FACULTY OF SCIENCE
AND ENGINEERING

MACQUARIE University

Comments and assessment of potential lead exposure risks reported in the Bowdens Silver EIS (May 2020)

Report prepared for the Lue Action Group

Report author

Mark P. Taylor, BSc (Hons), PhD (University of Wales, Aberystwyth)

With contributions from
Cynthia F. Isley, B Eng (Hons), PhD (Macquarie University)
Kara Fry, BEnv (Macquarie University)

Department of Earth and Environmental Sciences
Faculty of Science and Engineering
Macquarie University, Sydney 2109
New South Wales, Australia

Contact email:
mark.taylor@mq.edu.au

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DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES
Faculty of Science and Engineering

Macquarie University
NSW 2109 Australia
T: +61 (2) 9850 8382
F: +61 (2) 9850 8420

mq.edu.au

ABN 90 952 801 237
CRICOS Provider No 00002J

MACQUARIE University
SYDNEY·AUSTRALIA

15 July 2020

Delivered by email to: louee@louee.net.au

Mr Tom Combs
Chairman
Lue Action Group
Lue Station
Lue 2850

Re: Comments and assessment of potential lead exposure risks reported in the Bowdens Silver EIS (May 2020)

Dear Mr Combs

Please find attached our Report for the Lue Action Group: ***Comments and assessment of potential lead exposure risks reported in the Bowdens Silver EIS (May 2020).***

Yours sincerely

Professor Mark Patrick Taylor, BSc (Hons), PhD
Department of Earth and Environmental Sciences
mark.taylor@mq.edu.au
Tel: 02 9850 4221 | 0422 940 916

Terms of Reference

On 26 June 2020, the Lue Action Group requested that I evaluate the risk of lead dust associated with the proposed EIS submitted by Bowdens Silver mine operations (https://www.planningportal.nsw.gov.au/major-projects/project/9641). The request for review was to include the possible effects on the adjoining communities and businesses and to incorporate the risk of lead dust associated with traffic movements and prevailing winds.

Summary of lead exposure risks to human health

Lead is a naturally occurring metal with a range of industrial applications and well-documented adverse health effects when human exposure occurs (ATSDR 2007). Its widespread use has resulted in significant contamination of natural and human environments (Needleman 2004; Prüss-Ustün et al. 2011). Chronic lead exposure, even at very low levels, is associated with cognitive impairment, cardiovascular effects, anaemia and low birth weight, among other adverse health outcomes (Budtz-Jørgensen et al. 2013; Lanphear 2015; NTP 2012; United Nations Environment Programme 2010). Additionally, lead exposure has been associated with decreased economic output, lower life expectancy and increased societal violence (Demayo et al. 1982; Landrigan and Goldman 2011; Mielke and Zahran 2012; Prüss-Ustün et al. 2011; Taylor et al. 2016). The gold standard in protecting public health is primary prevention, which is particularly important with respect to lead exposure because there is no established safe exposure level (Lanphear 2017). No existing, large, multi-element mining operation, which processes lead can demonstrate an absence of off-site impacts.

A summary of the adverse impacts that low level lead exposures could have on the Lue community are provided in the National Toxicology Program's (2012) report. The evidence compiled in the National Toxicology Program's comprehensive report shows that while children are most at risk, adults are also subject to adverse outcomes where lead exposures occur (**Table 1, Table 2**).

NTP Monograph on Health Effects of Low-Level Lead

Table 1.1: NTP conclusions on health effects of low-level Pb by life stage

Life Stage	Blood Pb Level	NTP Conclusion	Principal Health Effects	Bone Pb Evidence
Children	<5 µg/dL	*Sufficient*	Decreased academic achievement, IQ, and specific cognitive measures; increased incidence of attention-related behaviors and problem behaviors	Tibia and dentin Pb are associated with attention-related behaviors, problem behaviors, and cognition.
		Limited	Delayed puberty and decreased kidney function in children ≥12 years of age	The one available study of bone Pb in children does not support an association with postnatal growth.
	<10 µg/dL	*Sufficient*	Delayed puberty, reduced postnatal growth, decreased IQ, and decreased hearing	No data
		Limited	Increased hypersensitivity/allergy by skin prick test to allergens and increased IgE* (not a health outcome)	No data
		Inadequate	*Any age* – asthma, eczema, nonallergy immune function, cardiovascular effects; *<12 years of age* – renal function	No data
Adults	<5 µg/dL	*Sufficient*	Decreased glomerular filtration rate; maternal blood Pb associated with reduced fetal growth	The one available study of bone Pb in the general population supports an association between bone Pb and decreased kidney function. Maternal bone Pb is associated with reduced fetal growth.
		Limited	Increased incidence of essential tremor	No data
	<10 µg/dL	*Sufficient*	Increased blood pressure, increased risk of hypertension, and increased incidence of essential tremor	The association between bone Pb and cardiovascular effects is more consistent than for blood Pb.
		Limited	Psychological effects, decreased cognitive function, decreased hearing, increased incidence of ALS, and increased cardiovascular-related mortality; maternal blood Pb associated with increased incidence of spontaneous abortion and preterm birth	The association between bone Pb and cognitive decline is more consistent than for blood Pb.
		Inadequate	Immune function, stillbirth, endocrine effects, birth defects, fertility or time to pregnancy**, sperm parameters**	No data

Abbreviations: ALS, amyotrophic lateral sclerosis; IgE, immunoglobulin E; IQ, intelligence quotient

*Increased serum IgE is associated with hypersensitivity; however, as described in **Section 1.4.3**, increased IgE does not equate to disease.

The NTP concludes that there is *inadequate* evidence that blood Pb levels <10 µg/dL are associated with fertility, time to pregnancy, and sperm parameters; however, given the basis of the original nomination, the NTP evaluated the evidence that higher blood Pb levels (i.e., >10 µg/dL) are associated with reproductive and developmental effects, and those conclusions are discussed in **Section 1.4.6 and presented in **Table 1.2**.

Table 1. Summary conclusions presented in the National Toxicology Program's (2012) report on health effects of low-level lead exposure at different life stages.

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Table 1.2: NTP conclusions on health effects of low-level Pb by major health effect areas

Health Area	Population or Exposure Window		NTP Conclusion	Principal Health Effects	Blood Pb Evidence	Bone Pb Evidence
Neurological	Prenatal		*Limited*	Decrease in measures of cognitive function	Yes, <5 μg/dL	No data
			Limited	Decreased IQ, increased incidence of attention-related and problem behaviors, decreased hearing	Yes, <10 μg/dL	No data
	Children		*Sufficient*	Decreased academic achievement, IQ, and specific cognitive measures; increased incidence of attention-related and problem behaviors	Yes, <5 μg/dL	Tibia and dentin Pb are associated with attention, behavior, and cognition.
			Sufficient	Decreased hearing	Yes, <10 μg/dL	No data
	Adults		*Sufficient*	Increased incidence of essential tremor	Yes, <10 μg/dL	No data
			Limited	Psychiatric effects, decreased hearing, decreased cognitive function, increased incidence of ALS	Yes, <10 μg/dL	The association between bone Pb and cognitive decline is more consistent than blood.
			Limited	Increased incidence of essential tremor	Yes, <5 μg/dL	
Immune	Children		*Limited*	Increased hypersensitivity/allergy by skin prick test to common allergens and IgE* (not a health outcome)	Yes, <10 μg/dL	No data
			Inadequate	Asthma, eczema	Unclear	No data
	Adults		*Inadequate*	–	Unclear	No data
Cardiovascular	Children		*Inadequate*	–	Unclear	No data
	Adults		*Sufficient*	Increased blood pressure and increased risk of hypertension	Yes, <10 μg/dL	The association between bone Pb and cardiovascular effects is more consistent than blood.
			Limited	Increased cardiovascular-related mortality and ECG abnormalities	Yes, <10 μg/dL	
Renal	Children <12 years old		*Inadequate*	–	Unclear	No data
	Children ≥12 years old		*Limited*	Decreased glomerular filtration rate	Yes, <5 μg/dL	No data
	Adults		*Sufficient*	Decreased glomerular filtration rate	Yes, <5 μg/dL	Yes, one study
Reproductive and Developmental	Prenatal		*Limited*	Reduced postnatal growth	Yes, <10 μg/dL	No data
	Children		*Sufficient*	Delayed puberty, reduced postnatal growth	Yes, <10 μg/dL	One study does not support effects of bone Pb on growth.
			Limited	Delayed puberty	Yes, <5 μg/dL	
	Adults	Women	*Sufficient*	Reduced fetal growth	Yes, <5 μg/dL	Maternal tibia Pb is associated
			Limited	Increase in spontaneous abortion and preterm birth	Yes, <10 μg/dL	No data
		Men	*Sufficient*	Adverse changes in sperm parameters and increased time to pregnancy	Yes, ≥15-20 μg/dL	No data
			Limited	Decreased fertility	Yes, ≥10 μg/dL	No data
			Limited	Increased spontaneous abortion	Yes, >31 μg/dL	No data
		Adults	*Inadequate*	Stillbirth, endocrine effects, birth defects	Unclear	No data

Abbreviations: ALS, amyotrophic lateral sclerosis; ECG, electrocardiography; IgE, immunoglobulin E; IQ, intelligence quotient.
*Increased serum IgE is associated with hypersensitivity; however, as described in Section 1.4.3, increased IgE does not equate to disease.

NTP Monograph on Health Effects of Low-Level Lead

Table 2. Summary conclusions presented in the National Toxicology Program's (2012) report on health effects of low-level lead exposure according to major health effect areas.

Response to the EIS covering air, dust, soil and water

The air quality and human health risk assessments presented in the EIS have been conducted by reputable organisations and experts. Nevertheless, some important areas of concern have been identified. These are discussed in detail below.

Baseline soil and dust values

- The EIS provides elemental analysis of the Bowden's Deposit waste rock, ore and soils. These values were used to scale PM emissions and modelling. A Pb concentration of 0.009 % (90 mg/kg) is provided for local soil (**p. 2 – 52 in the EIS**). In the health risk assessment, a 'conservative' soil concentration of 50 mg/kg is stated to be used due to the limited surface soil data available (**p. 7 86 and also 4 – 181, Table 4.49 in the EIS; Figure 1 in this report**).

ENVIRONMENTAL IMPACT STATEMENT
Section 4 – Environmental Assessment and Management

BOWDENS SILVER PTY LIMITED
Bowdens Silver Project
Report No. 429/24

Table 4.49
Soil and Dust Samples for Lead: Existing Environment

Media/Measure	Lead Level (Range or Maximum)	Guideline
Dust Indoors		
Dust wipes from indoor surfaces - Lue	0.002 to **9.92** mg/m²	5.4 mg/m² for interior window sills and ledges H 8.6 mg/m² for window troughs and exterior surfaces H No criteria for ceiling spaces
Dust wipes from indoor surface - Lue Public School where lead paint is present*	70 mg/m² in ceiling space	
Accumulated dust in ceilings and indoor surfaces - Lue	20 to 5600 mg/kg	300 mg/kg N for indoor surfaces No criteria for ceiling spaces
Accumulated dust in ceiling and indoor surfaces – Lue Public School where lead paint is present*	48 000 mg/kg in ceiling space	
Soil		
Soil on Mine Site (exploration licence areas)	< 50 mg/kg away from proposed main open cut pit (with 50 mg/kg assumed representative of existing lead concentrations in soil) 1.5 to **1 380** mg/kg in main open cut pit area	300 mg/kg N
Soil adjacent to building at Lue Public School where lead paint is present*	280 mg/kg adjacent to building 190 mg/kg, 1m away 36 mg/kg, 2m away 35 mg/kg, 3m away 42 mg/kg, 4 m away 12 mg/kg in another location	

Notes: **Bold shaded** values exceed nominated guidelines

Data provided in the following reports: JBS 2013c, JBS 2013b, JBS 2013a, JBS 2012

* Lead paint was confirmed to be present, with analysis of paint chips indicating lead content of 3% to 8.1%

H = Current guidelines of lead on indoor surfaces from NSW EPA and NSW Planning (2003), *Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices. A Guide for Councils* (NSW EPA and Planning NSW, 2003)

N = NEPM Health Investigation Levels for Low-Density Residential HIL-A (NEPC, 1999 amended 2013a)

Source: enRiskS (2020) – Modified after Table 4.2

Figure 1. Table 4.49 (**p. 4-181 in the EIS**) from the Bowdens Silver EIS showing a variety of soil and dust values referred to in the EIS.

- While it is clear that the value of 50 mg/kg was used to model existing exposures (**p. 7 – 269 in the EIS),** the concentration of lead soil used in predicted project emissions that forms the basis of the health risk modelling of project impact (e.g. Site Establishment and Construction Pb in soil = 3.35 / 3.4 mg/kg; **p. 7 – 281, 282 in the EIS**) is unclear.

- Soil collected at residential properties in Lue village and rural areas by Macquarie University in 2012 are significantly lower than the lead concentrations used in the EIS (of either 90 mg/kg or 50 mg/kg) (**Table 3**). Further, all but three of the soil test locations identified in the EIS are located inside the mining lease area (**Figure 2**). As a result, the baseline value of Pb in soil in Lue, as set in the EIS, may be inaccurate.

- In summary, it is not transparent what the input trace metal (including lead) values are as they do not appear consistent in the EIS. These values are critical because they influence the predicted impact of lead exposure on the community during operations.

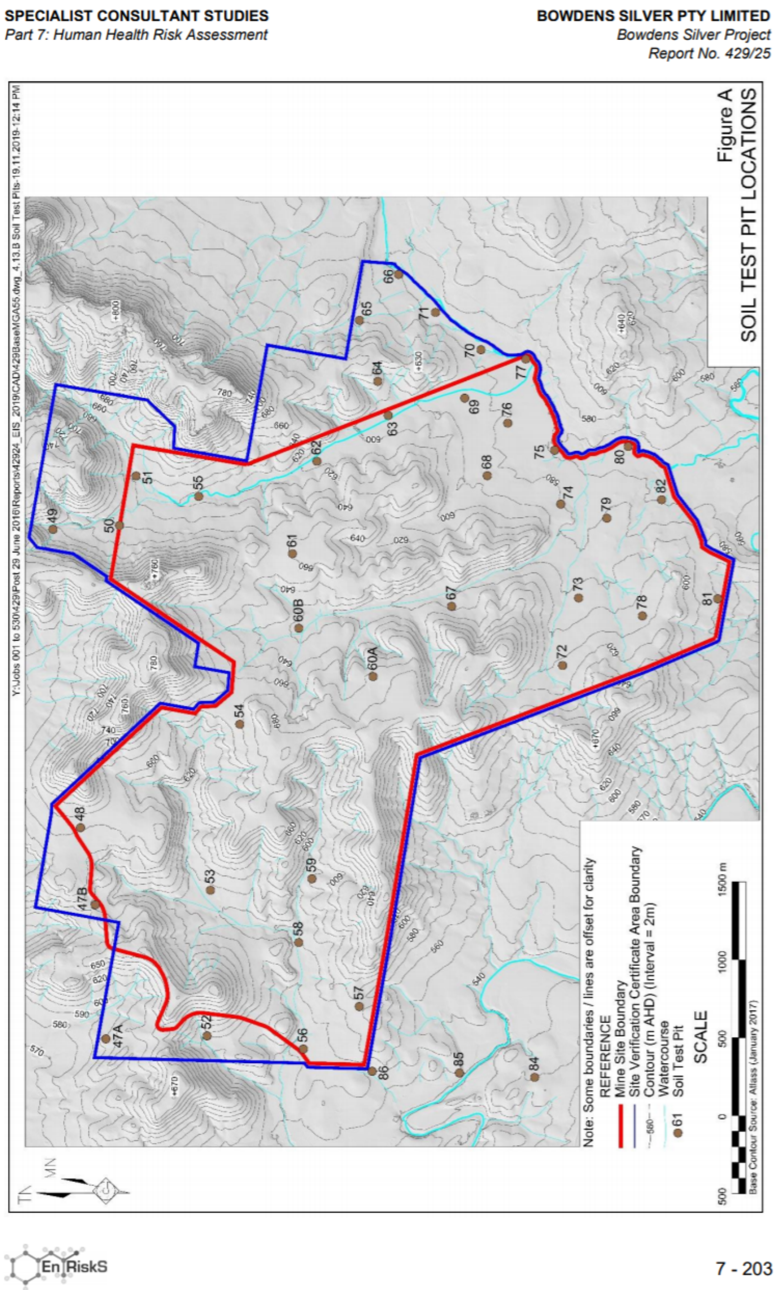

Figure 2. Bowdens Silver soil sample locations as detailed in their EIS. Note all but three soil test pits #84-86 are inside the mining lease area and these samples are not in the actual village of Lue, which is located at approximately the upper right of the inset key.

- Vacuum dust samples collected in residential dwellings in Lue show enriched trace metal concentrations by comparison to soil. The levels of lead in dust were significantly lower than those measured recently in Sydney at 299 mg/kg (arithmetic mean, Doyi et al. 2019). Enrichment of trace metals in vacuum dust versus soils often occurs because of additional indoor sources of contaminants, independent from the outdoor environment, such as lead paint (Doyi et al. 2019).

- The EIS presents values for dust wipes and accumulated dust, with a primary focus on ceiling dust and the Lue Public School, which are known to be high in Pb (**Table 4.2, p. 7 – 45 in the EIS**). Ceiling dust has limited potential as an exposure pathway and evaluating relevant environment data from likely environmental pathways, and at regular residential sites would be more useful for establishing an accurate baseline of extant lead risks in Lue.

Table 3. Measured values of trace elements in soil (n = 34) and vacuum dust (n = 24) in residences in Lue village and close rural areas. One outlier (Pb = 7530 mg/kg) was removed from vacuum dust calculations. This sample was from an older home in a high traffic area, with recent renovation of Pb painted surfaces.

		As (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Ag (mg/kg)	Zn (mg/kg)
Soil	Geomean	3.2	13.3	13.3	<LOD	69.2
(n = 34)	Arithmetic mean (95 % CI)	4.5 (3.3 - 5.7)	19.8 (13.9 - 25.7)	25.4 (8.1 - 42.7)	<LOD	99.6 (72.4 - 126.8)
	Minimum	0.7	2.0	4.7	<LOD	10.0
	Maximum	13	66	300	<LOD	340
Vacuum dust	Geomean	3.9	76.7	48.6	0.7	395.5
(n = 24)	Arithmetic mean (95 % CI)	4.8 (3.3 - 6.4)	87.5 (66.5 - 108.5)	64 (44.7 - 83.3)	0.8 (0.6 - 1.1)	486.3 (301.9-670.6)
	Minimum	1.5	20	12	0.11	160
	Maximum	17	290	7350* (190)	2.5	2500

*Outlier sample, removed from calculations of geomean, average and 95 % confidence interval (CI). The maximum value measured when this sample removed is indicated in brackets.

Rural soil and dust monitoring

- Surface soil samples (0 – 2 cm) were collected at two rural locations, approximately 4 and 6 km from the facility at Rylstone Olives. Data is provided in **Table 4**. Surface soils from these locations show lower trace element concentrations than those used in the EIS, which were predominantly from the mine lease area (see **Figure 2**). The effect of this is that by not using soil lead concentration data from the village may have resulted in establishing a higher baseline than what is actually the case. This would mean that the relative impact of the operations would appear less significant versus the existing exposures.

Table 4. Surface soil samples (0 – 2 cm) collected at two locations distal to the facility in Lue (n = 6).

Sample	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Ag (mg/kg)	Zn (mg/kg)
Soil A1 0-2 cm May 2017	1	<0.5	4.5	8.1	<0.5	30
Soil A2 0-2 cm May 2017	0.74	<0.5	2	6	<0.5	13
Soil A3 0-2 cm May 2017	0.68	<0.5	12	5.9	<0.5	120
Average	0.81	--	6.17	6.67	--	54.33
Soil B1 0-2 cm May 2017	2.1	<0.5	4.9	6.7	<0.5	13
Soil B2 0-2 cm May 2017	2	<0.5	4.3	7.2	<0.5	13
Soil B3 0-2cm May 2017	1.4	<0.5	6	9.9	<0.5	22
Average	1.83	--	5.07	7.93	--	16

Dust deposition data

- The dust deposition values at Rylstone Olives for the measured elements are provided in **Table 5**. Lead dust deposition sampling was carried out over a 12-month period between 2017-2018 in accordance with the Australian Standard 3580.10.1:2016 (Determination of Particulate Matter). Trace metal analysis was carried out at the National Measurement Institute, North Ryde, Sydney. The geometric mean lead dust deposition rate was 0.3 μg/m^2/day of lead.

- The EIS provides an annual average lead dust deposition rate of 0.001 g/m^2/month or 1000 μg/m^2/month (**p. 2 – 44 in the EIS**). This equates to a lead dust deposition rate of 33.3 μg/m^2/day. By comparison, six months of dust deposition sampling at a semi-rural Sydney location at approximately 40 km NW of the city centre in 2016 returned an average lead dust deposition rate of 19.8 μg/m^2/day (data used in Zhou et al. 2018).

- The background value promogulated in the EIS of 1000 μg/m^2/month (33.3 μg/m^2/day) is over 100 times greater than the average of the data collected by Macquarie University in Lue in 2017/18. Moreover the predicted rates of lead dust deposition during the operations, even at their peak, appears to be uncharacteristically low (**Table 6**), especially given that dust has been identified by Bowdens Silver as the primary pollutant from the mine (Bowdens Silver 2020).

- It is not clear what dust gauge data was used for the EIS modelling, the time frames, and the locations identified in the EIS (**Figure 2**). This needs to be clarified in the EIS and statistical assessment of the mean and confidence interval around the mean provided along with the raw values and locations.

- The existing data for air lead and other metals returned negligible concentrations (**p. 4-82 of the EIS**): maximum measured lead in air - 0.002 µg/m^3; average of 0.001 µg/m^3. The dates of sampling are also not clear. Footnote 5 on **p. 4-80 of the EIS** states "HVAS monitoring was halted in November 2014 and restarted in October 2016" but the text on the same page only provides dates for dust deposition gauge monitoring of between 2012 - 2018, not the HVAS air monitoring data.

- Analysis of HVAS samples for concentrations of arsenic, cadmium, chromium, copper, nickel, zinc and selenium are from a very short period during July and August 2017 and February 2018. It is not clear if this data is representative of long-term averages. These analyses reported ambient concentrations of arsenic, cadmium and selenium below the respective limits of detection. Mean concentrations of chromium, copper, nickel and zinc were 0.001 µg/m^3, 0.007 µg/m^3, 0.001 µg/m^3 and 0.009 µg/m^3, respectively.

- The modelling of project impacts in the EIS predicts very low values of lead in air along with deposited lead in dust. Given that all mine sites generate significant fugitive emissions and that operations extracting lead will inevitably cause surface contamination (as evidenced by dust emissions from fugitive sources at Broken Hill, Port Pirie and Mount Isa), it seems inconceivable that the predicted aerosol emissions of dust (**Table 7**) and its lead concentrations will be so low (**Table 8**) during the active phase of operations. Indeed, these low values estimated during operations versus existing values results in a conclusion that the impact of the operations will be trivial (e.g. **Figure 5.4, 7-80 of the EIS**).

- The key sources of lead dust are the soils on the mine site (maximum of 1380 mg/kg; **Table 4.49 (page 4-181 in the EIS**) and the lead ore concentrations recoverable from the pit operation 0.32% or 3,200 mg/kg (**p. 2-13 of the EIS**), which would be subject to remobilisation as dust during the operations. In addition, **p. 3 – 127** of the EIS shows waste geochemistry samples from weathered ignimbrite to contain up to 4,160 ppm of lead from samples at 13-14 m depth, further suggesting that waste materials at the site which are remobilised as dust would be very elevated in lead. It is unclear how the EIS modelling has accounted for the mobilisation of soils and mine waste with these high concentrations.

- Moreover, the proposed mitigation strategies for dust management e.g. during high wind events, lack specific details in regard to triggers and thresholds for total dust and its trace metal concentrations (**Table 4.25, p. 4-84 of the EIS**). Thus, the impact of high wind events on the broader area is overlooked.

- It is clear that prevailing winds according to Lue Met01 (see the wind rose data in **Figure 4.1, p. 2 – 31 in the EIS**) will impact the village, and winds according to Lue Met02 aerosols will be dispersed across away from the village toward the north west, towards agricultural lands. Nevertheless, examples of where wind flow is predominantly away (~80 % of the time) from primary receptors such as at Mount Isa, the local community are still causally exposed to lead dust from winds blowing only ~20 % of the time across the mine site towards the city (Taylor et al. 2010).

- A further gap is the cessation of modelling air and human health risks at year 9, the result of which is that it does not seem incorporate any dust generation effects from the tailing storage facility (TSF) after that time and during the post mine period when it is drying out and being reworked. The TSF will by its very nature collect fine particulates. These particulates will have higher metal concentrations due to their small size and higher surface area to volume ratios. In addition, the TSF will be absent any binding organic matter and as it dries out periodically and more permanently it will be subject to remobilisation as dust.

- A critical issue for the community and agricultural producers is that trace metal and metalloid emissions, including the known toxic substances lead and arsenic, are elemental and accumulate over time in environmental, human and biotic systems. Moreover, the role of wind dispersal and accumulation of contaminated dust on surrounding agricultural produce including grapes and olive berries has not been covered in the EIS. A study of South Australian red wine covering a 50-year period (1963-2012) showed that even though the grapes were washed, the lead concentration in wine corresponded to year matched lead petrol emissions (tonnes of lead petrol emissions; air lead concentrations, $\mu g/m^3$ and lead isotopic compositions) in Adelaide ~40 km away (Kristensen et al. 2016).

- Given that the entire community in and around Lue rely on rainwater tanks for drinking water, any deposition to rainwater (drinking water) tanks, which according to the EIS, have an existing average lead concentration of 5.9 $\mu g/L$ (> 50 % of the upper maximum value of 10 $\mu g/L$ for drinking water), would potentially result in exceedance of the Australian Drinking Water Guidelines value for lead (NHMRC 2018).

Table 5. Geomean and arithmetic average (95% confidence interval (CI)) of measured dust gauge values over a 12-month period (May 2017 – June 2018) at two co-located rural locations at Rylstone Olives, Lue (n = 26).

	As ($\mu g/m^2/day$)	**Cd ($\mu g/m^2/day$)**	**Cu ($\mu g/m^2/day$)**	**Pb ($\mu g/m^2/day$)**	**Ag ($\mu g/m^2/day$)**	**Zn ($\mu g/m^2/day$)**
Geomean	0.04	0.02	2.8	0.3	0.09	2.7
Average (95% CI)	0.2 (0.05 - 0.2)	0.03 (0.01 - 0.05)	13.5 (5.6 - 21.5)	0.9 (0.4 - 1.4)	0.6 (0.09 - 1.2)	13.9 (4.5 - 23.5)
Minimum	0.00	0.00	0.01	0.00	0.00	0.02
Maximum	0.5	0.09	50.1	5.1	4.1	103.8

Table 6. Modelled deposition rate (DR) of Pb under different scenarios, as shown in Annexure G (**p. 7 – 275 to 7 – 380 of the EIS**).

Scenario	**Page**	**$mg/m^2/year$**	**$\mu g/m^2/year$**	**$\mu g/m^2/day$**
1. Establishment	7 – 281	0.7667	766.7	**2.18**
2. Year 3	7 – 307	0.7225	722.5	**2.05**
3. Year 8	7 – 333	0.8421	842.1	**2.39**
4. Year 9	7 – 359	0.8760	876	**2.49**

Table 7. Maximum and minimum concentrations of Pb in PM 2.5 air and modelled maximum Pb in air concentration over a 1-hour average under four scenarios for acute exposures, as shown in Annexure G (**p. 7 – 275 to 7 – 380 of the EIS**).

Scenario	Page	PM2.5 in air (µg/m³)		Maximum 1 hr average air concentration (µg/m³)*	
		Maximum anywhere	Minimum receptor	All receptors	Private residences
1. Establishment	7 - 278	0.204	0.0262	0.2	0.026
2. Year 3	7 - 304	0.0769	0.0184	0.077	0.018
3. Year 8	7 - 330	0.0659	0.0193	0.066	0.019
4. Year 9	7 - 356	0.0705	0.0202	0.071	0.02

*Value provided in EIS as mg/m³

Table 8. Estimated concentrations of maximum Pb in air for all receptors, and private residences under four scenarios for chronic exposures, as shown in Annexure G (**p. 7 – 275 to 7 – 380 of the EIS**).

Scenario	Page	Estimated maximum concentration in air (µg/m³)*	
		All receptors	Private residences
1. Establishment	7 - 280	0.0073	0.00073
2. Year 3	7 - 306	0.0072	0.00033
3. Year 8	7 - 332	0.0061	0.0002
4. Year 9	7 - 358	0.0058	0.00021

*Value provided in EIS as mg/m³

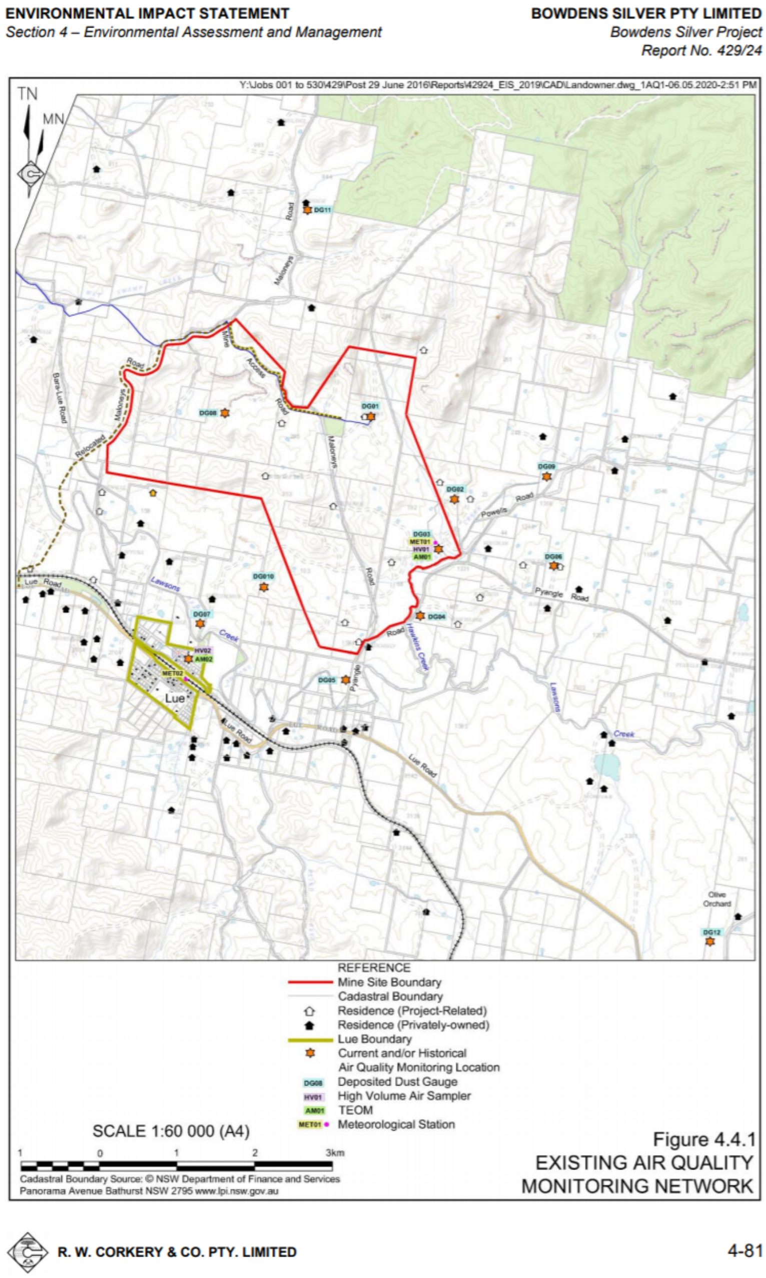

Figure 2. Bowdens Silver dust deposition sample locations as detailed in their EIS. Soil and dust deposition sampling was undertaken by Macquarie University in 2017/2018 close to site DG12, located in the SE of the map.

Drinking Water

- Drinking water samples were also collected from 25 residences in Lue during Macquarie University's sampling in 2012 (**Table 9**). Of these 25 samples, As, Pb and Ag were only detected in 4 % (n = 1), 36 % (n = 9), and 16 % (n = 4) of samples. When the sample reported below the limit of detection (LOD), a value equivalent to ½*LOD (0.5 mg/kg) was used to calculate geometric mean values. Copper and Zn were detected in 100 % of samples. With the exception of three samples that were collected directly from residential water tanks, water was drawn from kitchen taps that were flushed (at least 1 litre) then left to stand for 2 hrs prior to sampling.

- The EIS provides an average concentration of 0.0059 mg/L (5.9 μg/L) of Pb in rainwater tanks in Lue (**p. 7 – 51 in the EIS**). This value is higher than Pb measurement from Macquarie University's investigations.

Table 9. Concentration of trace elements in drinking water collected from residences (n = 25) in Lue in 2012.

	As (μg/L)	Cu (μg/L)	Pb (μg/L)	Ag (μg/L)	Zn (μg/L)
Geomean	0.5	33.7	0.9	0.7	244.9
Average	0.6	172.6	1.5	0.9	764.1
(95% CI)	(0.4 - 0.8)	(19 - 326.3)	(0.6 - 2.5)	(0.4 - 1.5)	(378 - 1150.2)
Minimum	0.5	1.2	0.5	0.5	6.8
Maximum	3	1600	12	6.9	3700

Health risk assessment

- The EIS uses standard methods for health risk modelling. However, the values used to model the risk index from existing exposures and intakes appear to be significantly larger than values measured by Macquarie University, as presented in this report. The modelling in the EIS is used to represent the proportionate increase in incremental risk from the project (e.g. **Figure 5.4 p. 7 – 80**). As result of the data used for the natural baseline, the impacts of the operations appear to be less than what they would be if more representative data were used.

Summary key points

- Blood lead modelling has used a criteria value of 10 μg/dL as guideline for benchmarking the human health risk assessment (**p. 7 – 144 in the EIS**).

- The blood lead value of 10 μg/dL is outdated. Whilst the National Health and Medical Research Council's (NHMRC) (2015) assessment reported that the evidence for adverse effects at levels less that 10 μg/dL is not clear, it revised (2015) the Australian investigation level for blood lead to 5 μg/dL. Therefore, the 5 μg/dL blood lead concentration should be the value to be used in Australian assessments.

- Moreover, 10 μg/dL does not reflect global opinion and is too high. Indeed, several studies show that lead exposure is more damaging per unit of exposure at the lowest levels in terms of lost IQ points (Canfield et al. 2003; Lanphear et al. 2005; Earl et al. 2016).

- There is no safe level of lead. Toxic effects are evident at less than 5 μg/dL and have lifelong effects on multiple organs including the cardiovascular system (Lanphear et al. 2018).

- Most concerningly, the effects of exposure do not remit with age (Reuben et al. 2017) and are also associated with adverse mental health pathologies (Reuben et al. 2019; Searle et al. 2014).

- The FAQs on the Bowdens Silver website say that blood lead monitoring is "expected to be undertaken, before and after operation of the mine" (Bowdens Silver 2020). This is not reflected in the EIS (that we are aware of). Blood lead monitoring should be required to be undertaken if the mine goes ahead and should incorporate the time periods before, during and after the mine's operational period.

- Trigger values should be implemented in the Lue area to better manage dust and its lead content, especially since Bowden's identify dust as being the primary pollutant from the mine (Bowdens Silver 2020). An example from other mining operation licence arrangements include:
  - Mount Isa Mines (https://apps.des.qld.gov.au/env-authorities/pdf/epml00977513.pdf):
    - Lead – 100 μg/m^2/day trigger value for lead in dust; 0.5 μg/m^3 annual maximum concentration for lead in air.

        - Arsenic – 4 μg/m²/day trigger value for arsenic in dust; 0.017 μg/m³ annual maximum concentration for arsenic in air.
    - These values correspond with the German dust values as set out in its *Federal Immission Control Act* (TA Luft 2002).

- The EIS should include total projections of dust deposition (in μg/m²/day) for trace elements of concern, primarily lead inside and outside of homes. The evidence shows that lead in deposited dust, rather than soil, is the most reliable predictor for blood lead in children, which arises predominantly via ingestion (e.g. Sydney city: Gulson et al. (2014); Mount Isa: Noller et al. (2017); Broken Hill: Dong et al. (2020)).

- Taylor et al.'s (2019 – not yet released report for the NSW EPA's Broken Hill Environmental Lead Program) recent review of blood lead at Broken Hill showed that lead in deposited dust (outdoors) needed to be lower than 90 μg/m²/day to keep children's blood lead below 5 μg/dL. Gulson and Taylor (2017) suggest a much more restrictive "action" level of 100 μg lead/m²/30 days.

- The point being is that lead dust loadings need more careful scrutiny than provided for in the EIS and should be linked to enforceable trigger values and frequent monitoring to best manage emissions.

- The EIS refers to an outdated indoor lead dust guideline (NSW EPA and NSW Planning, 2003, **Table 4.49**, **p. 4-181 in the EIS**) that relates to interior window sills and ledges at 5.4 mg/m² (or 5,400 μg/m²), rather than the floor standard in that same document that is set at 1.0 mg/m² (or 1000 μg/m²). It is not apparent what effect this has on the blood lead risk modelling, but modelling should be compared against using a more appropriate (contemporary) standard.

- For example, it is relevant that as of 6 January 2020 the US EPA (2019) lowered its lead dust hazard standard to 10 μg/ft² and 100 μg/ft² on floors and window sills (equivalent to 107.6 μg/m² and 1076.4 μg/m²).

- Lower standards than those noted in the EIS were also applied in the WA Esperance clean-up of lead from port emissions using 400 μg/m² (Pb) for surfaces accessible to children (WA Department of Health 2007).

Summary

The data used in the EIS relating air, dust and human health risks is rather opaque and does not appear to capture properly the true nature of the potential risks, particularly those associated with lead-rich depositions on the surrounding community. As a consequence, it is not possible to decipher what the real impact will be on the Lue community. This is particularly relevant for those residing in the village, young children attending the local primary school located at ~ 2km from the operations, and agricultural producers who rely on clean air and contaminant-free water.

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