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Monday, 6 June 2016

Bloomfield Collieries
P.O. Box 4
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Attention: John Hindmarsh

Response to Land Owner Concerns Proposed Extension of Mining at the Rixs Creek Colliery

1 Background

Mr John Hindmarsh of Rixs Creek Mine (RXC) requested JP Environmental to review expressions of concern from two neighbouring land owners that were submitted to the Department of Planning and Infrastructure regarding the proposed extension of mining at Rixs Creek Mine. The neighbours expressed concern regarding the quality and quantity of runoff entering Deadmans Creek from mining operations at Rixs Creek.

Alistair Bowman is the nearest neighbour owning land downstream in Deadmans Creek catchment. Mr Bowman's concerns are set out below:

1. Future performance: The primary concern was "the potential for unsuitable surface water entering Deadmans Creek".
2. Past performance: Mr Bowmans "experience has been that the current sediment dams that protects Deadmans Creek from surface water run-off from the existing out of pit dump has overflowed on at least three occasions in the last twelve months". Runoff from the mine has been has been a regular subject of discussion with Mine representatives.
3. Request for comfort, i.e. Rixs Creek provide a timetable to for the enlargement of existing dams to operate as sediment settling dams (Dams 16, 17 and 20) to protect Deadmans Gully prior to mining activity moving into this catchment.

Bruce Moxey is the next landowner downstream after Bowman in the Deadmans Creek catchment. Mr Moxey's concerns are:

1. Past performance: The main concern is the quality of the water of runoff from the mine that has occurred in the past.
2. Future performance: That the Mine "might not be able to contain excess water runoff from not only entering our property but the Hunter River", and
3. Impacts on livestock: "Our cattle also have free access to Deadman's Creek and drink from it".

2 Dam Overflows

The capacity of the sediment dams at Rixs Creek Mine was determined in accordance with Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries 2006 (the "Blue Book"), based on an 85th percentile 5 day rainfall event and Type D soils. When operated in accordance with the Blue Book, these dams would be expected to overflow, on average, between one and two times per year.

Using a rule of thumb calculation to estimate the daily rainfall that might cause Dams SD7, SD16, SD17 and SD20 to overflow, the required rainfall is:

Initial Losses	20mm
Ongoing Losses	10mm
Rainfall Excess	15 - 23mm *(depends on sediment levels in the dam)*
Daily Total	45 - 53mm

A review of the 2015 daily rainfall record for Rixs Creek Mine, referencing the above daily rainfall range indicates that there may have been 3 or 4 overflow events in 2015, and the spillways may have operated for 6 or 7 days. The number of overflows appears consistent with Mr Bowmans observations.

In the Rixs Creek Extension of Mining EIS, the Mine indicated it may either treat and release the clarified water or take the untreated water into the mine water management system. The method adopted could vary from time to time based on a risk assessment of the current water inventory held within the mine. If all water is taken from the sediment dams into the mine water management system, total flow in Deadmans Creek could reduce by up to 90%. If all water was treated and released, Creek flow could be reduced by about 10%.

3 Water Quality

Water quality testing results from monitoring of sediment dams at West Pit and Deadman's Creek since 2011 are attached.

Water quality results indicate that the runoff collected in the dams from mined and un-mined catchment can contain appreciable levels of sediment i.e. greater than 50mg/l. From observation of historical aerial photographs of West Pit from 2013, 2014 and 2015, most dams in the Deadmans Creek dams are turbid, reflecting the nature of the catchment soils and variable runoff across the catchment rather than any specific activity in the catchment. In December 2015, sediment dams below the advancing overburden dump are quite turbid in the aerial photograph when compared to farm dams to the west and north-west, reflecting the disturbed catchment runoff. In an aerial photograph from the start of 2014 the farm dams to the west and north-west and Dam 16 are very turbid when compared to Dam 17.

The average value of suspended solids results from sampling in Deadman's Creek catchment is lower in 2015 (65 mg/l) when overburden placement commenced, compared to 2011 – 2014 (95 mg/l).

The majority of soils and sub-surface materials in the upper reaches of Deadman's Gully can be classified as Type D soils, which are highly erodible soils containing substantial amounts of colloidal material – clays and fine silts. Rainfall runoff from disturbed land with Type D surface materials is normally quite turbid. It is the clays and fine silts suspended in the water that cause the turbidity. Settled water containing colloidal material remains turbid even when the suspended solids concentration is less than 50mg/l and can remain turbid at levels less than 20mg/l or less. Colloidal material is so small that it will never settle out naturally. Consequently this water required additional treatment before release or must be retained on site.

High turbidity due to colloidal material can make water appear very murky and degraded and is the most likely cause of the land owners concerns about poor water quality. High turbidity can affect the temperature and dissolved oxygen levels of water and limit photosynthesis, adversely impacting aquatic flora and fauna. Deadman's Creek only flows intermittently, with flows generally coinciding with flooding (and turbidity) in the Hunter River. The Creek is considered a low value aquatic environment and high turbidity in water flowing in Deadman's Creek is not considered an environmental risk. However, any water that is released into Deadman's Creek from sediment dams at times other than flood overflows (refer Section 2) should be of low turbidity as it may reach the Hunter River, which holds a much higher value as an aquatic environment.

ANZEC 2000 sets a trigger level of 5 mg/l of dissolved aluminium for stock water. Aluminium levels from water quality monitoring in the Deadman's Creek catchment, and at West Pit normally range between 1 and 5 mg/l, acceptable for stock water. Nevertheless, the aluminium level is higher than normal for most inland waters and warrants further investigation to understand the cause. Notwithstanding the above, the trend of elevated aluminium levels is apparent in the monitoring results from before mining activity commenced in Deadman's Creek catchment.

The monitoring results for aluminium from SD2, SD17 and SD20 were well above ANZECC trigger levels for stock water on 27th April 2015, and SD3 was just over. The issue here is that sustained consumption of water with elevated aluminium levels by stock may lead to nutrient deficiencies. A side issue is that the sediment dams were not re-tested in response to the high aluminium levels, which may indicate an omission in the site TARP. At this stage, scheduled testing will occur in April 2016. Responses to exceedances of trigger levels for aluminium and other heavy metals in water quality results should form part of the TARP plan for the site.

The elevated levels of aluminium detected by monitoring are not due to dissolved aluminium. *"In nature, aluminium exists in the trivalent oxidation state, i.e. Al3+. Its electric charge and the small ionic radius (0.51Å) give Al3+ a strong polarising effect*

on adjacent atoms; therefore the element is too reactive to be found free in nature. As a strongly hydrolysing element, Al is practically insoluble in the pH range of 6.5 to 8.5; the solubility is enhanced under acidic pH (pH < 6) or alkaline pH (pH > 8.5) conditions, and/or in the presence of complexing ligands."[1] The highest levels of aluminium were detected in water between pH 6.8 and 7.4.

Aluminium is highly toxic to plants, and the ongoing health of the vegetation also supports the aluminium detected in the monitoring results is not freely available.

The most likely cause of the measured elevated aluminium levels is that aluminium is adsorbed to colloidal (clay) particles that have passed through the standard filter used in preparation for the total dissolved solids test (TDS). The ratio of TDS to electrical conductivity result regularly departs markedly from the "accepted norm" for the Hunter Valley (about 0.65), indicating that clay particles may be contributing to the mass of the evaporated sample. TDS:EC ratios exceed 1 in 60% of the sample results, and for several of the results the ratio is greater than 6.

4 Clay Toxicology

The clays in Deadman's Creek catchment would be expected to be a mixture of clay minerals, but predominantly kaolinite. Cracking clays, formed predominantly from smectite (bentonite) may also be found in this area of the Hunter Valley[2].

Kaolinite and other clays (e.g. bentonite) have been tested and demonstrate "a low toxicity to aquatic species"[3], and, "There is no reason to believe kaolin and other clays pose significant toxicological dangers to the environment". The United States Food and Drug Administration classifies kaolinite and bentonite as "generally recognised as safe". Bentonite is used in preparation of foods, e.g. clarification of cooking oils. One peer reviewed paper found that, orally taken, kaolin is "practically non-toxic"[4]. The focus of research on adverse health effects appears to be mostly on inhalation by "persons reasonably likely to be exposed in the industrial manufacturing, processing, and use of kaolin"[5].

There is less literature available specifically dealing with the health effects in cattle from ingesting kaolin; however bentonite is widely used as a stock feed supplement; and kaolin mixtures are used to treat diarrhoea in stock (and humans e.g. Kaomagna). Literature was sighted describing beneficial effects of kaolin fed to pigs and chickens as a food supplement.

Clay particles "can adsorb a variety of toxic substances, bacteria, and viruses from solution or suspension and bind them more or less strongly. In the adsorbed state on the clay surface, the pollutant is probably not toxic, but the possibility exists that the

[1] "Aluminium in drinking water: An overview." Water SA Vol. 25 No. 1 January 1999; P T Srinivasan, T Viraraghavan and K S Subramanian.
[2] General Report on the Lands of the Hunter Valley; Land Research Series No.8, CSIRO 1963
[3] Environmental Health Criteria 231; Bentonite, Kaolin, and Selected Clay Minerals; World Health Organisation 2005.
[4] Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-95, Gosselin et al.
[5] http://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+630; TOXNET; Toxicology Data Network; US National Library of Medicine;

pollutant might be released from the clay in the environment of the alimentary tract and thus exert toxic effects. Whether or not such a process might take place would depend on the complex in question, so that no generalities are possible. Information is completely lacking in this area…..[6]". There have been no reports made to Rixs Creek Coal of ill health or loss of condition in the livestock by either of the concerned landholders that have been attributed to clay toxicity.

On balance, ingestion of suspended clays by cattle from mine sediment dam overflows poses little or no risk to the livestock. The water quality results collected by Rixs Creek Mine indicates generally acceptable levels of heavy metals and other toxicants with respect to trigger levels for stock in ANZECC 2000, with the exception of site wide elevated aluminium in results from April 2015. The effect of aluminium appears to be to reduce the ability of livestock to absorb phosphorous i.e. phosphorous deficiency, but this impact is less certain in ruminants. "Where aluminium concentrations in water exceed 5 mg/L, stock intake of phosphorus in the diet should be investigated. Animals, particularly ruminants, may tolerate much higher levels of aluminium as long as there is sufficient phosphorus in the diet to compensate for the effects of aluminium.[7] Aluminium levels in water quality results regularly exceeded 1 mg/l in runoff in Deadman's Creek before mining, and comparable water quality conditions exist on adjacent farm lands.

5 Sediment Dam Construction Schedule

Sediment dams can be constructed to treat runoff from the immediate catchment that is affected, or to manage the whole of the catchment, including clean and previously rehabilitated areas. From the aerial photograph provided, Rixs Creek Mine appears to have initially adopted the former approach. One reason for adopting this approach is that the required dams are generally smaller and (considered) less expensive to install, however the management approach may become more complicated once additional dams need to be constructed on rehabilitated overburden emplacements.

The Rixs Creek Extension of Mining EIS, in the absence of detailed year by year mine plans, adopted the whole of catchment approach, which leads to larger dams built only once. Based on the EIS mine plans, the required sizes and timing for sediment dams 6&7, 16 and 17 is set out in the Tables below. Sediment Dam 20 was not considered in these Tables as it is a relatively small dam at 4 ML when compared with the included dams. If Rixs Creek chooses to continue building dams for the treatment of the immediate disturbed catchment, then the **Table 1**, **Table 2** and **Table 3** values are moot.

[6] Drinking Water and Health: Volume 1; National Research Council (US) Safe Drinking Water Committee. Washington (DC) 1977.
[7] ANZECC 2000 Volume 3; page 9.3–13.

Table 1: Sediment Dams 6 & 7

Year	2017	2020	2023	2026
Catchment	**Area (ha)**	**Area (ha)**	**Area (ha)**	**Area (ha)**
Clean Catchment	1.3	1.3	1.3	1.3
Mature Rehabilitation:	0	29.03	49.05	64.05
Disturbed Catchment	15.01	14.1	15	0
Total Area	**16.31**	**44.43**	**65.35**	**65.35**
Required Volume (ML):	**3.5**	**13**	**16**	**0**

Table 2: Sediment Dam 16

Year	2017	2020	2023	2026
Catchment Type	**Area (ha)**	**Area (ha)**	**Area (ha)**	**Area (ha)**
Clean Catchment	51.51	51.51	12.23	12.23
Mature Rehabilitation:	0	0	21.27	35.67
Disturbed Catchment	0	13.45	14.4	15.46
Total Area	**51.51**	**64.96**	**47.9**	**63.36**
Required Volume (ML):	**0**	**12**	**11**	**15**

Table 3: Sediment Dam 17

Year	2017	2020	2023	2026
Catchment Type	**Area (ha)**	**Area (ha)**	**Area (ha)**	**Area (ha)**
Clean Catchment	33.3	33.3	1.5	1.5
Mature Rehabilitation:	0	27.1	18.4	43.2
Disturbed Catchment	27.1	0	0	24.5
Total Area		**60.4**	**19.9**	**69.2**
Required Volume (ML):	**16.3**	**0**	**8**	**17**

6 Conclusion and Recommendations

In response to the landowners concerns:

- The sediment dams on site should be (and are) designed in accordance with the requirements of the Blue Book. The currently installed dams appear to be responding to flooding/rainfall in a manner consistent with Blue Book designs.
- Sediment dams designed and operated in accordance with the Blue Book should pose little risk to the aquatic and environmental values of the Hunter River.
- A timetable of required sediment capacity for “whole of catchment” dams has been provided. It is also possible for smaller dams to be installed to manage only the recently disturbed areas and comply with the Blue Book guidelines. The final dam size and locations be different to **Table 1**, **Table 2** and **Table 3** above but still meet the requirements of the Blue Book.

- On balance, ingestion of suspended clays in water by cattle poses little or no health risk to the animals. Comparable conditions exist on adjacent farm lands. The main clay minerals appear to be non-toxic to humans, and, mainly by extension, animals. Clay adsorption pathways for toxicants and biological contamination are less well understood but this risk is still believed to be low.
- Aluminium levels in runoff water at West Pit and in Deadman's Creek catchment are elevated but generally remain below ANZECC 2000 trigger levels for stock water use. Elevated aluminium levels in drinking water can affect phosphorous uptake by some livestock. The source of aluminium at West Pit and Deadman's Creek catchment should be investigated and understood by Rixs Creek Mine.

Yours Sincerely,

John Pola
Managing Director