35 dBA night noise limits			Noise Level $L_{Aeq,adj,15min}$ dBA			Exceedance of 40 dBA day and 35 dBA night noise limits			Noise Level $L_{Aeq,adj,15min}$ dBA			Exceedance of 40 dBA day and 35 dBA night noise limits		
Met' condition	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse
13	27	34	30	nil	nil	nil	27	29	26	nil	nil	nil	28	33	34	nil	nil	nil	18	24	15	nil	nil	nil
14 (MLA[1])	50	55	52	NA	NA	NA	50	51	48	NA	NA	NA	51	55	56	NA	NA	NA	41	45	39	NA	NA	NA
15	24	30	28	nil	nil	nil	24	27	25	nil	nil	nil	22	27	28	nil	nil	nil	20	26	24	nil	nil	nil
16	30	35	34	nil	nil	nil	30	32	32	nil	nil	nil	29	34	35	nil	nil	nil	28	34	32	nil	nil	nil
17	21	27	27	nil	nil	nil	21	26	27	nil	nil	nil	21	27	28	nil	nil	nil	21	27	26	nil	nil	nil
18	21	26	26	nil	nil	nil	21	25	26	nil	nil	nil	20	26	27	nil	nil	nil	20	26	25	nil	nil	nil
19	26	31	29	nil	nil	nil	26	29	26	nil	nil	nil	22	28	28	nil	nil	nil	16	22	19	nil	nil	nil
20	26	31	32	nil	nil	nil	26	30	31	nil	nil	nil	27	32	33	nil	nil	nil	27	33	31	nil	nil	nil
21	22	27	26	nil	nil	nil	22	25	24	nil	nil	nil	21	27	27	nil	nil	nil	19	25	23	nil	nil	nil

Note: 1 – Receptors labelled as (MLA) are located within the MLA boundaries and therefore are to be acquired, and are not assessed to the proposed noise limits.

2 – Noise levels at Receptor 9 are reduced to compliance in Year 1 with equipment reductions in Scenario 1b.

Table 22: Predicted un-weighted noise levels for low frequency review

Receptor	Predicted un-weighted noise levels																							
	Scenario 1a: Year 1						Scenario 1b: Year 1						Scenario 2: Year 3						Scenario 3: Year 11					
	Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit		
Met' condition	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse
1 (MLA[1])	59	62	62	NA	NA	NA	58	61	61	NA	NA	NA	60	62	62	NA	NA	NA	74	75	78	NA	NA	NA
2 (MLA[1])	57	60	60	NA	NA	NA	56	59	59	NA	NA	NA	58	61	61	NA	NA	NA	69	70	71	NA	NA	NA
3 (MLA[1])	53	56	56	NA	NA	NA	53	56	56	NA	NA	NA	53	55	56	NA	NA	NA	54	57	56	NA	NA	NA
4	39	43	43	nil	nil	nil	37	41	41	nil	nil	nil	38	42	43	nil	nil	nil	38	42	40	nil	nil	nil
5	41	45	43	nil	nil	nil	38	42	40	nil	nil	nil	37	41	42	nil	nil	nil	33	37	36	nil	nil	nil
6	44	48	45	nil	nil	nil	41	45	42	nil	nil	nil	39	43	44	nil	nil	nil	34	39	37	nil	nil	nil
7	39	44	41	nil	nil	nil	37	41	39	nil	nil	nil	36	40	41	nil	nil	nil	31	36	34	nil	nil	nil
8	39	44	41	nil	nil	nil	37	41	38	nil	nil	nil	36	40	41	nil	nil	nil	31	36	34	nil	nil	nil
9[2]	51	54	52	nil	nil	nil	48	51	48	nil	nil	nil	45	48	48	nil	nil	nil	40	43	42	nil	nil	nil
10	42	45	43	nil	nil	nil	38	42	39	nil	nil	nil	43	46	46	nil	nil	nil	36	40	36	nil	nil	nil
11	44	48	46	nil	nil	nil	41	45	43	nil	nil	nil	40	44	44	nil	nil	nil	35	39	38	nil	nil	nil
12	40	44	41	nil	nil	nil	37	41	38	nil	nil	nil	36	41	41	nil	nil	nil	32	36	36	nil	nil	nil
13	44	47	45	nil	nil	nil	40	43	40	nil	nil	nil	44	47	47	nil	nil	nil	33	37	30	nil	nil	nil

Receptor	Predicted un-weighted noise levels																							
	Scenario 1a: Year 1						Scenario 1b: Year 1						Scenario 2: Year 3						Scenario 3: Year 11					
	Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit			Noise Level $L_{eq,adj,15min}$ dB			Exceedance of 55 dB noise limit		
Met' condition	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse	Day-neutral	Day-Adverse	Night-Adverse
14 (MLA[1])	63	66	63	NA	NA	NA	60	62	59	NA	NA	NA	64	66	67	NA	NA	NA	50	53	49	NA	NA	NA
15	42	46	43	nil	nil	nil	39	43	41	nil	nil	nil	39	43	44	nil	nil	nil	38	42	41	nil	nil	nil
16	47	50	48	nil	nil	nil	43	46	46	nil	nil	nil	46	49	49	nil	nil	nil	44	48	45	nil	nil	nil
17	39	43	43	nil	nil	nil	39	42	42	nil	nil	nil	39	43	43	nil	nil	nil	39	43	42	nil	nil	nil
18	39	43	42	nil	nil	nil	38	41	41	nil	nil	nil	38	42	43	nil	nil	nil	38	42	41	nil	nil	nil
19	43	47	44	nil	nil	nil	40	44	41	nil	nil	nil	39	43	44	nil	nil	nil	34	38	36	nil	nil	nil
20	43	47	47	nil	nil	nil	41	45	45	nil	nil	nil	45	48	48	nil	nil	nil	44	47	45	nil	nil	nil
21	39	43	41	nil	nil	nil	36	40	39	nil	nil	nil	38	43	42	nil	nil	nil	36	40	39	nil	nil	nil

Note: 1 – Receptors labelled as (MLA) are located within the MLA boundaries and therefore are to be acquired, and are not assessed to the proposed noise limits.

2 – Low frequency noise levels at Receptor 9 are compliant in all four scenarios.

From the results in Table 21, Table 22 and Appendix D it can be seen that:

- Compliance is not assessed at Receptors 1, 2, 3 and 14 as they are located on the MLA and are therefore not considered sensitive receptors. These properties will be directly affected by the mine and will therefore need to be acquired by the mine.
- A-weighted noise levels are compliant for Scenario 1a (Year 1) except at Receptor 9. When a compensation agreement is completed with Receptor 9, such that it is no longer considered a sensitive receptor, it would be compliant to operate under the limited constraints of Scenario 1a. If an agreement was not made with Receptor 9, the mine noise emissions would be compliant when operating under the more significant constraints of Scenario 1b (refer reduced equipment in Table 18).
- Low frequency noise levels are compliant for both Scenarios 1a and 1b (Year 1).
- A-weighted and low frequency noise levels are compliant for Scenario 2 (Year 3) and Scenario 3 (Year 11).

The noise model cannot predict L_1 noise levels, however, it is our experience at various coal mines that where L_1 and L_{eq} noise levels are both dominated by mining noise, the L_1 level tends to be approximately 5 to 8 dB higher than the corresponding L_{eq} noise level. Given that compliance is achieved with the proposed L_{eq} criteria, and the proposed L_1 criteria are 12 dB higher than the L_{eq} criteria, compliance with the L_1 criteria is predicted to be achieved for all the above scenarios.

6.8 Discussion and recommendations

6.8.1 Noise Monitoring, Management and Mitigation

Modelling determined that under all meteorological conditions, only receptors within the MLA (i.e. Receptors 1, 2, 3 and 14) are predicted to exceed noise criteria. Baralaba South Pty Ltd must agree compensation and reach agreement with the receptors on the MLA before the ML may be granted. Baralaba South Pty Ltd also proposes to reach agreement with Receptor 9 as the land parcel partially underlies the MLA, and this will minimise constraints on operations and allow operation as per Scenario 1a modelling, but that would not be required for operation to commence under Scenario 1b constraints.

Given that the predicted noise emission levels are close to the night-time noise limit at some receptors, it is recommended that a Noise Management Plan (NMP) be prepared prior to operations commencing. The NMP should include:

- Measures to avoid noise level exceedances including procuring equipment with an appropriate noise emission level (sound power level), determining appropriate physical mitigation measures (e.g. bunds) as the mine layout changes, and tracking mine noise levels and responding before exceedances occur.
- Noise monitoring requirements:
  - Continuous noise monitoring stations are setup, with one to the north of the mine (e.g. Receptor 9 or Receptor 11) and to the south of the mine (e.g. Receptor 16). These will inform the mine operators in real-time of the mine noise levels experienced in the community, and allow the mine to modify operations, if required, to maintain compliance.
  - Attended noise monitoring is conducted on a six-monthly basis at sites most affected by the mine operations. This monitoring will be used to confirm compliance with EA noise limits.
  - The noise monitoring should be undertaken in accordance with the latest version of the DES Noise Measurement Manual and relevant Australian Standards. Noise monitoring should record one-third octave band noise levels and audio samples, to enable extraneous noise (e.g. farm activities, dogs, insects, high wind speeds) to be removed from the data.
- Processes to enable the mine to promptly react to high community noise and/or vibration/airblast levels from aforementioned monitoring and/or related complaints. Such processes should advise on how the mine will respond.

- Noise mitigation to address noise level exceedances, including:
  - Management of mining equipment locations, such as operating at lower elevation or shielded areas.
  - Reducing the numbers of equipment in operation.
  - Attenuation of additional equipment; and
  - Construction of additional bund walls.

6.8.2 Cumulative noise impacts

The nearest other existing mines are Baralaba North coal mine to the northwest and the Dawson Mine to the south east.

Baralaba North is approximately 11 km away and most operations are further north and approximately 13 km away.

From the results in Table 21, the receptors closed to Baralaba North mine are the northernmost receptors (Receptors 5, 7, 8, and 12). All predicted noise levels at these receptors are at least 7 dBA below the proposed noise limit. These receptors are at least 7 km from the active mining areas of Baralaba North, which is further than their distance from Baralaba South. Given the similar mine sizes, and that Baralaba North operations would be winding down when Baralaba South operations are ramping up, it follows that noise levels from Baralaba North at these northernmost receptors (Receptors 5, 7, 8, and 12) would be less than that predicted from Baralaba South. Therefore, the cumulative noise level would remain significantly below the noise limit. Additionally, it is unlikely that wind conditions would result in Baralaba North noise levels being elevated to the south at the same time as elevated Baralaba South noise levels to the north.

Dawson Mine currently is over 23 kilometres south east from the Baralaba South MLA. Given the significant distance, it is extremely unlikely that cumulative noise impacts from both mines will be an issue.

Overall, cumulative noise is not considered to be an issue for this project.

7 Blasting assessment

The only significant vibration source at the Project will be associated with blasting within the open-cut pit. Blasting activities are assessed with respect to vibration and airblast.

The relevant criteria were outlined in Table 14 and could be summarised as follows:

- Vibration: 115 dB (Linear peak) for majority of blasts.
- Airblast: 5 mm/s for majority of blasts.

The blast details for the project have been provided to AARC as follows:

- Blasts per year: Year 1 = 150, Year 3 = 186, Year 11 = 135
- Typical blast area overburden: 13,333 m^2
- Number of holes per blast in overburden: 274
- Hole diameter (mm): 229 mm
- Burden: 6500 mm
- Stemming height: 5000 mm
- Maximum instantaneous charge (MIC): 1072 kg

7.1 Airblast calculation

7.1.1 Formulae

The following formula for estimation of airblast pressure levels is from AS 2187.2 – 2006:

$$P = K_a (R / Q^{1/3})^a$$

where

P = pressure, in kilopascals

Q = explosives charge mass, in kilograms

R = distance from charge, in metres

K_a = site constant

a = site exponent

For unconfined surface charges, in situations that are not affected by meteorological conditions, a good estimate may be obtained by using a site exponent (a) of −1.45, (which corresponds to an attenuation rate of 8.6 dBL with doubling of distance), and a site constant (K_a) of 516. For confined blasthole charges, when using a site exponent (a) of −1.45, the site constant (Ka) is commonly in the range 10 to 100.

From the ICI Handbook of Blasting Tables[3], airblast overpressure for unconfined surface charges may be estimated using a site exponent (a) of −1.2 and a site constant (K_a) of 185, and for confined blasthole charges may be estimated using a site exponent (a) of −1.2 and a site constant (K_a) of 3.3.

The sound pressure level (L_p Lin Peak) can be determined using the formula:

[3] Refer also DYNO Nobel Blasting and Explosives Quick Reference Guide 2010

$$L_p = 10 \log_{10} (P / P_0)^2$$

where

P = pressure, in kilopascals (calculated from formula above)

P_0 = reference pressure, 20 µPa

An alternative airblast calculation method[4] for confined blasts provides the following empirical formula to determine the distance to the 120 dB (Lin Peak) sound pressure level:

$$D_{120} = (K_b \bullet d/ B)^{2.5} m^{1/3} \text{ (burden-controlled blast)}$$

$$D_{120} = (K_s \bullet d/ SH)^{2.5} m^{1/3} \text{ (stemming-controlled blast)}$$

where

D_{120} = distance to 120 dB (Lin Peak) sound pressure level, in metres

K_b = calibration factor typically ranging from 150 to 250

K_s = calibration factor typically ranging from 80 to 180

d = hole diameter, mm

B = burden (refer Figure 11), mm

SH = stemming height (refer Figure 11), mm

m = explosives charge mass – MIC, in kilograms

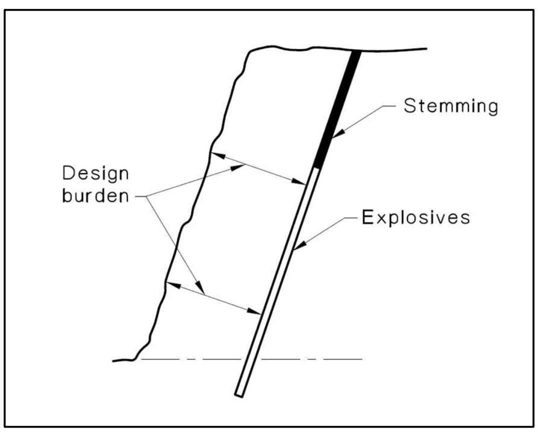

Figure 11: Diagram showing burden and stemming dimensions (ref: AS2187.2 – 2006)

The calibration factors K_b and K_s are determined by site measurement.

Burden controlled blasts produce higher airblast in front of the face than behind the face. Stemming controlled blasts produce equal airblast in all directions.

The distance to the 115 dB sound pressure level can be determined based on an attenuation rate of 8.6 dB per doubling/halving of distance, as noted for the AS 2187.2 criterion above.

[4] Richards, A B and Moore, A J (2002), Airblast Design Concepts in Open Pit Mines, presented at The 7th International Symposium on Rock Fragmentation by Blasting (FRAGBLAST 7), (China Society of Engineering Blasting and Chinese Society of Mechanics: Beijing, China), and other papers by these authors.

7.1.2 Calculations at sensitive receptors

From the above AS2187 formulae and the provided blast parameters, the distance to an airblast level of 115 dB (Lin Peak) can be calculated as follows for confined blasts:

- AS2187 site constants (a = -1.45, K_a = 10 to 100): 1100 to 5300 metres; and
- ICI Handbook site constants (a = -1.2, K_a = 3.3): 1200 metres.

Using the alternative method described above and the provided blast parameters, the calculations result in the following distances to the 120 dB and 115 dB (Lin Peak) sound pressure levels:

- D_{120}
  - 657 to 2356 metres (burden-controlled blast);
  - 263 to 1997 metres (stemming-controlled blast);
- D_{115}
  - 966 to 3463 metres (burden-controlled blast); and
  - 387 to 2935 metres (stemming-controlled blast).

It is noted that the above calculations do not account for meteorological effects (e.g. wind conditions) and terrain effects (e.g. shielding by pit walls and dumps), and these effects will need to be considered in the detailed blast design process.

The nearest receptors are approximately 3 km from the blasting and therefore airblast levels compliant with the 115 dB (Lin Peak) limit in Table 14 are expected based on the above calculations. However, monitoring results from initial blasts should be used to determine site conditions to allow for more accurate airblast calculations.

7.2 Vibration

7.2.1 Formulae

The following formula for estimation of ground vibration levels is from AS 2187.2 – 2006:

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

where

V = ground vibration as vector peak particle velocity, in millimetres per second

Q = maximum instantaneous charge (effective charge mass per delay), in kilograms

R = distance from charge, in metres

K_g, B = site constant related to site and rock properties for estimation purposes

Ground vibration levels depend on the maximum instantaneous charge (effective charge weight per delay), and not the total charge weight, provided the effective delay interval is appropriate.

When blasting is to be carried out to a free face in average field conditions, the following site constants may be used to estimate the mean (50% probability of exceedance) vector peak particle velocity: K_g = 1140, B = 1.6 (i.e. -B = -1.6). AS 2187.2 – 2006 suggests that due to variations in ground conditions and other factors, the resulting ground vibration levels can vary from two-fifths to four times that estimated. In cases where the site parameters have not been reliably determined from prior experience, advice should be obtained from suitably qualified and experienced persons, who may recommend initial trial blasts with conservative charge quantities.

The following site constants have been used as advised by Baralaba Coal Pty Ltd based on measurement data at the Baralaba North mine:

- Site exponent (B) (attenuation rate) of 1.8
- Site constant (K_g) in the range 530 to 1600

7.2.2 Calculations

Using the method described above and the provided blast parameters, the calculations result in the following mean vibration levels at various distances.

Table 23: Calculated vibration levels at various distances from blast

Distance	Vibration level mm/s (PPV) – default site constant B = 1.8, K_g = 530	Vibration level mm/s (PPV) – default site constant B = 1.8, K_g = 1140	Vibration level mm/s (PPV) – default site constant B = 1.8, K_g = 1600
0.5 km	3.9	8.4	11.8
1.0 km	1.1	2.4	3.4
2.0 km	0.3	0.7	1.0
3.0 km	0.2	0.3	0.5
4.0 km	0.1	0.2	0.3
5.0 km	0.1	0.1	0.2
6.0 km	<0.1	0.1	0.1
7.0 km	<0.1	0.1	0.1
8.0 km	<0.1	0.1	0.1
9.0 km	<0.1	<0.1	0.1
10.0 km	<0.1	<0.1	0.1

Given the nearest receptor is approximately 3 km from the blasting, the predicted vibration levels are below 1 mm/s and therefore comply with the 5 and 10 mm/s limits in Table 14.

7.3 Assessment

The nearest receptors are approximately 3 km from the blasting and therefore airblast levels compliant with the 115 dB (Lin Peak) limit in Table 14 are expected for the majority of potential site conditions based on the above calculations. However, as per standard practice, initial blasts should be used to determine site conditions to allow for more accurate airblast calculations.

Vibration levels are calculated to be compliant for the full range of the expected site conditions.

8 Conclusions

A noise and vibration impact assessment has been conducted for the proposed Baralaba South Project.

The following comments are made regarding the assessment:

- Baseline noise monitoring was conducted at three receptor locations.
- The modelling considers mining years 1, 3 and 11. Due to the proximity of Year 1 dumping activities to Receptor 9 to the north, two versions of Scenario 1 are modelled, with Scenario 1a aiming for compliance at all sensitive receptors except Receptor 9, and Scenario 1b aiming for compliance at all sensitive receptors including Receptor 9. The noise assessment therefore considered the following four scenarios:
    - Scenario 1a: Year 1 mine site layout and equipment numbers.
    - Scenario 1b: Year 1 mine site layout with reduced equipment numbers.
    - Scenario 2: Year 3 mine site layout and equipment numbers.
    - Scenario 3: Year 11 mine site layout and equipment numbers.
- Modelling has been based on attenuation packages for all haul trucks and the Caterpillar D11T tracked dozers (located on the dump) as presented in Table 17, equipment numbers included in Table 18, and noise bunding to dumps and haul roads as per Table 20. The Mine Operator may choose to use a different combination of mitigation measures in addition to equipment selection and location to achieve the same noise level outcomes.
- Calculations have also been made to predict noise and vibration levels due to blasting.

The proposed noise criteria are shown below (refer Table 13).

Noise level dBA measured as:	**All days**		
	Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
Sensitive Place			
$L_{Aeq,adj,15min}$	40	40	35
$L_{A1,adj,\ 15min}$	52	52	47
Commercial Place			
$L_{Aeq,adj,15min}$	47	47	42

The proposed blasting noise and vibration criteria are shown below (refer Table 14).

Blasting noise and vibration limits	**Sensitive place and commercial place criteria**	
	Monday to Friday 7am to 6pm; **Saturday, Sunday and Public Holidays 9am – 6pm**	**Other times**
Airblast overpressure	115 dB (Linear peak) for 9 out of 10 consecutive blasts and not greater than 120 dB (Linear peak) at any time	No blasting
Ground vibration	5 mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting

The conclusions of the assessment are as follows:

- Noise
  - Compliance is not assessed at Receptors 1, 2, 3 and 14 as they are located on the MLA and are therefore not considered sensitive receptors. These properties will be directly affected by the mine and will therefore need to be acquired by the mine.
  - A-weighted L_{eq} noise levels are compliant for Scenario 1a (Year 1) except at Receptor 9. When a compensation agreement is completed with Receptor 9, such that it is no longer considered a sensitive receptor, it would be compliant to operate under the limited constraints of Scenario 1a. If an agreement was not made with Receptor 9, the mine noise emissions would be compliant when operating under the more significant constraints of Scenario 1b.
  - A-weighted L_{eq} noise levels are compliant for Scenario 2 (Year 3) and Scenario 3 (Year 11).
  - Low frequency L_{eq} noise levels are compliant for all scenarios.
  - L_1 noise levels are compliant for all scenarios.
  - Cumulative noise has been assessed and is not expected to affect compliance and is therefore considered acceptable.
- Blasting
  - The nearest sensitive receptors are located approximately 3 km from the proposed blasting.
  - Vibration levels are predicted to be compliant at all sensitive receptors.
  - Airblast levels are predicted to be compliant at all sensitive receptors for the majority of potential site conditions. However, initial blasts should be used to determine specific site conditions to allow for more accurate airblast calculations. Blast parameters are to be adjusted to ensure compliance at all sensitive receptors.

The recommendations of the assessment are as follows:

- The mine EA should include the noise and blasting criteria proposed in Table 13 and Table 14.
- A Noise Management Plan should be prepared prior to operations commencing.
- Continuous noise monitoring stations are to be setup, including one to the north of the mine (e.g. Receptor 9 or Receptor 11) and one to the south of the mine (e.g. Receptor 16).
- Attended noise monitoring is to be conducted on a six-monthly basis at sites most affected by the mine operations.
- Blast monitors should be setup at the nearest receptor/s to monitor airblast and vibration during blasts.

With the inclusion of the proposed recommendations, noise and blast impacts are predicted to be compliant with the relevant regulations.

References

Department of Environment and Science (DES) 2012, *Guideline (EP Act): Application requirements for activities with noise impacts*, version 3.06, Department of Environment and Science, State of Queensland.

Department of Environment and Science (DES) 2017, *Guideline (EP Act)*: *Model mining conditions [*ESR/2016/1936*],* version 6.02, Department of Environment and Science, State of Queensland.

Department of Environment and Science (DES) 2019, *Environmental Protection (Noise) Policy 2019*, Department of Environment and Science, State of Queensland.

Standards Australia 2006, *Explosives - Storage, Transport and Use (AS2187.2:2006*), Standards Australia (Standards Association of Australia).

ASK Consulting Engineers Pty Ltd (ASK) 2021, Baralaba South noise report of (Report reference: Trinity Consultants Pty Ltd, 197401.0016.R01V02, dated 20/04/2021).

Appendix A. Terminology and descriptors

Table 24: Terminology and descriptors

Term or Descriptor	Definition
Noise	Noise is unwanted, harmful or inharmonious (discordant) sound. Noise usually includes vibration as well as sound.
Audible	Audible refers to a sound that can be heard. There are a range of audibility grades, varying from “barely audible”, “just audible” to “clearly audible” and “prominent”.
Ambient noise	The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Usually assessed as an energy average over a set time period ‘T’ ($L_{Aeq,T}$).
Decibel or dB	The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from 10 $\log_{10}(10^{(50/10)} + 10^{(50/10)})$ and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB.
‘A’ frequency weighting	The ‘A’ frequency weighting roughly approximates to an equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child’s scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The ‘A’ weighting is the most commonly used frequency weighting for occupational and environmental noise assessments. However, for environmental noise assessments, adjustments for the character of the sound will often be required.
‘Z’ frequency weighting	The ‘Z’ (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. A Z-weighted noise level will be higher than the A-weighted noise level for the same noise source due to the different weightings.
Sound pressure level, L_p	The level of sound measured on a sound level meter and expressed in decibels (dB). Where $L_P = 10 \log_{10}(Pa/Po)^2$ dB (or $20 \log_{10}(Pa/ Po)$ dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20×10^{-6} Pa) for airborne sound. L_p varies with distance from a noise source.
Sound power level, L_w	The sound power level of a noise source is the inherent noise of the device. Therefore sound power level does not vary with distance from the noise source or with a different acoustic environment. $L_w = L_p + 10 \log10$ ‘a’ dB, re: 1pW, (10-12 watts) where ‘a’ is the measurement noise-emission area (m^2) in a free field.
Free-field	In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.
Frequency	The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

Term or Descriptor	Definition
Loudness	The volume to which a sound is audible to a listener is a subjective term referred to as loudness. Humans generally perceive an approximate doubling of loudness when the sound level increases by about 10 dB and an approximate halving of loudness when the sound level decreases by about 10 dB.
Equivalent continuous sound level, L_{Aeq}	Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. Most modern sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - L_{Aeq}) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short-term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.
LP L_{Aeq} (also LP L_{eq})	The low pass (LP) L_{Aeq} (see definition above) is summed over the lower frequency range of 20 to 630 Hz.
Statistical noise levels, L_n (e.g. L_1, L_{10}, L_{90})	Noise which varies in level over a specific period of time 'T' (standard measurement times are often 15-minute periods) may be quantified in terms of various statistical descriptors with some common examples: • The noise level, in decibels, exceeded for 1 % of the measurement time period, is reference to as L_1. This may be used for describing short-term noise levels such as could cause sleep arousal during the night. • The noise level, in decibels, exceeded for 10 % of the measurement time period, is reference to as L_{10}. In most countries the L_{10} is measured over periods of 15 minutes and is used to describe the average maximum noise level. The noise level, in decibels, exceeded for 90 % of the measurement time period, is reference to as L_{90}. In most countries the L_{90} is measured over periods of 15 minutes and is used to describe the average minimum or background noise level.
Background noise level, L_{90}	Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. It is quantified by the noise level that is exceeded for 90 % of the measurement period 'T' ($L_{A90,T}$). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15-minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.
LP L_{A90} (also L_{90LF}, L_{A90LF}, LP L_{90}, or $L_{A90(20\text{-}630Hz)}$)	The low pass (LP) L_{A90} (see definition above) is summed over the lower frequency range of 20 to 630 Hz.
Maximum noise level, L_{max}	The maximum sound pressure level measured with sound level meter over a time period. If referring to a calculated noise level it may be referring to an average maximum noise level, though this should be clear in the report text.
Minimum noise level, L_{min}	The minimum sound pressure level measured with sound level meter over a time period.
Blasting related terminology	
Amplitude	The measurement of energy or movement in a vibrating object. Amplitude is measured and expressed in three ways: Displacement (commonly in mm Pk-Pk); Velocity (commonly in mm/s Pk); and Acceleration (commonly in m/s2 RMS). Amplitude is also the y-axis of the vibration time waveform and spectrum, it helps define the severity of the vibration.
Blast monitor	An instrument that measures seismic waves along three mutually perpendicular axes (x, y, z) to determine Peak Particle Velocity.

Term or Descriptor	Definition
Decibel or dB	A unit of sound measurement which quantifies pressure fluctuations associated with noise and overpressure.
dB (Lin Peak)	Decibel associated with the maximum excess pressure in the overpressure wave. Lin represents linear - indicating that no weighting or adjustment is made to the measurement.
Frequency	The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.
Ground vibration	Motion of the ground caused by the passage of seismic waves originating from a blast. The rate of the ground vibration movement is called Peak Particle Velocity (PPV) and is measured in millimetres per second (mm/sec).
Hertz (Hz)	Vibration can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. The frequency of vibration and sound is measured in hertz (Hz). Once hertz is one cycle per second. Structural Vibration is generally measured over the frequency range from 1Hz to 500Hz (0.5kHz).
Maximum Instantaneous Charge (MIC)	Maximum amount of explosive detonated per delay.
Overpressure	A pressure wave in the atmosphere which is caused by the detonation of explosives. Overpressure consists of both an audible (noise) and inaudible energy is measured in dB (Lin Peak).
Peak to peak (Pk-Pk)	This is the measure of the vibration amplitude, maximum to minimum, equal to twice the RMS value of a sine wave.
Peak particle velocity (PPV)	Vibration velocity can be measured in a number of ways. For some projects vibration levels can be given in terms of Peak Particle Velocity (PPV).
Peak vector sum	The resultant particle velocity magnitude or vector sum of the transverse, vertical and longitudinal particle velocity components.
RMS velocity	For most applications where there is continuous vibration, vibration is measured in terms of root mean square RMS velocity (mm/sec).
Spectrum	The spectrum is the result of transforming a time domain signal to the frequency domain. Spectrum analysis is the procedure of doing the transformation, and it is most commonly done with an FFT analyser.

Note: References include (1): https://aaac.org.au/Terminology, (2) Blasting and the NSW Minerals Industry, NSW Minerals Council

Appendix B. Noise logging results

Table 25: Statistical analysis of noise logging results

Parameter	Location	Noise level statistics Maximum – Top 10% - (Average) – Bottom 10% - Minimum		
		Day	**Evening**	**Night**
L_{max}	A (Receptor 20)	91-76-(64)-51-37	75-62-(46)-30-23	75-57-(39)-26-21
	B (Receptor 3)	76-67-(55)-45-33	67-51-(41)-29-20	84-55-(41)-25-18
	C (Receptor 9)	85-71-(65)-58-45	75-70-(59)-35-23	87-69-(52)-28-21
L_1	A (Receptor 20)	82-64-(52)-42-28	63-51-(34)-21-19	67-45-(28)-20-18
	B (Receptor 3)	69-56-(45)-35-29	58-46-(35)-22-17	69-48-(34)-19-17
	C (Receptor 9)	73-63-(58)-52-39	69-64-(52)-25-18	72-64-(45)-22-18
L_{10}	A (Receptor 20)	59-47-(39)-31-23	52-38-(26)-18-18	55-34-(23)-18-18
	B (Receptor 3)	59-46-(37)-28-22	55-40-(29)-19-16	55-41-(28)-17-16
	C (Receptor 9)	66-52-(46)-40-29	59-52-(38)-20-18	58-49-(33)-20-18
L_{eq}	A (Receptor 20)	67-51-(41)-32-22	49-39-(26)-18-18	53-34-(23)-18-17
	B (Receptor 3)	56-45-(35)-26-21	51-37-(27)-18-16	55-38-(26)-17-16
	C (Receptor 9)	61-50-(45)-40-30	55-50-(40)-21-18	60-49-(35)-19-18
L_{90}	A (Receptor 20)	39-31-(25)-20-18	44-28-(20)-18-17	37-22-(19)-17-17
	B (Receptor 3)	43-32-(24)-19-17	47-33-(21)-16-16	44-27-(19)-16-16
	C (Receptor 9)	45-34-(27)-21-18	38-26-(21)-18-18	35-27-(21)-18-18

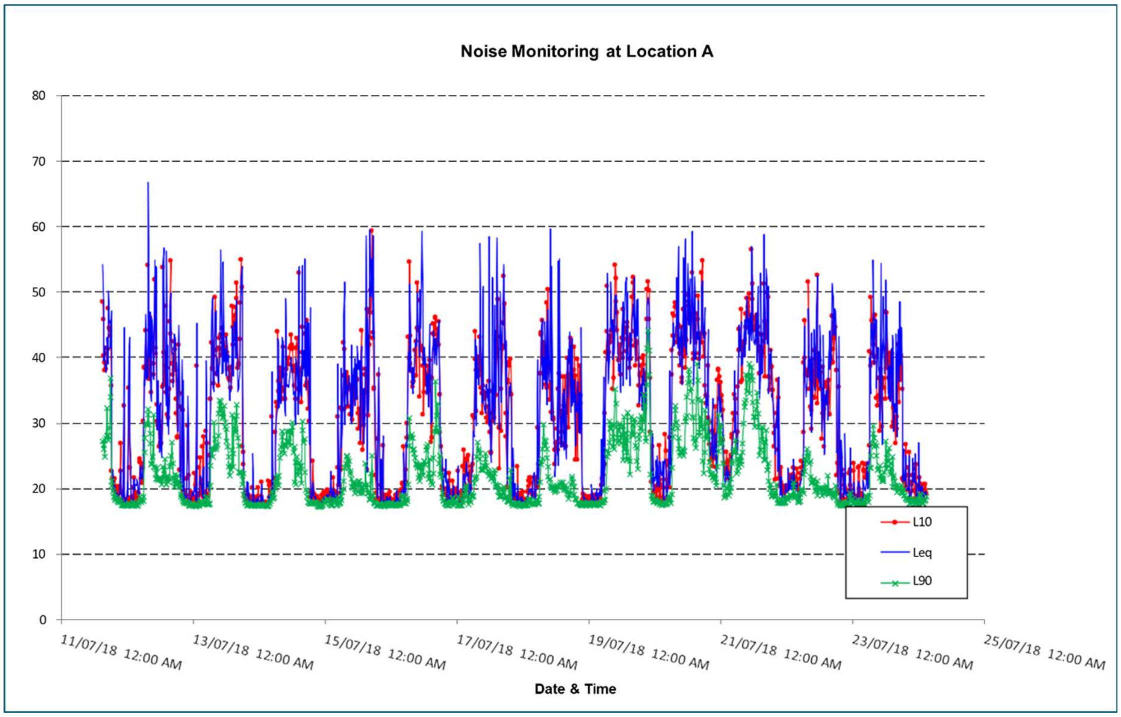

Figure 12: Noise logging results at Location A (Receptor 20)

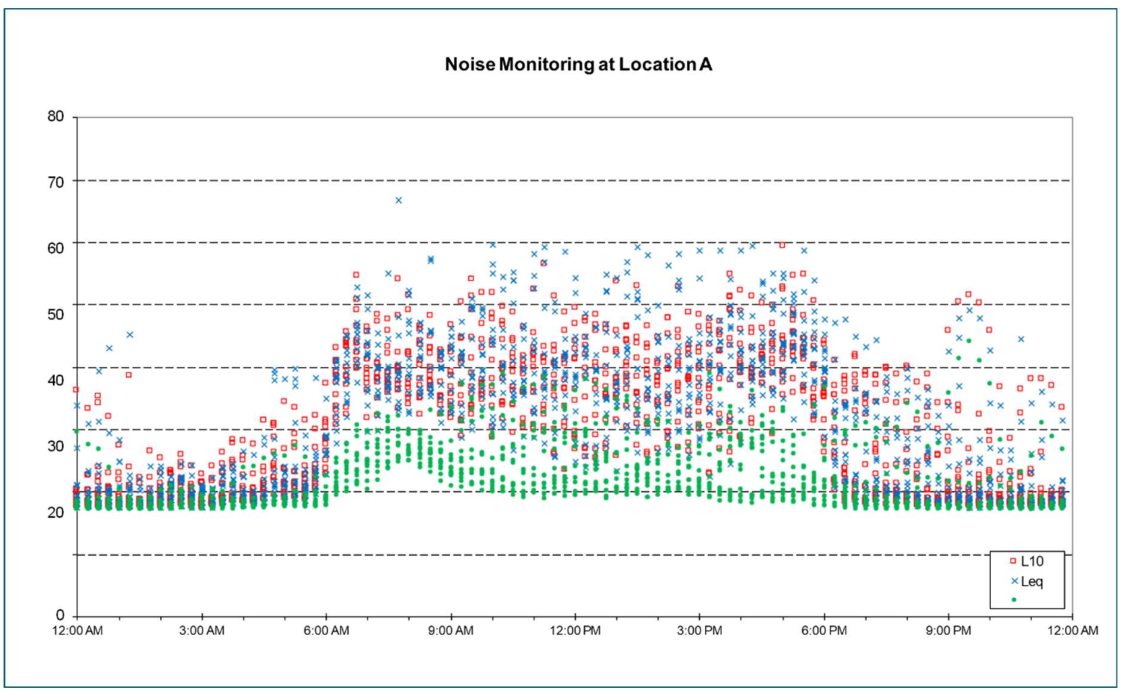

Figure 13: Noise logging results at Location A (Receptor 20) – 24 hour X-axis

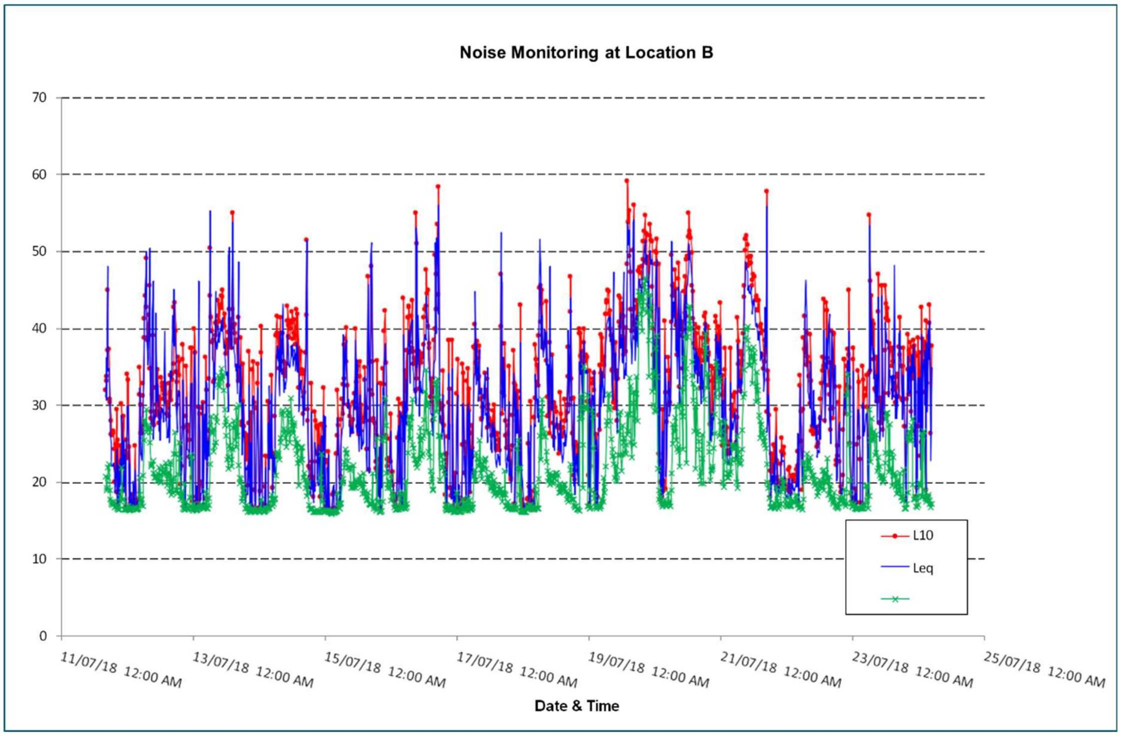

Figure 14: Noise logging results at Location B (Receptor 3)

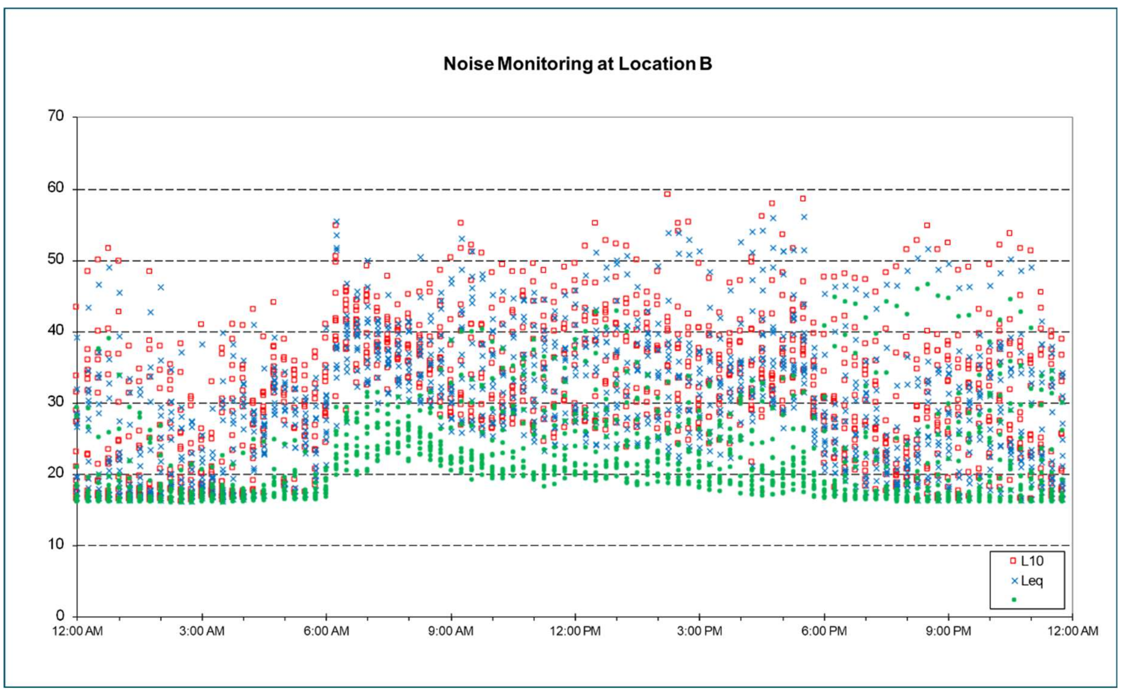

Figure 15: Noise logging results at Location B (Receptor 3) – 24 hour X-axis

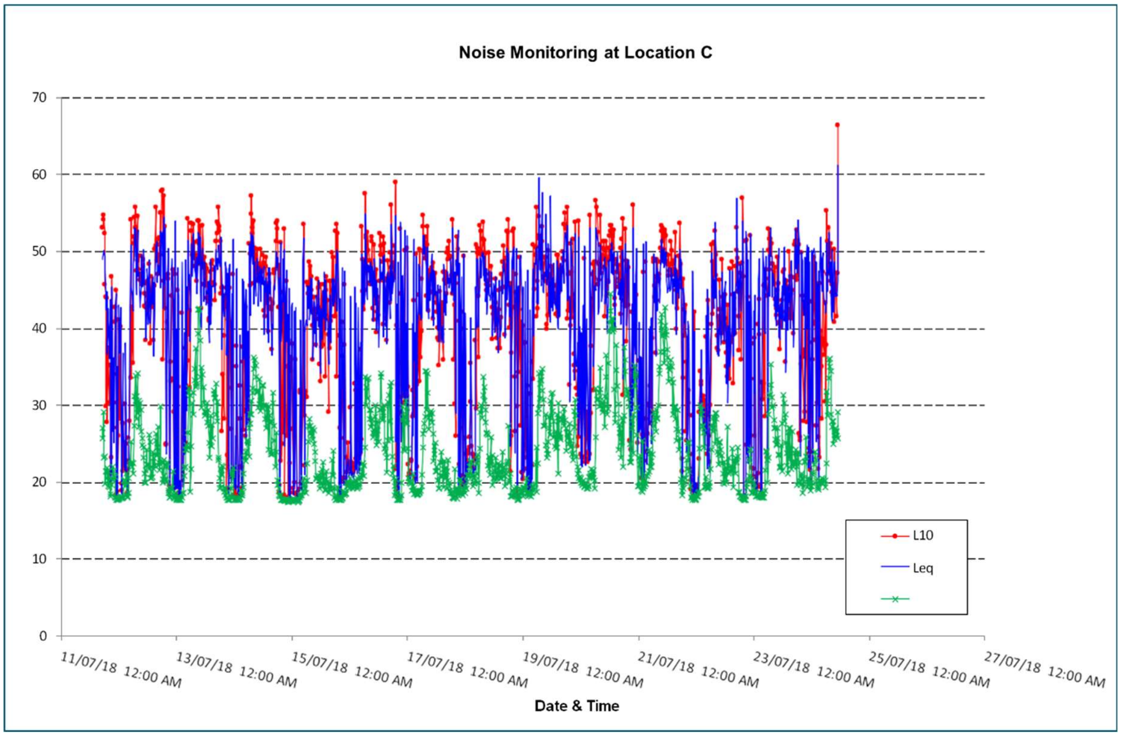

Figure 16: Noise logging results at Location C (Receptor 9)

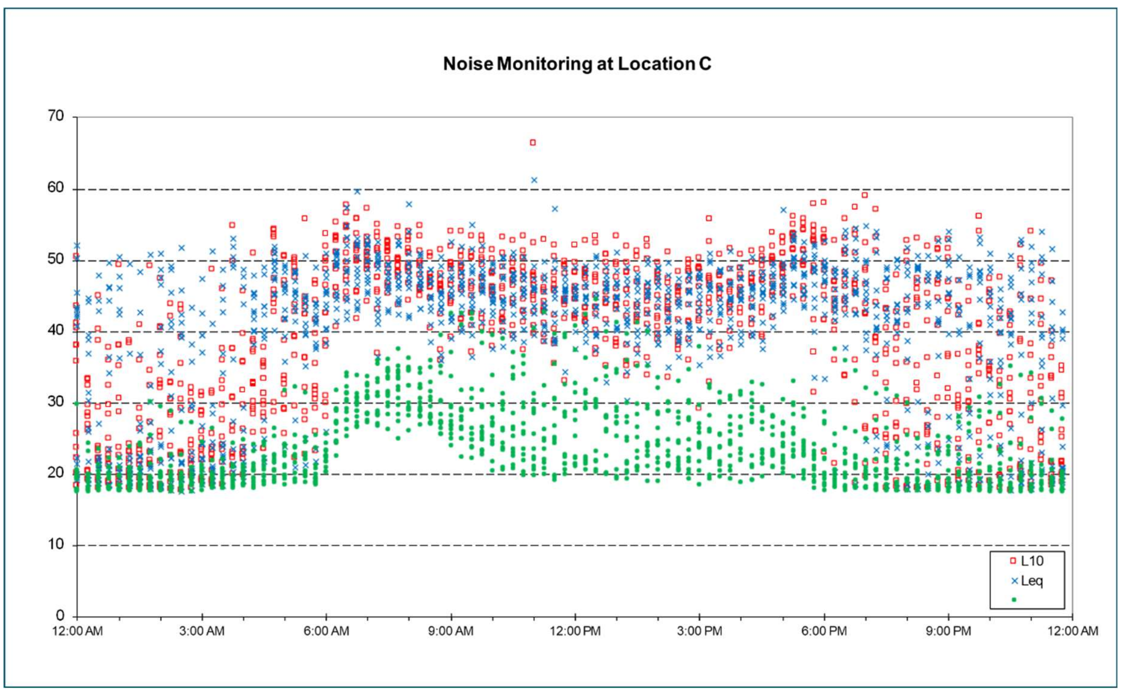

Figure 17: Noise logging results at Location C (Receptor 9) – 24 hour X-axis

Appendix C. Modelled equipment locations

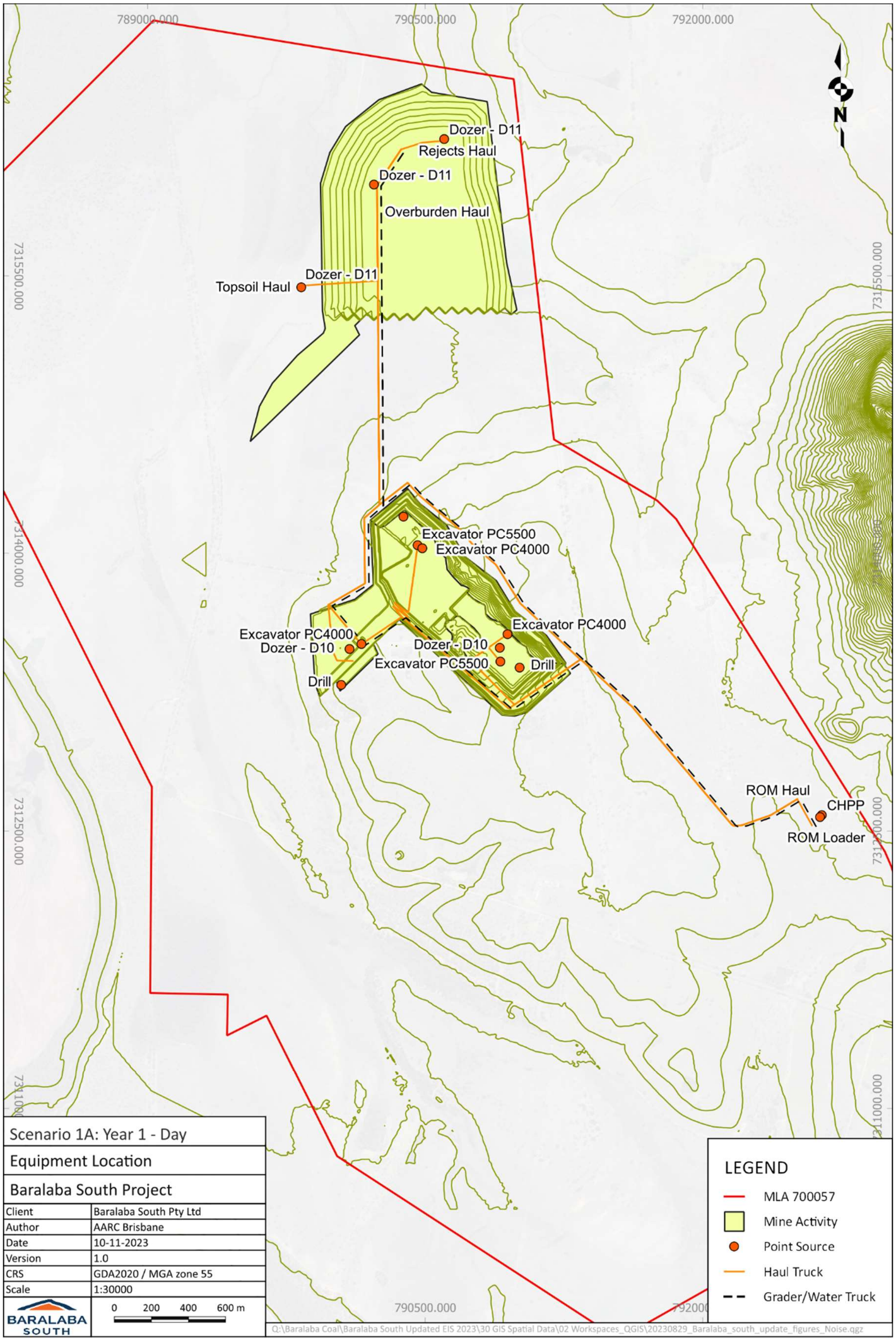

Figure 18: Modelled equipment locations – Scenario 1a: Year 1 (day)

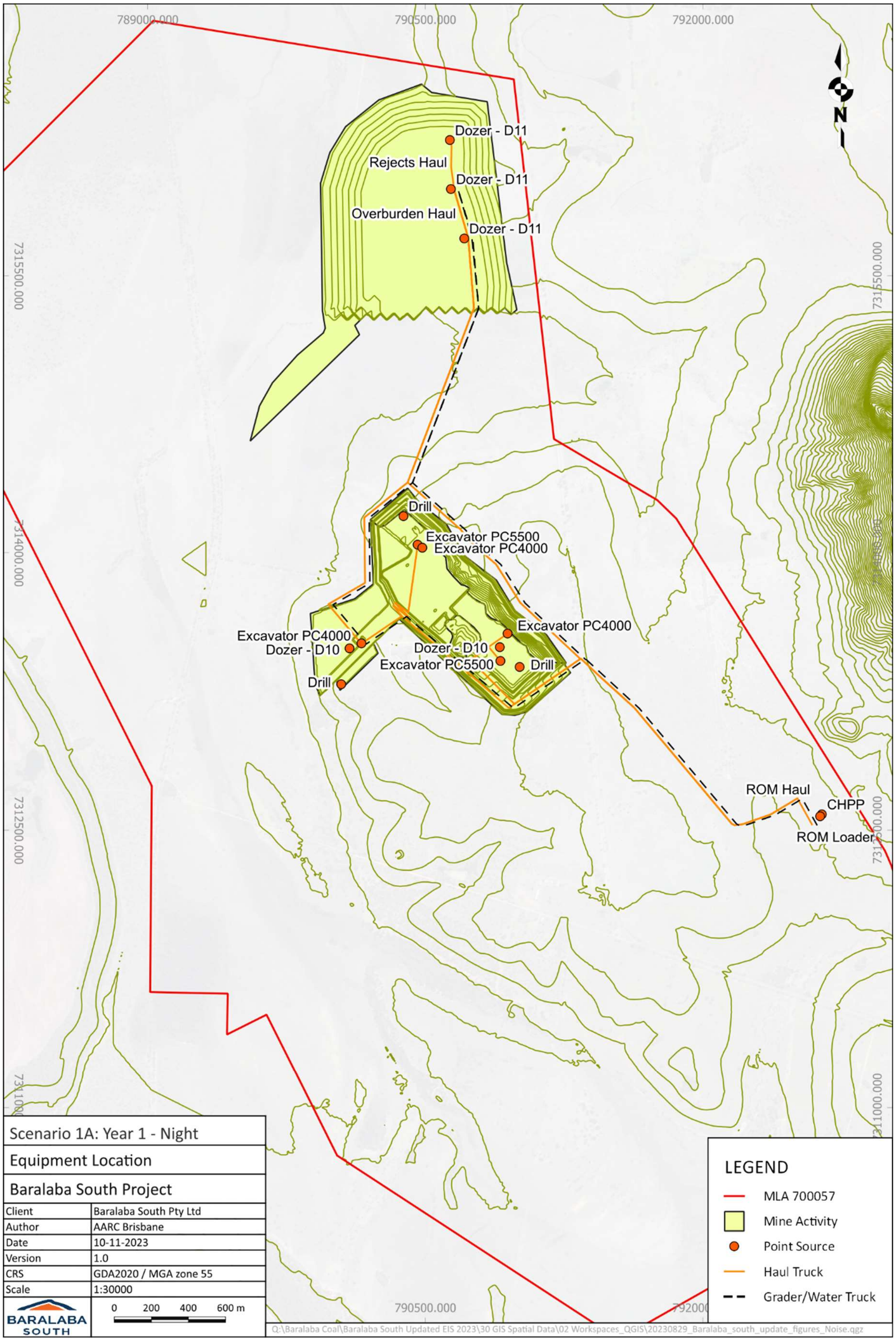

Figure 19: Modelled equipment locations – Scenario 1a: Year 1 (night)

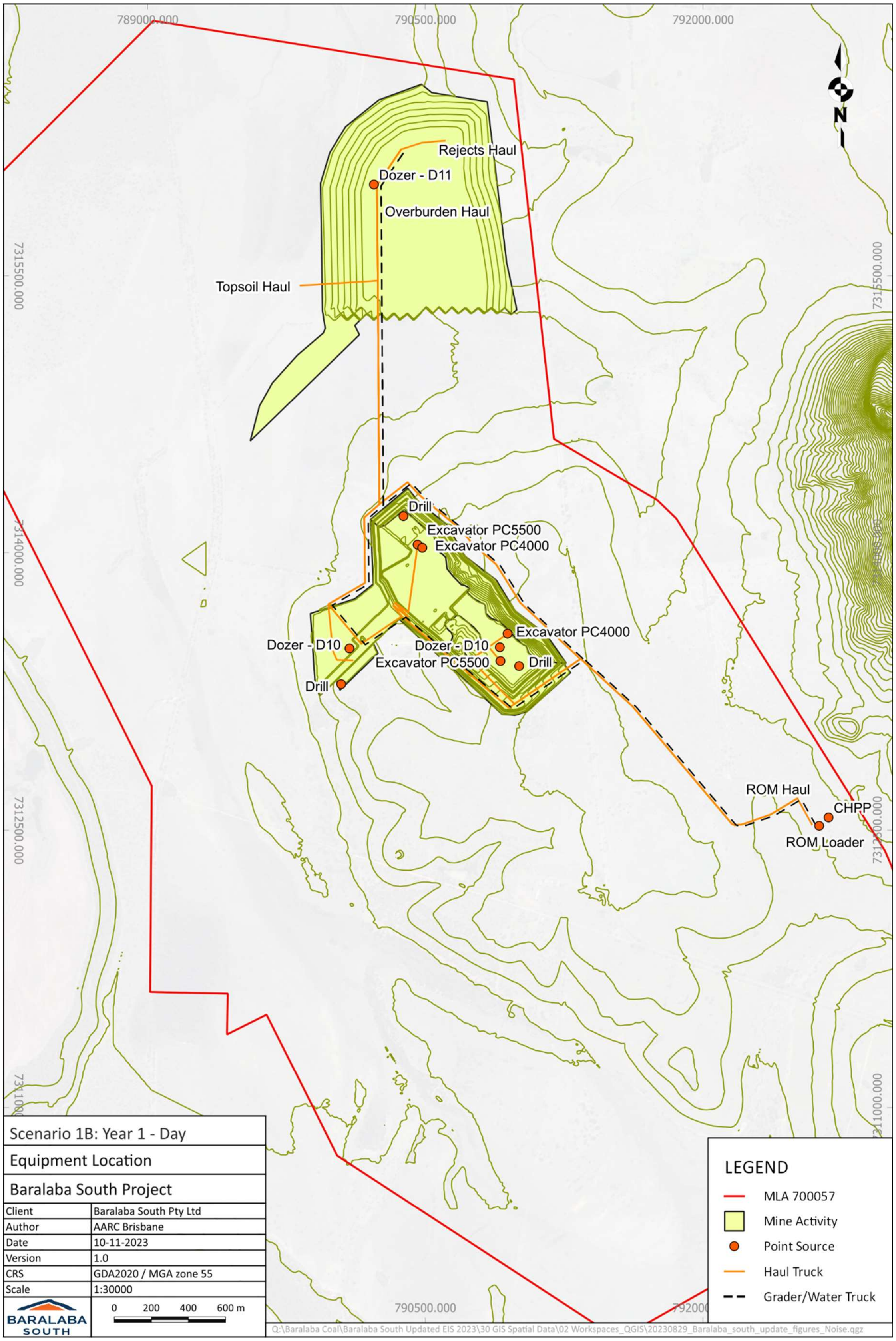

Figure 20: Modelled equipment locations – Scenario 1b: Year 1 (day)

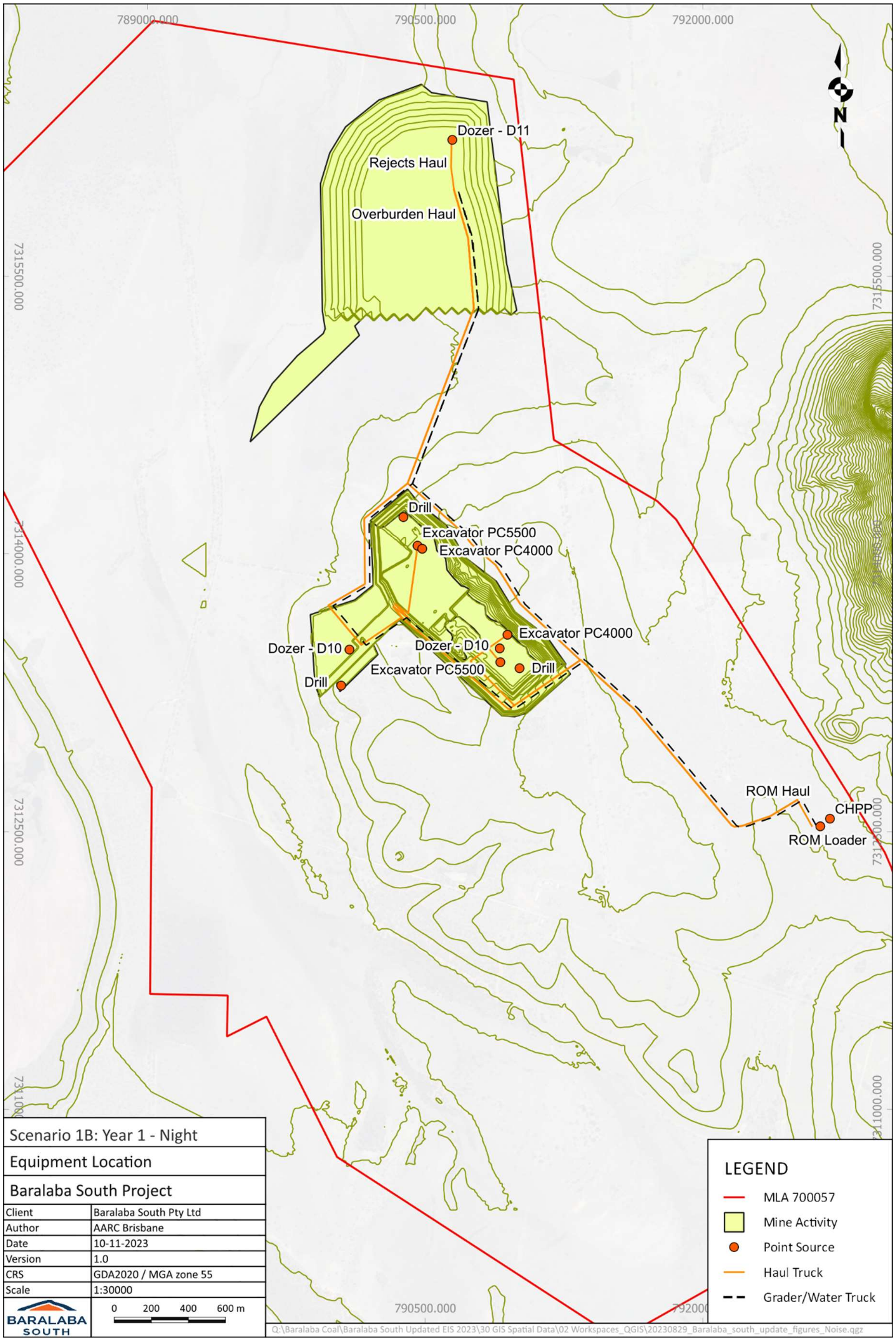

Figure 21: Modelled equipment locations – Scenario 1b: Year 1 (night)

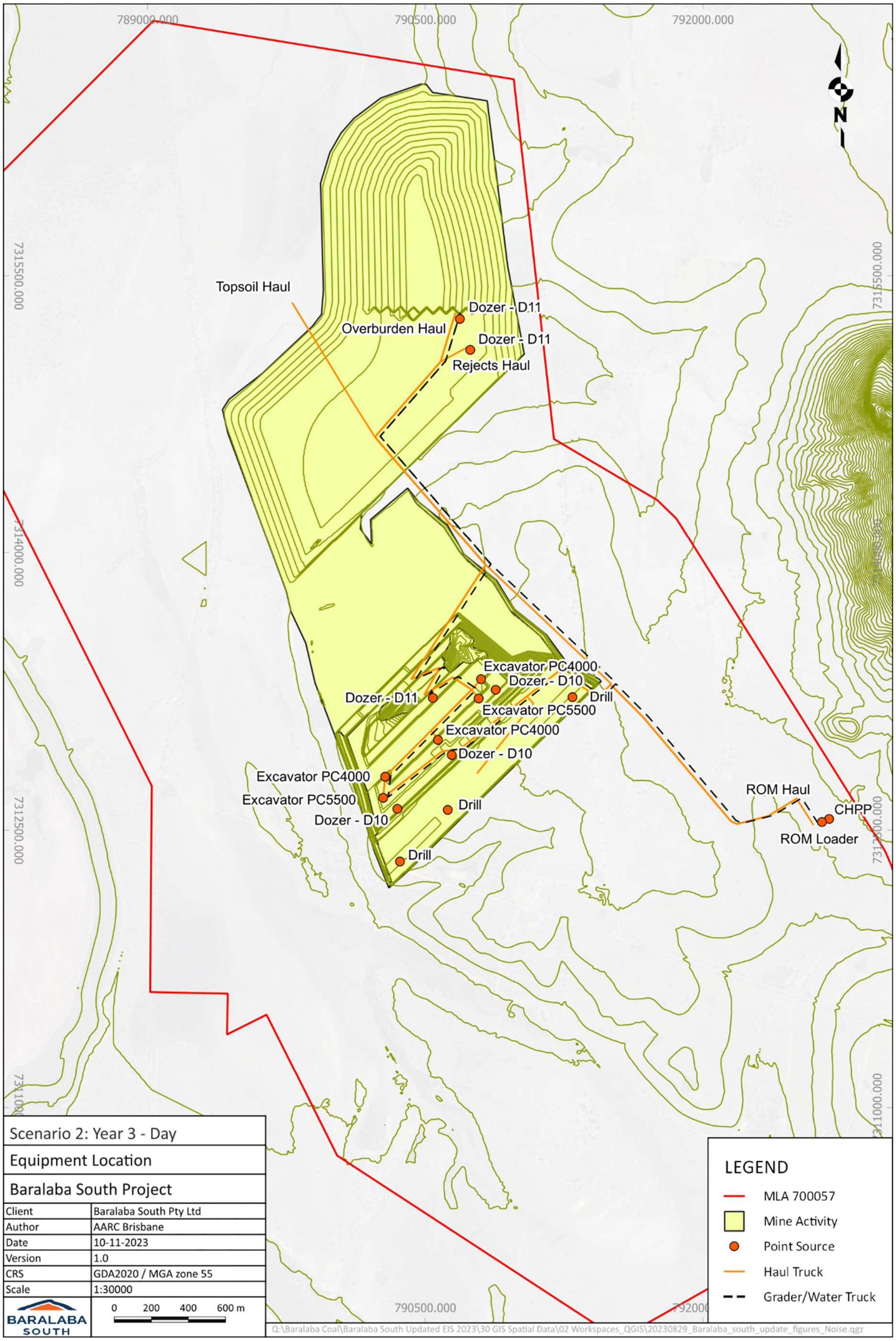

Figure 22: Modelled equipment locations – Scenario 2: Year 3 (day)

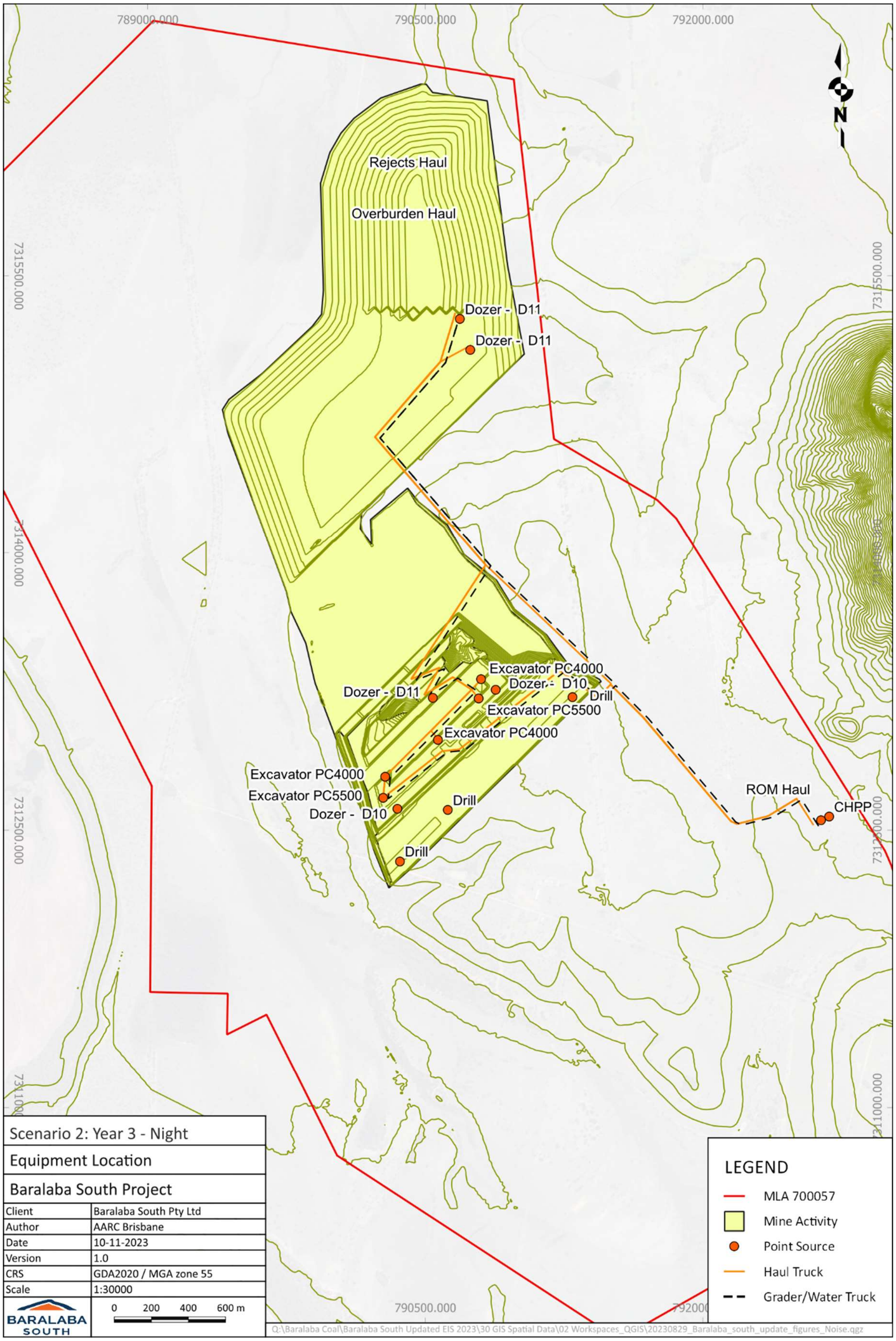

Figure 23: Modelled equipment locations – Scenario 2: Year 3 (night)

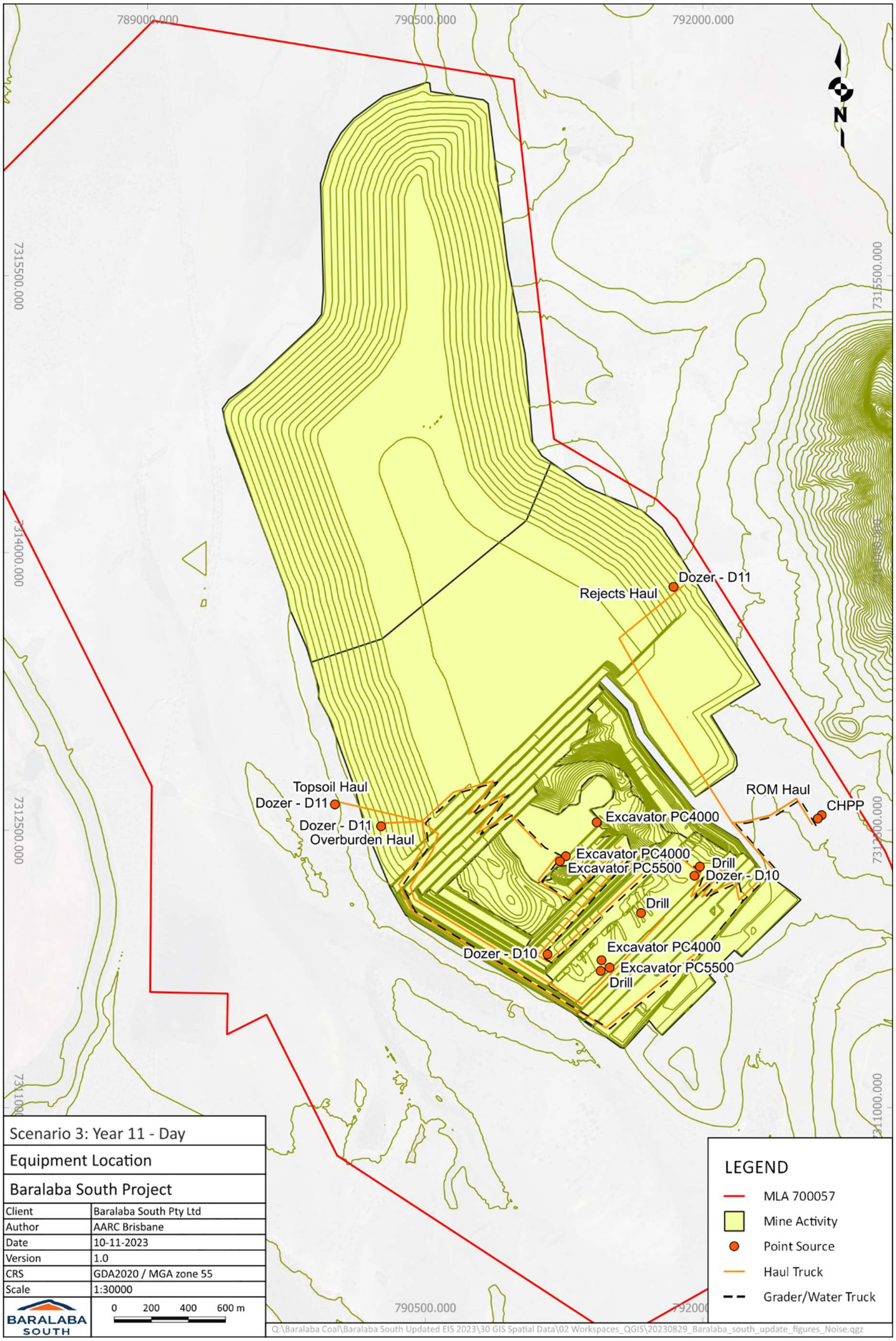

Figure 24: Modelled equipment locations – Scenario 3: Year 11 (day)

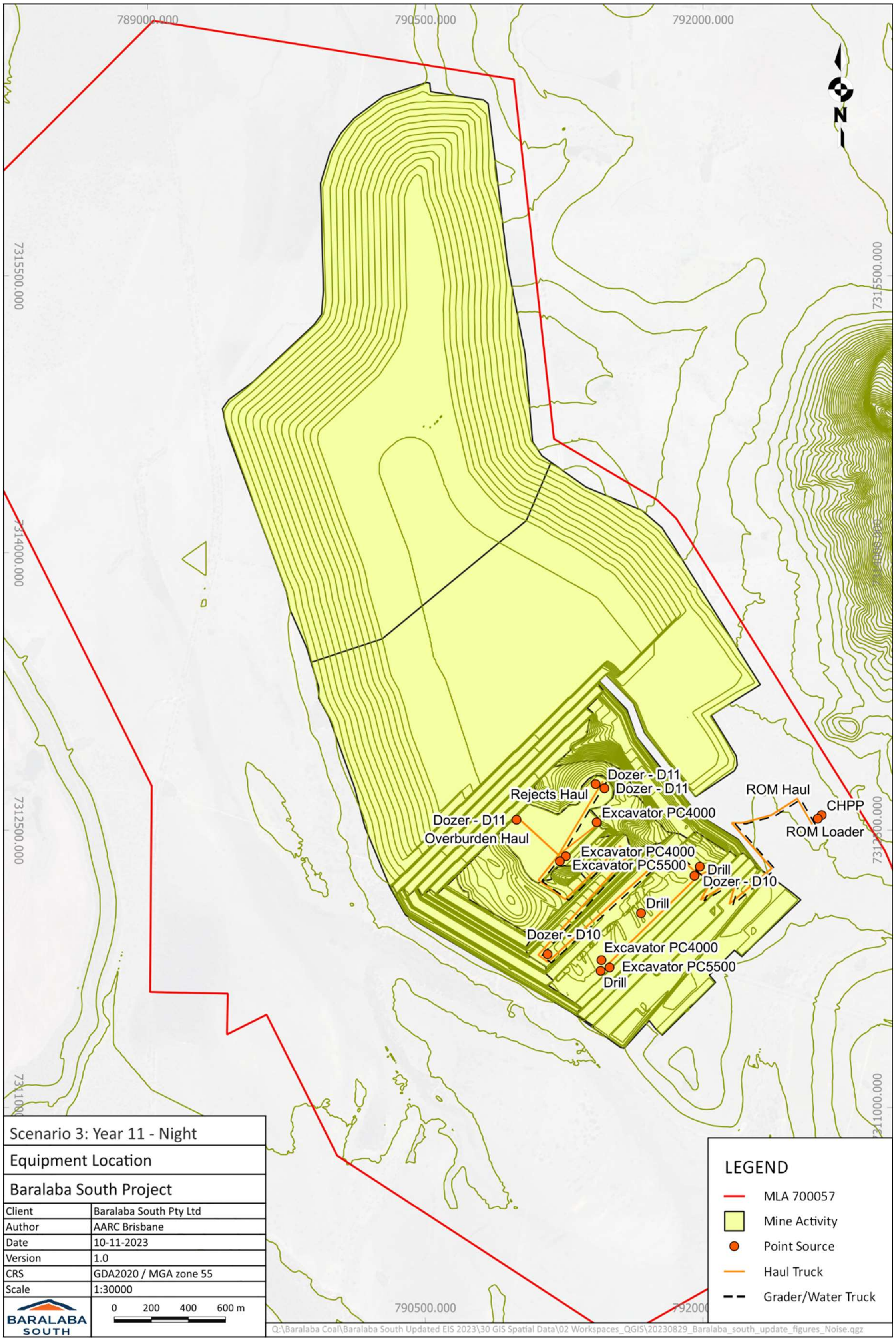

Figure 25: Modelled equipment locations – Scenario 3: Year 11 (night)

Appendix D. Noise model contours

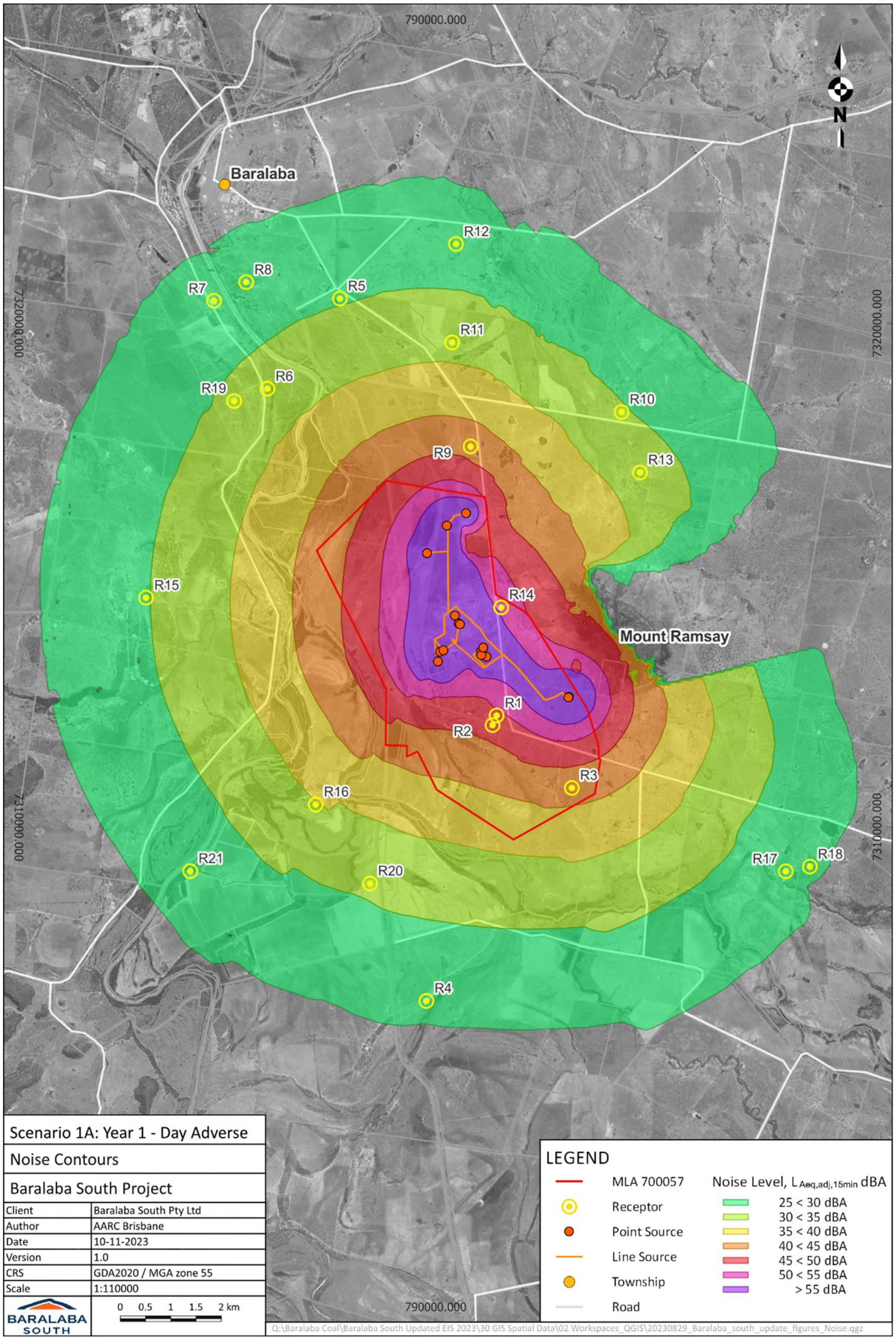

Figure 26: Noise contours – Scenario 1a: Year 1 (day-adverse)

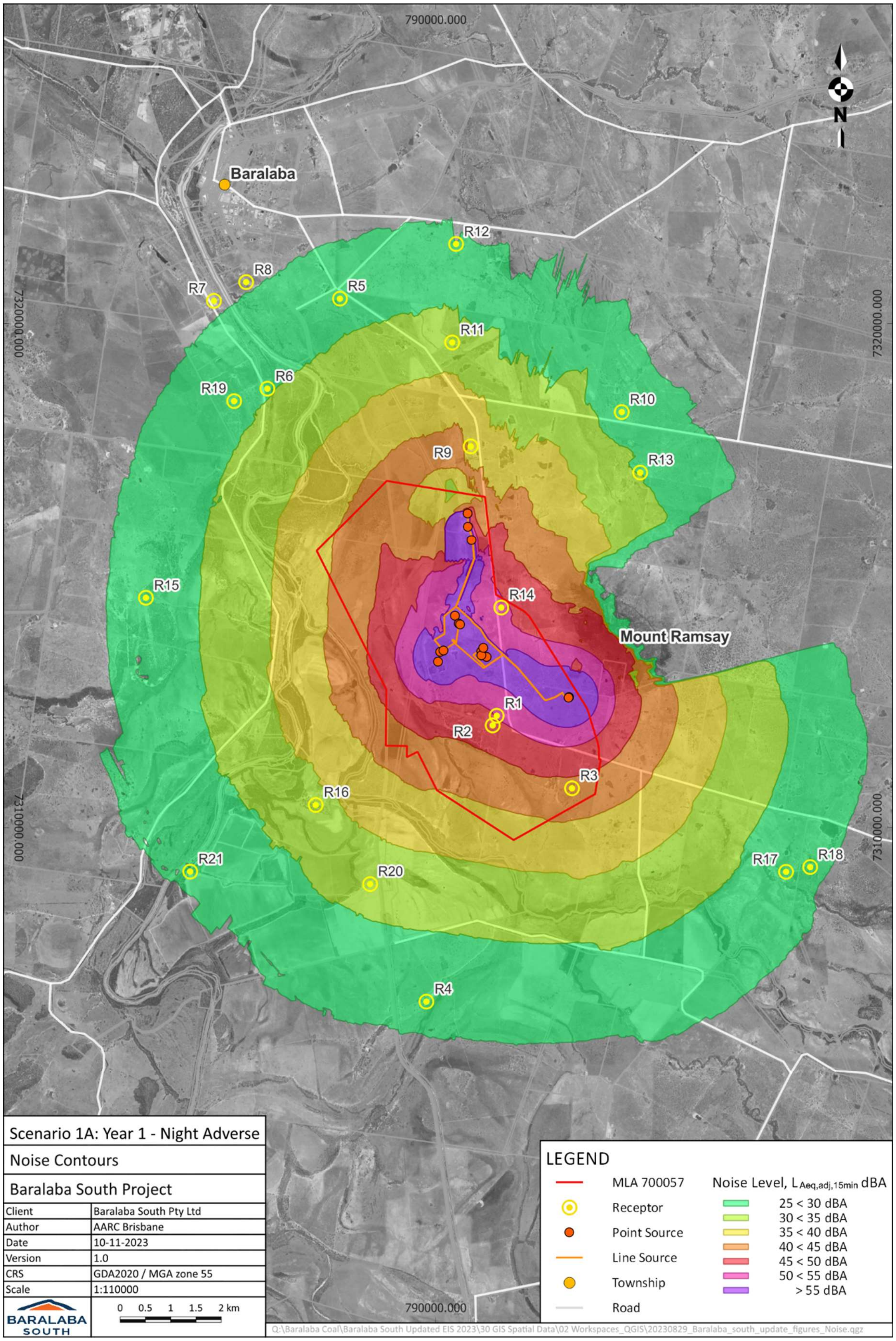

Figure 27: Noise contours – Scenario 1a: Year 1 (night-adverse)

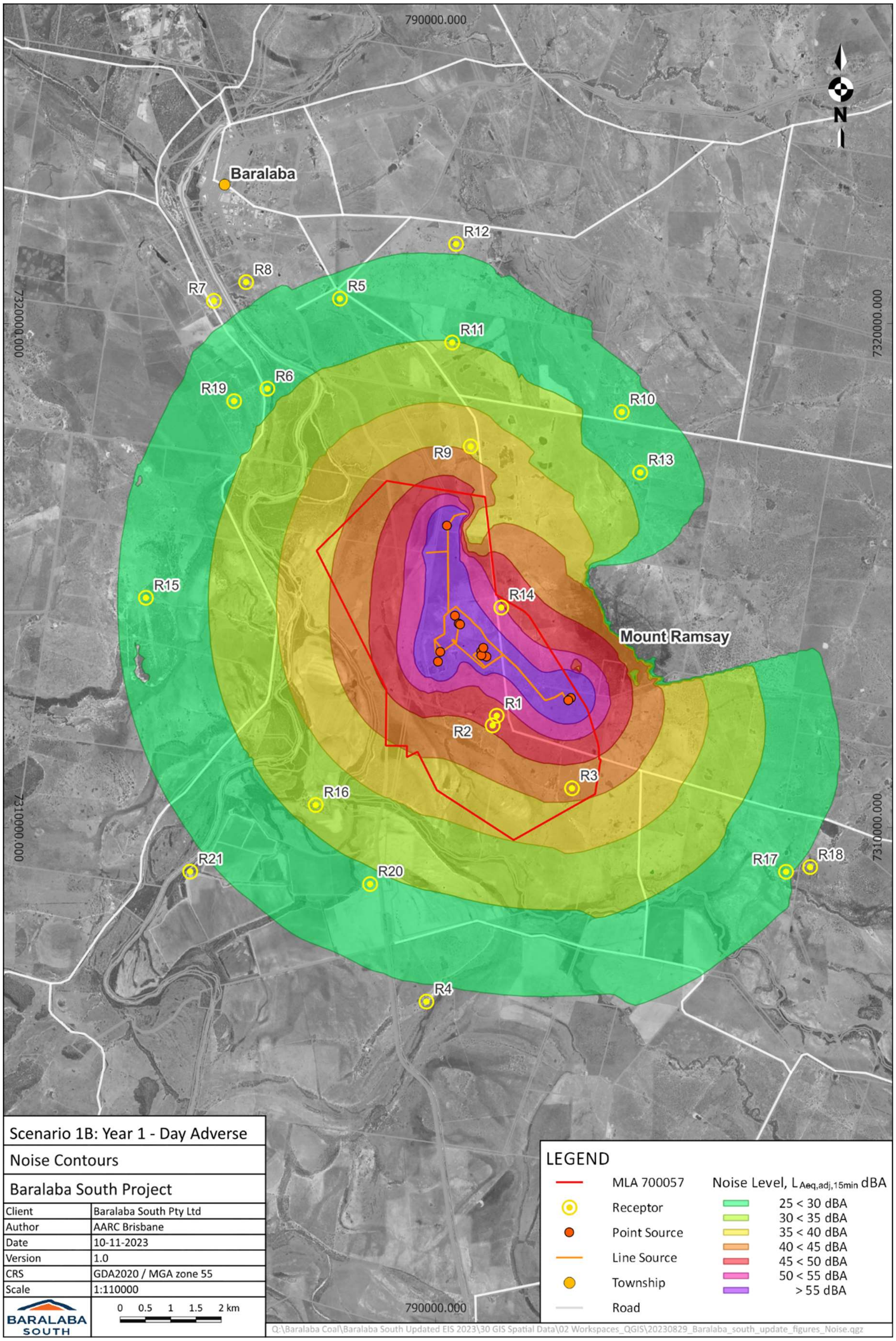

Figure 28: Noise contours – Scenario 1b: Year 1 (day-adverse)

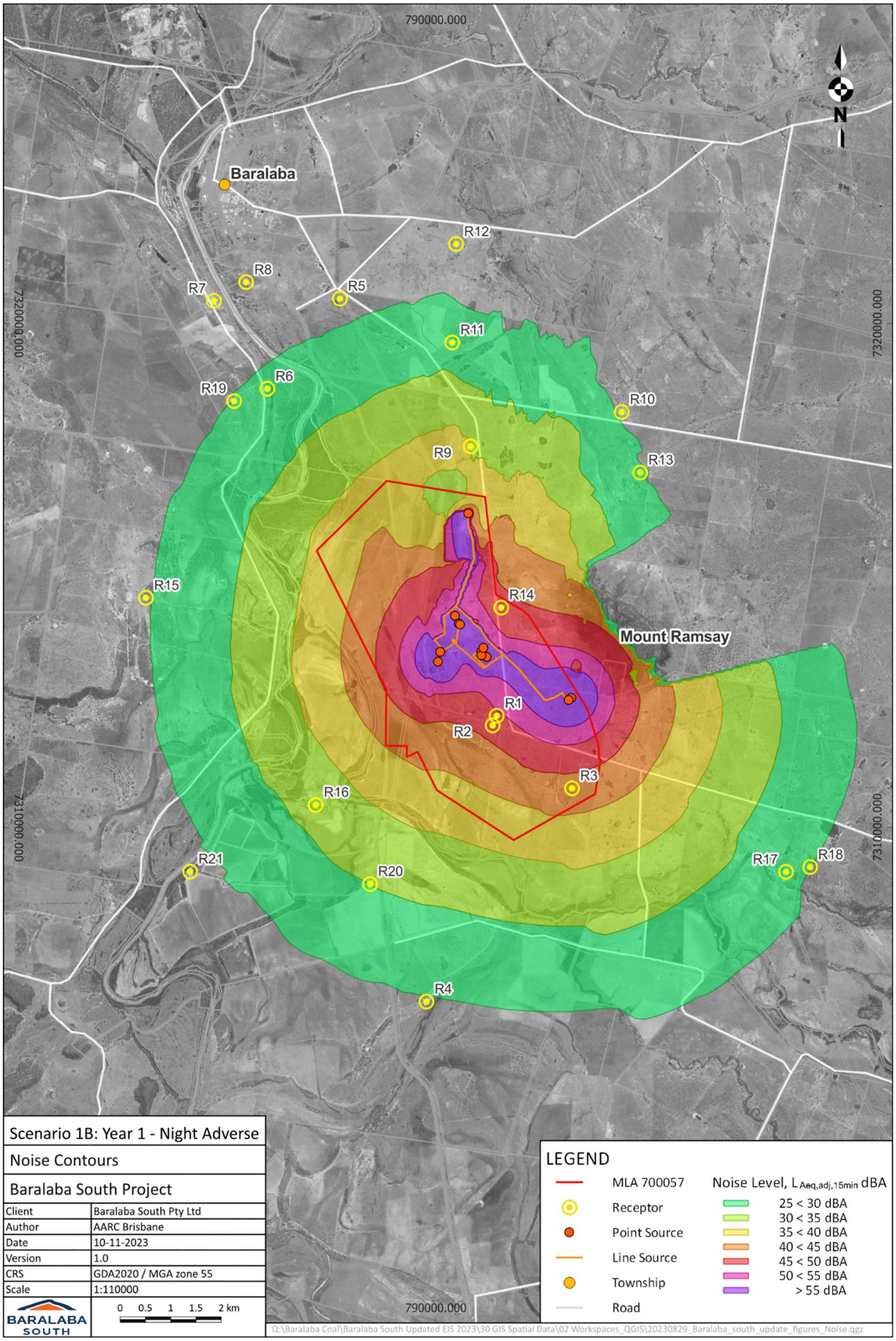

Figure 29: Noise contours – Scenario 1b: Year 1 (night-adverse)

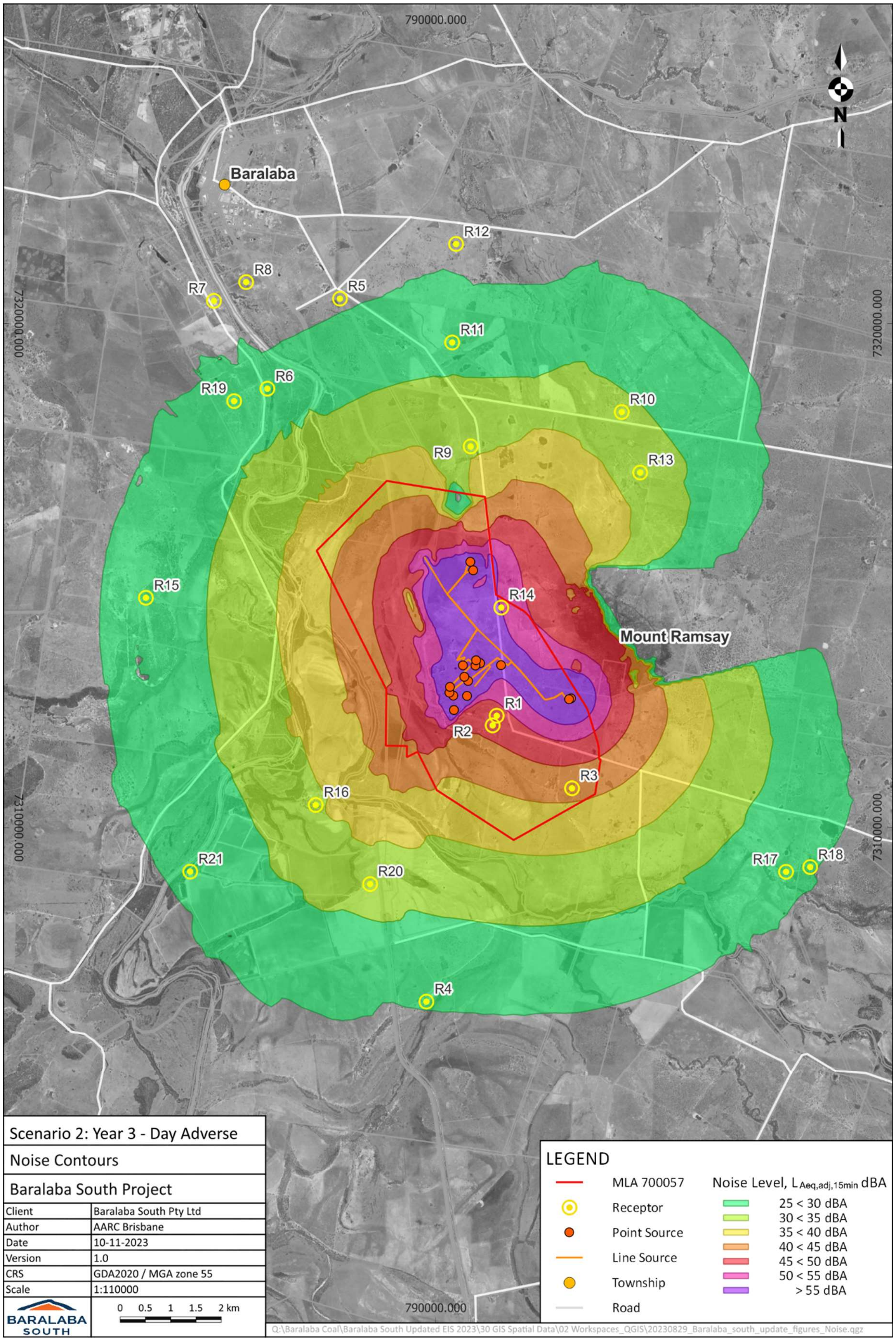

Figure 30: Noise contours – Scenario 2: Year 3 (day-adverse)

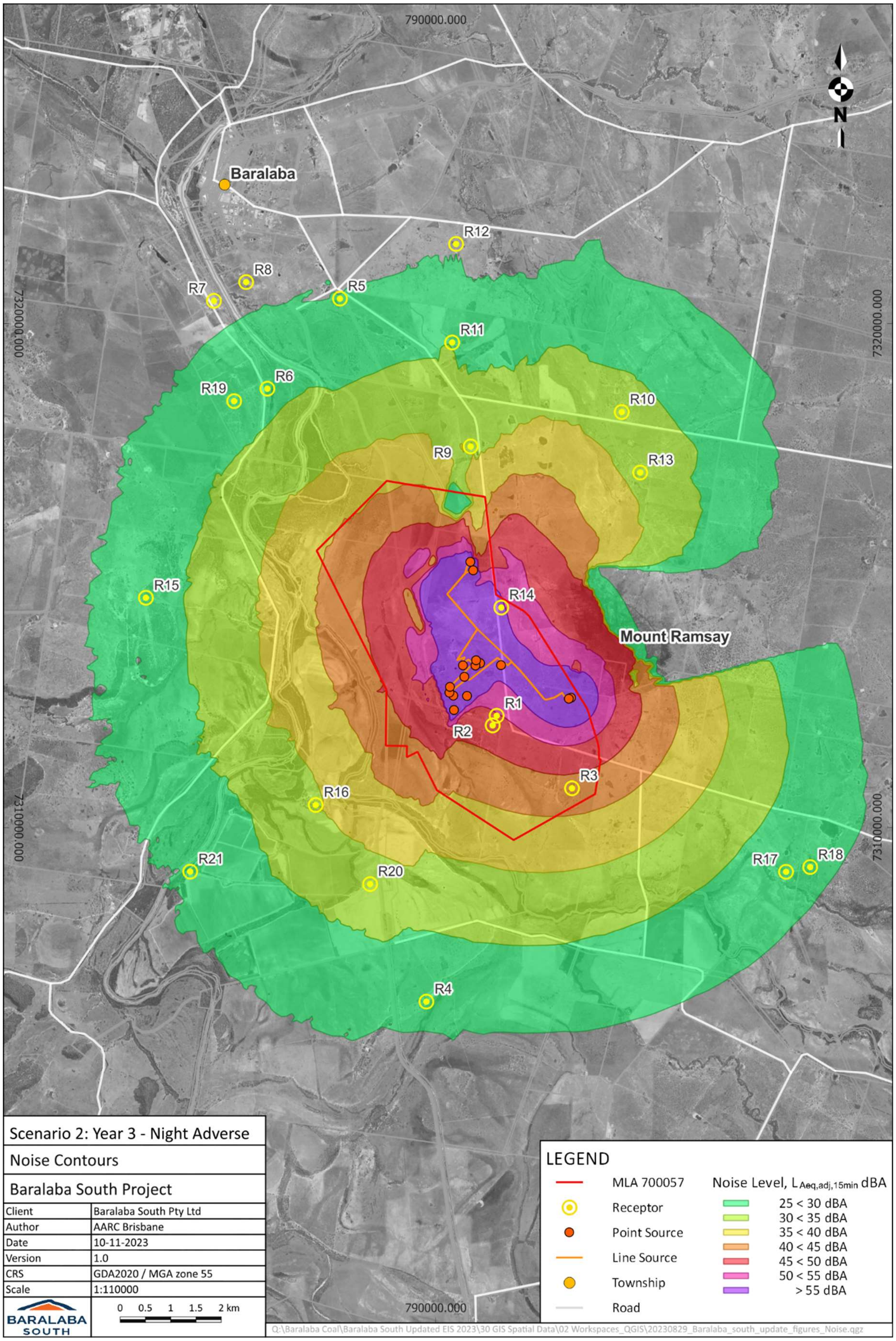

Figure 31: Noise contours – Scenario 2: Year 3 (night-adverse)

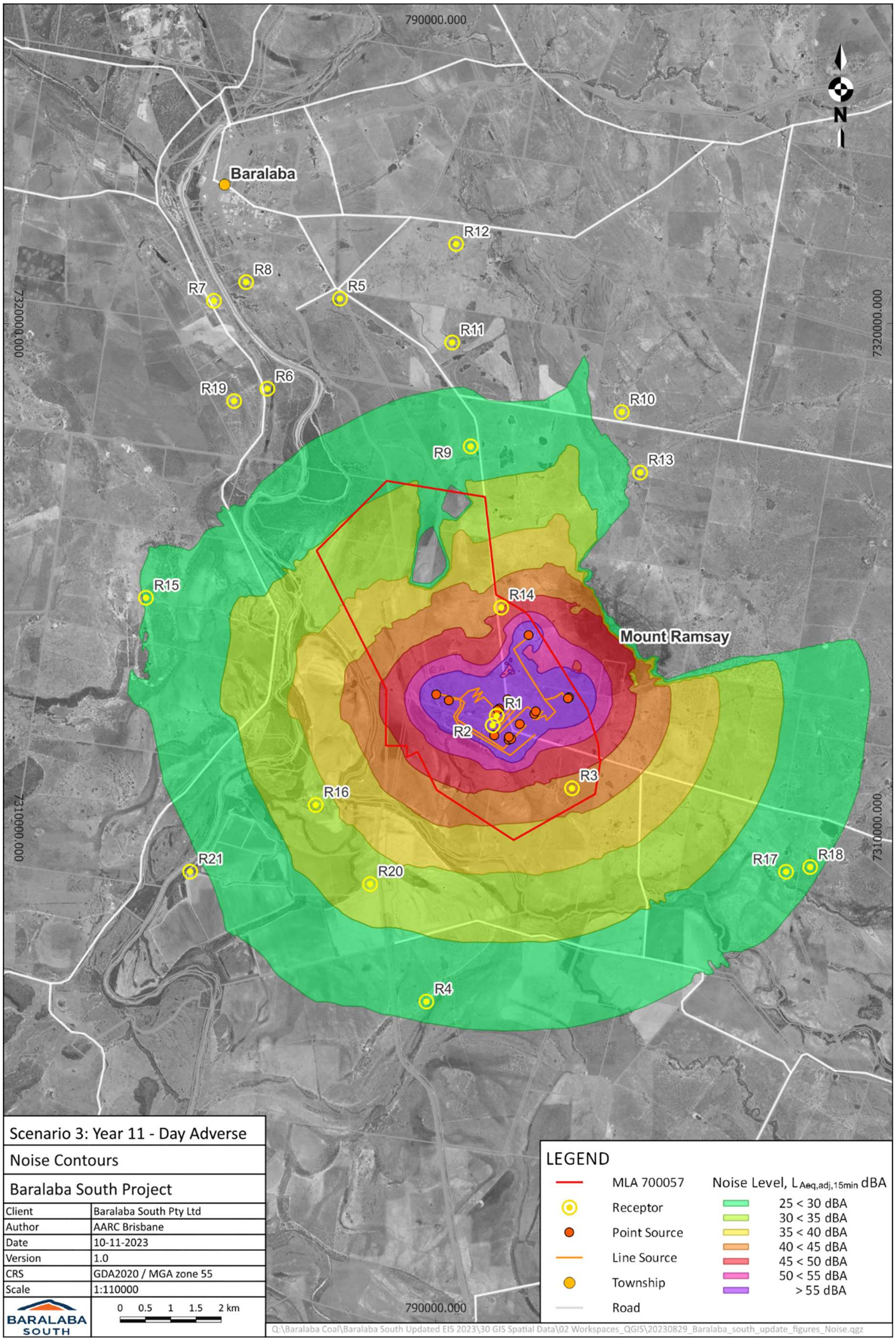

Figure 32: Noise contours – Scenario 3: Year 11 (day-adverse)

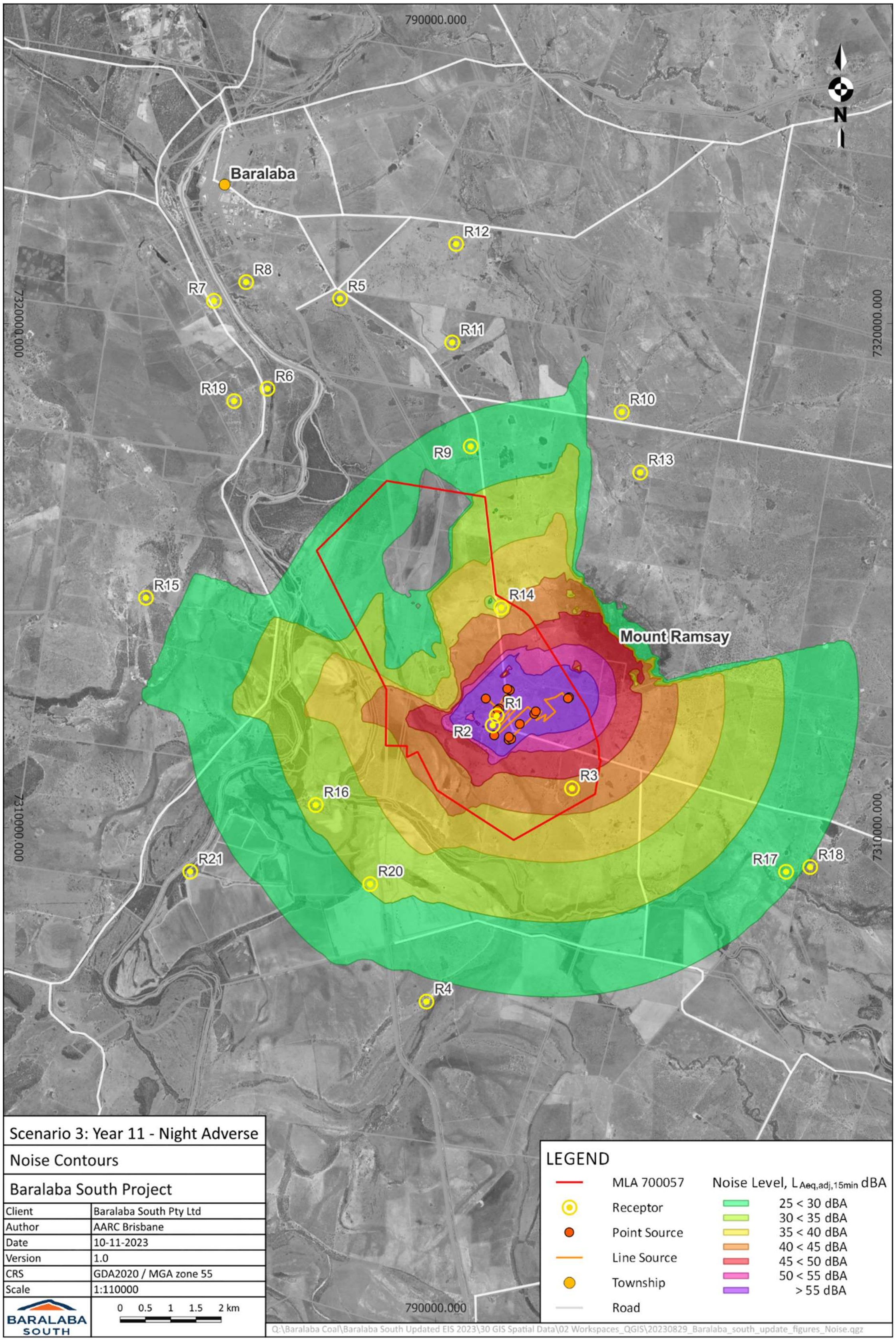

Figure 33: Noise contours – Scenario 3: Year 11 (night-adverse)