The Partitioning of Trace Metals in the Sediments of Lake Moondarra

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Statement of sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from published or unpublished work of others has been acknowledged in the text and a list of references provided.

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Abstract

This study examines the spatial distribution and phase associations of trace metals within Lake Moondarra sediments for the period from 1998 - 2000. Factors effecting phase partitioning in the sediments are evaluated, with particular reference to elements As, Cd, Cu, Pb and Zn. The other aims of this study were to identify the sources of the trace metals within the sediments of Lake Moondarra and determine the stability of these sediments with respect to oxidation events.

Because no standard method is used by all researchers for determining the partitioning of trace metals within the sediments, the first part of this study was devoted to validating methods. Method testing showed that for sediments collected in Lake Moondarra sequential extractions of anoxic sediments can be done in air with minimal impact on the partitioning of the trace metals with the sediment, providing the sample is stored frozen and thawed in a nitrogen atmosphere.

The flooded Leichhardt River bed contains elevated levels of Pb, Cu, Zn, As, and Cd compared to the rest of Lake Moondarra. A non linear optimisation technique applied to the sediment data indicated that the most likely source of the trace metals is atmospheric fallout and Pb/Zn tailings left in the Leichardt River by now discontinued waste disposal practices. The fallout and tailings constituted typically less than 5% of the sediment mass. There is little change in the relative contributions of these with sediment depth. This suggests that none of the remediation work done by MIM to remove Pb/ Zn tails from the Leichhardt River bed has had an effect on sediment quality to date as there is no major change in trace metal concentration with sediment

depth. Application of the ANZECC (2000) sediment quality guidelines indicated that toxicity testing should be done on the sediments of Lake Moondarra, particularly the flooded Leichhardt River bed.

The sequential extraction results indicate that most trace metals in the sediments of Lake Moondarra are not present as sulfides. The partitioning data show that the trace metals have undergone significant transformation either prior to entering Lake Moondarra or in situ in the benthic sediments. The prevailing belief that the trace metals in the sediments of Lake Moondarra are present as stable sulfides with low solubility products and hence have limited impact on the environment is flawed. The trace metals in the sediment are dynamic with trace metals being released to the water column under anoxic conditions and re-sorption of trace metals under oxic conditions.

Laboratory testwork on the sediments of Lake Moondarra indicates that iron redox chemistry and associated adsorption and desorption of trace metals in the suspended sediment layer is the dominant mechanism in controlling the release or removal of trace metals from the water column. Laboratory testwork also indicates that anaerobic decomposition of organic material may play a significant role in phase transformations within the sediments of Lake Moondarra.