PROJECT 3.3

CRC TiME
Transformations in Mining Economies

Mine site water: options for extracting value from open pits

Open pit mines that extend below the natural water table are dewatered to enable mining operations. Post mine closure, water needs to be managed. This project reviewed the impacts of dewatering on the regional groundwater system, the recovery of groundwater post-closure, and the formation and evolution of pit lakes.

KEY FINDINGS

- **After mine dewatering ceases, groundwater levels surrounding the mine pit will continue to decrease, before eventually increasing. Thus, ecosystems not affected by drawdown during the mine's operational life might still be affected after mine closure.**
- **Detailed information on the aquifer system surrounding the mine is required to predict water table drawdown after mine closure. This includes understanding geological structures that might act as barriers to groundwater flow and information for areas beyond the region directly impacted by water table drawdown during mining.**
- **For pits that are not backfilled, pit lakes will usually develop. Understanding pit lake evaporation rates, lake stratification cycles and how groundwater and surface water inflows to the pit change over time, is essential to accurately predict the final pit lake water level and the time taken for the water level to stabilise.**
- **Pit lake water quality is determined by the rate and chemistry of groundwater flowing into the pit, runoff from the pit walls and catchment, the time required for the pit to fill and the evaporation rate. There is a need to better understand these water and solute fluxes.**

THE CHALLENGE

Over the next 25 years, 50% of Australia's mines are expected to close. Post-mining landscapes will always be different to pre-mining landscapes. The challenge is to understand the impacts of mining activities, and how these impacts can be altered or ameliorated by management.

A (theoretical and empirically grounded) platform is required to enable assessments of major environmental, economic and social impacts of mine closures and potential transitions.

This project has laid the foundations for such a platform and will facilitate regional planning.

Water issues and water management in below water table open pit mines in particular present specific challenges when closing a mine and considering post mine risk and potential resource use.

We synthesised the current knowledge base through a literature review, identified best practice, challenges and knowledge gaps, outlined future research priorities, and built a strategic framework to inform future research.

THE OPPORTUNITY

Several innovative approaches exist for reducing the environmental footprint of mines and producing better environmental and economic post-closure outcomes.

Further investigation of these approaches could bring benefits:

- Engineering barriers to limit groundwater connections between mines and adjacent ecosystems
- Managing aquifer recharge during mine operations and/or diverting river water into pits post-closure to enhance water table recovery

- Modifying pit backfill, revegetation, and evaporation to achieve desired pit water levels
- Amending pit backfill materials to reduce oxygen levels and the development of acidic conditions in backfilled pits
- Using bioremediation to improve pit lake water quality.

None of these approaches will be suitable at all mine sites, and evaluation of their likely effectiveness in different environments is urgently required.

Potential uses of pit lakes post mine closure include energy generation, water reservoirs for municipal supply or irrigation, aquaculture, recreation and tourism, and wildlife conservation. Geotechnical stability of pit walls, pit lake water quality and the geographic environment will determine the most beneficial uses.

OUTCOMES

This project has benchmarked current state-of-knowledge on water issues and water management in below water table open pit mines. The key knowledge gaps identified will provide a baseline for future projects in this area that will help manage water quality and quantity after mines are closed. This not only supports closed mines to protect social and environmental values but also promotes mine closure business solutions that facilitate integrated water management through a profitable mine closure industry.

NEXT STEPS

The project recommended future directions for better understanding the water environment post mine closure, including:

1. Modelling to examine how groundwater and pit lakes interact post mine closure. This modelling should include predictions of rates of water level recovery, steady state pit lake water levels and time for stable pit lake water levels to develop, and how this is affected by pit geometry and aquifer parameters.
2. Developing best practice models to predict evaporation rates from pit lakes.
3. Studying how pit lake models can be linked with groundwater and surface water models, to enable accurate prediction of changes in pit lake water levels and chemistry over time. A guidance document detailing advantages and limitations of different numerical models that can be used during mine closure planning is also required.
4. Generic modelling to examine the potential for managed aquifer recharge, rapid filling of pits with water and low permeability grout walls to improve mine closure options. This modelling should also be applied to demonstration case studies that can be validated with field data.
5. Pit lake water balance and water quality modelling to assess potential beneficial uses of pit lakes in different environments. This should include assessment of the effectiveness of different geochemical interventions to improve pit lake water quality.

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PROJECT REPORTS/PUBLICATIONS

Cook, P.G., Black, S., Cote, C., Kahe, M.S., Linge, K., Oldham, C., Ordens, C., McIntyre, N., Simmons,C. & Wallis, I. (2021). Hydrological and geochemical processes and closure options for below water table open pit mines. CRC TiME Limited.

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ABOUT US

The Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) brings together over 70 leading mining and mining service companies, regional development organisations, State and Commonwealth governments, research partners, community and indigenous groups. Our unique coalition brings scale and coordinated investment into innovative research that addresses the complex challenges underpinning mine closure and relinquishment.

We acknowledge the traditional custodians across all the lands on which we live and work, and we pay our respects to Elders both past and present.

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