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16th July 2020

Submission to EIS on Bowden Silver mine, Project SSD-5765

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Introduction

I oppose the Bowden Silver EIS on the basis that it is ***scientifically inadequate*** and seriously underestimates the threat of acid mine drainage impacting on Lawson Ck. I am an environmental scientist and writer, and from 1978 to 1985 I was an Experimental Scientist in the CSIRO Physical Technology Unit (now disbanded) doing biological research into the effects on aquatic freshwater ecosystems of heavy metals from heavy metal mines. Our team focused on pollution from heavy metal mines, both closed and operating. These included mines such as Sunny Corner (near Portland), Captains Flat (near Canberra) and Woodlawn (near Tarago), while Woodlawn was operating as an open cut mine. I researched in my time in CSIRO the literature around many dozens of examples of the acid mine drainage pollution caused by heavy metal mines from around the world.

Acid mine drainage from heavy metal mines is one of the great ‘forgotten’ issues in terms of environmental impact, even though it has been with society for thousands of years. The pollution from such mines can continue for hundreds of years after a mine is closed (where society bears the long-term burden of poisoned rivers).

The key problem of *Acidithiobacillus* bacteria in the production of acid mine drainage

The Bowden silver mine EIS fails to even mention the name of the *Acidithiobacillus* bacteria, but once a sulphide metal deposit (as in the Lue site owned by Bowden Silver) is opened up to air and water, the bacteria *Acidithiobacillus* lives by breaking down the sulphide minerals to sulphuric acid. This liberates the heavy metals such as zinc, copper and cadmium, which are highly toxic to aquatic life (in particular all gilled animals plus most plants). pH levels in streams can become highly acidic because of this. These bacteria can accelerate pyritic oxidation by a million times over what would happen chemically (Mielke et al 2003).

Historical global acid mine drainage

The Rio Tinto in Spain (which gave the name to Rio Tinto Corporation, the second largest metals and mining corporation in the world) is a highly polluted river (pH 2) due to mining of sulphide ores in a major way since Roman times (Lederer and Arcoitia 2017), and part of this is due to historical mining. Lead mines in Wales have been known to pollute long after they were closed (Davies 1987) and pollution was certainly evident 90 years after one mine closed (O'Grady 1981). The Ohio University (2016) notes:

> Legacy mining in the Appalachian Coal Region has numerous mines that continue to yield acid mine drainage (AMD) more than 100 years after closure. An example of an extreme case is a tin mine in England that was mined by the Romans more than 2,000 years ago and it still produces AMD from pyrite oxidation.

The US Forest Service (1998) noted that between 20,000 and 50,000 mines generate acid mine drainage on USDA Forest Service lands, affecting approximately 14,000 miles of streams (Benner et al 1997). The majority of the AMD comes from inactive or abandoned mines. They also note (Ibid):

> … if the mine rock contains more acid-generating minerals than alkaline materials, the alkaline materials will eventually be used up, and the water acidity will increase (Durkin and Herrmann 1996). This process can last for weeks, months, or centuries until the minerals completely oxidize and the rock comes into equilibrium (Durkin and Herrmann 1996).

Historical acid mine drainage in Australia and NSW

Engineers Australia (EA 2019) summarises the problems of acid mine drainage:

> Acid mine drainage (AMD) occurs when mining operations result in sulfide bearing ores, such as pyrite and chalcopyrite, being exposed to oxygen and water. Over time, sulfides react with oxygen and oxidise to form sulfates. These sulfates dissolve in water forming sulfuric acid which then leaches heavy metals from rock exposed by mining. Often, this leads to large quantities of water with very low pH having high concentrations in heavy metals such as manganese, iron, copper, nickel and zinc. Unfortunately, AMD is expensive and difficult to treat, and as a consequence, large quantities of acid mine drainage is stored at both operational and disused mine sites globally. The United Nations recently labelled AMD as the **second biggest problem facing the world** after global warming, and when considering previous case studies of dam failures and the dwindling global supply of fresh water, it is easy to see why. (my emphasis)

Earth Science Australia (ESA n.d.) states:

> One of the most under-publicized problems facing environmental health in Australia is that of toxic waste emissions or acid mine drainage (AMD) from abandoned mining sites. It threatens the quality of the surface and ground water supply with contamination of toxic heavy metals and high levels of acidity.

My experience with operating and closed heavy metal mines confirms the serious problems involved. Examples of heavy metal mines with serious problems in NSW are discussed below.

The Sunny Corner mine near Portland. This was mined for silver and copper from 1875 to 1922, and the stream from the main adit has a pH of 2.8 and levels of Cu of 12.7 ppm and Zn of 130.8 ppm and cadmium levels of 0.23 ppm[1] (Chapman et al 1982, 1983, metal levels converted from mM figures in original). No money was spent to rehabilitate the site, which continues to pollute today. Daylight Ck below the mine does not attain normal aquatic diversity until 22 km below the mine (Washington unpublished). The mine stopped operating 98 years ago yet there is no sign of the acid mine drainage and heavy metal pollution ceasing.

Captains Flat near Canberra. The mine operated from 1892 until 1962, producing lead, zinc, copper, pyrite, silver and gold. Because the mine drains to Lake Burley Griffin in Canberra, extensive rehabilitation work has been conducted by government since closure to control erosion, improve safety and to control tailings pollution leaving the site. Significant works were undertaken in 1976 to a value of $2.5M. (R and G n.d.). Current and ongoing issues include acid mine drainage seepage and heavy metal contaminants leaving the site, with zinc being the primary contaminant of concern (R and G n.d.). Thus, while substantial money was spent by government on rehabilitation, this has failed to stop all heavy metal pollution issues. The mine stopped operating 58 years ago, and despite $2.5 million being spent, it still causes pollution today.

Woodlawn mine near Tarago. The open cut was operated from 1978 to 1998, though underground mining recommenced in 2019 (https://www.heronresources.com.au/woodlawn-zinc-copper-project). Below the waste rock dump was a dam which flowed over into a creek flowing to Lake George (a closed catchment). The first site below the waste rock pile had high levels of Cu of 19 ppm and of Zn of 327 ppm (Chapman et al 1983, metal levels converted from mM figures in original). The bed of this creek was coated bright blue from copper carbonate that had precipitated out (Washington pers. comm.). Cadmium levels in the water were 2.2 ppm at Site 1 and remained high at 0.23 ppm (mg/L) or 230 ug/L (compared to WHO safety guideline of 3 ug/L[2], WHO 2011) close to the mine property boundary at site 10 (Chapman et al 1983). The EIS for the Woodlawn mine that I read closely while we researched the mine said that 'water leaving would be cleaner than water entering' but this was clearly not the case in practice. This is an example of the PR spin used by metal mining companies.

[1] Note that 0.23 ppm of cadmium is 230 ug/L - which is much higher than the WHO guideline in water for cadmium of 3 ug/L.

[2] Note that this is a worry as cadmium precipitates out at a higher pH than copper or zinc, hence can travel longer down a stream. Cadmium is responsible for the disease Itai Itai where it replaces calcium in the bones causing the to weaken and break (http://www.kanazawa-med.ac.jp/~pubhealt/cadmium2/itaiitai-e/itai01.html).

The Bowden EIS and acid mine drainage

The Bowden EIS seeks to *avoid* the topic of acid mine drainage totally. It is only mentioned in Table 3.2 as a topic that government and the community had identified (Bowden Silver in the EIS ignores the topic completely despite questions raised by government and the community). The EIS *fails to discuss* acid mine drainage at any level. *Acidithiobacillus* as a bacteria causing acid mine drainage is not mentioned at all in the EIS. Similarly in the Appendix ‘Part 3 Materials Characterisation Assessment’ acid mine drainage or *Acidithiobacillus* are not mentioned at all.

This failure to discuss acid mine drainage is despite that fact that the EIS notes on p. 8-16 in the ‘Technical Terms’ that pyrite (iron sulphide) is the most wide-spread sulphide material found throughout the ore and waste rock within the mine site. Page xvii of the EIS notes that there is primary and low grade sulphide ore of approximately 29.9 million tonnes. Page 2-13 states that primary ore is unweathered silver, zinc and lead **sulphide** minerals within the host rock. The Mass Characterisation Addendum on p. 3-14 notes that total-sulphide values range between 0.30 and 5.2%. This is certainly at a high enough level to produce significant and long-lasting acid mine drainage, though the EIS fails to mention this.

In all its PR material Bowden Silver ignores the problem of acid mine drainage, but the reason for this failure to mention a process that is found almost universally with metal sulphide deposits is never explained. They may think they do not have a problem due to some alkaline rocks being present in the bed rock (though this is never actually stated in the EIS). However, this does not mean there will not be acid mine drainage from the waste rock dump that could continue for centuries. Alkaline rocks can be coated and cease to neutralize AMD, as happened with crushed limestone dumped on the spillway of the dam below the waste rock dump at Woodlawn (my personal observation). Bowden Silver seems to be relying on ‘kinetic’ testing of ore samples, where this relied on a number of columns run for 30 weeks and a mere 4 columns for 128 weeks with water being passed over the crushed ore in the columns. We are never told if the columns are inoculated with *Acidithiobacillus* to mimic a real life situation (as it is never mentioned). On p. 3.20 of the Appendix ‘Part 3 Materials Characterisation Assessment’ it says: ‘mass balance calculations indicated that a sizeable fraction (e.g. up to c. 60+ %) of the Total-S had been removed from the columns during the course of the program’. It thus tends to downplay the possibility of any long-term acid mine drainage. This is not scientifically credible, especially as Fig 10 of the leachate columns shows that the pH of the leachate of one sample was consistently **pH 3 or less** (quite acidic). The assessment by Bowden Silver thus fails to rule out that acid mine drainage will occur. A pH of 3 means that many heavy metals can travel downstream in solution. It is notable that the highly toxic cadmium does *not* precipitate out of the water column until the pH gets higher than 8. As found at Sunny Corner and Woodlawn, cadmium in solution could well move downstream into Lawson Creek, which flows towards Mudgee.

This raises the question of how much cadmium might be present in the ore. We simply *do not know this* as this information is not provided in the EIS (nor are we provided with copper concentration in the ore). We do know from the majority of metal sulphides that with zinc sulphide there is almost always an impurity of cadmium (as the two metals are related chemically, as cadmium sites below zinc on the periodic table).

p. 4-160 of the EIS states:

> The principal metal likely to be dissolved in runoff from the NAF waste rock would be manganese. Table 4.1 in WRM (2020) summarises the median metal concentration that GCA (2020) established during kinetic testing of NAF waste rock samples. Potential exists for elevated concentrations of these metals to be present in runoff from the areas of the Mine Site where these materials are present and collected in some sediment dams. The median concentration of zinc, cadmium, copper and nickel exceeded the Australian and New Zealand Guideline values.

The WRM report is hidden away in the appendices of the EIS, however this comment clarifies that water levels of zinc, cadmium, copper and nickel *will* exceed the Australian and New Zealand guideline values for water - and hence create a significant water pollution problem. The water quality of Lawson's Ck is thus at risk. Given the history of almost all heavy metal mines, water quality is at risk *long after* the mine closes and Bowden Silver ceases to become legally responsible for the mine (and where any water treatment system has been closed). As with most other heavy metal mines, society - rather than the company - will inherit the long-term damage of polluted waterways due to the Bowden Silver mine operation. This is simply no longer acceptable for Australia in the year 2020.

Conclusion

Acid mine drainage has been a pollution problem for thousands of years wherever metal sulphide deposits have been mined. Heavy metal pollution of river systems accompanies such mines for hundreds of years after the mine closes. In Australia, mining companies have sought to *ignore or downplay* the consequences of long-term heavy metal pollution, which results in the degradation of our rivers. This strategy continues in the Bowden Silver EIS, which has no discussion of acid mine drainage, though some data does emerge that indicates that water pollution will occur that *exceeds Australian guidelines*. As an environmental scientist who worked on heavy metal pollution on inland waters in CSIRO for seven years, I conclude the EIS is **simply inadequate** in terms of discussing this topic of acid mine drainage and heavy metal pollution. It also fails to provide solutions to an issue that other heavy metal mines in Australia have been *unable to solve*. I also have some reservations as to whether heavy metal pollution would be properly monitored from this (and other heavy metal) mine in the future. There is now no CSIRO unit monitoring heavy metal pollution of inland waters from mining. The EPA *should* monitor such pollution, however its predecessor the State Pollution Control Commission historically failed to do this effectively in regard to Woodlawn. The question as to whether water pollution from the Bowden Silver mine will be adequately monitored over time - if it is approved - thus remains an open question.

Once you disturb a metal sulphide deposit and allow water and oxygen to enter, *Acidithiobacillus* will ensure acid mine drainage occurs and continues until the sulphide is all converted. There is no known solution to this reality, and acid mine drainage can continue for hundreds of years. Bowden Silver's failure to discuss this is both unscientific and unethical. The EIS is thus totally inadequate scientifically, and ignores and downplays the risk of acid mine drainage. Accordingly, **the project should be rejected.**

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