Before a Hearings Panel Appointed by the Selwyn District Council and Canterbury Regional Council

Under	the Resource Management Act 1991 (**Act**)
And	
In the Matter	an application under section 88 of the Act by Bathurst Coal Limited in relation to the completion of mining and closure and rehabilitation of the Canterbury Coal Mine in the Malvern Hills, Canterbury

Summary Statement of **Christopher Wayne Hickey (Ecotoxicology)** for Bathurst Coal Limited

Dated: 26 October 2021

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INTRODUCTION

1. My full name is Christopher Wayne Hickey.

2. I have the qualifications and experience set out at paragraphs 1 - 9 of my statement of evidence dated 1 October 2021.

3. I reconfirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014.

4. In this statement, I provide a summary of the key points in my evidence and respond to the evidence provided for the Council which I have read.

KEY POINTS

5. In my evidence I provide an ecotoxicological risk assessment for the potential effects of exceeding the currently consented compliance guidelines for boron, iron and manganese present in the CC02-underdrain water.

Monitoring data for risk assessment

6. Historical monitoring of chemical parameters at site CC02-tele has shown a progressive decline in concentrations for some parameters (e.g., boron) and a marked decline for many metals (e.g., dissolved zinc and dissolved manganese (**Appendix 2** of my 1 October 2021 evidence).

7. Recent monitoring for CC02-tele has shown that the discharge has been largely compliant with the boron consent limit of 1.5 mg/L – or not discharging at the time of sampling (**Appendix 3** of my 1 October 2021 evidence).

8. Concentrations of boron at the downstream CC03 site are generally substantially lower that that at CC02 on paired sampling occasions. I consider that the receiving water consistent reductions in boron concentrations in this reach are either associated with uptake by wetland plants – submerged or emergent – or dilution by seeps with low boron concentrations.

9. My understanding is that characteristic water quality for the CC02-underdrain discharge provides the basis for predictions of future discharge

concentrations and loads and for this risk assessment. The CC02-underdrain has a markedly lower flow than the current CC02-tele (medians 0.20 L/s and 70 L/s respectively, **Appendix 4** of my 1 October 2021 evidence). Thus, the flow volume to Tara Stream will markedly reduce in future.

10. I have reproduced the summary monitoring plots for recent CC02-underflow data for flow, boron, dissolved zinc and dissolved manganese concentrations; and provide summary statistics for the CC02-underdrain and CC02-tele sites for data since January 2019 in **Appendix 4** of my 1 October 2021 evidence.

11. Both the boron and dissolved manganese concentrations show an increasing trend as the flow rate decreases in the CC02-underdrain, while the mass load discharges progressively decreases as a result of decreasing flow. The median boron concentration for the monitoring since 2019 was 2.4 mg/L and the maximum 4.3 mg/L and flow of 0.05 L/s on 15th April 2021.

12. I consider that the proposed mussel shell reactor (**MSR**) will provide effective treatment for iron and zinc removal, with a lower removal efficiency for manganese, based on the monitoring trial MSR. The MSR will not remove boron and additional dilution will be required as set out in the evidence of Dr Paul Weber. This dilution water will be used to achieve compliance with the boron trigger level of 1.5 mg/L at the CC02-tele discharge site.

13. Dr Paul Weber has developed a range of scenarios for managing future discharges from the mine site. He has identified that, based on long-term rainfall patterns and a high flow rate through the MSR, there may be periods when no dilution water would be available from the NO2 pond. The likely boron concentrations (potentially 3.7 mg/L) for such an undiluted discharge provided the basis for my ecotoxicological risk assessment. However, I note that the assessed periods of no dilution are predicted be rare with an estimated 21 occurrences over a 32-year modelled period.

Toxicological risk assessment

14. The Australian and New Zealand Guidelines (**ANZG**) for toxicants in water are derived for chronic (i.e., long-term) exposure to elevated chemical concentrations. Note that the previous Australian and New Zealand Environment and Conservation Council (**ANZECC**) guidelines were

published in 2000 and many have not yet been updated for some contaminants (e.g., zinc, manganese).

15. The ANZG guideline values (**GVs**) for boron in freshwater have recently been updated. The species sensitivity distribution (**SSD**) data for the 22 species with chronic data for the boron derivation are shown in **Appendix 6**.

16. Additional data are shown on the SSD for chronic sensitivity data for juvenile Canterbury mudfish and a filamentous alga from streams adjacent to the CCM site. The juvenile Canterbury mudfish have a chronic sensitivity of 10.2 mg/L – i.e., the 71st percentile of SSD values – based on a 40-day toxicity test, measuring toxicity endpoints of survival, growth (length and weight) and condition. The filamentous algae sensitivity was 1.7 mg/L based on a 7-day growth test.

17. Compared with the consented standard for boron at site CC02-tele of 1.5 mg/L, there is a 6.8x safety factor for the Canterbury mudfish and a 1.1x safety factor for protection of those species from long-term effects from boron exposure.

18. Increasing the boron discharge concentrations to 3.7 mg/L for chronic duration periods has the potential to result in chronic effects on multiple species, reducing the safety factor for Canterbury mudfish to 2.8x. This threshold is shown on the SSD and equates to the 30th percentile of the distribution (**Appendix 6**).

TARPs

19. I have contributed to the revision of the draft Acid Mine Drainage (**AMD**) Trigger Action Response Plans (TARP) in collaboration with Mr Eden Sinclair and Dr Weber.

20. The AMD TARP incorporates action triggers for management of key water quality contaminants of potential concern discharging from the site. It also includes sites and monitoring parameters for continuous and discrete monitoring during the Active Closure and Post Closure management phases.

21. This TARP was briefly discussed during our Water Quality Conferencing on 19th October. It was agreed that the AMD TARP provided a useful basis for the adaptive management of discharges from the site.

22. The caucusing also recommended a TARP for managing the NO2 Pit Pond and assessing the level of potential stratification and deoxygenation once the reservoir is filled. The various TARPs proposed for the site are discussed by Dr Weber in his evidence.

RESPONSES TO SECTION 42A REPORTS

23. I raised several specific issues in relation to the s42A report in paragraph 60 of my evidence.

24. I consider that a number of these issues will be specifically addressed, and agreed with ECan, with the finalising of the AMD TARP document.

25. These include: (i) undertaking the Boron Options Review study as part of the Active Closure phase. I envisage that this study would include monitoring associated with the Tara Stream wetland and a review of the boron treatment publications, some of which I have cited in my evidence; (ii) inclusion of compliance and performance monitoring information and decision-making criteria in the AMD TARP; and (iii) oxygenation considerations for the NO2 pond and Tara Pond/MSR discharge.

26. Most of the above issues were discussed in the WQ caucusing and will be resolved when that document is finalised.

Conclusion

27. The conclusions I have drawn from my analysis of potential ecotoxicological effects are:

    (a) I expect that the proposed treatment and dilution will appropriately manage boron concentrations almost all of the time.

    (b) based on my assessment, using the site monitoring data and a water-balance model for the storage ponds and treatment system (developed by Dr Weber), there may be very infrequent prolonged dry years where water is not available to meet chronic water quality guidelines for boron. This can be monitored and responded to by adaptive management techniques developed in the Active Closure phase, when additional (potable) dilution water is available, and applied in the future Passive Closure phase with dilution water from the NO2 pond if this proves suitable.

(c) that efficient treatment at both high and low water flows will be required to manage iron and manganese concentrations and discharge loads to Tara Stream from the underdrain. But recent monitoring suggests concentrations are currently stabilising and mass-load reducing from historic levels. This is both to provide compliance with water quality guidelines but also to minimise accumulation and regeneration of dissolved iron and manganese which may precipitate at downstream sites.

(d) that the wetland on Tara Stream downstream of the CC02 discharge will likely provide efficient removal of boron by plant uptake, reducing exposure to downstream aquatic species. The water quality changes during passage through the wetland should be incorporated as a component of the receiving water monitoring programme covered by the AMD TARP.

28. Overall, I consider that a robust adaptive management process will be employed to manage the treatment system and future discharges. I understand that the various TARPs related to this process are to be incorporated in conditions of consent to incorporate decision-making criteria and agreed triggers for management actions, compliance monitoring, together with appropriate statistical assessment procedures.

Christopher Hickey

26 October 2021