Repurposing mine tailings (evaluating extraction methods and their impact on tailings storage facility stability)

K Weerasekara[1], *C Vuillier*[2] *and A Dyson*[3]

1. Honours Student in Civil Engineering, University of Tasmania, Hobart TAS 7005, Australia. Email: kaveedewmi.weerasekara@gmail.com , kdw2@utas.edu.au

2.(Industrial Supervisor)Technical Director Tailings and Repurposing, GHD, Melbourne VIC 3000, Australia. Email: charles.vuillier@ghd.com

3. (Academic Supervisor) Ashly Dyson, University of Tasmania, Hobart TAS 7005, Australia. Email: ashley.dyson@utas.edu.au

Keywords: tailings, reprocessing, critical minerals, geotechnical stability, circular economy

ABSTRACT

The global mining industry generates an estimated 100 billion tonnes of mineral waste annually, with mine tailings representing one of the largest and most persistent waste streams. As high-grade primary ore reserves deplete and demand for critical minerals accelerates, tailings are increasingly viewed not as a permanent liability but as a secondary resource containing recoverable metals, rare earth elements and silicate fractions suitable for construction reuse. The reprocessing of tailings, however, introduces a critical tension, extraction methods such as bioleaching, acid leaching and hydrometallurgical processing alter the mineralogical composition, particle size distribution and porewater chemistry of the residual tailings mass, with direct implications for the geotechnical stability of the tailings storage facility (TSF) in which the residue remains stored.

This research evaluates sustainable tailings repurposing pathways and investigates how the selective removal of mineral fractions affects the long-term geotechnical stability of TSFs. Bioleaching and acid leaching are reviewed as metal recovery methods for sulfide-bearing tailings, alongside hydrometallurgical extraction of rare earth elements from iron ore tailings. The repurposing of silicate-rich residues as manufactured sand, geopolymer binders and bricks is also evaluated against relevant Australian construction standards. Geotechnical stability is assessed through numerical limit analysis and limit equilibrium modelling, examining changes in cohesion, internal friction angle and factor of safety under baseline and post-extraction conditions.

The methodology treats the characterisation and processing of tailings as analogous to the development of a new orebody, the existing waste stream is explored to identify recoverable value and hazardous constituents, processing pathways are selected to align with downstream end-user specifications, and the resulting changes to the residual tailings mass are evaluated for their effect on dam safety. This integrated approach allows the economic and environmental benefits of reprocessing to be weighed directly against the geotechnical risk introduced by extraction.

The research identifies practical limits on extraction before a TSF approaches instability and proposes a framework for selecting reprocessing pathways that balance resource recovery against dam safety. The findings are intended to support the mining industry's transition toward circular economy principles, providing practical guidance for operators considering tailings reprocessing as a means of reducing both environmental liability and long-term storage risk.

REFERENCES

Vuillier, C, 2025a. A practical approach to tailings repurposing, in Proceedings Life of Mine | Mine Waste and Tailings Conference 2025, Brisbane (The Australasian Institute of Mining and Metallurgy: Melbourne).