Key issues and weaknesses of the Bowdens Silver Project Environmental Impact Statement

Report for Lue Action Group (LAG)

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1. Summary

The Key issues and weaknesses of the EIS are summarised as follows:

1. The EIS has been found to be vague and unclear for the purpose of assessing community exposure to deposition of air-borne contaminants from mining operations particularly from lead and heavy metals.
2. The information needed to assess dust transmission to the village is quite hidden or excluded and insufficient to validate the conclusion drawn in the EIS that people living in Lue village will not be affected – consequently more data is required to enable independent validation of community exposure.
3. The EIS underestimates community exposure levels because it doesn't use concentrate, mine ore materials including stockpiled oxide material and tailings as sources of dust and also does not analyse the effect of peak wind events biannually with change of seasons on dust movements – this omission is required to enable independent validation of community exposure. More effort is needed to examine community exposure to lead from mined materials by taking drill core samples and tailings from pilot trials. More reliable dust deposition data is needed for lead and other heavy metals to allow proper assessment of ingestion pathway for exposure of people, as distinct from total dust only fallout measurement.
4. Limited data used in the health risk assessment for lead bioaccessibility in 14 soil samples from the mine lease and community shows values of 14.6% to 53.8% (average bioaccessibility 32.7% compared with an average of 25% at Mount Isa city residential area), and indicating that surface and near surface mined material at Lue will have 24% higher absorption (bioavailability) by people than observed at Mount Isa. Surface soil sampled only have a maximum lead concentration of 305.5 mg/kg total concentration whereas drill core data shows concentrations of lead up to 4150 mg/kg. Therefore further measurement of lead and also arsenic bioaccessibility (as no data is provided in the EIS) and particle size distributions on mined and processed tailings material is required before a mining lease is granted and as mining proceeds to enable reliable health risk assessment to be performed.
5. The compliance level for acceptable community exposure in houses is taken from out of date guidelines (NSW 2003) - the EIS should use the more recent USEPA criteria (2019a) which considers blood lead of children to be below 5 micrograms per decilitre.
6. The EIS indicates some existing (baseline) soil and dust lead levels from Lue village buildings in 2012 currently exceed the guidelines for allowable lead concentrations, supporting an argument that the mine will not adversely affect the community because they're already exposed to high levels. There needs to be a more current baseline assessment of Lue population lead exposure including pre-mining blood lead survey.
7. Limited data on tank water shows that existing supplies may be contaminated with lead from historical sources, probably lead paint. An increased build up of lead in tank and drinking water is not desirable for the community. It is recommended that community water supply be replaced by reticulated water meeting Australian Drinking Water Criteria where this is possible.

8. More data is needed on the estimated Hydrogen cyanide (HCN) gas level for the Bowden's silver project. This has been calculated from a reported 1% of total loss through volatilisation within processing areas of gold operations. It is not a measured value at Bowden's silver project site and needs to be confirmed by measurement when/if the plant built and operating. Normally in gold processing extraction cyanide is 200-400 mg/L. However for zinc the control is 60 mg/L. Nevertheless the Bowden's Silver project will still use sodium cyanide on site. The project needs to seek accreditation for cyanide handling with the International Cyanide Management Code which now includes silver extraction as well as gold.

9. Dispersion of respirable crystalline silica (as $PM_{2.5}$ annual average) derived from Project operations will require regular monitoring to ensure that appropriate levels are met in the community based on 3 $\mu g/m^3$ now applied in Victoria (EPA Victoria 2007) based on California EPA Office, and beyond the current workplace exposure level of 0.05 mg/m^3 (50 $\mu g/m^3$). Evidence from coal mining in the Hunter Valley shows that heavy vehicles on mine sites creates $PM_{2.5}$ particulates by action of tyres driving over sedimentary rock and releases silica particles.

2. Introduction

The Lue Action Group (LAG) has sought the University of Queensland to undertake a critical review of Silver Mines Limited Bowdens Environmental Impact Statement (EIS) submission for a proposed lead/silver mine at Lue Station, New South Wales.

The consultancy has involved an independent and thorough review of the EIS and supporting documentation from the proponent, especially with regard to human and environmental health, and prepared this report for submission by the Lue Action Group to relevant authorities.

Bowdens Silver Pty Limited (Bowdens Silver Project) proposes to develop and operate an open cut silver mine approximately 26km east of Mudgee within the Mid-Western Regional Local Government Area of New South Wales. The Mine Site would be located approximately 2km to 3km northeast of Lue on Bowdens Silver-owned land, land under option to purchase, or land the subject of agreements with Bowdens Silver.

The Bowdens Silver Project EIS was released for exhibition by the NSW Dept. of Planning Tuesday 2 June 2020 (https://www.planningportal.nsw.gov.au/major-projects/project/9641) to enable public comment.

This report gives a specific focus on issues that are of significance to human health of the Lue Community via the human health risk assessment process.

3. Project Description

Bowdens Silver Project is being developed by Bowdens Silver Pty Ltd as described in the EIS (BSPL EIS, 2020). The Mine Site is located approximately 26km east of Mudgee, NSW and approximately 2km to 3km northeast of Lue with a total of 28 privately-owned rural residences and the school. Figure 1 shows (BSPL EIS, 2020; Figure ES-2 pES-8). Four of these residences are located within 2km and the school is within 3 km of the closest open cut pit.

The Mine Site is located inland with moderate levels of rainfall. The average annual rainfall in Mudgee is 663 mm, while that recorded at Lue is 635 mm, with the wetter months being December and January and drier months being April and May.

The geology of the study area comprises Ordovician bedrock and Early Permian Rylstone Volcanics overlain by shallow marine sandstones, conglomerates and shales, associated with a number of faults and fractures. The upper soil profile comprises alluvium and colluvium particularly around surface water/drainage features having silty sandy gravel and clays. The mineralised area, the target of the proposed open cut pits, occurs as a thick zone extending from the surface (or near surface) to vertical depths of around 200 m. The ore body dips at up to 30 degrees and is not uniformly mineralised. The mineralised materials comprise silver, zinc and lead. The mineralised area has already had some influence on the nature of natural soil materials in the area, as well as sediments and water quality.

Bowdens Silver Project plans to recover the mineralised rock (ore) containing silver and small percentages of zinc and lead from an open cut pit and comprises seven principal components, namely:

i) A main open cut pit and two satellite open cut pits, collectively covering approximately 52ha;

ii) A processing plant and related infrastructure covering approximately 22ha;

iii) A Waste Rock Emplacement (WRE) covering approximately 77ha;

iv) A low grade ore stockpile covering approximately 14ha (9ha above WRE);

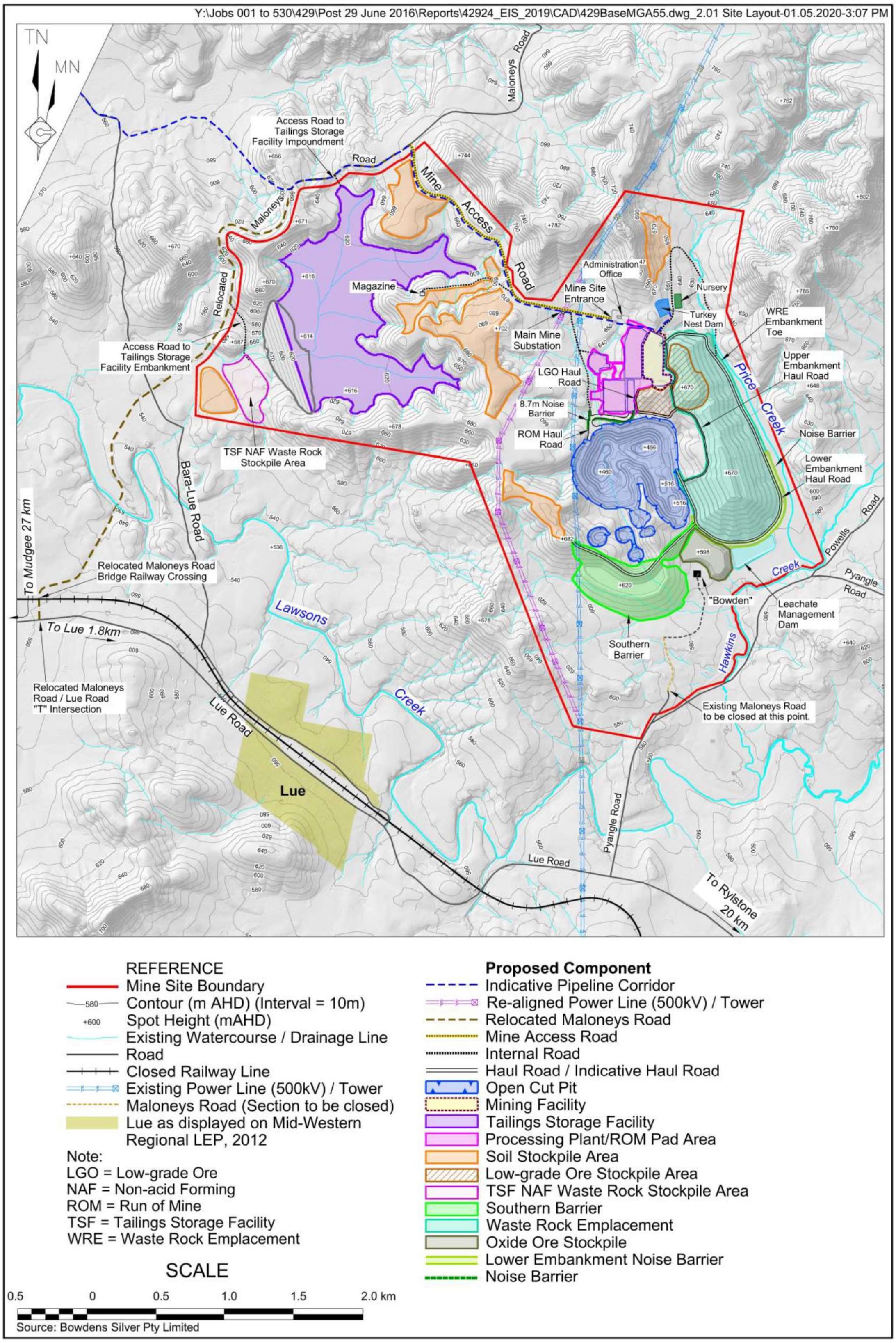
v) An oxide ore stockpile covering approximately 8ha;

vi) A Tailings Storage facility (TSF) covering approximately 117ha; and

vii) The southern barrier to stockpile non-acid forming (NAF) waste rock for later use in rehabilitation activities and provide visual and acoustic protection to properties south of the Mine Site covering approximately 32ha.

Figure 1 shows the indicative locations of the principal mine components (BSPL EIS, 2020). The most extensive coverage by area is in sequence the TSF, WRE, open cut pits, the southern barrier to stockpile NAF waste rock, and other stockpiles. It is the larger features that are likely to be the origins of dust dispersal from the mining and mineral processing activities.

The EIS describes the different operations that will be undertaken at Bowdens Silver Project (BSPL EIS, 2020; pp ES-9-10).



Source: Bowdens Silver Pty Limited

Figure 1 (Figure ES-2 in BSPL (2020))

The Mining Operations will initially remove surface and near-surface vegetation and soil materials. Mining would then remove friable weathered materials for transportation to the waste rock emplacement, low grade ore stockpile or other locations where for construction of infrastructure. Removal of the near-surface material will then allow blasting of bulk ore and waste rock.

To enable removal, the boundaries between ore and each type of waste rock can be identified from prior measurements of ore grade silver, lead and/or zinc and waste rock below ore grades and other potential contaminants like arsenic and sulfur for acid generation prediction can be identified, and marked out. Following each blasting sequence, ore and waste rock are removed and transported in haul trucks using an excavator. Ore would be transported to respective storage pads while the run-of-mine material would be stockpiled prior to being processed.

The ore types and quantities are:

- Primary and low grade sulfide ore – approximately 29.9 million tonnes.
- Oxide ore – approximately 1.8 million tonnes (stored separately on site).

Waste Rock Management deals with material designated as below ore grade that contains insufficient quantities of silver, zinc and/or lead to justify processing, and would be identified as part of pre-blasting. Potentially-acid forming waste rock would be taken to the waste rock emplacement for placing and storage via encapsulation. Non-acid forming waste rock (% total sulfur below 0.3%) is intended for use with on-site construction activities including the tailings storage facility embankment, backfilling of satellite pits away from the main pit and in the southern barrier for subsequent retrieval and for rehabilitation activities.

Low Grade and Oxide Ore Stockpiling Low grade ore and oxide ore are to be placed in specifically-designated sites on the mine lease for stockpiling. Processing of these materials would be dependent upon either the economic conditions (low grade ore) or treatment (processing) requirements (oxide ore). If they are not processed, quantities of the low grade ore and oxide ore may remain in part, or in full at the end of the Project life and need to be considered as potential contamination issues.

The Processing Operations of Bowdens Silver project are proposed to process all ore extracted from the open cut pits using an on-site processing plant to produce a silver/lead concentrate and a zinc concentrate (with a small content of silver) (BSPL EIS, 2020; pp ES-9-10). The Project would produce approximately 310 000t of mineral concentrates throughout the mine life, approximately 60% of which would be zinc concentrate and approximately 40% silver/lead concentrate. The bulk of the silver recovered would be within the silver/lead concentrate. Annual production of mineral concentrates would vary from approximately 20 000t to 30 000t, with the quantity and proportion varying annually and reflecting the proportion of the recovered minerals in the ore extracted.

The processing plant has been designed to process approximately 2 million tonnes per annum of run-of-mine ore to produce silver/lead and zinc concentrates using sequential flotation. The processing plant would include the following principal components that become potential dust-generating activities following mining, blasting and transport by haul trucks, as follows:

- A single stage primary jaw crusher.
- A crushed ore stockpile and reclaim.
- A semi-autogenous grinding mill, ball mill and pebble crusher giving consistent particle size diameter, around 70 microns or less and releases finer minerals including free silica.

- Reagent mixing and distribution including sodium cyanide and other reagents.
- A silver/lead flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Silver/lead concentrate thickening and filtration.
- A zinc flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Zinc concentrate thickening and filtration.
- Concentrate bagging/containerisation facilities and storage.
- Tailings thickening and pumping.

The processing plant step introduces several reagents including sodium cyanide for zinc contrail during flotation separation. The waste from the flotation circuits called 'Tailings' would be pumped to the tailings thickener where flocculant would be added to assist fine particle settling. The thickened tailings underflow (approximately 56% solids by weight) would be pumped to the tailings storage facility for storage and further water (decant) recovery. If drying of exposed tailings surface occurs, it may become a dust source. Recovered water that includes cyanide from the tailings storage facility would be collected and pumped to the processing plant for re-use.

The Project Life is summarised in Figure 2. Approximately 23 years comprising the site establishment and construction stage, mining and processing operations (to the end of concentrate production) and includes an approximately 7 year period for final rehabilitation and maintenance. Progressive rehabilitation would occur from the commencement of site establishment and construction.

The Mine Life would be approximately 16.5 years comprising the site establishment and construction stage, mining and processing (approximately 15 years to the end of concentrate production). Tailings exposure from dust shows a projected gaps in monitoring before the end of the Project and potential for shutdown following economic decline. There is also a gap in air monitoring because the Project monitoring schedule ceases before the change in guideline conditions is finalised.

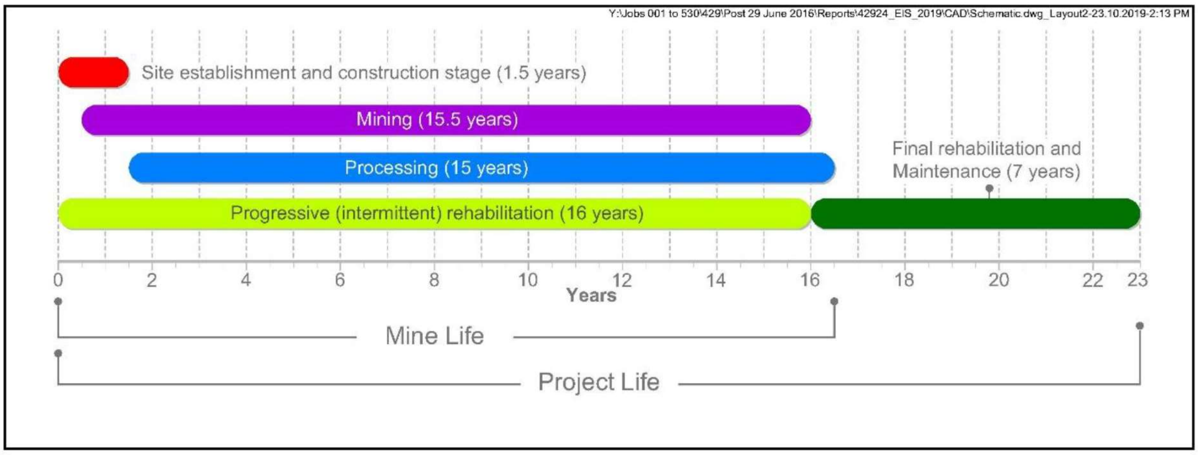


Figure 2 (Figure ES-2 in BSPL Part 7: Human Health Risk Assessment May 2020, P 7-25-27 (2020))

4. Guidelines that apply

The EIS deals with issues that relate to the Lue Community. The key component of the EIS is the Human Health Risk Assessment (HHRA) that has been conducted using existing information with additional detail obtained via literature review and is described in Section 5 of this report. The guidelines that have been used for the HHRA are listed here so that they appear in a discrete place in this report. The HHRA has been undertaken in accordance with the following national guidelines (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-36-37):

- enHealth Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012b);
- Health Impact Assessment: A practical guide (Harris 2007)
- Health Impact Assessment Guidelines, Commonwealth Department of Health and Aged Care (enHealth 2017)
- SEPP No. 33 - Hazardous and Offensive Development (NSW Government 2014)
- NEPC National Environment Protection (Ambient Air Quality) Measure (NEPC 2016)
- National Environmental Protection Measure – Assessment of Site Contamination including:
- – Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a);
- – Schedule B4 Guideline on Health Risk Assessment Methodology (NEPC 1999 amended 2013b);
- – Schedule B6 Guideline on Risk Based Assessment of Groundwater Contamination (NEPC 1999 amended 2013c);
- – Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013d); and
- – Schedule B8 Guideline on Community Consultation and Risk Communication (NEPC 1999 amended 2013e).
- NSW Approved Methods for the Modelling and Assessment of Air Pollutants (NSW EPA 2016)
- NSW Noise Policy for Industry (NSW EPA 2017)
- NHMRC Australian Drinking Water Guidelines (NHMRC 2011 updated 2018)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).

In cases where additional guidance was needed relevant Australian and International guidance, such as from the United States Environmental Protection Agency (USEPA) and the World Health Organisation (WHO), were used and are referenced in the HHRA section of the EIS, where relevant, throughout this report (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-19).

An important addition to the guideline list given in Footnote 2 (BSPL, 2020; Part 7: Human Health Risk Assessment May 2020, P 7-40) is the reference to the USEPA (2019a) revisions to lead dust criteria for floors (107.5 µg/m^2) and window sills (1076 µg/m^2) for use in 2020. These more stringent guidelines are suggested for consideration in any further assessment and management of lead exposures from lead paint at Lue school, and in the future at Lue. Elevated levels of lead at Lue school were identified in indoor dust and are in excess of the current guidelines from NSW EPA and NSW Planning (2003), which includes a guideline of 5.4 mg/m^2 for interior window sills and ledges (BSPL, 2020; Part 7: Human Health Risk Assessment May 2020, P 7-40). Further discussion is given in Section 6 regarding house dust assessment for lead. No guidelines are provided for heavy metals and arsenic in dust fallout.

Other cases where no NSW or Australian guideline is available from the list above will also be described in Section 5.

5. Review of Health Risk Assessment

Assessment of Existing Environment

The HHRA (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-36-37) has been undertaken as a desk-top assessment. This means the assessment has been conducted using existing information with additional detail obtained via literature.

The overall objective of the HHRA presented in this report is to provide an assessment of the impacts of the Project on the health of the community (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-18). The HHRA has been undertaken to address impacts to human health as outlined in the SEARs, namely:

- Air quality (particulates from crustal materials and heavy metals, in particular) Ramboll (2020), Air Quality Assessment;
- Noise and vibration (including blasting) SLR (2020), Noise and Vibration Assessment; and
- Drinking water quality (surface and/or groundwater) (Jacobs, 2020; WRM, 2020).

The HHRA has been undertaken accordance with the national guideline for conducting Environmental Health Risk Assessment (enHealth, 2012). The Health Risk Assessment Process is shown in Figure 1.3 in the HHRA (BSPL, 2020; Part 7: Human Health Risk Assessment May 2020, P 7-21) which is derived from guidance given in enHealth (2012). The assessment of risks to human health that were undertaken using the methodology and framework outlined by enHealth (enHealth 2012), where the following four key tasks were undertaken:

- Task 1 - Data Review, Evaluation and Issue Identification (Problem Identification)
- Task 2 –Toxicity/Hazard Assessment
- Task 3 - Exposure Assessment
- Task 4 - Risk Characterisation

The HHRA has presented the Secretary's Environmental Assessment Requirements (SEARs) and other NSW government agency requirements for the EIS that are relevant to human health (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-22-23; Table 1.1). Community consultation activities were undertaken throughout the EIS process identified a range of community concerns that relate to human health, that are summarised (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-36-37; Table 3.3).

The HHRA lists the following considerations when evaluating health risks (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-21; Section 1.8). These relate to claimed limitations of the methodology and the constraints applied within the HHRA, as follows:

- 'The risk assessment does not present an evaluation of the health status of any specific individuals in the community. Rather, it is a logical process of calculating the potential daily intake of, or exposure to, chemicals and noise within a community associated the Project. This estimate is then compared to regulatory and published estimates of daily intakes or noise levels that a person may be exposed to over a lifetime without unacceptable risks to their health'.

- ‘A HHRA is a systematic tool used to review key aspects of a specific Project that may affect the health of the local community. The assessment includes both qualitative and quantitative assessment methods’.
- ‘Where quantitative assessment methods are presented, a HHRA is typically based on a conservative estimate of impacts in the local community and thus is expected to overestimate the risks for all members of the community (including sensitive individuals)’.
- ‘A HHRA involves a number of aspects where a qualitative assessment is required to be undertaken. Where this is undertaken, it provides a general indication of potential impacts only’.
- ‘A HHRA relies on data provided from other studies prepared for the EIS (as listed for this project in Table 1.2). The conclusions of this HHRA, therefore, depend on the assumptions and calculations undertaken to generate the data from these other studies utilised in this assessment’.
- ‘Conclusions can only be drawn with respect to impacts related to a Project as outlined in the EIS. Other health issues, not related to the Project that may be of significance to the local community are not addressed in the HHRA or EIS’.
- ‘The health impact assessment reflects the current state of knowledge regarding the potential health effects of identified chemicals and pollutants for this Project. This knowledge base may change as more insight into biological processes is gained, further studies are undertaken, and more detailed and critical review of information is conducted’.

Soil

A description is given of soil samples collected from a number of areas, mainly within the Mine Site and prospect areas within Bowdens Silver’s exploration licence areas, to understand the composition of various metals and metalloids at these sites. Data is identified from the following sampling programs (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-39-40; Section 4.3). The soil concentration data is summarised in Table 4.1 (P7-44) for a range of metals and metalloids, excluding lead and Table 4.2 (P7-45) specifically for lead. The soil data are compared against health-based guidelines relevant to low-density residential land-use available from Australia (NEPC 2013) and the US (USEPA 2016). Both tables do not indicate the number of samples analysed per category listed nor do they give percentile distributions of concentration apart from median values and excluding for lead. Soil concentrations are generally lower than the NEPM health-based soil guideline (NEPC, 2013), with the exception of levels reported in the proposed main open cut pit.

There is very little detail about composition and physical properties of mining ore and wastes given in the EIS document. There needs to be further concentration data for all concentrates and wastes (tailings and unprocessed waste rock, including oxide ore) and particle size ranges needs to be characterised to assess likely exposure to Lue population.

The data for lead in Table 4.2 (P7-45) includes a sub-set of soil and dust samples from the Lue Public School collected in 2012 which are clearly associated with the presence of lead paint. These samples were also analysed for selected other metals (not provided in the EIS). These data reflect concentrations of metals in soil, as well as levels that are present in dust indoors (as a bulk dust sample or as surface sample), but do not relate to the survey of natural background in soil or of the orebody halo from Bowden’s deposit.

Exposure to lead paint at Lue School (and associated elevated levels of lead in dust indoors[2] and in soil close to the building) was advised as a matter to be addressed and managed by the school, and Department of Education. Metal concentrations reported at the public school and in other properties near the site were generally similar to those reported in soil, with the exception of zinc, most likely from building materials commonly used in the area) (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-39-40; Section 4.3). The level of mercury reported indoors may also reflect older building materials.

Groundwater

The occurrence and quality of groundwater beneath and surrounding the Mine Site is described in the Groundwater Assessment for the Project (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-40-47; Section 4.4) and was undertaken by Jacobs (2020). The concentrations of metals and metalloids summarised in Table 4.3 (P 7-46) show that certain metals (cadmium, cobalt, copper, lead, lithium, manganese and nickel), and metalloids (arsenic) associated with orebody mineralisation have potential to exceed drinking water guidelines (ADWG, 2018; USEPA, 2019b). Some groundwater (and potentially spring water) are reported being used to supplement drinking water stored in rainwater tanks and this warrants testing to ensure safety for household use. The incidental contact by the community is possible with groundwater and surface water during use for irrigation or stock watering, and recreational use of creeks. However, comparison with recreational water guidelines (NHMRC 2008; 10 times higher than drinking water guidelines) show no exceedances; recreational water quality are only provided for metals having a health-based criteria.

Surface Water

The surface water catchments and water quality within and surrounding the Mine Site (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-47-50; Section 4.5) are described in the Surface Water Assessment for the Project (WRM, 2020). The Project is located within Lawsons Creek catchment, in the eastern headwaters of the Macquarie River basin. Lawsons Creek flows in a NW direction and drains to the Cudgegong River near Mudgee and eventually draining to Lake Burrendong. Hawkins Creek, a tributary of Lawsons Creek, flows in a SW direction along the SE boundary of the Project (WRM, 2020). The main drainage catchments on the proposed Mine Site are ephemeral in nature and therefore depend on rainfall, with negligible base flow from groundwater. Lawsons Creek flows to the Cudgegong River confluence (near Mudgee), and below Mudgee is used for irrigation purposes.

Surface water quality were evaluated through the collection of samples from 33 sampling locations (WRM, 2020). Monitoring since 2013 has shown no elevated levels of metals and metalloids (Table 4.3, P7-46). However, the water runoff from the upper catchment of the Hawkins and Lawsons Creeks and downstream from the Mine Site has shown elevated nitrogen, phosphorus and electrical conductivity, due to agricultural activities.

Tank Water

The rainwater tank sampling program within Lue and surrounding the Mine Site was undertaken in 2012 by JBS to evaluate concentrations of metals that may be present in the water and sediment in tanks (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-50-52; Section 4.6).

The occupants at Lue use rainwater tanks as the primary source of potable water, for drinking and household use, and supplement with groundwater or water trucked in from Mudgee, when needed. The roof materials were galvanised iron, colorbond, zincalume, ceramic tiles and slate. The type of rainwater tank were constructed from sheet metal, poly, fibreglass and concrete. The latter can give higher pH levels than in rainwater. Organic matter from vegetation that enters the tank may absorb some of the dissolved metals, but can lower the pH and dissolve metals that are present.

The rainwater tank sampling program were undertaken on 84 tanks located between 0 km and 5.85 km from the proposed Mine Site (see Figure 4.5 P7-53 in EIS). The sampling comprised the collection of: (i) a preliminary water sample (prior to cleaning and sediment sampling) from the tank or outlet; (ii) cleaning of the tank to enable sediments to be sampled; and (iii) sampling of tank water post cleaning (at some locations). Rainwater quality in the area is characterised by low levels of salts with electrical conductivity, EC (around 27 µS/cm) and a slightly low pH (average 6.52). Bore water or Mudgee water has higher EC (>200 µS/cm) than rainwater.
The summary of metals in rainwater tanks, as dissolved concentrations in water is given in Table 4.4 (P7-51). The data is presented for the different types of tanks included in this study. All except one house had metal roof materials. One property (with a poly tank) had a tiled roof. Comparison of the measured concentrations compared with current drinking water guidelines show that arsenic, cadmium, lead and nickel exceed the drinking water guidelines (ADWG, 2018) in some tanks. The concentrations of metals in sediments (Table 4.5, P7-51) in the rainwater tanks indicated a range of metals present in sediments where concentrations were elevated. In four tanks (at three separate properties), there were significantly higher concentrations of arsenic, copper, manganese or mercury than the range reported in other tanks. These anomalous data likely reflect specific building materials, and condition of these materials, on the roof or guttering at the specific property, and show the potential of rainwater tanks to collect metals from dust and other fallout.

Air Quality

The air quality within and surrounding the Mine Site pre-mining has been described in the Air Quality Assessment (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-52-59; Section 4.7; Ramboll, 2020).

The Lue area is a rural area, with local air quality generating moderate levels of air particulates that is affected by dust-generating activities including: Traffic on unsealed roads; Agricultural activities; Motor cycle activity; and Small-scale quarrying activity. Local vegetation produces little dust and traps dust arising from the vegetated land surface. Bushfires and extended dry periods can produce increased amounts of dust that add to particulates levels in air.

Existing air quality at Lue is monitored using an air quality monitoring network (Figure 4.6, P 7-53). Measurement of fine particulates as PM_{10} and $PM_{2.5}$ from two locations and measuring continuous PM_{10} only is since 2012). Measurement of total suspended particulates (TSP) corresponds to particles <50 µm diameter from two locations operated on a one-in-six-day routine (excluding November 2014 to October 2016). The TSP data includes both coarse particles (>PM_{10}) that cannot penetrate into the lungs and fine PM_{10} particles and therefore TSP-lead was not used in the assessment of health impacts. The data was analysed for lead content as it gives an indication of the likely content of lead in the smaller/fine particles.

A summary of the PM_{10} and $PM_{2.5}$ concentrations reported on a 24-hour average basis for 2017 (Figures 4.7a and 4.7b; P 7-57-58) shows that the 24-hour average levels varied throughout the year. The levels reported were in compliance with the NEPM guideline value (NEPC 2016) with the exception of a dust storm event affecting 2 days of 2017 (note that this is a different event to the higher wind velocity events associated with the change of seasons).

Metrological data is collected from two weather stations (Figure 4.6, P 7-53).

The ‘Adopted Background for Cumulative Assessment (Bowdens Silver Project Executive Summary Report No. 429/24 P ES-20-21; Ramboll (2020) Table 5.3) are as follows:

- Air PM10 (24-hour average) Daily varying with a maximum of 43.7 µg/m^3 ; Annual average 13.6 µg/m^3
- Air PM2.5 (24-hour average) Daily varying with a maximum of 15.4 µg/m^3 ; Annual average 3.9 µg/m^3
- TSP Annual average 30.7 µg/m^3
- Lead Annual average Negligible (i.e. 0.2% of the impact assessment criteria; 0.5 µg/m^3)
- Dust deposition Annual average 1g/m^2/month (or 33 mg/m^2/day cf NSW guideline 120 mg/m^2/day)

No dust deposition details or guidelines are listed here for lead, arsenic and other heavy metals.

Other Emissions

Two items are covered (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-60-61; Sections 4.8 and 4.9).

- ***Other sources of Exposure to metals*** (Section 4.8). Food Standards Australia New Zealand (FSANZ) provides data on the levels of metals (and other chemicals such as pesticides) within food products consumed by the public. A summary of data available from FSANZ (FSANZ 2011) in relation to intakes from food. The median intakes reported for children aged 2-5 years and adults 17 years and older, with the intakes presented as mg ingested/kg body weight/day, adopting the body weights referenced by FSANZ is given in Table 4.7 (P 7-60). The dietary intakes evaluated by FSANZ also include drinking water.
- ***Existing Noise*** (Section 4.9).The existing noise environment within and surrounding the Mine Site has been described in the Noise and Vibration Assessment (SLR, 2020). Monitoring of noise was undertaken between 2011 and 2013 in Lue and the rural areas. Contributions to background noise sources in the vicinity of the Mine Site include: Traffic on Lue Road; Occasional light aircraft; Domestic and rural noise such as lawn mowers, tractors and other agricultural machinery; Rural fauna noise such as stock, insects and birds; and Rural natural noise such as wind in the trees. Measured background noise levels from all sources as a LAeq(period) ranged from 44 to 55 dB(a) during the day-time, 36 to 57 dB(A) during the evening, and 35 to 51 during the night-time. Monitoring of existing noise levels in the area and background noise levels were determined in accordance with the Noise Policy for Industry (NSW EPA 2017) to be 35 dB(A) during the day-time and 30 dB(A) during the evening and night-time periods (the minimum RBLs).

Assessment of Air Quality Contribution to Health

The assessment of potential health impacts associated with air emissions from the Project was derived from the Air Quality Assessment (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, P 7-52-59; Section 4.7; Ramboll, 2020). This assessment considered all Project-related activities, including construction and operation, and provided the basis for undertaking modelling of air concentrations and dust deposition throughout the surrounding community.

The Air Quality Assessment considered emissions to air that may occur during the following years, or scenarios:

- • Scenario 1 - representative of the site establishment and construction stage where total waste rock is highest and the Stage 1 TSF embankment construction is undertaken;
- • Scenario 2 - mining operations in operational Year 3, representing the year where total extracted material (ore and waste rock) is highest and the Stage 2 TSF embankment raise is undertaken;
- • Scenario 3 - mining operations in operational Year 8, representing the year with the maximum extent of the southern barrier construction and the final (Stage 3) TSF embankment raise is undertaken; and
- • Scenario 4 - representative of mining operations in operational Year 9, with the second highest year of waste rock extraction and when NAF waste rock transport to the TSF has ceased.

The assessment of air quality impacts considered the following activities:

- Dust emissions from all activities during construction and operations. The assessment of these emissions has considered TSP, PM10 and PM2.5, as well as the composition of metals on these particulates based on elemental analysis of the waste materials, ore and soil (Section 5.2, P7-64-68);
- Emissions of fine particulates as PM10 and PM2.5 from diesel combustion in mining equipment (Section 5.2, P7-68-70);
- Emissions of silica within PM2.5, based on the silica (quartz) content of the Bowdens deposit (Section 5.3, P7-84); and
- Emissions of hydrogen cyanide from the volatilisation from the processing area and the active surface of the TSF (Section 5.3, P7-85).

Potential health impacts associated with exposure to these emissions have been examined by using quantitative estimates for possible exposure pathways together with details of how toxic the various mine-derived pollutants are to humans. The Project activities comprise site establishment and construction works, open cut mining (including blasting), ore handling and processing and product transport. The processing operations include a jaw crusher, two mills and sequential floatation processes to produce silver/lead and zinc concentrates. Emissions to air that occur during all these processes were evaluated in the Air Quality Assessment (BSPL 2000; Part 2: Air Quality Assessment May 2020, P 2-52; Section 6.4; Ramboll, 2020).

Discussion given on comparison with emissions to air from other well-known lead mining operations such as Port Pirie, Broken Hill and Mt Isa claims that these sites differ significantly from those in the Project (P7-63). The key differences are described as large mine and smelting operation of long time frames, community (towns) located directly adjacent to the mine sites and smelting operations, and scale of the mines at Mt Isa and Broken Hill (significantly larger) and the proximity of the community to the operations.

The community at Lue is located at a similar distance from the boundary of mining operations as Mt Isa and Broken Hill when considering the whole affected areas. The example of the historical operations at Mt Isa and Broken Hill have demonstrated that where there has been a long history of dust deposition within the towns, the communities are exposed to both naturally elevated levels of lead and re-dispersed historical deposition. There are a number of examples of mine sites with mineral processing by sequential floatation processes to produce silver/lead and zinc concentrates that have resulted is dispersion of black-coloured metal sulfide halos that are clearly visible. Such examples are the current processing facilities at

Broken Hill and former Woodcutters lead-zinc mine in the Northern Territory, that don't have smelter facilities. Exposed tailings surface is also a potential source of dusts.

Dust Exposures

The Project is an open cut mine and the most significant emissions to air are likely to be dust generated from activities that remove soil and rock, and the metals (including lead, silver, cadmium, copper, manganese, zinc, cobalt, chromium, mercury, lithium and nickel) and metalloids (arsenic) that may be present in the dust from mining extraction and processing. This metal and arsenic composition analysis was used to scale the particulate matter (PM) emission estimates (TSP <50 micron, PM10 <10 micron and PM2.5 <2.5 micron- see Section 5.2.2, P7- 65-66) for each proposed mining activity listed in in Table 6.1 (P 2 - 49-50), based on the type of material being handled or processed (waste rock, ore and soil only and not oxide ore, concentrates or tailings). A summary of the metal composition analysis, used to scale the PM emissions and modelling results, is presented in Table 6.3 (P 2-52) as the median of each measurement is selected for use in this assessment (P 2-52) (BSPL 2000; Part 2: Air Quality Assessment May 2020, P 2-52; Section 6.4 P 2-48-50; Section 6.2;; Ramboll, 2020).

The description of community exposures to the mining emissions identifies the assessment of the inhalation of dust particles that are small enough to reach the lungs, namely PM10 and PM2.5 (particles with diameters < 10 microns or <2.5 microns BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.2.2 P 7-68). This assessment has considered potential health effects that are related to this particle size range only, as well as health effects related to the inhalation of various metals (present in the soil and rock) bound to these particles. The assessment does not appear to include particles >10 micron up to <250 micron that can be ingested, and are the most common size range found with mining operations including this Project. This assessment has also only evaluated those metals and arsenic modelled in the Air Quality Assessment based on elemental analysis of the ore to be mined; it does not include oxide ore, concentrates and tailings.

The dust generated by the proposed activities may deposit onto the ground, where metals and arsenic present in the dust may accumulate in topsoil, in household dust or be deposited onto a roof where it may then be washed into rainwater tanks. The community may then be exposed to these metals and arsenic via ingestion through direct contact with soil and dust on a property, and/or drinking rainwater. Once deposited to soil, any home grown fruit and vegetables, eggs from chickens, milk and meat, may accumulate these metals. The community may be exposed to these metals through the ingestion of this produce, with ingestion of home grown produce of most significance. These pathways are collectively referred to as 'multi-pathway exposures'. The assessment of community exposures to dust emissions is presented in Figure 5.1 (P 7-65). This includes consideration of exposures to metals that occur in the existing environment, and then adding on additional exposures that may occur as a result of dust emissions from the Project. Given the rural/agricultural nature of the Lue area surrounding the Project, inhalation and multi-pathway exposures have been evaluated in this assessment. The latter needs to include particles >10 micron up to <250 micron that can be ingested,

An air quality monitoring network was established for the Project in order to characterise the existing ambient air quality environment as described above (Bowdens Silver Project Executive Summary Report No. 429/24 P ES-20-21; Ramboll (2020) Table 5.3). Using collected data, the baseline air quality presented in Table ES-4 has been established and used for assessment purposes. However no dust deposition details or guidelines are listed here for lead, arsenic and other heavy metals.

A suite of meteorological data has also been assembled to assist in modelling dust emissions attributable to the Project.

- Minimising drop heights when loading ore, waste rock, and soil.
- Enclosure of the run-of-mine feed hopper on three sides and water application during crushing.
- Use of water sprays and/or dust aprons/collectors for drill rigs. In addition to these management measures, a proactive air quality management system would be adopted using a combination of the following.
- Meteorological forecasts – to predict when the risk of dust emissions may be high (due to adverse weather) in specific directions around the Mine Site and allow procedures and preparatory measures to be implemented.
- Visual monitoring – to provide an effective mechanism for proactive control of dust at source. For example, using the NSW EPA Dust Assessment Handbook, visual triggers for unacceptable dust at source (e.g. wheel-generated dust above tray height) are established to determine the need for action and response.
- Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.

It is intended that these management measures and the proactive air quality management system would be outlined within an Air Quality Management Plan prepared for the Project.

Particle Size and Dust Fallout

The significance of each size range collected by monitoring is important to ensure that all contributions to human exposure are included. The detail described above for PM10 (<10 micron) and PM2.5 (<2.5 micron) needs the additional detail to include particles >10 micron up to <250 micron that can be ingested to cover all kinds from the proposed mining activity listed above from Table 6.1 (P 2- 49-50), based on the type of material being handled or processed (waste rock, ore and soil only and not oxide ore, concentrates or tailings). All materials produced in the mining and mineral processing of the Project need to have measured particle size distributions. This data can then be related to likely exposure pathways for health risk assessment. Monitoring of those metals and arsenic modelled in the Air Quality Assessment based on elemental analysis of the ore to be mined; it does not include oxide ore, concentrates and tailings.

The summary of the metal composition analysis, used to scale the PM emissions and modelling results, is presented in Table 6.3 (P 2-52) as the median of each measurement is selected for use in this assessment (P 2-52) (BSPL 2000; Part 2: Air Quality Assessment May 2020, P 2-52; Section 6.4 P 2-48-50; Section 6.2;; Ramboll, 2020).

The description of community exposures to the mining emissions identifies the assessment of the inhalation of dust particles that are small enough to reach the lungs, namely PM10 and PM2.5 (particles with diameters < 10 microns or <2.5 microns BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.2.2 P 7-68). This assessment has considered potential health effects that are related to this particle size range only, as well as health effects related to the inhalation of various metals (present in the soil and rock) bound to these particles. The assessment does not appear to include particles >10 micron up to <250 micron that can be ingested (excepting for soil samples analysed for lead bioaccessibility in Annexure 4, P7-197-254) , and are the most common size range found with mining operations including this Project. The monitoring of metals and arsenic in dust needs to be performed more reliably as the currently available data is not at sufficiently low detection limits to compare against international metal dust guidelines.

Comparison is given for the composition of dust reported as deposited dust with units of μg/m^2/day for the average deposition rate for arsenic, lead and zinc is 0.002 g/m^2/month (67 μg/m^2/day), 0.001 g/m^2/month (33 μg/m^2/day) and 0.002 g/m^2/month (67 μg/m^2/day) respectively (Section 4.7 P 7-59) with the TA Luft (2002) standard guidelines (Table 1). The measured deposited dusts appear to be too high.

Table 1 Arsenic and metal deposition guidelines for fall out

Arsenic or metal	Standard (μg/m^2.day)	Averaging period
Arsenic	4	1-year
Cadmium	2	1-year
Lead		1-year
Protection of human health	100	
Protection of crop land integrity	185	
Protection of grassland integrity	1900	
Nickel	15	1-year

Source: TA LUFT (2002)

Bioavailability of Lead

For potential exposures to lead from ingestion of dust, the total bioavailability is described as the amount / proportion of lead that can move from the media being ingested into solution in either in the stomach or intestine and then how much lead in solution within the body can be absorbed by the body such that the lead can get into the blood and then move into other systems in the body) (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.2.2.4 P 7-71). For lead, this is important as the data used to develop a toxicity reference value is based on studies related to blood lead levels, not an intake from various media.

Total bioavailability = Bioaccessibility x Absorption

Bioaccessibility

Bioaccessibility is the proportion of lead present in the media that is ingested that can move into the gastrointestinal fluids. For most media ingested, such as water and food products the bioaccessibility is 100%. However, for soil, the bioaccessibility varies significantly between different sources of lead (including speciation) and soil types. Where no site-specific data is available, the default bioaccessibility value for soil is 100%. Lead in soil or rock from mine sites is considered to be less bioaccessible and hence site-specific bioaccessibility testing has been undertaken for the Mine Site.

Lead bioaccessibility testing for the Project (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Annexure 4, P7-197-254) has been undertaken by the University of South Australia using the Solubility Bioaccessibility Research Consortium (SBRC) method/assay, which is considered to be a suitable method (NEPC 2013) on 14 soil samples. The samples selected for analysis are from the Mine Site and related to different soil types

within these areas, which are representative of materials to be disturbed during Project works. Annexure D (Table 3) presents a summary of the soil samples selected for bioaccessibility analysis (which is noted to cover a range of different materials in the Mine Site).
Lead bioaccessibility reported in the samples analysed ranged from 14.6% to 53.8%, with an average of 33%. This average is higher than found at Mt Isa which was an average of 22% (Noller et al., 2017). This indicates that the lead mineralogy at Bowden's deposit has higher capacity for dissolution of lead in soil in the gastro-intestinal tract than for Mt Isa
For the Bowdens EIS assessment, where oral exposures to lead in soil relate to emissions of dust to air from Project activities the average bioaccessible fraction of 33% has been adopted. This bioaccessibility value only relates the ingestion of soil or dust, not the ingestion of lead from any other media such as water or food products.

Absorption
Absorption relates to how much lead that is in solution in the gastrointestinal fluids is absorbed into the blood and circulated throughout the body. Sufficient data is available to support that absorption is 50% for children and 20% for adults (NEPC 2013). For this assessment, 50% absorption was adopted for the ingestion of lead vial all pathways (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.2.2.4 P 7-71).

Due to a limited number of samples, further measurement of lead and also arsenic bioaccessibility (as no data is provided in the EIS) and particle size distributions on mined and processed tailings material is required as mining proceeds to enable a more reliable health risk assessment to be performed.

Characterising Exposure

This task was undertaken to provide quantification of the potential exposure pathways relevant to the surrounding community at Lue, for both acute and chronic intake (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.2.3. P 7-72).

The risk assessment has primarily focused on exposure occurring over a prolonged period of years, and, possibly, a lifetime, i.e. a chronic exposure. Whilst an activity might occur infrequently (i.e., several days a year), it might occur regularly over a long period, and, therefore, have the potential to increase long-term or chronic intake of the chemical. This assessment has also addressed acute inhalation exposures.

The assessment presented has addressed potential worst-case exposures within the Lue and district community, and exposure has been calculated for a Reasonable Maximum Exposure (RME) scenario estimated by using intake variables and chemical concentrations that define the highest exposure that is reasonably likely to occur in the area assessed. The RME is conservative and likely to over- estimate total exposure, and, therefore, over-estimate the health risk.
The exposure assessment involved the following.

- • Identification of the population(s) that might be exposed – for this assessment, residents (adults and children) in the surrounding community areas have been addressed. Figures 4.2 and 4.3 (P 7-41-43) show the location of properties and the receptors evaluated within the community surrounding the Mine Site. The assessment of children in these areas also adequately assesses the children attending the Lue Public School;

- • Identification of the activities by which exposure might take place for each population – for this assessment, the community comprises rural-residential areas where exposures may occur via:

- – Inhalation

- – Incidental ingestion and dermal contact with soil and dust
- – Ingestion and dermal contact with water from rainwater tanks
- – Ingestion of home-grown produce such a fruit and vegetables, eggs from chickens, meat and milk from livestock.
- • Identification of parameters which define these activity exposure parameters (such as time spent at home) and physiological exposure parameters (such as body weight, inhalation rate and ingestion rates); and
- • Identification of the chemical concentrations in air, soil, water and produce. This may include the identification and use of models to estimate chemical concentrations for receptors and exposure pathways that cannot be measured directly.

The assessment of risks to human health was undertaken using the methodology and framework were outlined by enHealth (2012) with the following tasks undertaken. Health risks of concern during any stage of the Project operation. These conclusions apply to all members of the community, adults and children as well as sensitive individuals.

The assessment of potential exposure to silica and hydrogen cyanide also concluded that there were no health risk issues.

1. Data review, evaluation and issue identification.
2. Toxicity/hazard assessment.
3. Exposure assessment.
4. Risk characterisation.

In assessing human health risk, assessment was made of potential impacts arising from air quality, surface water, groundwater and noise. Consideration has also been given to mental health and opportunities for health improvement.

Assessment of Silica Exposure

The Air Quality Assessment (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 5.3 P 7-84; Ramboll, 2020) evaluated potential emissions of crystalline silica from Project operations where crustal materials are disturbed, and where these materials have the potential to contain quartz. The assessment presented has considered respirable crystalline silica as $PM_{2.5}$, with the maximum predicted concentration of silica (as $PM_{2.5}$) at all locations (Project related and privately-owned) predicted to be 0.76 µg/m³ and at all privately-owned residences predicted to be 0.21 µg/m³ (as an annual average). The workplace exposure standard for respirable crystalline silica that must not be exceeded is 0.05 mg/m³ (eight hour time weighted average). Worker exposures to respirable silica dust need to be kept as low as reasonably practicable.

In relation to non-occupational exposures, EPA Victoria (EPA Victoria, 2007) has established a guideline of 3 µg/m³ for respirable crystalline silica (as PM2.5, over an annual average), which is consistent to the public health guideline established by the California EPA Office for Environmental Health Hazard Assessment (OEHHA 2005), and slightly higher than the TCEQ long-term guideline of 2 µg/m³ (TCEQ 2009).

Dispersion of respirable crystalline silica (as $PM_{2.5}$ annual average) derived from Project operations will require regular monitoring to ensure that appropriate levels are met in the community based on 3 µg/m3 now applied in Victoria (EPA Victoria 2007) based on California EPA Office, and beyond the current workplace exposure level of 0.05 mg/m3 (50 µg/m3). Evidence from coal mining in the Hunter Valley shows that heavy vehicles on mine sites creates $PM_{2.5}$ particulates by action of tyres driving over sedimentary rock and releases silica particles (Cox and Isley, 2012).

Assessment of Hydrogen Cyanide Exposure

The Air Quality Assessment (BSPL 2000; Part 7: Human Health Risk Assessment May 2020, Section 6.6 P 7-85; Ramboll, 2020) estimated the potential fugitive emissions of hydrogen cyanide (HCN) by volatilisation for the processing area and the TSF. Using the NPI Emission Estimation Technique Manual for Lead Concentrating, Smelting and Refining (1999) who report that 1% of total cyanide is lost through volatilisation as HCN within the processing area of gold operations, it was assumed to also apply to this level to the processing area of the Project. Emissions of HCN from the processing area are therefore derived based on the estimated usage of 190 tonnes of sodium cyanide per annum. The free cyanide concentration in the TSF return water was estimated as 0.0025 kg/m^3 while the volume of slurry throughput to the TSF was estimated as 2,522,880m^3/yr. Assuming a volatilisation rate of 80% (based on an assumed pH of 8) emissions of HCN from the TSF are estimated as 4,827 kg/annum or 0.15 g/s. Emissions were modelled across the full extent of the TSF.

A 1-hour guideline of 2000 µg/m³ is based on no adverse health effects in humans (NRC 2002), with a lower value of 340 µg/m³ established by Office of Environmental Health Hazard Assessment (OEHHA) (OEHHA 2008). The maximum concentrations of hydrogen cyanide predicted to be in air as a 1-hour average, are well below these health-based levels.
On the basis of the above, there are no health risk issues of concern in relation to community exposures to hydrogen cyanide derived from Project operations.

More data is needed on the estimated Hydrogen cyanide (HCN) gas level for the Project to confirm calculated values from a reported 1% of total loss through volatilisation within processing areas of gold operations. It is not a measured value at Bowden's silver project site and needs to be confirmed by measurement when/if the plant built and operating for zinc control is 60 mg/L. Nevertheless the Bowden's Silver project will still use sodium cyanide on site. The project needs to seek accreditation for cyanide handling with the International Cyanide Management Code which now includes silver extraction as well as gold.

6. Issues

The Key issues and weaknesses of the EIS that were identified are summarised as follows:

1. The EIS has been found to be vague and unclear for the purpose of assessing community exposure to deposition of air-borne contaminants from mining operations particularly from lead and heavy metals.
2. The information needed to assess dust transmission to the village is quite hidden or excluded and insufficient to validate the conclusion drawn in the EIS that people living in Lue village will not be affected – consequently more data is required to enable independent validation of community exposure.
3. The EIS underestimates community exposure levels because it doesn't use concentrate, mine ore materials including stockpiled oxide material and tailings as sources of dust and also does not analyse the effect of peak wind events biannually with change of seasons on dust movements – this omission is required to enable independent validation of community exposure. More effort is needed to examine community exposure to lead from mined materials by taking drill core samples and tailings from pilot trials. More reliable dust deposition data is needed for lead and other heavy metals to allow proper assessment of ingestion pathway for exposure of people, as distinct from total dust only fallout measurement.
4. Limited data used in the health risk assessment for lead bioaccessibility in 14 soil samples from the mine lease and community shows values of 14.6% to 53.8% (average bioaccessibility 32.7% compared with an average of 25% at Mount Isa city residential area), and indicating that surface and near surface mined material at Lue will have 24% higher absorption (bioavailability) by people than observed at Mount Isa. Surface soil sampled only have a maximum lead concentration of 305.5 mg/kg total concentration whereas drill core data shows concentrations of lead up to 4150 mg/kg. Therefore further measurement of lead and also arsenic bioaccessibility (as no data is provided in the EIS) and particle size distributions on mined and processed tailings material is required before a mining lease is granted and as mining proceeds to enable reliable health risk assessment to be performed.
5. The compliance level for acceptable community exposure in houses is taken from out of date guidelines (NSW 2003) - the EIS should use the more recent USEPA criteria (2019a) which considers blood lead of children to be below 5 micrograms per decilitre.
6. The EIS indicates some existing (baseline) soil and dust lead levels from Lue village buildings in 2012 exceed the guidelines for allowable lead concentrations, supporting an argument that the mine will not adversely affect the community because they're already exposed to high levels. There needs to be a more current baseline assessment of Lue population lead exposure including pre-mining blood lead survey.
7. Limited data on tank water shows that existing supplies may be contaminated with lead from historical sources, probably lead paint. An increased build up of lead in tank and drinking water is not desirable for the community. It is recommended that community water supply be replaced by reticulated water meeting Australian Drinking Water Criteria where this is possible.
8. More data is needed on the estimated Hydrogen cyanide (HCN) gas level for the Bowden's silver project. This has been calculated from a reported 1% of total loss through volatilisation within processing areas of gold operations. It is not a measured value at Bowden's silver project site and needs to be confirmed by measurement when/if the plant built and operating. Normally in gold processing extraction cyanide is

200-400 mg/L. However for zinc control is 60 mg/L. Nevertheless the Bowden's Silver project will still use sodium cyanide on site. The project needs to seek accreditation for cyanide handling with the International Cyanide Management Code which now includes silver extraction as well as gold.

9. Dispersion of respirable crystalline silica (as PM2.5 annual average) derived from Project operations will require regular monitoring to ensure that appropriate levels are met in the community based on 3 µg/m^3 now applied in Victoria (EPA Victoria 2007) based on California EPA Office, and beyond the current workplace exposure level of 0.05 mg/m^3 (50 µg/m^3). Evidence from coal mining in the Hunter Valley shows that heavy vehicles on mine sites creates PM2.5 particulates by action of tyres driving over sedimentary rock and releases silica particles.

7. Conclusions

The Lue Action Group (LAG) has sought the University of Queensland to undertake a critical review of Silver Mines Limited Bowdens Environmental Impact Statement (EIS) submission for a proposed lead/silver mine at Lue Station, New South Wales.

The consultancy has involved an independent and thorough review of the EIS and supporting documentation from the proponent, especially with regard to human and environmental health, and prepared this report for submission by the Lue Action Group to relevant authorities.

Bowdens Silver Pty Limited (Bowdens Silver Project) proposes to develop and operate an open cut silver mine approximately 26km east of Mudgee within the Mid-Western Regional Local Government Area of New South Wales. The Mine Site would be located approximately 2km to 3km northeast of Lue on Bowdens Silver-owned land, land under option to purchase, or land the subject of agreements with Bowdens Silver. The Bowdens Silver Project EIS was released for exhibition by the NSW Dept. of Planning Tuesday 2 June 2020 to enable public comment.

The EIS assessment considered the rural-residential nature of the existing community, as well as Lue where Lue Public School is located and claims ‘to have not identified any additional management measures, over and above those identified within the air quality, noise and water assessments’.

This report gives a specific focus on issues arising from the development of this Project that are of significance to human health of the Lue Community via the human health risk assessment process. Nine Key issues were identified and are given in the Summary.

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9. Appendix

Experience of Consultant

Professor Noller has a PhD (1978) in Environmental Chemistry from the University of Tasmania. He worked as a Research Fellow at the Australian National University (1978-1980), Senior Research Scientist at the newly created Alligator Rivers Region Research Institute, Jabiru, Northern Territory (1980-1990) and then as Principal Environmental Chemist for the Department of Mines and Energy, Darwin Northern Territory (1990-1998). From 1998-2006 Professor Noller has been Deputy Director of the National Research Centre for Environmental Toxicology (ENTOX) – The University of Queensland, Coopers Plains, Qld. ENTOX has a strong involvement with the utilisation of the risk assessment process to deal with toxicological hazards, including in environmental systems. Since November 2006 Professor Noller has been appointed as Honorary Consultant and Associate Professor at the Centre of Mined Land Rehabilitation (CMLR) a centre of the University of Queensland based at St Lucia. The CMLR is part of the Sustainable Minerals Institute. Professor Noller has been working and publishing in the field of environmental chemistry and industrial toxicology for the past 40 years and has presented 430 conference papers and published 220 papers. His professional activities undertaken at 4 different centres have covered processes and fates of trace substances in the environment, particularly in tropical environmental systems with special reference to risk management associated with their application and studies of the bioavailability of toxic elements in mine wastes, including waters. He has undertaken a number of consulting activities in Queensland, Tasmania, New South Wales, Western Australia and the Northern Territory and has undertaken a number of investigations at the Metropolitan Colliery since 2007. He was appointed in 2007 as Lead Author of the Australian Government Leading Practice Sustainable Development Program for the Mining Industry Handbook on Cyanide Management and was Project Leader for the Lead Pathways Study conducted at Mount Isa on behalf of Glencore Xstrata 2007-2013.

Centre for Mined Land Rehabilitation (CMLR) (www.cmlr.uq.edu.au)

At the forefront of research, education and technical expertise, the Centre for Mined Land Rehabilitation (CMLR) is leading the way we think about mining environmental management. CMLR is involved in a broad range of research and training projects with mining companies, industry bodies and government departments from across Australia and the world. As a part of one of the largest universities in the world, the CMLR has a team of highly skilled professionals focusing on the key issues facing modern mining and minerals processing industries.

A member of the Sustainable Minerals Institute (previously the Sir James Foots Institute of Mineral Resources), the Centre was established at The University of Queensland in 1993 and has built on more than twenty years involvement with the mining and minerals industries.

CMLR and the Sustainable Minerals Institute (www.smi.uq.edu.au)

The Sustainable Minerals Institute (SMI) was established in 2001 as a joint initiative between the Queensland Government, The University of Queensland and the Minerals Industry. The proposed development was to build upon the existing expertise within the various centres and departments and provide and over-arching framework for progressing Minerals Industry Research, Education and Training activities.

The CMLR is the sole provider of environmental mining management within the University and has established for itself and the SMI a reputation of national and international significance.

Our Location. The CMLR is situated on the 5th floor of the Sir James Foots Building (No 47A) at the University of Queensland, St Lucia campus (www.uq.edu.au).