Supplementary Submission to Submission 423.- Centrifuges

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Abstract

The decision not to proceed with the temporary Tailings Storage Facility is welcomed as in addition to overestimating the water recoverable from this facility it's deconstruction would have been problematic.

However, it is unproven whether the thickener and centrifuges will work as expected and the additional cost involved in buying and operating the centrifuges is likely to render an already economically questionable project unviable.

Supplementary Submission to Submission 423

TSF

The initial proposal in the Environmental Effects Statement (EES) to process the fine tailings by means of a temporary TSF (tailings storage facility?) would have been a disaster if allowed to proceed.

Several submissions, including my original 423, pointed out that huge volumes of water were to be pumped to the TSF, and any miscalculation in the quantity to be retrieved would have led to the project running out of water. EMM (EES, Appendix A006, Appendix A , Fig 8-2) assumed that even with rainfall assumed to exceed evaporation, contrary to Bureau of Meteorology figures provided in my earlier submission, 1.1GL of water per year remained "entrained" in the TSF. With 12 MT of ore processed per year (Kalbar) and slimes 21% of ore this comes to 2.5 Mt of slimes solids, so with 1.1GL of water the assumption is that they could be reduced to 70% solids.

It is now admitted (Section 7 of TN01, Pre-hearing document (Pd) 43) that a review of the modelling used to estimate the recovery of water from the Temporary Tailings Facility (TSF) using amphirols was markedly overestimated. It is unclear what gave rise to the original estimate, but flocculant manufacturer Nalco (Appendix C, Pd 130, p12) in promoting their "WATERSHED" tailings treatment claim that water usage for the project could be reduced from 5.7 to 2.8 GL/year. As it now appears that this estimate was flawed some doubts must be raised about Nalco's other claims regarding flocculant use for the thickener and centrifuges. Details of the revised modelling are not provided, but the original flawed model was accepted both by the EES submitters and the original suite of expert witnesses. It seems incredible that during the four years preparation of the EES such a major error could have been undetected until after publication of the EES. The contributors appear to have accepted figures provided by Kalbar without question.

The second problem with the TSF is that at 2.5 Mt/year solids+ 30-35% water, some 4 million tonnes of wet slimes would accumulate per year in the TSF, upward 20Mt over the 5 years of operation, covering an area of 90 ha. Kalbar stated that this material is then to be returned to the mine voids. There appears to be no recognition of the magnitude of this task, or provision of extra machinery to accomplish it. It is highly probable that it would be decided that this task is uneconomic and that the TSF would become a fixture on the landscape unless it eventually failed with catastrophic results.

Therefore I welcome the abandonment of the proposal to construct the TSF.

However, I remain unconvinced that the proposed mine is either environmentally acceptable or financially viable. Mr Rod Campbell (Pd 93, 187) makes a convincing case that the costs and risks of the project are understated and the benefits overstated. The additional costs involved with the purchase and operation of the centrifuges only exacerbates this precarious financial situation.

Centrifuges

The original EES proposes to construct one wet concentrator plant (WCP), to which slurried ore from the two mining unit plants is pumped for separation. Fine tailings (slimes) are to be treated with flocculant then thickened in a large tank called a "thickener" If centrifuges are to be used, thickened slimes will be treated with further flocculant then centrifuged to remove excess water and produce a stackable "cake" containing 65-70% solids.

Technical note 01 (TN01,Pd 43) appears to completely misunderstand this process. Section 6 states that:

"As the project entails two mining unit plants (MUP) in two separate areas, two centrifuge plants would also be required."

They go on to state:

"The centrifuge plants would be located in close proximity to the mining area in order to reduce the overland haul distance of the centrifuge cake back to the mining void, and thereby minimise noise and dust generation. Based on the preliminary mine planning it is anticipated that each centrifuge plant would be relocated to a new position every four to five years"

Given this fundamental misunderstanding of where centrifuges fit into the processing procedure casts doubt on the validity of any conclusions drawn.

Saracik,(Pd 130) in his expert review of the technical note, makes no comment that the centrifuges follow the WCP, rather than the MUPs during processing, casting doubt on the thoroughness of this review.

It would of course be possible to pump the thickened slimes slurry from the WCP to centrifuges located near the mining voids. This would necessitate the construction of additional pipelines, additional pumps and more electricity to power them. It would reduce the haul distance needed to truck the fine tailings "cake" to the mine void. Offsetting this would be the fact that slurry would no longer be pumped to the TSF, so this change may be neutral

Neither of these documents make any estimate of the electricity required to run the centrifuges. The EES (p3-35) estimated the power demand for the MUPs and WCP to be 9,000 kVA. The revised work plan incorporating centrifuges increases this to 14,000 kVA, a 55% increase. However, Welchman (Pd 139) para 45 was advised that they would require approx. 10,194 MWh per annum which equates to 10,400t CO_2 equiv . The MUPs require electricity for a vibrating screen and for water and slurry pumps. The WCP requires electricity for multiple pumps for water and slurry, and possibly screens and magnets. Welchman (Pd 84) Fig 1 p5 estimated the electricity requirement of these to generate 500,000 t CO_2 equiv over the life of the project. A 55% increase over the 15 years of the operation of the centrifuges would generate an additional 250,000 t CO_2 equiv .

In both the technical note and its review it is accepted without question that the thickener will remove supernatant water and thicken the slimes slurry to 30-35% solids. Given that the Nalco estimate of water retrievable from the TSF (Appendix C, Pd 130, p12) is now considered to be erroneous, this statement is also open to question.

Nalco (Appendix C, Pd 130) undertook settling rate trials in the laboratory using a range of flocculants. They determined that Nalco 83384 was the most economical of the anionic polyacrylamide flocculants tried, giving a settling rate of 10m/hr at 130 g/t under ideal calm conditions. They added the proviso that it was very important to dilute the slurry as thickener feed to less than 3% w/w. This condition is not met for material leaving the WCP

According to the draft work plan (EES Attachment B, Figure 5.1, 5747 m^3 (5.747ML) of water will flow into the thickener each hour, of which nearly 88% is expected to flow through, with 700m^3 remaining in the slurry. This massive flow will clearly be highly turbulent, so the applicability of the laboratory testing to this situation is uncertain.

There has been a range of slimes content as a percent of ore given, 21% (Technical Note 01, p1), 23% (EES draft work plan p 4.22), 25.1% (EES draft work plan Fig 5.1) At a process rate of 1500 tonnes of ore per hour (work plan p 5.2) these equate to 315, 345 or 376.5 tonnes of slimes per hour. Mixed with 5747 m^3 of water they come to 5.2%, 5.7% or 6.1% respectively entering the thickener.

.Nalco did provide a conceptual design for a thickener, however their assumptions for the characteristics of the input material do not match those provided by Kalbar, so it is uncertain whether their design has been adopted. Kalbar do not appear to have provided the design of the thickener they intend to adopt. It is uncertain whether it will perform as hoped with the flocculant concentration intended, due to the rapid water movement and turbulent flow in the thickener.

Alfa Laval (Appendix B, Pd 130) confirmed that a 25% suspension (w:w) of slimes, with 340g/tonne solids of flocculant added, could be successfully concentrated to 70% solids in a bench top centrifuge. The addition of flocculant was essential for separation. They believed that dewatering decanter centrifuges could be used successfully to dewater the fine tailings.

Technical Note 1 (Pd 43) states that centrifuges would have a throughput rate of around 55 t/hr solids. If this throughput is correct, 6 operating centrifuges would be able to process 330 t/hr, sufficient to cope with the 315 tonnes throughput if the ore is 21% fines, but insufficient if the 23% or 25.1% figures are correct. Technical Note 14 (Pd 194) settles on an average of 321 t/hr.

Flocculants

Flocculant use will also be considerable. At 130g/t in the thickener and 370 g/t in the centrifuge (TN14, Pd 194, P3) this works out at 3.85 tonnes per day for 321 tonnes slimes/hr , 1400 tonnes per year. At 55c for 130 g (Nalco 2013 price for their WATERSHED flocculant (Pd 130 Appendix C P10) this comes to $6 million per year. Around $4.4 million is ascribed to flocculant used solely for the centrifuges.

It is also proposed to use additional flocculant for dust suppression on bare areas and coagulants and flocculants in the DAF. Other compounds are touted to reduce dust on roads. Chemicals will be a major budget item.

TN 14 (Pd 194) states (correctly) that 370g flocculant/tonne x 321 tonnes solids per hour through the centrifuges comes to 118 kg/hour flocculant used. It follows that as the centrifuges will be running continuously this is 2.83 t flocculant /day or nearly 88 t over a 31 day month. Adding the 130 g/t needed for the thickener brings it to nearly 120 t/month for slimes processing. Bulk density of Nalco Optimer 83384 (Pd 194 Appendix 2) is .72, which comes to 165 cu m/month.

TN14 (p3) states that a 50 cu m silo will hold enough flocculant for a month. This is clearly incorrect. At the rate proposed it wouldn't last 10 days.

McAlister (TN14, Appendix 3) is even worse. He states that 5 bags of flocculant would be enough for 10 days. This calculation appears to be based on flocculant for the thickener only. Bulka bags normally hold 1 tonne to allow handling by normal forklifts (this would be about 1.4 cu m). Counting flocculant for the centrifuges as well as the thickener, five bags would last just 31 hours. One can have very little confidence in documents which contain such glaring errors.

The potential biological hazard from the use of flocculant is completely glossed over. Nalco Optimer 83384, the preferred option, is a high molecular weight anionic polyacrylamide (PAM) which is considered non-toxic when intact. Anionic PAM compounds work by aggregating small solid particles into larger flocs which then readily come out of suspension. Hence size of the PAM molecule is important. Degradation of these molecules is incompletely understood, however *"it is well known that PAM can undergo degradation by a variety of mechanisms, significantly increasing its mobility and potentially leading to the release of acrylamide monomer, a known toxin and potential carcinogen"* (Xiong *et al* 2018, p3). PAM can degrade in the presence of iron and oxygen. The presence of nanoparticles caused a further reduction…(Xiong *et al* 2018 p4).

Iron, oxygen and TiO_2 are present in abundance in the slimes slurry, raising the possibility that the flocculant could break down in the thickener, losing effectiveness and allowing a build-up of particulate matter in the recycled water.

Worse, mobile fragments of PAM, and acrylamide monomer could leach from the slime cake stockpiles during rain, or leach from the tailings placed in the mine void, and hence enter the ground or surface water.

These potential outcomes have not been considered by the proponent.

Economics

TN14 (p3) states that it would cost $3.50 –$4.00 per tonne for tailings processed and hauled to the pit for backfill. This could well be conservative. At 55c/130g, 370g/t would come to $1.56 per tonne for flocculant. Centrifuges are estimated to take 17000 MWhr/year to run, at 2.8 million tonnes of tailings this is 6 kWhr/tonne. It is unknown how much Kalbar will pay for power, but at the current 34c/kWhr this comes to $2.00. Thus we have $3.50 per tonne to stockpile slimes at the centrifuge, not counting labour or the cost of cartage to the mine void, or of depreciation and maintenance of the centrifuges.

RJ Robbins and Associates, pp 44-45 *in* Bishop, SR (2013) Geological Survey of Victoria Report No 29569, stated of the Fingerboards ore quality

"Although they would still be saleable, chromium and magnesium content would downgrade most titanium products, causing price reductions in the vicinity of 30%

Uranium and thorium content would cause the downgrade of zircon produced, potentially by up to 20%."

Kalbar, in touting for investors (Kalbar Resources Ltd, Fingerboards Mineral Sands Project, Analysts Presentation May 2017) https://www.businesses.com.au/Analysts-Presentation-May-2017-for-website.pdf

makes the claim that Rio Tinto, during their exploration of the Glenaladale deposit, completely overlooked the Fingerboards Resource, therefore the Robbins analysis does not apply to this deposit. (The Environmental media Foundation Inc, Submission 610). It seems extremely unlikely that a highly experienced mining company would overlook a resource, extending over 1600 ha, discoverable by a new player in the industry.

It is quite possible that the additional cost involved in the centrifuges will render an economically marginal project completely unviable.

Also, the potential health and environmental problems created by the use, and particularly the increased use, of flocculants with the centrifuges have not been considered.

References.

RJ Robbins and Associates, pp 44-45 *in* Bishop, SR (2013) Geological Survey of Victoria Report No 29569.

Xiong, B; Loss, RD; Shields, D; Pawlik, T; Hochreiter, R; Zydney, AL and Kumar,M. (2018). *Polyacrylamide degradation and its implications in environmental systems.* Nature Partner Journals **|** Clean Water 7 September 2018