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1. Introduction

Exco Resources Ltd engaged Simpson Engineering Group (‘SEG’) to perform a environmental noise and vibration assessment for the proposed Wynberg Project (‘Wynberg’) 25 km east southeast of Cloncurry in northwest Queensland.

The objective of this assessment is to provide the proponent with information to assist with preparation of an Environmental Values Assessment (EVA) for the Project.

This noise and vibration assessment addresses the following issues:

• description of existing noise conditions;
• likely change in noise environment following development of the mine;
• development of appropriate noise and vibration goals;
• assessment of noise at sensitive receptors, and comparison to the noise and vibration goals; and,
• recommendations for relevant impact mitigation measures.

2. Project Description

The site is a greenfield operation situated approximately 25 km east southeast of Cloncurry in northwest Queensland, refer to Figure 1.

The proposed mine has an up to 2 year life from 2018. This mining lease application covers a proposal for an operation at Wynberg based on multiple open pits, to initially produce approximately 25,000 ounces of gold over an 18 month operating project. The site layout includes seven pits, onsite crusher, a mining compound, two waste rock dumps, associated infrastructure, and a new 7.5 km ore haulage road to join the old Mt Norma haul road, refer to Figure 1 to Figure 3. Mining will take place 7 days per week between 6am and 6pm.
Figure 1: Wynberg Mine and Haul Route
It is anticipated there will be two waste rock dumps (WRDs) with operating designs based on 10m lifts, with 10m berms on each lift, with up to three lifts for a maximum WRD dump height of 30m. The rock will be dumped at the angle of repose of 37 degrees. This is shown in Figure 3.
Ore from Wynberg will be delivered by road train, using haulage contractors. The haul roads will use minor roads owned by the Cloncurry Shire Council, and new roads constructed by CopperChem. Haulage on the Landsborough Highway will be conducted at the consent of Landholders and the Department of Main Roads. As shown in Figure 1 haulage will depart the MLA100111 on the designated mine access for 1.7km to the south of the ML before intersecting with the Landsborough...
Highway. At the highway the haulage will continue west onto Cloncurry for 23.5km where ore will be delivered to Great Australia Operation via the Round Oak Road for 3.5km managed by Cloncurry Shire Council. The total haulage distance is measured to be 28.7km from the Wynberg ML to the Great Australia Operation.

![Figure 4: Oblique View Looking North of the Wynberg Mine Pit Design Showing the Seven Pits](image)

### 2.1 Locality Description

Wynberg is situated in an established grazing region of the Cloncurry Shire Council. The region is comprised of rolling hills with farmlands and scrublands. The closest residential community is Cloncurry, located some 25 km to the west of the site. Figure 4 shows the homestead and mining lease.
2.2 Meteorology

The site is situated 25km from Cloncurry and 130km east of Mount Isa. Both locations maintain a Bureau of Meteorology weather monitoring station. Cloncurry Airport Climatological Station (Latitude -20.6664, Longitude 146.5050) is an automatic station with the weather records recorded several times per day. The closest Bureau of Meteorology continuous recording automatic weather station (AWS) is at Mount Isa Aero (Latitude -20.6778, Longitude 139.4875).

Cloncurry is situated in north-western Queensland, an inland area. The region has a warm climate with two distinct seasons, a dry winter season and a wet summer season. Dry season temperatures average from 16 °C to 31 °C, while wet season temperatures range from 24 °C to 37 °C. The region averages approximately 561 mm of rainfall each year, falling mostly between December and March. This is shown in Figure 5.

Figure 5: Wynberg Project, Homestead and Noise Monitoring Locations
Figure 6: Typical Climate Data for Cloncurry Airport ID029141 (Long term Average 1978 to 2014)
3. Existing Noise Environment

Noise level monitoring was conducted from 21/2/2018 to 28/2/2018 at Wynberg Station. The objective of this report is to provide Exco Resources with information regarding the background levels at the homestead before the commencement of mining operations.

The monitoring was carried out in accordance with Queensland Government Noise Measurement Manual 2013, Version 4 and AS 1055 Acoustics—Description and measurement of environmental noise. The noise monitoring equipment complies with AS1259 Acoustics - Sound Level Meters and all the equipment has a current NATA certification and was calibrated using a portable calibrator before and after use.

Monitoring was conducted at Wynberg Station Refer to Figure 6 showing the noise monitoring location. The noise monitor was located at GPS 473979, 7702401 UTM Zone: -54 WGS84 approximately 40m from the closest dwelling. The surroundings comprise homestead grassed block and flat farming grasslands. The location was chosen to reduce the impact of homestead generated noise such as air-conditioning.

![Figure 7: Monitoring Location](image-url)
Figure 8: Monitor and Homestead Buildings

A summary of the 9am, 3pm and daily observations during the period of monitoring is included in Table 1.

Table 1: Summary of weather during February 2018 monitoring period (Source: Bureau of Meteorology Cloncurry Airport ID029141)

<table>
<thead>
<tr>
<th>Date</th>
<th>Temp (°C)</th>
<th>Rain (mm)</th>
<th>9:00 AM</th>
<th>3:00 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min (°C)</td>
<td>Max (°C)</td>
<td>Temp (°C)</td>
<td>RH (%)</td>
</tr>
<tr>
<td>21/2</td>
<td>25.6</td>
<td>43.3</td>
<td>0.4</td>
<td>33.9</td>
</tr>
<tr>
<td>22/2</td>
<td>27.2</td>
<td>39.4</td>
<td>0.0</td>
<td>28.9</td>
</tr>
<tr>
<td>23/2</td>
<td>25.8</td>
<td>37.8</td>
<td>0.0</td>
<td>28.0</td>
</tr>
<tr>
<td>24/2</td>
<td>26.6</td>
<td>39.2</td>
<td>0.0</td>
<td>28.7</td>
</tr>
<tr>
<td>25/2</td>
<td>23.9</td>
<td>40.1</td>
<td>5.2</td>
<td>26.6</td>
</tr>
<tr>
<td>26/2</td>
<td>24.0</td>
<td>39.3</td>
<td>0.2</td>
<td>28.3</td>
</tr>
<tr>
<td>27/2</td>
<td>23.2</td>
<td>41.6</td>
<td>0.0</td>
<td>32.1</td>
</tr>
<tr>
<td>28/2</td>
<td>28.0</td>
<td>41.8</td>
<td>0.0</td>
<td>31.2</td>
</tr>
</tbody>
</table>
3.1 Monitoring Results

The ambient noise levels were obtained at the monitoring location continuously over a period of seven days from 21 February 2018 to 28 February 2018. A calibrated noise logger recorded the noise level statistics in fifteen-minute intervals.

The noise levels are presented in terms of the $L_{A01(15\text{ minute})}$, $L_{A10(15\text{ minute})}$, $L_{A90(15\text{ minute})}$ and $L_{Aeq(15\text{ minute})}$. The $L_{A90(15\text{ minute})}$ reported in the tables for the day, evening and night comprises the Assessment Background Level (ABL), i.e. the lowest 10% of the measured background noise levels during the period and date in question. For the $L_{A01(15\text{ minute})}$, $L_{A10(15\text{ minute})}$ and $L_{Aeq(15\text{ minute})}$ the table refers to the median result. The rating background level (RBL) is the median of the ABL for the period in question.

The $L_{A90(15\text{ minute})}$ noise levels for some time periods are close to the noise floor of the sound level instrument (15 dB(A) to 17 dB(A)). Any reported levels below 20 to 22 dB(A) are likely to have been significantly affected by the inherent electrical noise of the sound level meter (Rion NL21). There were several periods when the noise levels dropped below the electrical noise floor of the instrument, however it has no bearing on the noise measurements. All other noise levels are well above the electrical noise floor of the instrument.

The weather during the monitoring periods was mostly fine. The wind speeds were up to 33 km/h mostly from the west quadrant. The noise levels are shown in Table 2. Chart of the noise levels is shown in Figure 8.
Table 2: Measured Noise Levels [in dB(A)] at Wynberg Station

<table>
<thead>
<tr>
<th>Date</th>
<th>Background Noise Level (L_{B10(15	ext{minute})})</th>
<th>L_{A10(15	ext{minute})} Noise Level</th>
<th>L_{A10(15	ext{minute})} Noise Level</th>
<th>L_{A01(15	ext{minute})} Noise Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day</td>
<td>Evening</td>
<td>Night</td>
<td>24 Hour</td>
</tr>
<tr>
<td>21/02/2018</td>
<td>28.3</td>
<td>22.9</td>
<td>24.1</td>
<td>38.1</td>
</tr>
<tr>
<td>22/02/2018</td>
<td>25.6</td>
<td>27.7</td>
<td>25.9</td>
<td>37.1</td>
</tr>
<tr>
<td>23/02/2018</td>
<td>25.9</td>
<td>25.4</td>
<td>29.2</td>
<td>38.4</td>
</tr>
<tr>
<td>24/02/2018</td>
<td>26.5</td>
<td>40.3</td>
<td>32.1</td>
<td>46.0</td>
</tr>
<tr>
<td>25/02/2018</td>
<td>25.6</td>
<td>26.0</td>
<td>26.3</td>
<td>39.4</td>
</tr>
<tr>
<td>26/02/2018</td>
<td>25.9</td>
<td>25.7</td>
<td>25.0</td>
<td>35.0</td>
</tr>
<tr>
<td>27/02/2018</td>
<td>23.6</td>
<td>23.9</td>
<td>24.8</td>
<td>34.7</td>
</tr>
<tr>
<td>28/02/2018</td>
<td>24.6</td>
<td>-</td>
<td>30.6</td>
<td>-</td>
</tr>
<tr>
<td>Median</td>
<td>29.6</td>
<td>29.5</td>
<td>23.7</td>
<td>44.5</td>
</tr>
</tbody>
</table>

*Note 1*: Sunday
3.2 Local Noise Impact on Measurements

From Figure 8, it can be noticed that a continuous, non-varying noise source was operating between 18:30 24/2/2018 and 10:35 25/2/2018. It is likely that this noise originates from the homestead and is likely to be the operation of a diesel generator or similar device. The impact of this is minimal to the overall RBL statistic. This is shown in Table 3.

Table 3: Impact on RBL from Local Noise

<table>
<thead>
<tr>
<th></th>
<th>Day</th>
<th>Evening</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBL</td>
<td>25.8</td>
<td>25.7</td>
<td>26.1</td>
</tr>
<tr>
<td>RBL without local noise</td>
<td>25.6</td>
<td>25.5</td>
<td>25.9</td>
</tr>
</tbody>
</table>

3.3 Noise Monitoring Summary

The noise levels for the homestead without the impact of any mining operations on the homestead. The rating background noise level in each period is:

- Day 25.8 dB(A);
- Evening 25.7 dB(A); and,
- Night 25.9 dB(A).
4. Noise and Vibration Criteria

4.1 Model mining conditions

The model mining conditions may be used as a basis for proposing environmental protection commitments in the application documents. They may also be used to expedite the process of developing appropriate conditions for an environmental authority for a mining project in consultation with the administering authority. The noise level limits are not linked to specific meteorological conditions; hence the limits apply for all meteorology cases.

Table D1 – Noise Limits

<table>
<thead>
<tr>
<th>Sensitive Place</th>
<th>Noise Level dB(A) measured as:</th>
<th>Monday to Saturday</th>
<th>Sundays and Public Holidays</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 am to 6 pm</td>
<td>6 pm to 10 pm</td>
</tr>
<tr>
<td></td>
<td>$L_{Aeq, adj, 15m}$</td>
<td>CV=50 AV=5</td>
<td>CV=45 AV=5</td>
</tr>
<tr>
<td></td>
<td>$L_{A01, adj, 15m}$</td>
<td>CV=55 AV=10</td>
<td>CV=50 AV=10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commercial Place</th>
<th>Noise Level dB(A) measured as:</th>
<th>Monday to Saturday</th>
<th>Sundays and Public Holidays</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 am to 6 pm</td>
<td>6 pm to 10 pm</td>
</tr>
<tr>
<td></td>
<td>$L_{Aeq, adj, 15m}$</td>
<td>CV=55 AV=10</td>
<td>CV=50 AV=10</td>
</tr>
</tbody>
</table>

Table D1 – Noise limits notes:

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

<table>
<thead>
<tr>
<th>Sensitive Place</th>
<th>Monday to Saturday</th>
<th>Sundays and Public Holidays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Level dB(A) measured as:</td>
<td>7 am to 6 pm</td>
<td>6 pm to 10 pm</td>
</tr>
<tr>
<td>$L_{Aeq, adj, 15m}$</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>$L_{A01, adj, 15m}$</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

**Airblast overpressure nuisance**

The model mining conditions for blasting has limits for peak particle velocity and air blast overpressure, described in Table D2 - Blasting noise limits.

**Table D2 – Blasting Noise Limits**

<table>
<thead>
<tr>
<th>Blasting noise limits</th>
<th>Sensitive or commercial place limits</th>
<th>Sundays and public holidays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airblast overpressure</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time</td>
<td>&lt;insert either no blasting or limits justified by proponent not less stringent than 7am – 6pm&gt;</td>
</tr>
<tr>
<td>Ground vibration peak particle velocity</td>
<td>5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time</td>
<td>&lt;insert either no blasting or limits justified by proponent not less stringent than 7am – 6pm&gt;</td>
</tr>
</tbody>
</table>

Typical conditions for Sunday and public holidays may include references such as “No blasting will occur on Sundays or Public Holidays without notification to sensitive receivers”.

### 4.2 Environmental Protection Act 1994

The objective of the EP Act is to protect Queensland’s environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP Act states a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm. This is termed the ‘general environmental duty’.

Environmental harm is defined as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

The noise level goals for operations may be determined from the *Environmental Protection (Noise) Policy 2008* (EPP (Noise) 2008).
The EPP (Noise) 2008 came into effect on 1 January 2009. There are two main considerations namely:

1. Acoustic quality objective (noise levels that are conducive to human health and well-being, ensuring a suitable acoustic environment for individuals to sleep, study or learn, be involved in recreation, including relaxation and conversation; and preserve the qualities of the acoustic environment that are conducive to protecting the amenity of the community); and

2. Controlling background creep.

4.2.1 Acoustic Quality Objectives

The ‘Acoustic Quality Objectives’ seek to protect the amenity of an acoustic environment. The indoor night-time goals effectively address sleep disturbance and sleep awakenings, while during the day it protects conversation. It should be noted that these are not strictly design limits for individual sources but objectives that are considered to provide acceptable health and wellbeing for the community.

The acoustic quality objectives are expressed as indoor noise level goals for dwellings at Night (10 pm to 7 am) and outdoor noise level goals during the Day (7 am to 6 pm) and Evening (6 pm to 10 pm). These objectives are all contained in Table 5.

The indoor noise quality objective for dwellings is converted to an outdoor noise level by conservatively assuming that the windows of the dwellings are wide open. The equivalent external noise levels (for the dwelling indoor noise level goals in Table 5) measured at least 4 m from the dwelling would be 5 dB higher (to allow for the reduction of noise through the building envelope).

Table 5: Acoustic Quality Objectives for Dwellings and Other Receivers Relevant to the Project during the Day (7 am to 6 pm), Evening (6 pm to 10 pm) and Night (10 pm to 7 am).

<table>
<thead>
<tr>
<th>Location</th>
<th>Time of Day</th>
<th>Acoustic Quality Objectives (Measured at the receptors) dB(A)</th>
<th>Environmental Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( \text{L}<em>{\text{Aeq, adj, 1 hr}} ) ( \text{L}</em>{\text{A10, adj, 1 hr}} ) ( \text{L}_{\text{A1, adj, 1 hr}} )</td>
<td></td>
</tr>
<tr>
<td>Dwelling outdoors</td>
<td>Daytime &amp; evening</td>
<td>50 55 65</td>
<td>Health and wellbeing</td>
</tr>
<tr>
<td>Dwelling indoors</td>
<td>Daytime &amp; evening</td>
<td>35 40 45</td>
<td>Health and wellbeing</td>
</tr>
<tr>
<td>Dwelling indoors</td>
<td>Night-time</td>
<td>30 35 40</td>
<td>Health and wellbeing, in relation to the ability to sleep</td>
</tr>
<tr>
<td>School or playground</td>
<td>When the children</td>
<td>55 - -</td>
<td>Health and wellbeing, and community amenity</td>
</tr>
</tbody>
</table>

Source: EPP (Noise) 2008
4.2.2 Controlling Background Creep

The controlling background creep objectives are twofold, firstly it seeks to avoid intrusiveness and secondly that the acoustic environment not be permitted to deteriorate. To the extent that it is reasonable to do so, noise from an activity must not be:

1. for noise that is continuous noise measured by $L_{A90,T}$, more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or

2. for noise that varies over time measured by $L_{Aeq,adj,T}$, more than 5 dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$.

These are measured noise level goals. Hence when developing a limit for the purposes of assessing a "modelled or component" noise level the cumulative effect of the background noise level needs to be included. For a noise that varies over time, as is the case with most noise sources, the limit is an $L_{Aeq,adj,T} = L_{A90,T} + 3$ dB(A).

4.3 DEHP Ecoaccess Guideline - Low Frequency Noise

The DEHP Ecoaccess Guideline "Assessment of Low Frequency Noise" identifies a number of industrial sources and processes having high noise levels and frequency content less than 200 Hz. Industrial sources may exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high, even though the dB(A) level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environs of residences, offices and factories adjacent to, or near, low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise emission occurs exhibiting an unbalanced frequency spectra, the overall sound pressure level inside residences should not exceed 50 dB(Linear) to avoid complaints of low frequency noise annoyance.

4.4 Blasting Criteria

Open cut coal mining procedures often include drilling and blasting of overburden material above the coal to make removal of that material easier.

According to the DEHP Ecoaccess Guideline "Noise and Vibration From Blasting" (DERM, 2004), blasting for the mining industry should generally be limited to the hours of 7:00 am to 6:00 pm.

Blasting outside these recommended times should be approved only where:

a) blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply); or

b) there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise-sensitive place, then:

a) the airblast overpressure must be not more than 115 dB(linear) peak for 9 out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and

b) the airblast overpressure must not exceed 120 dB(linear) peak for any blast.
Blasting operations must be carried out in such a manner that if ground vibration should propagate to a vibration-sensitive place:

   a) the ground-borne vibration must not exceed a peak particle velocity of 5 mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and,

   b) the ground-borne vibration must not exceed a peak particle velocity of 10 mm per second for any blast.

### 4.5 Road Traffic Noise Goals

Queensland Department of Transport and Main Roads (QDMR) is responsible for setting noise level limits from road traffic on public roads in Queensland. Typically, the planning goals for roads are met close to the road, i.e. distances up to about 30 m or thereabouts. There are no criteria in Queensland to assess the impact of noise from a road traffic-generating development. However, an increase of 3 dB(A) over a short period of time is considered to be a significant increase in traffic noise and an increase which justifies consideration of noise control.
4.6 **Summary of Noise Goals**

*Model License Conditions*

The model license conditions are a composite the two considerations contained (Acoustic quality objectives and background creep) of the *Environmental Protection (Noise) Policy 2008* (EPP (Noise) 2008), assuming a time varying noise source. The model license conditions also include reference to the Planning for Noise control document to develop alternate goals in the event that the project is unable to meet the model noise level goals.

*Application of Low Frequency Noise Goals*

It is possible that, due to the propagation of noise over the large separation distances between the source of noise and the receiver, a loss of high frequency components may occur. Thus, the low frequency noise goal of 50 dB(Linear) applies at noise sensitive receptors.

*Application of Blasting Limits*

The blasting goals apply and it is proposed to carry out the assessment with typical blasting charge weights.

A summary of the noise and vibration goals for this project is contained in Table 6.
Table 6: Summary of Proposed Noise and Vibration Goals

<table>
<thead>
<tr>
<th>Location</th>
<th>Time Period</th>
<th>Monday to Saturday</th>
<th>Sundays and Public Holidays</th>
<th>Low Frequency Noise Limit [dB]</th>
<th>Blasting to Avoid Annoyance at Sensitive Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Residential Receptors</td>
<td>Day</td>
<td>35 [dB(A)]</td>
<td>35 [dB(A)]</td>
<td>50</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
<tr>
<td></td>
<td>Evening</td>
<td>35 [dB(A)]</td>
<td>35 [dB(A)]</td>
<td>50</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>30 [dB(A)]</td>
<td>30 [dB(A)]</td>
<td>50</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
<tr>
<td>Commercial Receptors</td>
<td>Day</td>
<td>40 [dB(A)]</td>
<td>40 [dB(A)]</td>
<td>-</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
<tr>
<td></td>
<td>Evening</td>
<td>40 [dB(A)]</td>
<td>40 [dB(A)]</td>
<td>-</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>35 [dB(A)]</td>
<td>35 [dB(A)]</td>
<td>-</td>
<td>115 dB (Linear) Peak for 9 out of 10 consecutive blasts and not greater than 120 dB(Linear) Peak at any time</td>
</tr>
</tbody>
</table>

Note: No blasting to occur on Sundays or Public Holidays without notification to sensitive receptors

Noise [dBLin Peak]  Vibration PPV [mm/s]
5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time
5. Predicted Noise Levels

5.1 Modelling Methodology

A digital terrain noise model of the site and surroundings has been developed using PEN3D software. The PEN3D General Prediction Model (GPM) is based on the method contained in a book by Bies and Hansen (1988, pages 117, 127). The implementation is a more complex variation of the approach to sound propagation described in Concawe (1981). Concawe is one of the most commonly used methodologies to predict outdoor noise propagation from industrial sites. PEN3D also draws on aspects from ISO 9613-2. The PEN3D software was originally developed in 1993 and has been in constant development and review. The basic equation adopted by the GPM is:

\[ L_p = L_w - 20 \log_{10}(r) - 10\log_{10}(4\pi) + AE \]

Where:

- \( L_p \) is the sound pressure level at an observer
- \( L_w \) is the sound power level of the source, in octave bands from 63 Hz to 8 kHz
- \( 20 \log_{10}(r) + 10\log_{10}(4\pi) \) is the distance attenuation (spherical)
- \( AE \) is the excess attenuation factors.

The excess attenuation factors \( AE \) comprise:

\[ AE = A_a + A_g + A_m + A_b + A_f \]

Where:

- \( A_a \) = Excess attenuation due to air absorption from Sutherland et al. (1974)
- \( A_g \) = Excess attenuation due to ground reflection
- \( A_m \) = Excess attenuation due to meteorological effects
- \( A_b \) = Excess attenuation due to barriers
- \( A_f \) = Excess attenuation due to forests.
PEN3D is a sophisticated environmental noise model incorporating a 3D terrain model that permits accurate representation of the ground, ground cover, tree zones, mounds, barriers and weather conditions. PEN3D calculates a curved noise path based on surface friction, vertical temperature gradients and wind speed. All the noise calculations are based on this curved path. A finite differences approximation method is used to calculate the curved path. The curvature of the path determines the meteorology corrections. The meteorology corrections are frequency and distance dependent and are limited to +12 dB (downwind at night) and –7 dB (upwind and during the day) similar to the Concawe Category 1 and Category 6 meteorological corrections.

The excess attenuation due to ground reflection is obtained by combining the direct wave and the reflected wave incoherently, that is the energy from the ground wave is added to the direct wave. The ground reflection attenuation (or ground effects) will be between 0 and –3 dB (a negative value is an increase in noise levels) for all cases. This contrasts with the coherent reflection approach. The coherent approach is considered to be an “exact” method. For those situations where the source and receiver are located close to the same very hard reflecting plane and the path difference between the direct path and the reflected path is small, then the addition of the reflected wave and the direct wave will result in 6 dB increase rather than a 3 dB increase. However, at large distances the sound pressure level reduces at 12 dB per doubling with the coherent model (not 6 dB as per the incoherent model). This approach, while “exact”, is dubious as Digital Terrain Models (DTM) models are neither of sufficient accuracy nor can noise models truly account for the effects of atmospheric turbulence. Other methods such as the Nordic method or ISO 9613-2 divide the region between the source and receiver into three zones, and those zones closest to the source and to the receiver can potentially have higher absorption values. Consequently, if a noise source was measured say at a distance of 30 m and the sound power level is calculated by the commonly adopted formula PWL = SPL + 10log10(2 π r²) then the calculations using the PEN3D methodology would remain conservatively high for all distances.

The ground reflection (or ground effects) is a complex calculation using the flow resistivity for the surface likely to provide the ground reflection and the likely angle of incidence of the reflected wave to the ground. In those instances where the ground is highly absorptive the excess correction will approach zero. For those surfaces which are highly reflective the correction will be -3 dB, i.e. will lead to an increase in noise levels of 3 dB(A) (simulates hemispherical propagation).

While there are numerous methods to calculate ground effects (some of which provide significant attenuation [reduction of noise levels]), the PEN3D implementation is one of the more conservative estimates of ground effect in the far field. Bies & Hansen (1988) indicate “as the distance from the source or frequency increases, the incoherent model will become more appropriate”.

The theoretical approach to meteorology implies that PEN3D is likely to provide more significant corrections than other models. Thus, at night or during downwind predictions, the PEN3D calculations are likely to result in conservatively high results, i.e. the modelled noise levels are likely to be higher than the measured levels.
The likely barrier attenuations are calculated for four possible curved paths, namely:

- source, to the top of barrier then to the receiver;
- source, reflection from ground (source side), top of barrier, receiver;
- source, top of barrier, reflection from ground (receiver side), receiver; and
- source, reflection from ground (source side), top of barrier, reflection from ground (receiver side), receiver.

These are combined to obtain effective barrier attenuation. In the situation where the source and receiver are well above the ground and the barrier just intercepts line-of-sight then the barrier effect will be 5 dB(A). However, if the source and receiver are close to the ground and the noise barrier just intercepts line of sight (a pebble) the barrier effect will tend to zero.

Once the most likely curved path has been calculated, the method determines if it intercepts any tree zones within the digital terrain model. If the curved noise path travels in the lower 75% of the tree zone then the full excess attenuation is applied for the distance travelled in the tree zone. If the curved noise path travels in the upper 25% of the tree zone then:

a) the average propagation height is determined;

b) the length in the zone is determined; and,

c) the forest excess attenuation is taken to be linearly interpolated between zero at the top of the tree zone and full excess attenuation at 75% height.

Tree zones can potentially provide extremely high attenuation if the tree coverage is large. However, in practice, the curved path adopted in the PEN3D methodology usually results in the noise rays passing above tree zones (at night or during downwind conditions) and only intercepting tree zones if they exist on the tops of hills or whenever the noise ray approaches the ground. Tree zones can potentially provide higher than expected attenuation during calm neutral conditions.

5.2 Meteorology

The meteorology for the site has been analysed to address frequent wind speeds, wind directions and inversions. The meteorology was prepared for the Air Quality Assessment (SEG 2018) and is based on a 1-year modelling simulation, years 2015.

5.3 Temperature Inversions

The total night-time period during winter (June, July and August) has been analysed to determine the frequency of inversions, as presented in Table 5. Temperature inversions generally occur during the night-time and early morning periods. The likelihood of inversions reduces with wind speed. It was determined that inversions are likely 86% of the time. This indicates that modelling during inversion conditions is appropriate. However, since the terrain is essentially flat without any dominant (katabatic) drainage flows it is not necessary to include a wind component. The wind direction analysis confirmed that the light winds at night are evenly distributed with direction.

It is proposed to model inversions with the following parameters:

- 3 degrees Celsius (°C)/100 m temperature inversion strength
- Zero wind speed
- Air temperature 10°C.
Table 7: Inversion Analysis June to August (6 pm to 7 am)

<table>
<thead>
<tr>
<th>Wind speeds</th>
<th>Percentage of Time Occurring (%)</th>
<th>Percentage of Time having Inversions (%)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calms</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Winds less than 1 m/s</td>
<td>2</td>
<td>66</td>
<td>1</td>
</tr>
<tr>
<td>Wind from 1 to 2 m/s</td>
<td>12</td>
<td>78</td>
<td>10</td>
</tr>
<tr>
<td>Wind 2 to 3 m/s</td>
<td>16</td>
<td>88</td>
<td>14</td>
</tr>
<tr>
<td>Wind 3 to 4 m/s</td>
<td>46</td>
<td>93</td>
<td>43</td>
</tr>
<tr>
<td>Wind 4 to 5 m/s</td>
<td>21</td>
<td>91</td>
<td>19</td>
</tr>
</tbody>
</table>

Percentage of time inversions are likely to occur between 6 pm and 7 am 86%

5.3.1 Wind Effects

Wind effects are typically assessed when wind is a feature of the area. Wind is a feature when source-to-receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season. This differs from the procedure used with temperature inversions, in that the 30 percent occurrence applies to all seasons and each assessment period—and not just the winter season and night/early morning assessment period.

The wind direction and wind speeds were analysed to determine whether wind effects need to be considered. For this analysis, the wind speed was limited to 3 m/s since higher wind speeds tend to increase the ambient noise. Each season and each time period (day, evening, night) was analysed and winds were not found to occur more than 30 percent of the time in any direction. A selection of the critical windroses for each relevant period is contained in Appendix C. It is noted however northerly winds occur infrequently during autumn and winter. Since the closest sensitive receptor is almost due south, a single wind case at night has been included in the noise model.

The modelling cases adopted in Table 8 are based on the location of the closest homestead to the project.
Table 8: Meteorology Modelling Cases Assessed

<table>
<thead>
<tr>
<th>Case</th>
<th>Wind speed [m/s]</th>
<th>Wind Direction [degrees from North]</th>
<th>Vertical Temp Profile [ºC/100 m]</th>
<th>Air Temp [ºC]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>0</td>
<td>0</td>
<td>-3</td>
<td>25</td>
</tr>
<tr>
<td>Evening (Neutral)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Night (Inversion) (see Section 0)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Night north wind and mild inversion</td>
<td>3</td>
<td>360</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

5.3.2 Noise Model Parameters

The DTM for each year of the Project has been provided by the proponent. The DTM was supplied for the seven pits. The areas surrounding these working areas has been based on NASA Shuttle Radar telemetry and contoured to 1 m intervals. The noise model has an adopted ground cover of 'thick grass' as a representation of the combination of the roughness provided by pasture and the taller vegetation that exists throughout the region. The model does not incorporate excess attenuation factors associated with tree zones.

The mining process comprises:

1. hammer drilling of 89-102mm blast holes;
2. 120t class backhoe excavators;
3. Cat 777 (90t) class rigid dump trucks;
4. 1 bulldozer;
5. 1 graders;
6. 1 water trucks;
7. road train (for ore haulage) and,
8. various light service trucks.

All the pits are of physical size and shallow depth size suited to this size of mining equipment.

The $L_{Aeq(60 \text{ min})}$ equipment noise levels are contained in Table 9. The noise levels are expressed as a sound power level. The overall sound power levels are “A” weighted. The “A” weighting emulates the way the human ear responds to sound. These noise levels are based on measurements by SEG and published data. The numbers of equipment for the modelling case is contained in Table 9.
All the noise sources have been placed in typical operating positions in the noise model. For instance, the route of the overburden trucks encompasses the haul roads as well as the waste rock emplacement. This are typically elevated positions and completely or partially unscreened by nearby terrain. Similarly, the road trains B-double exit the pit and travel to the access road via the internal haul roads and the most efficient route possible.

The b-double route is modelled as line sources and include correction for the cumulative time all truck travel road segments contributes to the $L_{Aeq(1 \text{ hr})}$. For instance, if the cumulative time all haul trucks travel on a road segment is say 30 minutes in a one hour period then the sound power level for that route entered into the noise model would be -3 dB(A) below that expressed in Table 9. All other noise sources are fixed in location and assumed to operate at the sound power levels indicated for the entire hour.

<table>
<thead>
<tr>
<th>Fleet Item</th>
<th>SWL $L_{Aeq(1 \text{ hr})}$ dB(A)</th>
<th>Project</th>
<th>Source</th>
<th>Number of Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining Excavator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi EX3600</td>
<td>112</td>
<td>Millenium Mine</td>
<td>Site measurements (2006) Modified from EX3600</td>
<td>1</td>
</tr>
<tr>
<td><strong>Haul Truck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT 777</td>
<td>115</td>
<td>Millenium Mine</td>
<td>Site measurements (2006) Cat 789</td>
<td>2</td>
</tr>
<tr>
<td><strong>Dozer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT D10</td>
<td>111</td>
<td>Baralaba North (2013)</td>
<td>SEG (2012)</td>
<td>1 for ¼ time</td>
</tr>
<tr>
<td><strong>Grader</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Truck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Komatsu HD785 Water Truck</td>
<td>114</td>
<td>Moolarben Coal Mine</td>
<td>Global Acoustics (2012)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Drill</td>
<td>116</td>
<td>Duralie Coal Mine</td>
<td>SLR Consulting (2014)</td>
<td>1</td>
</tr>
<tr>
<td>Mobile Jaw Crusher</td>
<td>114</td>
<td>Clem 7</td>
<td>SEG (2006) Modified to address rock hardness</td>
<td>1</td>
</tr>
</tbody>
</table>

The noise sources are positioned 4.5m above local terrain. There are several items of minor mining plant not included in Table 9. Minor noise sources are comparatively quiet or operated infrequently. The exclusion of this plant from the noise model will not make a noticeable difference in the calculated noise levels at sensitive receptors. In addition, it has been found that the model is relatively insensitive to operating height of the equipment since the model calculates a curved path.
through the air and for downwind or inversion cases the curved path passes above most obstructions.

**Blasting**

PEN3D contains a blasting module that includes the effects of meteorology. The basic equations were originally developed and verified for Collinsville coal mine in central Queensland. The basic equation for blast overpressure is:

\[
\text{dBL} = 20 \times \log(3557/0.00005) - 20 \times 1.26 \times \log(\text{Distance}) + 20 \times 1.268 \times 3 \times \log(\text{MIC}) + 3
\]

For a charge weight of 500 kg, the blast overpressure at 1000 m is 115 dB Lin peak.

For vibration, the peak particle velocity is:

\[
V = 2000 \times (\text{Distance}/(\text{MIC})^{0.5})^{-1.6}
\]

For a charge weight of 500 kg, the peak vibration velocity at 1000 m is 4.6 mm/s. This assessment is based on a charge weight of 300 kg.

**5.4 Noise Modelling Results**

A noise model has been developed for the one mining stage for the fully operational project. All the noise models provide the \( L_{Aeq(1\ hr)} \). Each item of equipment goes through a repeating short duration cycle representative of operations. The \( L_{Aeq} \) noise model incorporates the fluctuating noise levels to obtain the \( L_{Aeq} \) at the receiver. This is a mathematically correct analysis as it is independent of the time the noise is generated. However, it is also a conservative methodology as it requires the meteorology to remain constant for the entire hour (i.e. it ignores the small variations in a turbulent atmosphere that lead to variations of actual noise level below the calculated noise level). The \( L_{A01} \) is calculated to be the greater of either the sum of the \( L_{Aeq} \) from all equipment plus 5 dB(A) or the \( L_{Aeq} \) from the noisiest item of plant plus 10 dB(A).

Table 10 contains the calculated \( L_{Aeq(15\ min)} \) noise levels at the sensitive receptor for all modelling cases in tabular format, Appendix B contains the noise contour diagrams. The results are summarised for the day, evening and night periods. The \( L_{A01} \) is likely to be between 5 and 10 dB(A) greater than the \( L_{Aeq(15\ min)} \).
Table 10: Predicted Noise Level at Sensitive Receptor

<table>
<thead>
<tr>
<th>Meteorological Case</th>
<th>Wind speed [m/s]</th>
<th>Wind Direction [degrees from North]</th>
<th>Vertical Temp Profile [°C/100 m]</th>
<th>Air Temp [°C]</th>
<th>L_{Aeq}(15 min) [dB(A)]</th>
<th>L_{A01}(15 min) [dB(A)]</th>
<th>L_{eq}(15 min) Linear [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>0</td>
<td>0</td>
<td>-2</td>
<td>25</td>
<td>25</td>
<td>32</td>
<td>37</td>
</tr>
<tr>
<td>Evening</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>33</td>
<td>38</td>
<td>41</td>
</tr>
<tr>
<td>Night (neutral)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>38</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>Night north wind</td>
<td>3</td>
<td>360</td>
<td>2</td>
<td>10</td>
<td>46</td>
<td>51</td>
<td>51</td>
</tr>
</tbody>
</table>

Sensitive Receptor R01

Note: <thh represents a noise level below the threshold of human hearing.

The calculated overpressure from a blast (MIC 300kg) is contained Table 11.

Table 11: Calculated Noise and Vibration from Blasting (300 kg MIC) (Day Meteorology)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Maximum dB(Lin)</th>
<th>PPV (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wynberg Homestead</td>
<td>110</td>
<td>0.7</td>
</tr>
</tbody>
</table>
6. **Assessment of Modelled Noise Levels**

*Operational Noise Assessment*

The noise from the operation of the mine is expected to readily comply with the proposed operational environmental goals (L\text{Aeq}, L\text{A01} and low frequency) during the day and evening at Wynberg Homestead.

The mining operations are likely to exceed the noise level goals during the night period.

*EA Blasting Objectives*

The blast over pressure and blast vibrations from the blasting at the mine (MIC of 300kg) is expected to readily comply with the proposed environmental goals.

*Low Frequency Noise Objectives*

The low frequency noise from the operation of the mine is expected to readily comply with the proposed operational environmental goals for during the day and evening.

It is understood the mine operations are intended to be during the day and as a consequence it is not necessary to provide mitigation measures.

7. **Conclusions and Recommendations**

The assessment of the Project has been based on a conservative modelling methodology.

Initially the meteorology for the site was assessed in detail to determine whether inversions and/or winds were likely to be frequent for the site. It was determined that inversions are frequent in winter. Assessment of wind occurrence indicated that adverse winds occur during the evening and night.

The DTM map for the pits was based on the models developed as part of the mine planning process. Beyond the pit area 1 m contours were adopted based on NASA shuttle radar mission.

One modelling case was adopted with most of the plant and equipment on the natural ground. Only the excavator being situated within a pit.

The model mining conditions were adopted as the appropriate goals for the proposal.

The modelling of the mining case demonstrated that the noise levels are expected to be readily met at the Wynberg Station Homestead during the day and evening. There was an exceedance of the noise level limits at night during inversion conditions. It is understood that mining operations at night are not proposed.

The low-frequency noise level goals are readily met at Wynberg Station Homestead during the day and evening.

No exceedances of the relevant air blast or vibration criteria are predicted at Wynberg Station Homestead.
### Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{A10,t}$</td>
<td>The $L_{A10}$ is the “A”-weighted statistical noise level exceeded 10% of the time. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours. It is sometimes referred to as the average maximum noise level.</td>
</tr>
<tr>
<td>$L_{A90,t}$</td>
<td>The $L_{A90}$ is the “A”-weighted statistical noise level exceeded 90% of the time. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours. It is commonly referred to as the background noise level.</td>
</tr>
<tr>
<td>$L_{Aeq,t}$</td>
<td>The $L_{Aeq}$ is the “A”-weighted energy average noise level over the time in question. It is the constant noise level containing the same energy as the actual fluctuating noise level. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours.</td>
</tr>
<tr>
<td>Day</td>
<td>Refers to the period between 6 am and 6 pm.</td>
</tr>
<tr>
<td>Evening</td>
<td>Refers to the period between 6 pm and 10 pm.</td>
</tr>
<tr>
<td>Night</td>
<td>Refers to the period between after 10 pm and before 6 pm.</td>
</tr>
<tr>
<td>Ambient noise</td>
<td>The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.</td>
</tr>
<tr>
<td>Assessment background level (ABL)</td>
<td>The single-figure background level representing each assessment period—day, evening and night (i.e. three ABLs are determined for each 24-hour period of the monitoring period). ABL is a measure of background noise level in the absence of noise from the source. Determination of the ABL is by the tenth percentile method, i.e. sort the recorded hourly $L_{A90}$’s into ascending order and select the lowest ten percentile level.</td>
</tr>
<tr>
<td>Rating background level (RBL)</td>
<td>The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the ABL). It is the median value of the ABL’s.</td>
</tr>
<tr>
<td>Free field</td>
<td>A position where there are no reflecting surfaces, other than the ground, close enough to influence the sound pressure level. Taken as a minimum of 1.2 metres above ground level and 4m from the closest building façade.</td>
</tr>
<tr>
<td>Noise floor</td>
<td>The noise floor, inherent or ‘self-noise’ of sound level measuring equipment is the combination of the preamplifier’s electrical noise and thermal noise from the microphone.</td>
</tr>
<tr>
<td>Separation distance</td>
<td>the distance between a source and sensitive receptors</td>
</tr>
</tbody>
</table>
Appendix A: Sound Power Level Details
## Wynberg Project Noise Assessment

### Octave dB Sound Power Levels in dB at Octave band Hz

<table>
<thead>
<tr>
<th>Plant</th>
<th>Mining Excavator</th>
<th>Haul Truck</th>
<th>Dozer</th>
<th>Grader</th>
<th>Water Cart</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
<td>125</td>
<td>250</td>
<td>500</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>Hitachi EX1200</td>
<td>89.8</td>
<td>96.9</td>
<td>102.9</td>
<td>105.6</td>
<td>105.9</td>
<td>106.6</td>
</tr>
<tr>
<td>CAT 777</td>
<td>99.4</td>
<td>109.3</td>
<td>112.1</td>
<td>109.9</td>
<td>111.9</td>
<td>115.4</td>
</tr>
<tr>
<td>CAT D10</td>
<td>104.8</td>
<td>112.6</td>
<td>106.3</td>
<td>111.9</td>
<td>104.4</td>
<td>101.1</td>
</tr>
<tr>
<td>CAT 24M</td>
<td>113.7</td>
<td>108.9</td>
<td>107.6</td>
<td>106.3</td>
<td>108.0</td>
<td>104.6</td>
</tr>
<tr>
<td>Komatsu HD785 Water Truck</td>
<td>106.0</td>
<td>110.0</td>
<td>107.0</td>
<td>108.0</td>
<td>109.0</td>
<td>110.0</td>
</tr>
<tr>
<td>Production Drill</td>
<td>108.0</td>
<td>114.0</td>
<td>114.0</td>
<td>113.0</td>
<td>110.0</td>
<td>108.0</td>
</tr>
<tr>
<td>Crusher (Jaw) Striker JQ1165</td>
<td>107.6</td>
<td>107.9</td>
<td>108.0</td>
<td>111.7</td>
<td>110.3</td>
<td>105.3</td>
</tr>
<tr>
<td>B-Double road train</td>
<td>89.0</td>
<td>89.0</td>
<td>93.0</td>
<td>99.0</td>
<td>98.0</td>
<td>97.0</td>
</tr>
</tbody>
</table>
Appendix B: Calculated $L_{Aeq\ 1hr}$ Noise Levels Contour Diagrams
Figure 10: LAeq - Day Meteorology
Figure 11: $\mathbf{L_{Aeq}}$ - Evening Meteorology
Figure 12: LAeq - Night Without Wind Meteorology
Figure 13: LAeq - Night Meteorology and North Wind
Appendix C: Windrose Diagrams
WIND ROSE PLOT:  
Winberg Gold  
Wind Roase  

COMMENTS:  
COMPANY NAME: Simpson Engineering Group  
MODELER: Chris Simpson  
DATE: 10/05/2018  
PROJECT NO.: 171220  

DATA PERIOD:  
Start Date: 1/01/2015 - 00:00  
End Date: 31/12/2016 - 23:00  
AVG. WIND SPEED: 3.16 m/s

WIND SPEED (m/s)  
- Calms: 1.20%  
- 0.50 - 2.10  
- 2.10 - 3.60  
- 3.60 - 5.70  
- 5.70 - 8.80  
- 8.80 - 11.10  
- >= 11.10

Display: Wind Speed  
Direction (blowing from)
Winberg Gold
Wind Rose - Day

WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10
- Calms: 1.38%

COMMENTS:

DATA PERIOD:
Start Date: 1/01/2015 - 07:00
End Date: 31/12/2016 - 17:00

COMPANY NAME:
Simpson Engineering Group

MODELER:
Chris Simpson

CALM WINDS:
1.38%

TOTAL COUNT:
8041 hrs.

AVG. WIND SPEED:
3.24 m/s

DATE:
10/05/2018

PROJECT NO.
171220
Winberg Gold
Wind Rose - Night

WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10
- Calms: 0.72%

COMMENTS:

DATA PERIOD:
Start Date: 1/01/2015 - 00:00
End Date: 31/12/2016 - 23:00

COMPANY NAME:
Simpson Engineering Group

MODELER:
Chris Simpson

CALM WINDS:
0.72%

AVG. WIND SPEED:
3.19 m/s

TOTAL COUNT:
5848 hrs.

DATE:
10/05/2018

PROJECT NO.:
171220