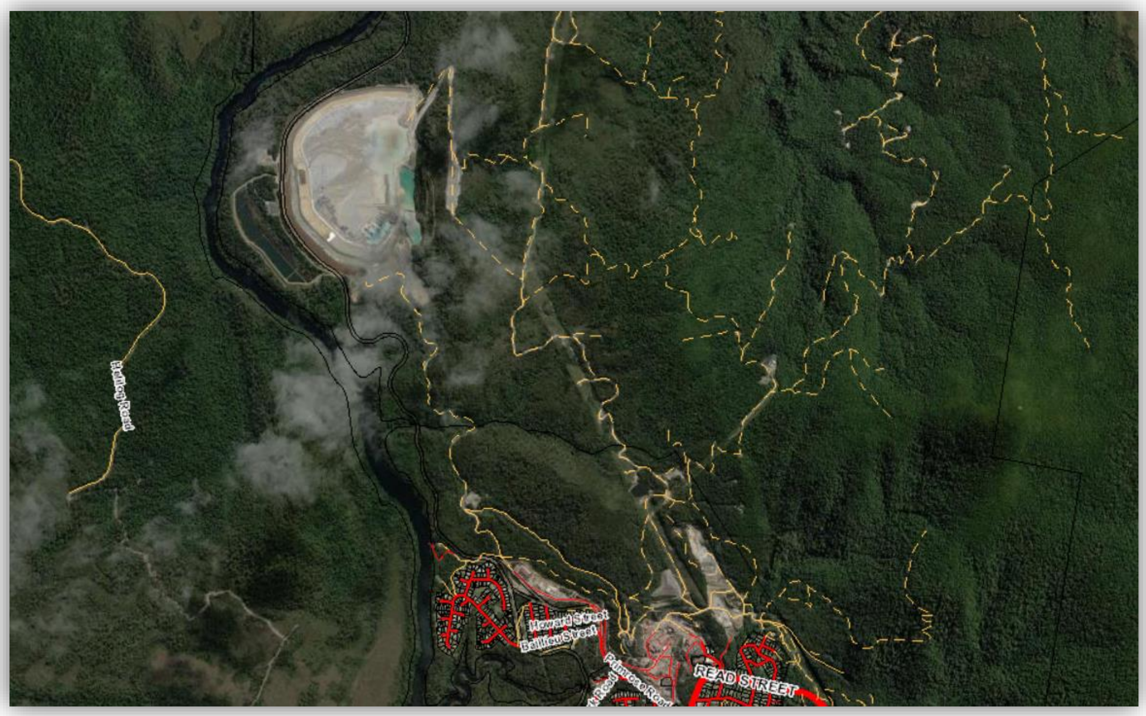
MMG Australia Limited

Bobadil Tailings Storage Facility Stages 11 and 12 embankment raise environmental noise, ground vibration and air blast overpressure assessment



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Tarkarri Engineering

Air Quality • Acoustics • Environment • Vibration

DOCUMENT CONTROL

MMG LIMITED
BOBADIL TSF STAGES 11 AND 12 EMBANKMENT RAISE ENVIRONMENTAL NOISE, GROUND VIBRATION AND AIR BLAST OVERPRESSURE ASSESSMENT

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Keywords

Airborne noise (dB re 20 µPa)

dBA – *Decibels A-weighted.*

A-weighting – *Weighting of the audible frequencies reflective of the response of the human ear to noise.*

$L_{Aeq,T}$ – *Equivalent continuous, fast response, A-weighted sound pressure level over a given time (T).*

$L_{A90,T}$ – *A-weighted sound pressure level exceeded for 90 % of a given time (T).*

$L_{A10,T}$ – *A-weighted sound pressure level exceeded for 10 % of a given time (T).*

dB Lin Peak – *Unweighted peak (no time constant) sound pressure level.*

PPV – peak particle velocity (mm/s)

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References

[1] SoundPLAN Acoustic modelling software - Braunstein & Berndt GmbH.

[2] ISO 9613-2:1996 Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation.

[3] CONCAWE The oil companies' international study group for conservation of clean air and water – Europe (est. 1963) report 4/81.

[4] Office of Surface Mining Reclamation and Enforcement (https://www.osmre.gov/).

Executive summary

Tarkarri Engineering has been commissioned by MMG Australia Limited to conduct an environmental noise, ground vibration and air blast over pressure impact assessment as part of an Environmental Impact Statement in relation to a proposed Bobadil Tailings Storage Facility (TSF) Stage 11 and 12 embankment raises for the MMG Rosebery mine.

Environmental noise modelling of proposed embankment raise works demonstrates that this activity is highly unlikely to exceed the project noise management criteria of 60 and 65 dBA at residential locations to the south and it is likely to be inaudible. At the levels predicted impact is not expected and the prejudicing of environmental values is unlikely.

Prediction of ground vibration and air blast overpressure levels from activity in the proposed quarry locations for the Bobadil TSF Stage 11 and 12 embankment raise works are well below criteria levels with for a charge mass/delay of 80 kg.

1 Introduction

Tarkarri Engineering has been commissioned by MMG Australia Limited (MMG) who own and operate the Rosebery Mine to conduct an environmental noise, ground vibration and air blast over pressure impact assessment as part of an Environmental Impact Statement (EIS) in relation to a proposed Bobadil Tailings Storage Facility (TSF) Stage 11 and 12 embankment raises for the MMG Rosebery mine. Project specific guidelines have been issued by the Tasmanian Environmental Protection Authority (EPA) with those specific to noise provided below:

5.5 Noise emissions

Discuss impacts of the proposal on existing (surrounding) noise levels during construction and operation, including methodology where appropriate.

5.5.1 Existing Environment

- Provide a map of the location of all major sources of noise and the closest noise sensitive, including residential, premises in the vicinity of the boundary of the activity.

5.5.2 Assessment

- Describe all major sources of noise.
- Provide details of the need for blasting, the expected number of blasts and the notional blast plan, including:
  - Results of ground vibration modelling to predict peak particle velocity contours out to 1mm/s;
  - Results of airblast overpressure modelling to predict dB (lin) level contours out to 100 dB (lin).
- Analyse the potential for noise emissions (during both the construction and operational phases) to cause nuisance for nearby land users, particularly at noise sensitive premises (NSP)
  - 'Noise sensitive premise' is defined as residences and residential zones (whether occupied or not), schools, hospitals, caravan parks and similar land uses involving the presence of individual people for extended periods, except in the course of their employment or for recreation.
  - When assessing nuisance at the NSPs, discuss the *Environment Protection Policy (Noise) 2009* and the existing acoustic environment.
- Discuss the potential for noise emissions to affect terrestrial and freshwater wildlife.

5.5.3 Avoidance and mitigation measures

- Discuss the proposed noise and vibration management plan to minimise impact and to address noise/vibration-related complaints.
- Demonstrate that the proposal is consistent with environmental performance requirements, including any identified in the Environment Protection Policy (Noise) 2009.

2 Site description

The MMG Bobadil TSF is located to the north north-west of the township of Rosebery. The Stage 11 and 12 projects considered here involves the construction of a four-metre raise of the existing facility embankment (two-meters er stage) to an RL of 205 m. Construction materials would be sourced from onsite quarried material.

Figures 2-1 presents an aerial views with with the location of the Bobadil TSF marked. Figure 2-2 presents a view showing the location of two borrows (borrow pits north and south).

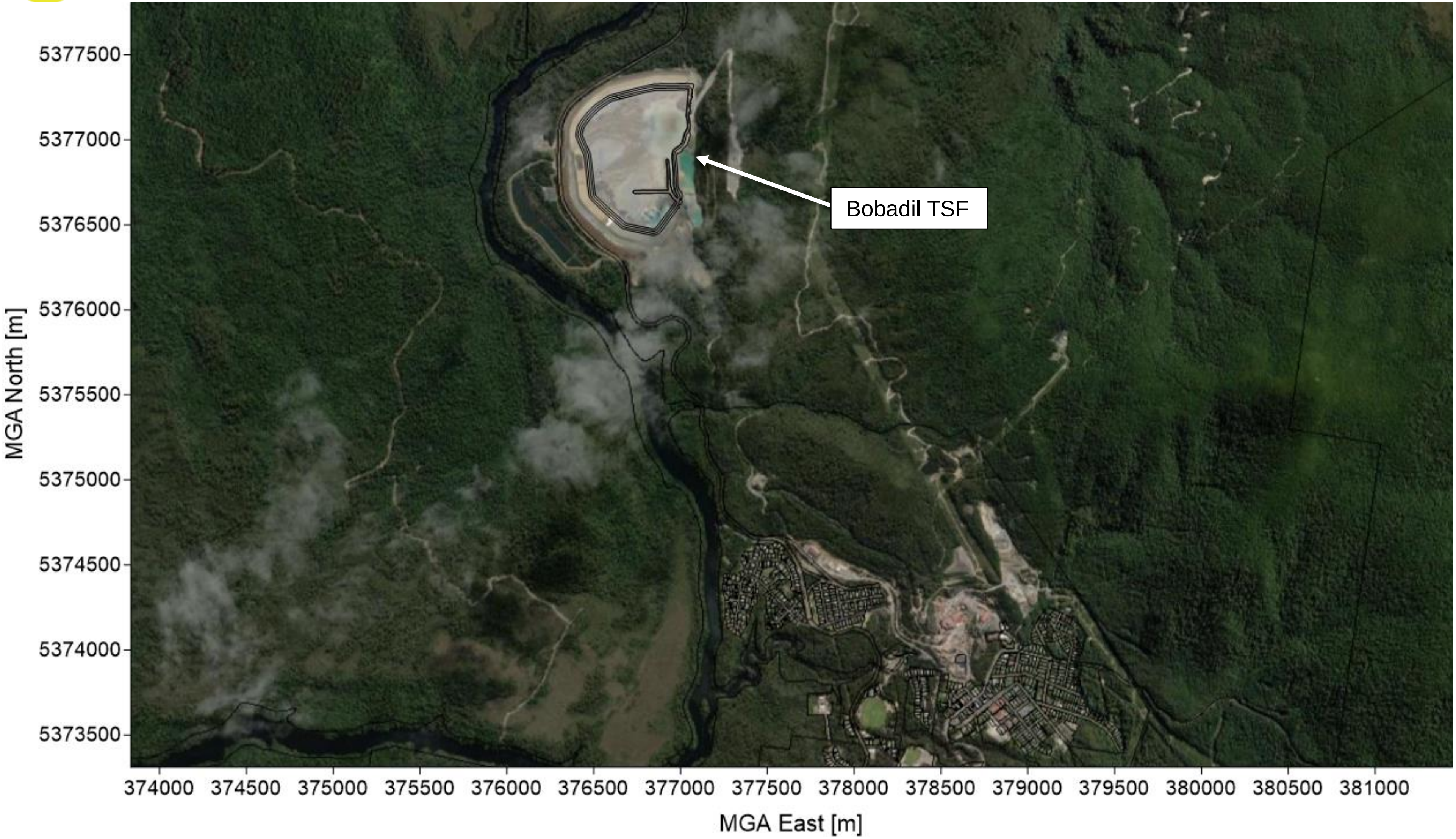

Figure 2-1: Aerial view with Bobadil TSF marked.

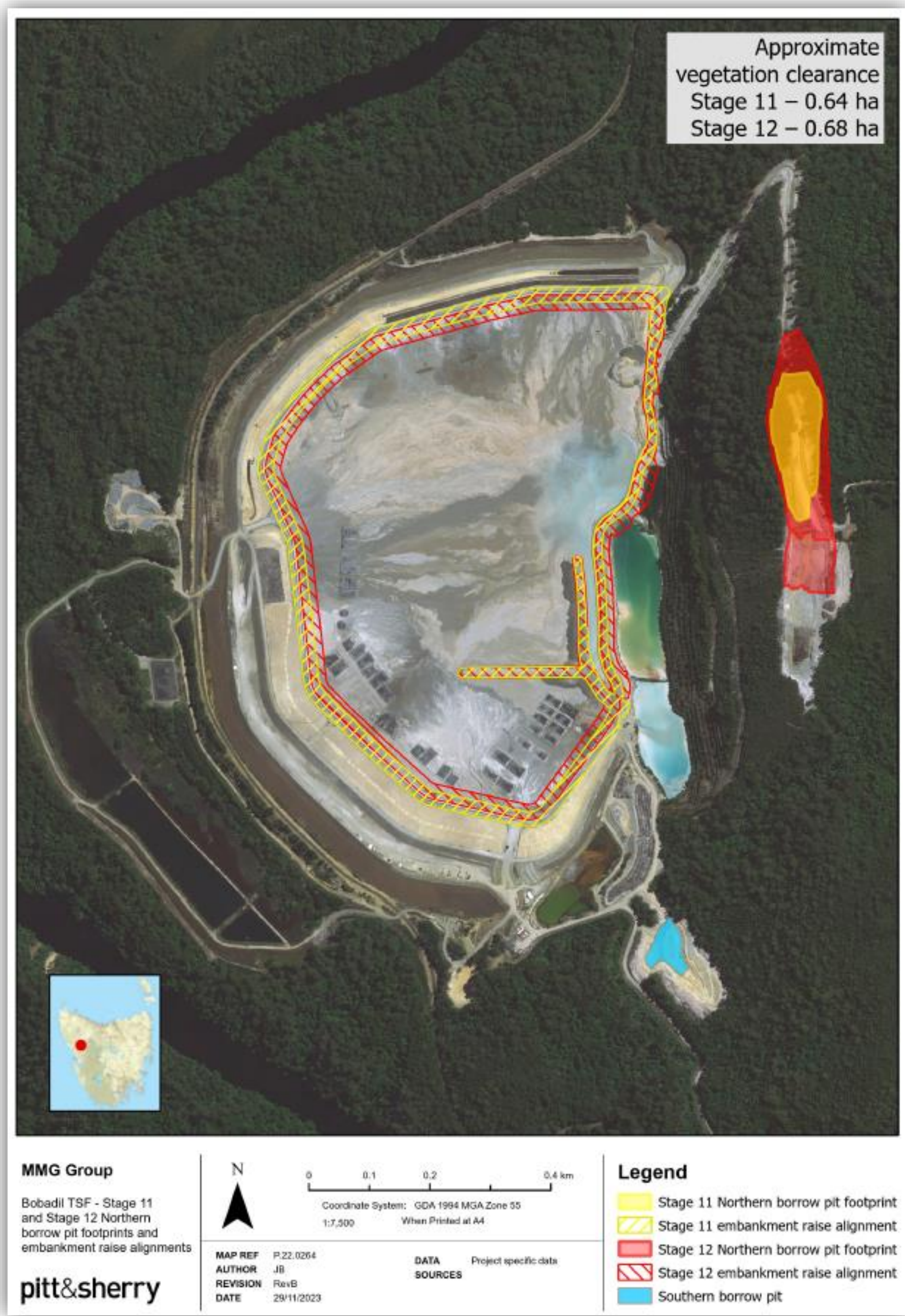

Figure 2-2: Aerial view of the Bobadil TSF with quarry areas marked.

The works would involve the blasting (north borrow pit only) and excavation of materials from the quarry areas and transport of the material to embankment areas for deposition, shaping and compaction. The following list of equipment would be operational during the works:

- Excavators (X6 units)
- Dozer (X2)
- Vibrating roller
- Grader
- Fuel/service trucks
- Mobile crane
- Mine Trucks (X6 units)
- Drill rig

Works would occur during daylight hours 7 days a week, noting that operations have the potential to fall outside of standard day time hours of 0700 to 1800 hrs on weekdays and 0800 to 1600 hrs on Saturdays.

3 Environmental noise

3.1 Noise management approach

The *Environment Protection Policy (Noise) 2009* (made under section 96K of the *Environmental Management and Pollution Control Act 1994*) is a framework for noise management in Tasmania through the setting out of objectives and principles for noise control with human health as a value to be protected. It does not include implementation measures, which are dealt with through other instruments such as regulations and planning schemes.

The environmental values identified in the Noise EPP are the qualities of the acoustic environment that are conducive to:

- the wellbeing of the community or a part of the community, including its social and economic amenity; or
- the wellbeing of an individual, including the individual's –
  - health; and
  - opportunity to work and study and to have sleep, relaxation, and conversation without unreasonable interference from noise.

The focus of the Noise EPP is on ongoing noise and the intensification of generation overtime. Tarkarri Engineering proposes a quantitative management approach in accordance with previous construction works at the MMG 2/5 TSF. For the original construction of the 2/5 TSF the *Noise Monitoring Plan, 2/5 Dam Tailings Storage Facility Construction* document was developed in 2016 to meet the requirements of Permit Condition Environmental (PCE) No.9084 (r1) condition M4. Under the monitoring plan criterion for the construction was nominated as follows and this is adopted here for the Bobadil Stage 11 and Stage 12 embankment raise:

- A-weighted equivalent continuous noise level (L_{Aeq}) of 65 dBA over a 15-minute time period.

  NB: For operational times outside of 0700 and 1800 hrs on weekdays and 0800 to 1600 hrs on Saturdays the criterion is reduced by 5 dB to 60 dBA.

This was derived from the *NSW Interim Construction Noise Guidelines* (July 2009). This is deemed suitable for temporary construction works where resonable noise management levels are preferred. The objectives are in accordance with the priciples of the Noise EPP while acknowleging that some noise from construction is inevitable.

3.2 Existing noise

Table 3-1 presents average 15-minute noise statistic data from the 2021/2022 and 2022/2023 years at permanent noise monitoring location N2, operated by MMG (data from Tarkarri Engineering report 5830_ACVIB_R). Table 3-2 presents summary data for positions R1 and R2 from the most recent three-yearly environmental noise survey of the MMG operations in Rosebery (data from Tarkarri Engineering report 5578_AC_R_R1). The locations chosen for this assessment are located in the north-west of Rosebery and are the closest to the Bobadil TSF where environmental noise levels have been monitored. Refer to Figure 3-3 in section 3.3 for an aerial view with the locations shown. These three locations are specifically designed to monitor noise from the mines Filter Plant and train loading operations, both of which are located in close proximity to the residential premises that are closest to the Bobadil TSF.

Environmental noise monitoring summary data, average 15-minute Ln-statistics (dBA)										
Location	Period	2022/2023			2021/2022			Difference (dB)		
		L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}
Cohen St	Day	52	50	53	52	49	52	0	1	1
	Evening	51	49	52	50	49	51	1	0	1
	Night	50	49	51	49	48	50	1	1	1

Table 3-1: Environmental noise monitoring summary data.

Environmental noise survey summary data, average 10-minute Ln-statistics (dBA), 2021						
Position		Average $L_{Aeq,10min}$	Average $L_{A90,10min}$	Tonal Adj. (dB)	$L_{Aeq,10min,adj}$	Comment
R1	Day	39.8	37.5	-	39.8	MMG Filter Plant and Train Loading area controlled noise environment.
	Evening	40.7	39.8	0.5	41.2	
	Night	40.4	39.8	1.5	41.9	
R2	Day	44.1	42.4	0.3	44.4	MMG Filter Plant and Train Loading area controlled noise environment.
	Evening	43.3	42.2	-	43.3	
	Night	43.3	42.5	1.7	45.0	

Table 3-2: Summary table of environmental noise survey results.

3.3 Environmental noise modelling

SoundPLAN[1] software was used for carrying out detailed noise emission spectra and contour modelling. This program allows the use prediction algorithms for the modelling of atmospheric attenuation/amplification of noise. Parameters influencing sound propagation and attenuation include:

- Source type (point, line, plane).
- Relative source and receiver height.
- Topography and barriers.
- Industrial buildings as sources and/or barriers.
- Ground and air absorption.
- Distance attenuation.
- Atmospheric conditions.
- Reflecting surfaces.

- Source directivity.

As all propagation and attenuation parameters are frequency dependent, all input source data has been based on 1/3-octave or 1/1-octave band sound power spectra.

Equipment list and equipment location data was provided by MMG.

All source and geodata is referenced to the Map Grid of Australia (MGA).

3.3.1 Model input data

Input sound power (SWL) spectra were taken from information provided by MMG and Tarkarri Engineering library data. Table 3-3 presents overall SWLs and source details while Table 3-4 presents 1/1-octave band SWL spectra.

Overall sound power levels (dBA)		
Source	L_{Aeq} SWL	Comment
Excavator (large)	104	Tarkarri Engineering library data for CAT 345B. X3 units modelled.
Excavator (small)	99	Tarkarri Engineering library data for CAT 320. X5 units modelled.
Dozer	107	Tarkarri Engineering library data for CAT D9. X1 units modelled.
Vibrating roller	108	Tarkarri Engineering library data for Dynapac CA612D, X2 units modelled.
Grader	101	Tarkarri Engineering library data for CAT 12G. X1 units modelled.
Fuel/service truck	103	Tarkarri Engineering library data. X1 units modelled.
Mobile crane	104	Tarkarri Engineering library data. X1 units modelled.
Trucks (X3 as line source)	105	Tarkarri Engineering library data.
Drill (engine and drilling)	112	Tarkarri Engineering library data.
Drill (rattling)	109	Tarkarri Engineering library data. L_{Amax} SWL 126 dBA.

Table 3-3: Overall sound power levels and data source information.

1/1-octave band sound power levels spectra (dBA)										
Source	Frequency (Hz)									Total
	31.5	63	125	250	500	1k	2k	4k	8k	
Excavator (large)	70	78	91	92	99	98	98	92	84	**104**
Excavator (small)	55	71	90	90	94	92	91	87	78	**99**
Dozer	65	83	88	92	98	102	102	97	87	**107**
Vibrating roller	87	86	89	97	103	103	102	96	87	**108**
Grader	64	70	88	89	95	97	93	87	76	**101**
Fuel/service truck	58	78	87	91	95	99	98	92	85	**103**
Mobile crane	58	73	92	100	93	96	96	92	85	**104**
Trucks (X3 as line source)	60	80	88	93	97	101	99	94	86	**105**
Drill (engine and drilling)	55	89	93	91	98	106	107	107	99	**112**
Drill (rattling)	44	79	81	79	91	98	103	105	101	**109**

Table 3-4: 1/1-octave band sound power level spectra.

3.3.2 Model receivers

Three environmental noise model receivers were considered in this study. The receivers are a combination of permanent monitoring location N2 and noise survey locations R1 and R2 (see ambient data for these locations in section 3.2). The receivers are used in the model for the prediction of single point noise emission level data. Location details are provided below in Table 3-5. Refer to Figure 3-3 for an aerial view with the locations shown.

Environmental noise model receiver positions		
Number	Location	Coordinates (MGA, Zone 55 G)
N2	24 Cohen St, Rosebery	377803 5374399
R1	26 Beech Dr, Rosebery	377633 5374379
R2	21 Fraser St, Rosebery	377883 5374383

Table 3-5: Environmental noise model receivers.

3.3.3 Atmospheric conditions

SoundPLAN[2] allows the use of the ISO 9613[2] and CONCAWE[3] prediction algorithms to model the attenuation /amplification of noise in the environment. In this study the following propagation conditions were considered:

- **ISO 9613** prediction algorithm with default settings.
- **CONCAWE worst case propagation (wcw)**: CONCAWE models atmospheric attenuation using Pasquill stability indices in combination with vector wind speed and direction to determine appropriate frequency dependent attenuation/amplification This condition considers all receiver points to be downwind with a Pasquill stability class F and a vector wind speed of 2 m/s. Under these conditions noise contours will typically represent the highest predicted noise levels at any location.

NB: Under both algorithms a relative humidity of 70 %, air pressure of 1013.3 mbar and temperature of 10 °C was modelled.

3.3.4 Model scenario

Figure 3-1 presents a model plan view with source locations marked for the Bobadil Stage 11 and 12 embankment raise works while Figure 3-2 presents a model wire frame view from the south.

NB: Works are focused in the northern borrow pit as a conservative assumption. The location of the north borrow pit is elevated and more exposed (less topographic shielding) than the southern borrow pit.

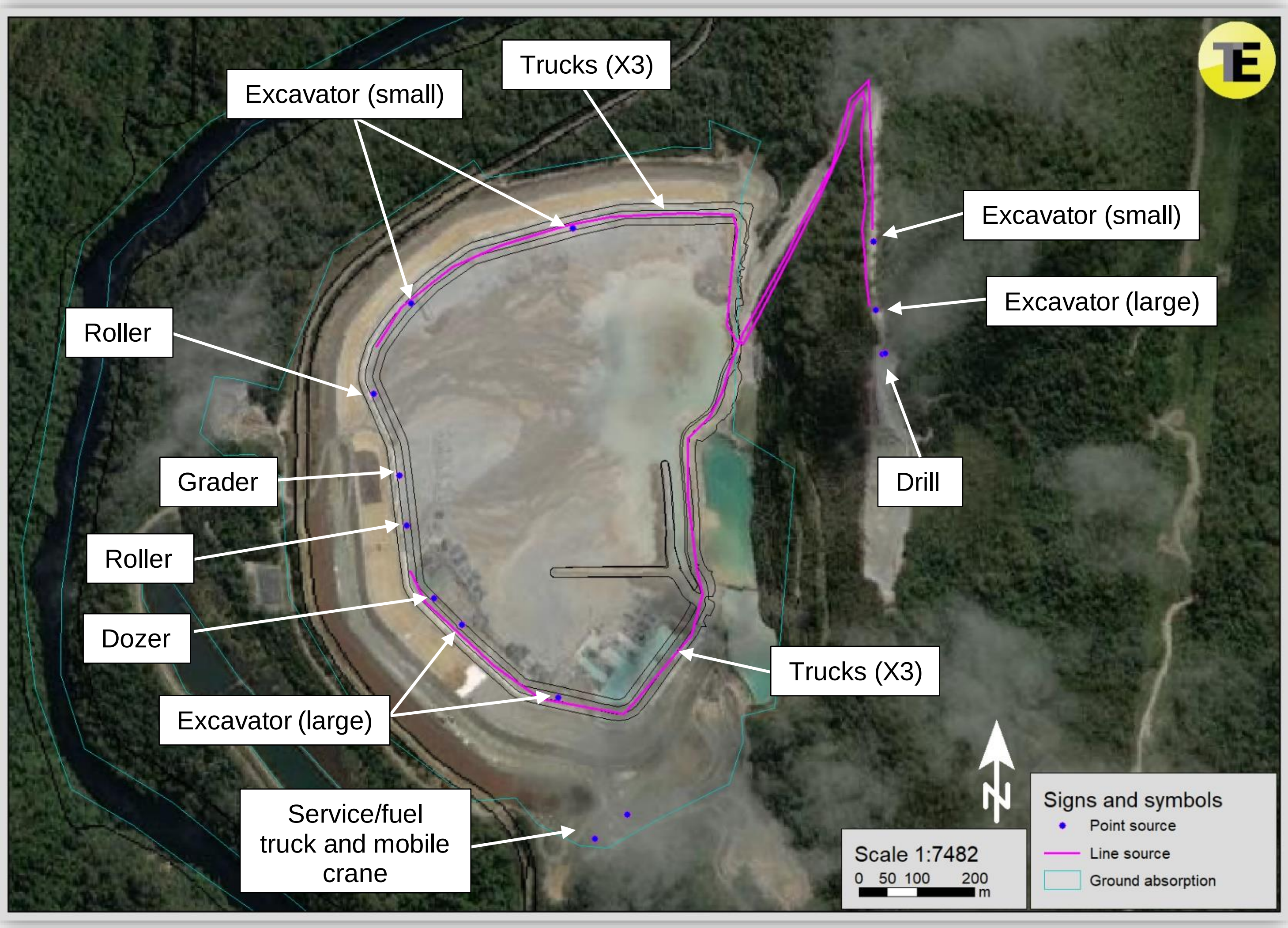

Figure 3-1: Model plan view.

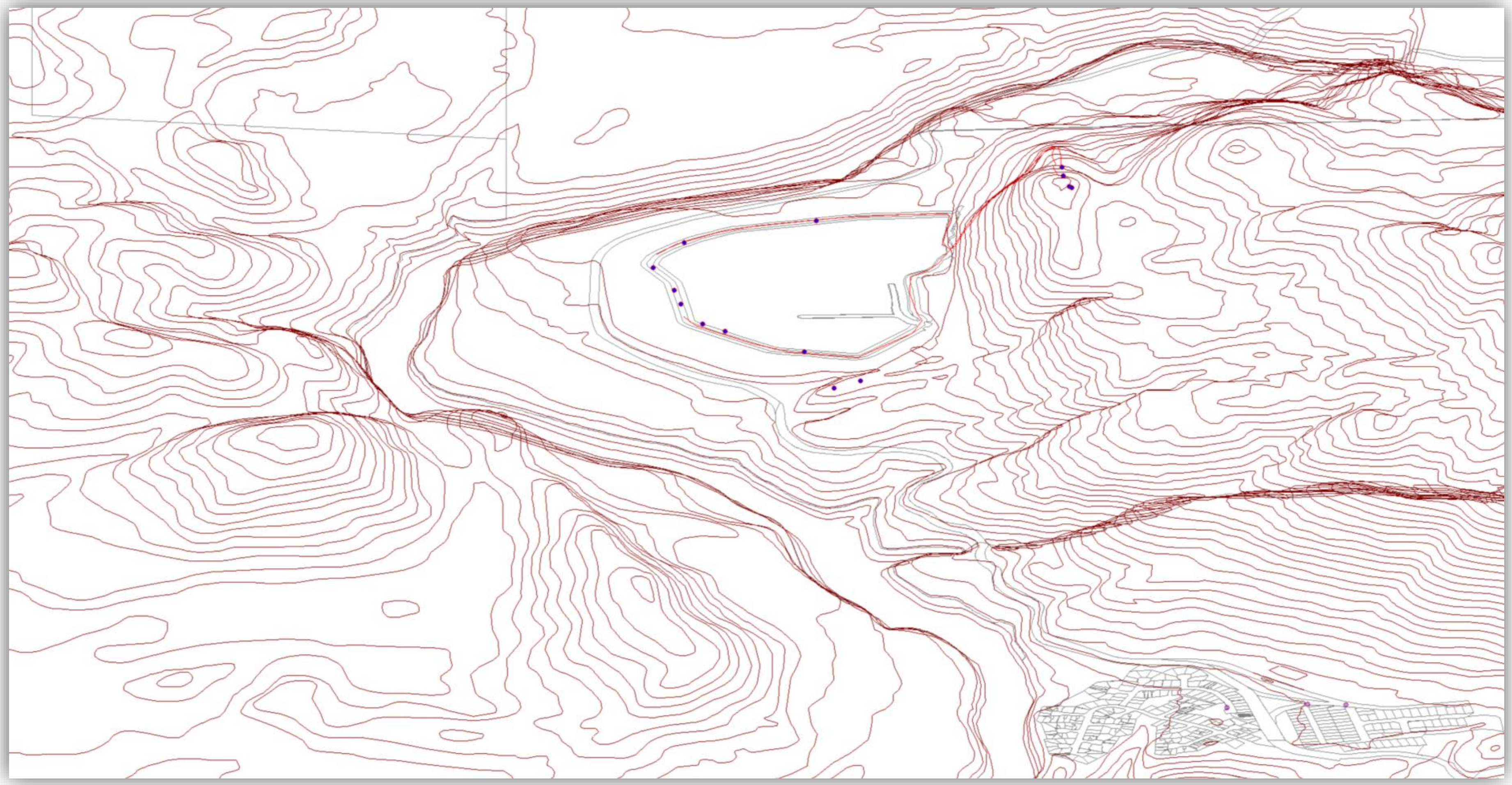

Figure 3-2: Model wire fame view, from the south.

Figure 3-3: Model plan view, receiver locations.

3.4 Modelling results and discussion

3.4.1 Predicted sound pressure levels

Table 3-4 presents predicted L_{Aeq} sound pressure levels at the three environmental noise receiver locations. Results are presented under both the ISO prediction algorithm and wcw conditions under the CONCAWE prediction algorithm.

Predicted L_{Aeq} sound pressure levels (dBA)		
Receiver	ISO	wcw
N2	24	9
R1	24	11
R2	24	9

Table 3-6: Predicted L_{Aeq} sound pressure levels.

From the above:

- The predicted sound pressure levels are well below the project noise management criteria levels of 60 and 65 dBA, by more than 30 dB.
- The predicted levels are well below existing noise levels in the Rosebery community which are generally above 40 dBA $L_{Aeq,10min}$ and $L_{Aeq,15min}$ and 35 dBA $L_{A90,10min}$ and $L_{A90,15min}$ (see section 3.2 for details) and highly likely to be inaudible.

3.4.2 Predicted noise emission contours

Using the environmental noise model, noise contour maps were generated to assist in the visualisation of noise propagation from the works to the surrounding environment. The contours maps shown are as follows for the Stage 11 and 12 construction operations and are the prediction of noise levels 1.5 m above ground height. The noise management criteria contours (i.e. 60 and 65 dBA) are highlighted in shades of turquoise on each map:

- ISO algorithm.
- wcw (CONCAWE algorithm).

The predicted contours show that noise levels from the Bobadil TSF stage 11 and 12 embankment raise works wouldn't exceed 30 dBA at residential locations in Rosebery, well below the project noise management criteria levels of 60 and 65 dBA.

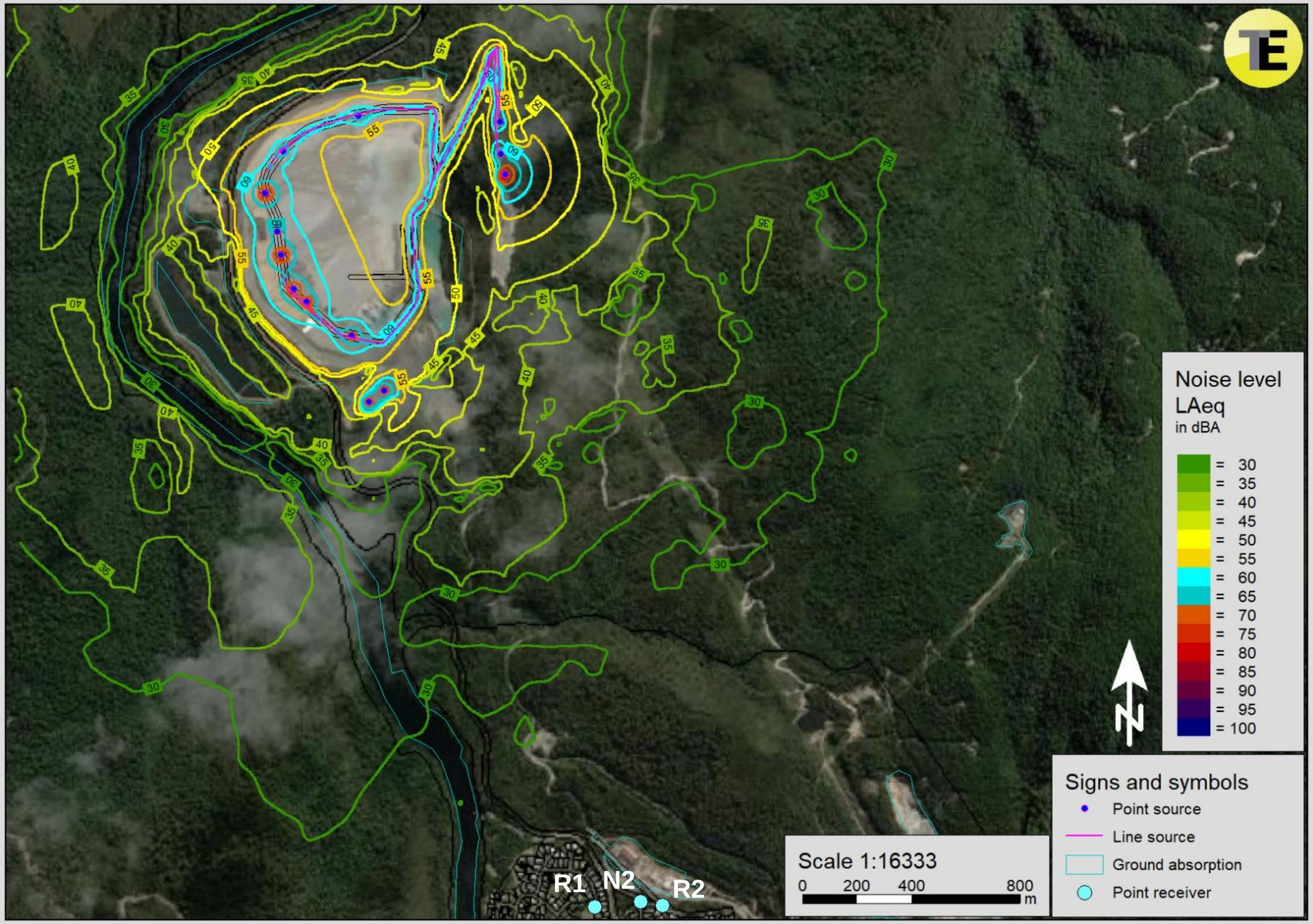

Figure 3-4: Predicted noise emission contours, ISO.

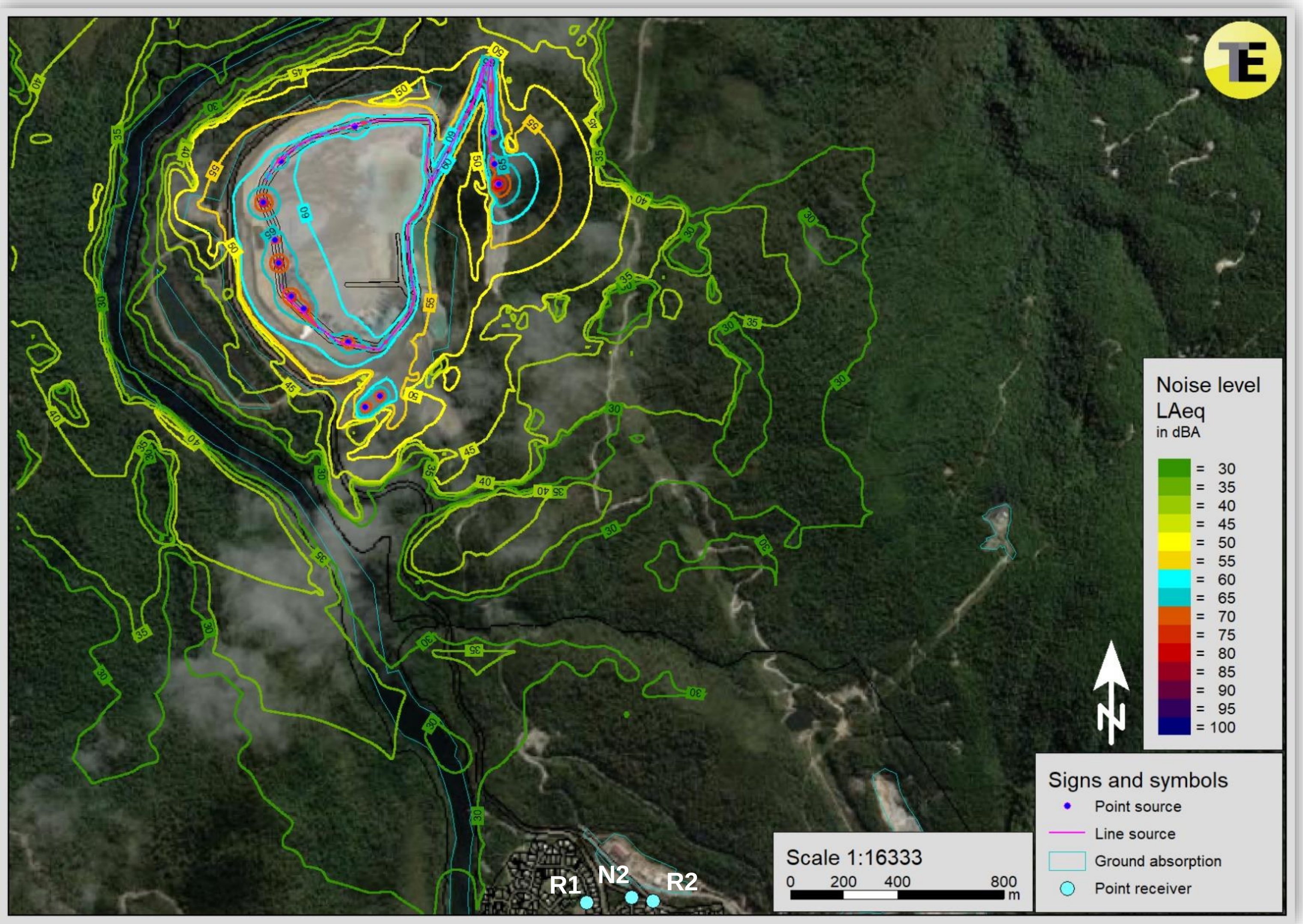

Figure 3-5: Predicted noise emission contours, wcw.

4 Ground vibration and air blast overpressure

Ground vibration and air blast overpressure prediction is typically conducted using site specific scaled regression equations developed from monitored data from multiple blasts of varying charge mass and measured at locations with significant variation in distance between blasts and monitors. A suitable data set for the Bobadil TSF is not available and given this Tarkarri Engineering has sourced regression equations developed by the *Office of Surface Mining Reclamation and Enforcement*[4] in the USA from their extensive data sets. Ground vibration and air blast overpressure predictions are assessed here against conditions applicable under the Tasmanian *Quarry Code of Practice 3rd Edition* that relate to human comfort. The relevant section from the code is provided below:

> Blasting must be carried out such that, when measured at the curtilage of the nearest residence (or sensitive use) in other occupation or ownership, air blast and ground vibration comply with the following:
>
> *a) for 95% of blasts, air blast overpressure must not exceed 115 dB (Lin Peak);*
>
> *b) air blast overpressure must not exceed 120 dB (Lin Peak) at all;*
>
> *c) for 95% of blasts, ground vibration must not exceed 5 mm/s peak particle velocity; and*
>
> *d) ground vibration must not exceed 10 mm/s peak particle velocity at all.*
>
> The ground vibration level at heritage buildings and structures of significant intrinsic value should not exceed 3 mm/s peak particle velocity.
>
> It has been recommended that the long term regulatory goal for ground vibration should be 2 mm/s peak particle velocity and, where possible, this may be a suitable design target.

Predictions are made to the edge of the closest grouping of residences to the Bobadil TSF quarry areas. The distances is based off the shortest distance between the northern borrow pit area (as shown in Figure 2-2) and the closest premises in the Rosebery residential area. A maximum charge mass/delay of **80 kg** is assumed.

4.1 Ground vibration

Prediction of ground vibration was conducted using the following regression equation from OSM which expresses the inverse relationship between PPV and distance from blast as:

$$\mathrm{PPV} = \mathrm{k}\left(\frac{\sqrt{\mathrm{m}}}{\mathrm{D}}\right)^{\mathrm{a}}$$

PPV = peak particle velocity (in/s)
k = constant
m = charge mass / delay (lb)
D = distance to receiver (ft)
a = exponent

The constants (k) and (a) were developed by OSMRE from quarry production blast data and are as follows:-

Average: k = 52, a = 1.38
Upper bound: k = 138, a = 1.38

The above equation and constants are expressed in imperial units and as such all relevant data was first converted to imperial before PPV predictions were made. The subsequent answers were then converted back to metric and are presented in Table 4-1 below.

Predicted ground vibration (mm/s) PPV for 80 kg charge mass/delay			
Receiver	Regression constant (k)	Min distance to receiver [m]	Predicted PPV [mm/s]
Nearest residence	Average	2200	0.22
	Upper bound		0.59

exceeds 2 mm/s.

exceeds 5 mm/s.

Table 4-1: Predicted ground vibration.

From the above:

- The predicted ground vibration levels from the 'average' OSMRE regression are below the 5 mm/s criterion under the 'average' and 'upper bound' OSMRE regression.
- Predicted levels are also below the 2 mm/s 'goal' under both OSMRE regressions.

Predicted ground vibration contours projected on to an aerial views for a representative blast centred at MGA coordinate point 377306, 5376829 (at the southern edge of the northern borrow bit extraction area) are provided below in Figures 4-1 and 4-2 for the 'average' OSMRE regression and 'upper bound' regressions. Contour levels, in mm/s, are provided as a white number on back background.

The predicted ground vibration contours show that ground vibration would likely be well below 1 mm/s at any residential location within Rosebery.

1

5

10

Figure 4-1: ‘Average’ OSMRE regression ground vibration contours.

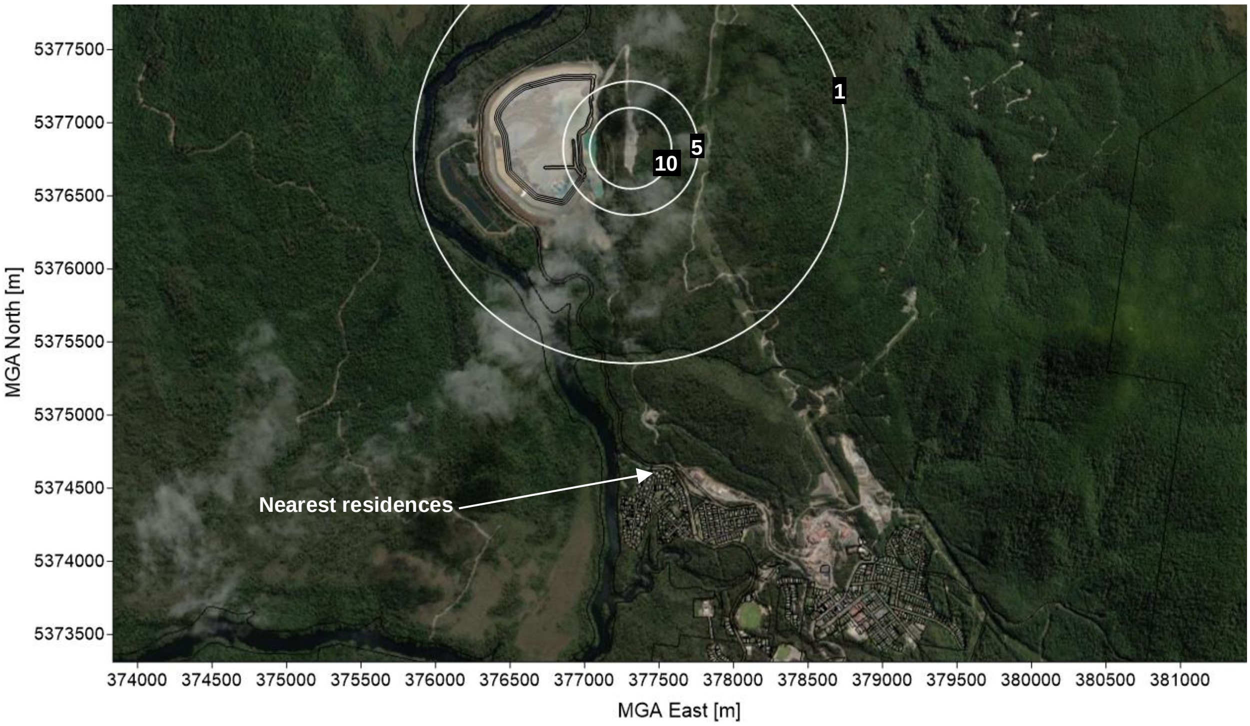

Figure 4-2: ‘Upper bound’ OSMRE regression ground vibration contours.

4.2 Air blast overpressure

Air blast overpressure (ABO) predictions were conducted using the following regression equation from OSM which gives the following empirical inverse relationship between air pressure and distance from blast as:

$$\mathrm{PSI} = \mathrm{k}\left(\frac{\sqrt[3]{\mathrm{m}}}{\mathrm{D}}\right)^{\mathrm{a}}$$

psi = pounds per square inch
k = constant
m = charge mass / delay (lb)
D = distance to receiver (ft)
a = exponent

Predictions of ABO (in psi), from the above equation, were calculated using imperial units with the resulting pressure converted into dBL with a reference sound pressure level of $2.9(10^{-9})$ psi, i.e. $2(10^{-5})$ Pa.

Predicted ABO levels were calculated using the following constants given by OSMRE for highwall blasting:

k=0.162
a=0.794

Table 4-2 presents the predicted air blast overpressure levels with a charge mass/delay of 80 kg.

Predicted air blast overpressure (dB, Lin Peak) for 80 kg charge mass/delay			
Receiver	Regression constant	Option 1	
		Min distance to receiver	Predicted ABO
Nearest residence	Highwall	2200	106

exceeds 115 dB, exceeds 120 dB.

Table 4-2: Predicted air blast overpressure.

From the above:

- The predicted air blast overpressure levels don't exceed either 115 dB or 120 dB (Lin Peak) criteria at any receiver.

Predicted ABO contours projected on to aerial views for a representative blast centred at MGA coordinate point 377306, 5376829 (at the southern edge of the northern borrow bit extraction area) are provided below in Figure 4-5 for the 'highwall' OSMRE regression. Contour levels, in dB (Lin Peak), are provided as a white number on black background. The second aerial view is provided at a coarser resolution to show the extent of the 100 dB contour.

The predicted contours show that ABO levels would likely be well below 110 dB (Lin Peak) at any residential location within Rosebery.

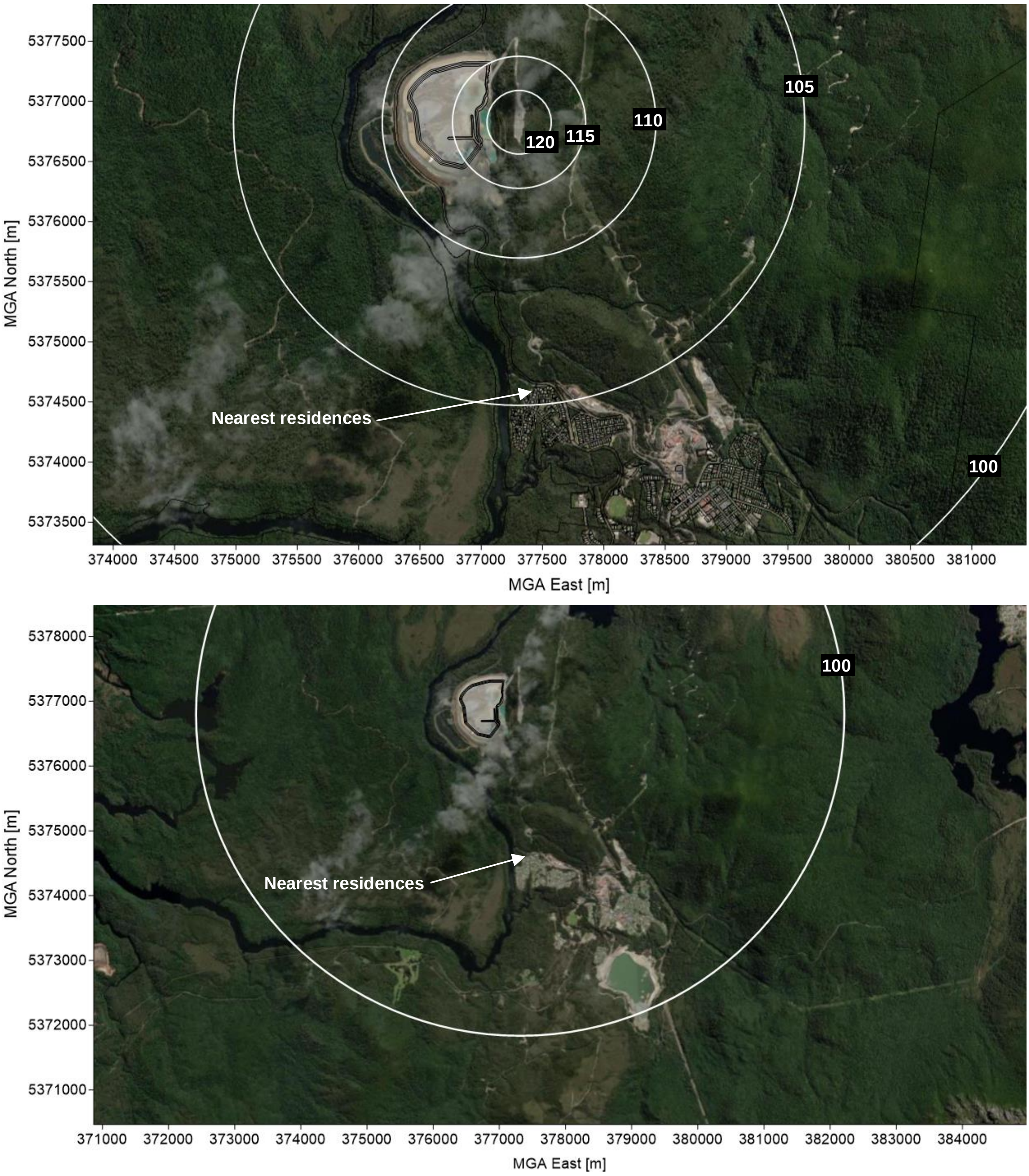

Figure 4-3: 'Highwall' OSMRE regression ABO contours.

5 Conclusions

5.1 Environmental noise

Environmental noise modelling of proposed Bobadil TSF Stage 11 and 12 embankment raise works demonstrates that this construction activity is highly unlikely to exceed the project noise management criteria of 60 and 65 dBA adopted for this project. Predicted levels are below 30 dBA within the closest residential area of Rosebery. At the levels predicted the construction work is not expected to be audible in residential areas. The Stage 11 and 12 works are not expected to prejudice environmental values as defined in the Noise EPP.

5.2 Ground vibration and air blast overpressure

Prediction of ground vibration and air blast overpressure levels from extraction works in the northern borrow pit for the Bobadil TSF Stage 11 and 12 embankment raise works were well below criteria levels at the nearest residences with a charge mass/delay of 80 kg:

- Predicted ground vibration levels are between 0.22 and 0.59 mm/s (criteria of 5 mm/s for 95 % of blasts and never above 10 mm/s, long term goal of 2 mm/s)
- The predicted air blast overpressure level was 106 dB (Lin Peak) (criteria of 110 dB for 95 % of blasts and never above 120 dB).

The predictions provided suggest a significant safety margin available such that a charge mass of up to 150 kg / delay is potentially viable.

NB: The above does not address TSF embankment stability in relation to the potential for increased ground vibration amplitude with increased charge mass. This would need to be considered in any blast planning.

6 Management actions

6.1 Environmental noise

A noise complaints line will be maintained. Noise investigation action and any necessary mitigation will be triggered if a community complaint is received.

The following general actions would also be adopted as part of the Stage 11 and 12 works:

- Establish best work practices for adopting quieter work methods were available.
- Regular inspection and maintenance of work equipment.
- Use of broad band style reversing beacons on mobile plant.

6.2 Ground vibration and air blast overpressure

Blast planning, monitoring, and reporting would be adopted for the Stage 11 and 12 works for the extractive works in the northern borrow pit.

An initial charge mass/delay of 80 kg limit for any blast would be applied to the project with any potential increase in charge mass applied for to the EPA as the project progresses if required. Application for an increase would be based on evidence from blast monitoring results and with an initial trial period of X2 blasts to demonstrate compliance.