Noise and Vibration Baseline Conditions Report

Prepared for:

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1 Introduction

The technical characteristics of noise and vibration in the region of the Roşia Montană Project were examined in a baseline noise and vibration study, commissioned by Roşia Montană Gold Corporation (RMGC) in 2002 and 2003. This study was conducted for RMGC by S.C. Cepstra Grup A.R.L. (Cepstra), Bucharest, with additional support provided by Agraro Consult S.R.L. (Agraro) and RMGC staff. Baseline noise and vibration monitoring are limited to the existing mining operations at C.N.C.A.F. MINVEST S.A. (MINVEST) Deva, Roşiamin Subsidiary (Roşiamin), located in the Roşia Montană Valley.

2 Background

The Roşia Montană area has a long history of mineral exploitation that dates back many centuries, and mining and mineral processing activities have until recently, or are presently, being carried out in Roşia Montană and the nearby towns of Abrud and Roşia Poieni. These communities have a strong mining heritage that is an integral part of the regional and national cultural patrimony. The noise and vibration from mining, mining-related transportation and other related activities are generally recognised as inherent parts of community life. However, variability is to be expected in the outlook held by local residents, and has important implications in how these communities view noise and vibration impacts. At "nuisance" levels such impacts tend to be highly subjective. In a community with no mining heritage or no active cultural memory of a historical mining heritage, mining-related noise or traffic might be regarded as highly intrusive. On the other hand, for communities such as these with existing mining activities or an active mining heritage, such impacts may be regarded as a welcome condition, associated with economic well being and other benefits.

3 Technical Considerations

Major technical issues that must be considered in the evaluation of noise and vibration impacts are summarised in the following sections.

3.1 Noise Considerations

Although sound pressure can be readily measured, the perception (and judgement of the relative magnitude) of sound is highly subjective, and variability in the physical response of humans to sound complicates its analysis. Sound pressure magnitude is typically measured and quantified using a logarithmic ratio of pressures, the scale of which gives the level of sound in decibels (dB). A typical illustration of the decibel scale is presented in Figure 1. Because human hearing is not equally sensitive to sound at all frequencies, an "A-weighting" filter system is typically used to adjust measured sound level to approximate this human frequency-dependent response. A-weighted sound level units are typically expressed as "dBA" or "dB(A)."

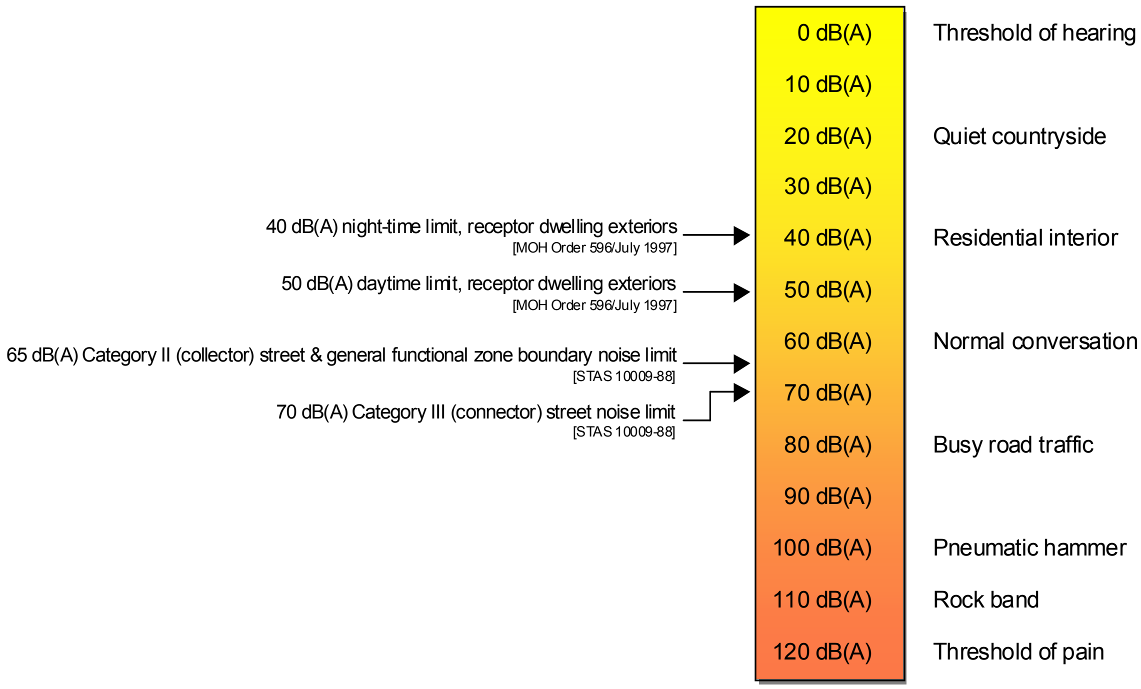

Figure 1. Typical Decibel Scale, with Romanian Regulatory Levels Noted[i]

When sound is measured for distinct time intervals, the statistical distribution of the overall sound level can be obtained during that period. The energy-equivalent sound level (L_{eq}) is the most common parameter associated with such measurements. The L_{eq} metric is a single-number noise descriptor that represents the average sound level over a given period of time, where the actual sound level varies with time. L_{max}, L_{min}, and L_{xx}, are also common noise descriptors. L_{max} and L_{min} are the maximum and minimum noise levels respectively, and L_{xx}, known as a statistical sound level, is the time-varying noise level that would be exceeded "xx"percent of the time.

Although the A-weighted scale is commonly used to quantify a range of human response to individual events or general community sound levels, the degree of annoyance or other physical response effects also depends on several other perceptibility factors, including:

- ambient (background) sound level;
- magnitude of the event sound level with respect to the background;
- duration of the sound event;
- overall number of event occurrences and how often they are repeated; and
- the time of day that the event occurs.

Pressure disturbances with frequencies above 20 Hz, are typically characterised as “noises”, whereas those having frequencies below 20 Hz (i.e. below the human hearing range) are usually characterised as “airblasts.” With regard to the latter, blasting operations at mine site generate seismic waves that are propagated into the ground, along with a potential atmospheric disturbance with a wide range of frequencies. These disturbances (airblasts) may interact with parts of various structures (such as windows or walls), and a transfer of energy is produced which results in vibration or resonance. Airblast is also measured in decibels, but since no weighting scale is used, the results are expressed as “dB Linear.”

With regard to noise from blasting, meteorological conditions have a substantial effect on the perceived intensity of a blast, although noise enhancement effects are extremely site specific and subject to significant variability.[ii] Wind velocity and temperature (as a function of altitude) influence the propagation of sound waves. When compared to still air conditions, steady light to moderate winds tend to amplify noise levels downwind, and to decrease noise levels upwind from a given source.[iii] It has been noted that a steady, gentle breeze can increase noise levels without increasing background noise levels. On the other hand, winds of higher velocity tend to increase background levels due to turbulence or the movement of trees and shrubs, and may obscure other noise sources. Low wind velocities can enhance noise levels by several decibels relative to still conditions, assuming flat topography between sources and receiver. Conversely, upwind noise levels upwind may be reduced by a similar amount. Temperature inversions are also known to increase noise levels at some distance from the source, and most inversions occur during the nighttime. Nighttime blasting therefore increases the potential for noise to be considered a nuisance by human receptors, as sleep patterns may be disrupted.

3.2 Vibration

Vibration measurement is typically interpreted with regard to its potential harmfulness to structures and equipment. In an open pit mining operation such as the Roşiamin operation, drilling and blasting operations are a major source of vibration, along with the mechanical crushing and separation equipment used in the ore beneficiation process.

4 Noise

Noise monitoring for this study was focused on determining noise levels for operating mobile sources at the existing Roşiamin operations and checking for compliance with applicable Romanian regulations. This operation also uses blasting, which is widely audible.

Apart from the above limited mining operations, the Roşia Montană Valley area may be classified as rural in character and as such, (away from roads and streets) generally characterised by noise levels of ≤ 35 dB(A). Existing noise pollution sources (other than mining) include road traffic, agricultural operations and small, fixed mechanical devices (e.g. pumps and generators).

The adjacent Corna Valley is also rural in character and while during the study it was not itself the focus of mining operations, the existing open pit mine and waste dumps are in full view at the top of the Valley and residents are affected by the noise from mining and waste rock haulage operations.

Under Romanian noise regulations for industrial sites, a general limit of equivalent noise level 65 dB(A) is set at the boundary, in urban situations (STAS 10009-98).[iv] With respect to receptors, a noise limit of 50 dB(A) is set at a distance three meters from the dwelling wall, and 40 dB(A) at night.

4.1 Current Open Pit Areas

Within the open pit areas of the Roşiamin operation, activities mainly consist of blasting, followed by ore excavation, the loading of tip trucks, transport, and the first phase of ore sorting and crushing (for which the ore is conveyed to a silo for the loading of railcars underground and subsequent rail transportation down the valley.

The noise related to this activity was observed to contribute significantly to the acoustic environment within the open pits and the neighbouring areas as well. The levels of acoustic pressure represent values that must be taken into consideration for health and safety protection reasons, although configuration of operations within the open pits contains acoustic screens many metres high which serve as barriers between noise sources and their nearest residential receptors. Because of this distance, the noise produced from the open pit areas is perceived to be at low levels by the neighbouring population.

The impulse type noise, produced by blasting operations, is measured at values of 70 – 80 dB(A) in the residential areas. Typically, for a blasthole loaded with 50 kg of explosives, the expected results would be L_{max} = 110 dB(A) at the distance of 100 m for a direct view receptor. The attenuation is due to the presence of the pit configuration and other mentioned previously.

The noise sources are mainly semi-mobile (small sources that move moderate distances during the operations) or mobile (e.g. the tip trucks for ore transportation).

The most important observed noise sources are represented by the following equipment items, with different periods of utilisation and acoustic powers between 112 to 125 dB(A), which are listed below:

crusher C12, (Progresul Braila)	2 units
driller SB – 250mm , for deeper wells up to 60m	2 units
excavator UNEX – E203 (Czechoslovakia)	1 units
excavator EKG 4.6 m3 (USSR)	2 units
ditcher S1203 (Progresul Braila)	2 units
bulldozer S1500 (UM Campina)	5 units

bulldozer S1800 (UM Campina)	1 unit
pusher IF3602	1 unit
front end loader A3600 (U.M. Craiova)	2 units
front end loader LK34 (Stalowa Vola - Poland)	2 units
tip trucks of 16 tones	4 units

At locations adjacent to these noise sources, noise levels sometimes exceed 90 dB(A), which implies that additional mitigation measures (i.e., hearing protection) should have been considered for the operators.

Measurements of noise carried out at Roşia Montană during highwall blasting, indicated values below 95 dB(Linear) for low frequency sounds and 75 dB(A) for audible sounds.

The level of the noise measured at the border of the residential area nearest to the source was observed to be much lower than the admissible limit.

4.2 Surface Ore Transportation

The ore is transported by conveyor belt and railway transportation of the ore from Gura Minei, the exit of the underground transportation line at the 714 Adit down to the phase II and III crushing and sorting station located at Aprabus. Several points along this transportation route are near to residential areas.

Ore transportation by belt conveyor stretches a distance of about 560 m between Aprabus and the current Roşiamin processing plant at Gura Rosiei. The noise produced during the operation of the conveyor is 60 – 65 dB(A), measured at a distance of 5m. Due to the fact that this is aerial ore transfer, that employs a flyover above the the Abrud – Campeni road, it is not located near residential houses, and therefore the observed noise meets specified noise limits.

The technological transport on the narrow-gauge railway line, with small rail cars and locomotives, represents an important noise source for the areas where this is performed at surface level. This transportation path passes near several residential houses, and thus it represents an important noise source for the people living in the area. This activity is performed for the whole working day, which represents about 40 trips passing with full cargo and 40 trips with the railcars empty. The locomotives, which may have electric or diesel engines represent important noise sources as well, with noise levels of 86 – 95 dB(A) measured at a distance of 5 m. The noise generated by a train travelling through on poorly maintained rails and roadbed line is also important The distribution maps for the noise levels measured during the study are presented in Figures 2 and 3. These figures also show the location of the major features of the existing Roşiamin operations in relation to the concession boundary and protected areas that will be associated with the Roşia Montană Project.

The calculation of the maximal affected area and the noise distribution was performed considering the free propagation hypothesis and attenuation in air as well as attenuation due to soil effects; no attenuation was assumed due to topographical relief, vegetation, or other barriers. The receptor height was assumed to be 4 m in accordance with Directive 2002/49/EC.[v]

It is obvious that the greatest contribution to the general noise levels in the area observed during the study was due to the railway transportation.

4.3 Processing Plant

The current Roşiamin processing plant site is located about 10 meters distance to this limit of a small area of dwellings. At the plant, the important noise sources come from several processing equipment items, including the blowers from the laboratory, which are not provided with proper acoustic protection measures.

At the eastern side of the plant site there is an important road which links Abrud and Campeni. Based on the STAS 10 144/1-80[vi], this road is classified as a second technical category, for which the equivalent maximal admissible noise level is 70 dB(A) as is stipulated onto STAS 10 009-88.[vii]

Below are presented the characteristic noise level measured at the edge of the road (border):

- Leq (24h or average over 24 hours) = 64,8 dB(A)
- Leq (6-22 or average from 0600-2200 hours) = 66,2 dB(A)
- Leq(22-6 or average from 2200-0600 hours) = 59,1 dB(A)

Table 4-1 presents the noise levels measured during the site visit in August 2002. The measurements have been performed with a sonometer meeting the requirements of IEC 651 type 1.

Table 4-1. Measured noise levels

No	Location	Measured dB(A)	Admissible limits dB(A)
1	Nearby the main preparation workshop	68.6	90 (STAS 10009-88)
2	1 m from the left blower 1 at the northern side of the laboratory	91.9	Noise source
3	Between the blowers from the northern side of the laboratory	90.7	Noise source
4	Nearby the blowers from the southern side of the laboratory	90.3	Noise source
5	In front of the house located nearby the access plant gate	54.9	50 for the period 6^{00} AM - 10^{00} PM and 40 the period 10^{00} PM - 6^{00} AM (O.M.S. 536 – 1997)
6	In front of the house located in the proximity south-west of the plant side edge	57.2	50 for the period 6^{00} AM - 10^{00} PM and 40 the period 10^{00} PM - 6^{00} AM (O.M.S. 536 – 1997)
7	In front of the house located 20 m far from the south-west of the plant side edge	53.8	50 for the period 6^{00} AM - 10^{00} PM and 40 the period 10^{00} PM - 6^{00} AM (O.M.S. 536 – 1997)
8	Road traffic	66.5	Noise level

5 Vibration

5.1 Open Pits

At the time the study was performed, the existing Roşiamin open pit mine conducted blasting daily between 14^{30} and 15^{30} hours. In principle, the most important vibration sources are represented by the blasts, due to their impact to the environment. The vibration measurements, performed for two blasts using NONEL (non-electric millisecond delay detonation) technology, indicated vibration speed values (PPV – Peak Particle Velocity) below 1 mm/s (0.65 mm/s, respectively 0,7 mm/s) for a loading of 45 kg/delay, measured at about 600 m at the nearest sensitive receptor (a house in the Roşia Montană locality). At the time of the study, no complaints had been recorded and the vibration levels from this source experienced by the nearest dwellings were insignificant given the small scale of the blasting and the separation distance.

5.2 Ore Transportation and Preparation

The vibration caused by the operation of equipment for excavating, loading, transporting, unloading, crushing, and other operations are less important for the environment, because the distance to the nearest dwelling area is far enough for the received vibration to be negligible.

5.3 Traffic

Traffic on the access roads contributes to both noise and vibration levels. Official traffic census data are not available for local roads; however, RMGC undertook traffic counts over one week in May of 2001. These data are summarised in Tables 5-1 through 5-6. National Road DN 74A skirts the western side of the Project area and provides a link with the Romanian trunk route network via the regional centre of Alba Iulia. This highway has a moderate use by a mix of heavy and light vehicles in line with its role as a link between centres of population in the Alba Iulia County (Tables 5-5 and 5-6).

National road DN 74 connecting Abrud to Brad to the west is indicated to carry significantly lower volumes of traffic compared to the DN 74A. Other roads include the Country Road DJ 742 which links the DN 74A with Roşia Montană and Corna. This road is used by a mix of heavy and light traffic with heavy lorry traffic associated with mining activities (Tables 5-2 and 5-3).

Figures represent daily averages for census undertaken from 14 to 20 May 2001 (the date of the study, by Knight Piesold Ltd.). Locations are marked Morning (06^{00} - 12^{00}); Afternoon (12^{00} - 18^{00}); Night (18^{00} - 06^{00}).

Table 5-1. Traffic Movements - Location 1 Abrud - Brad National road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	342	41	105	91
	Afternoon	323	21	104	88
	Night	242	19	98	23
	TOTALS	**907**	**81**	**307**	**202**
Weekend	Morning	217	16	47	24
	Afternoon	242	14	39	53
	Night	244	13	87	17
	TOTALS	**703**	**43**	**173**	**94**

Table 5-2. Traffic Movements - Location 2 Abrud - Corna County road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	315	110	78	79
	Afternoon	358	112	97	94
	Night	218	70	38	56
	TOTALS	**891**	**292**	**213**	**229**
Weekend	Morning	336	134	91	43
	Afternoon	281	95	41	66
	Night	279	101	65	106
	TOTALS	**896**	**330**	**197**	**215**

Table 5-3. Traffic Movements - Location 3 Abrud - Rosia Montana County road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	582	78	122	30
	Afternoon	601	80	123	37
	Night	272	55	84	15
	TOTALS	**1455**	**213**	**329**	**82**
Weekend	Morning	533	53	58	12
	Afternoon	517	55	57	25
	Night	317	59	57	18
	TOTALS	**1367**	**167**	**172**	**55**

Table 5-4. Traffic Movements - Location 4 Abrud - Brad National road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	168	15	58	65
	Afternoon	172	15	57	45
	Night	71	16	58	13
	TOTALS	**411**	**46**	**173**	**123**
Weekend	Morning	152	10	27	19
	Afternoon	208	14	33	22
	Night	185	15	63	17
	TOTALS	**545**	**39**	**123**	**58**

Table 5-5. Traffic Movements - Location 5 Abrud - Zlatna National road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	390	92	108	47
	Afternoon	400	68	90	60
	Night	318	63	76	34
	TOTALS	**1108**	**223**	**274**	**141**
Weekend	Morning	316	58	48	33
	Afternoon	435	65	49	52
	Night	326	71	73	68
	TOTALS	**1077**	**194**	**170**	**153**

Table 5-6. Traffic Movements - Location 6 Abrud - Cimpeni National road

Day	Time	Cars	Vans	Trucks	Others
Weekday	Morning	484	117	127	31
	Afternoon	681	92	150	55
	Night	422	65	93	23
	TOTALS	**1587**	**274**	**370**	**109**
Weekend	Morning	401	77	58	21
	Afternoon	634	72	56	50
	Night	520	50	72	22
	TOTALS	**1555**	**199**	**186**	**93**

In addition, the area supports numerous tracks, some accessible only by four-wheel drive, tractor or horses. These tracks provide access to hamlets, individual dwellings and agricultural land holdings.

At RMGC's direction, Consilier Construct also performed a traffic study on regional road CR 742 Gura Roşia, Roşia Montană Road and Corna Valley Road. Continuous traffic counting was performed from 12 – 17 April 2003 at two locations selected by the project co-ordinator.

Tables 5-7 and 5-8 show the estimated WADT (Weekly Average Daily Traffic) at each point for each vehicles group.

Table 5-7. Gura Roşia – Roşia Montană Road at km 0 + 000 – WADT in April 2003

Vehicles category	Bicycles and motorcyclees	Cars, minibuses, special cars	Trucks and 2-axle derivates	3 and 4-axle trucks	Long semitrailers	Buses	Tractors and special vehicles	Trailers	Vehicles with animal drive	Total vehicles
Weekly average traffic (WADT)	20	797	17	6	0	26	1	11	5	883

Table 5-8. Corna Valley Road at km 6 + 180 – WADT in April 2003

Vehicles category	Bicycles and motorcyclees	Cars, minibuses, special cars	Trucks and 2-axle derivates	3 and 4-axle trucks	Long semitrailers	Buses	Tractors and special vehicles	Trailers	Vehicles with animal drive	Total vehicles
Weekly average traffic (WADT)	3	98	13	13	1	23	0	0	1	152

6 Conclusion

6.1 Noise

Maximal admissible noise limits are in the STAS 10009-88[viii] standard, which a noise limit to the edge of a site, a maximal value of 65 dB(A), or the values of the noise curve Cz 60 (Table 3 from the noted STAS standard), and regarding the location of the houses within the dwelling areas (§2.5 same STAS) the noise level is not to exceed the maximal value of 50 dB(A) outside the buildings, measured al 2 m distance, as indicated by STAS 6161/1-89.[ix]

For the interval between 6^{00} AM – 10^{00} pm, Ministry of Health Order No. 536/1997[x] provides the same noise admissible level. For the interval between 10^{00} pm – 6^{00} am the same Order provides a equivalent continuous A-weighted acoustic pressure level of 40 dB(A).

The measured noise levels generated by the equipment operation exceed the maximal admissible limits.

Nearby the dwelling areas, due to the operation of the ore transportation system and processing plant the noise levels sometime exceed the legal limits.

6.2 Vibration

In principle, due to the potential impact on the environment, vibration induce by blasting operations is potentially the most important. However, the observed he ground vibration values are below 1 mm/s (for Peak Particle Velocity).

As mentioned earlier, vibration due to vehicle and other equipment operation for excavation, transporting, unloading, crushing, and other operations, is insignificant in this case, because the distance to the nearest dwelling area is substantial and the received vibration is negligible.

As a general note, Romanian standards do not cover the domain of the vibration generated by blasting. For comparative purposes, however, British Standard 6472/1992[xi] stipulates that for less than three blasts per day, vibration levels may not exceed 8.5 mm/s (parameter PPV – Peak Particle Velocity), which is well above the measurements obtained on site in this study.

6.3 Airblast

Measurements of noise carried out at Roşia Montană, during highwall blasting, indicate values below 95 dB(Linear) for low frequency sounds and 75 dB(A) for audible sounds. The attenuation is due to the distance and the presence of obstacles.

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[i] Government of Romania, 1997: Order 536/97 of the Ministry of Health for endorsement of the Norms and Hygiene and of the Recommendations on the Life Conditions of the Population and Government of Romania, 1988: STAS 10009-88, Maximum Allowable Values of Noise Emissions for Road Traffic.

[ii] DuPont, 1969: *Blaster's Handbook: A Manual Describing Explosives and Practical Methods of Use* (15th Edition); Chapter 28, "Noise and Vibration from Blasting"; E.I, du Pont de Nemours & Co., Inc., Wilmington, Delaware.

[iii] Source: Environment Australia, 1998: *Noise, Vibration and Airblast Control: Best Practice Environmental Management In Mining*, ISBN 0 642 54510 3.

[iv] *Government of Romania, 1988:* STAS 10009-88, Maximum Allowable Values of Noise Emissions for Road Traffic.

[v] European Union, 2002; Directive 2002/49/EC of the European parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise.

[vi] Government of Romanian; STAS 10144/1-8.

[vii] *Government of Romania, 1988:* STAS 10009-88, Maximum Allowable Values of Noise Emissions for Road Traffic.

[viii] Ibid.

[ix] Government of Romania, 1989; STAS 6161/1-89, Methods to determine noise levels in urban areas.

[x] Ministry of Health Order No. 536/1997, *Hygiene standards and recommendations.*

[xi] British Standard 6472, 1992, Guide to evaluation of human exposure to vibration in buildings (1Hz to 80 Hz).