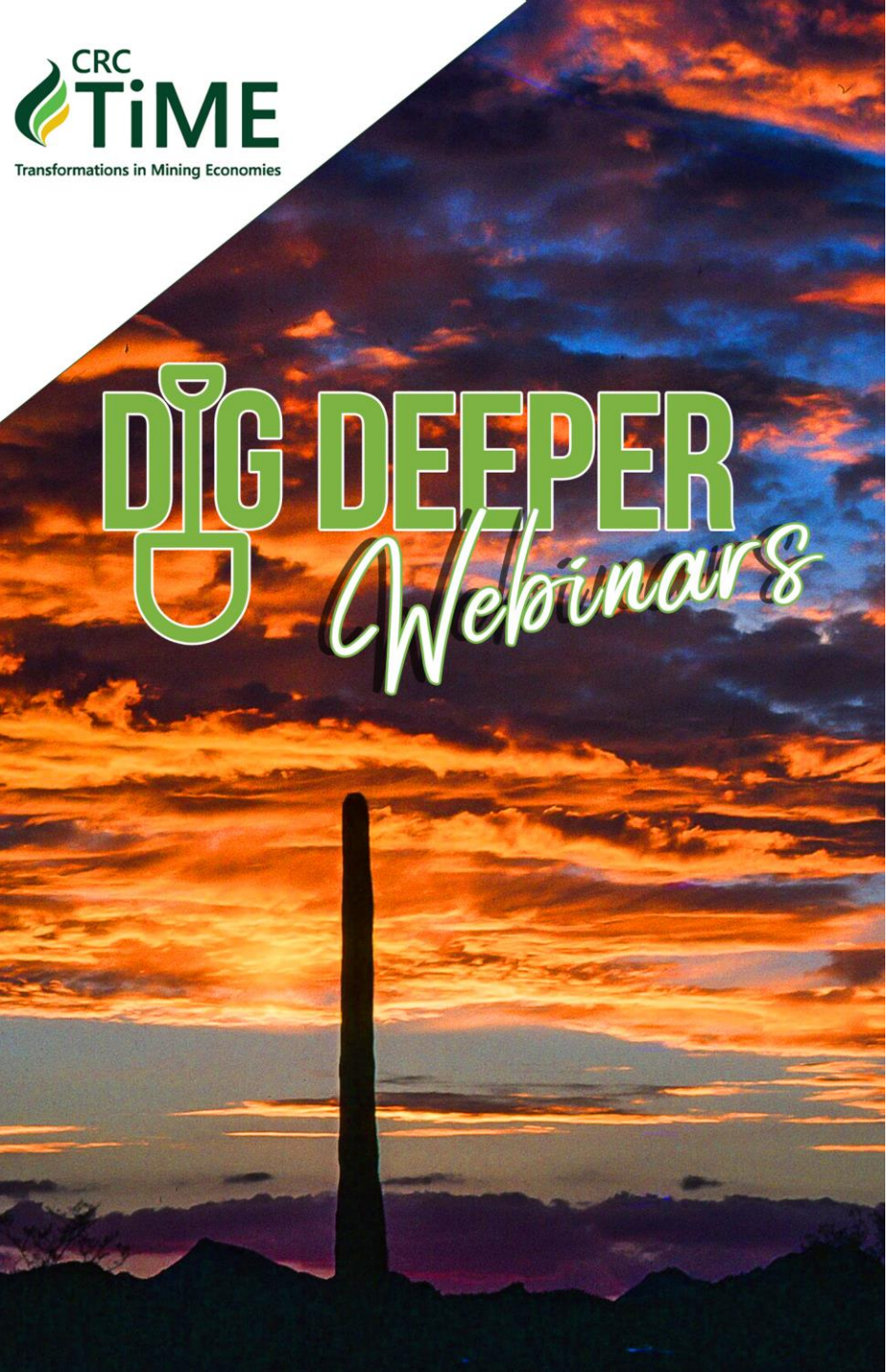


# MINE SITE WATER: OPTIONS FOR EXTRACTING VALUE FROM OPEN PITS

PROJECT 3.3 | KATHRYN LINGE | 13TH MAY 2022

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# The Team

## Project Team

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## Partners

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Gabor Bekesi (DEM, SA Govt)
Jasmine Gale (South32)
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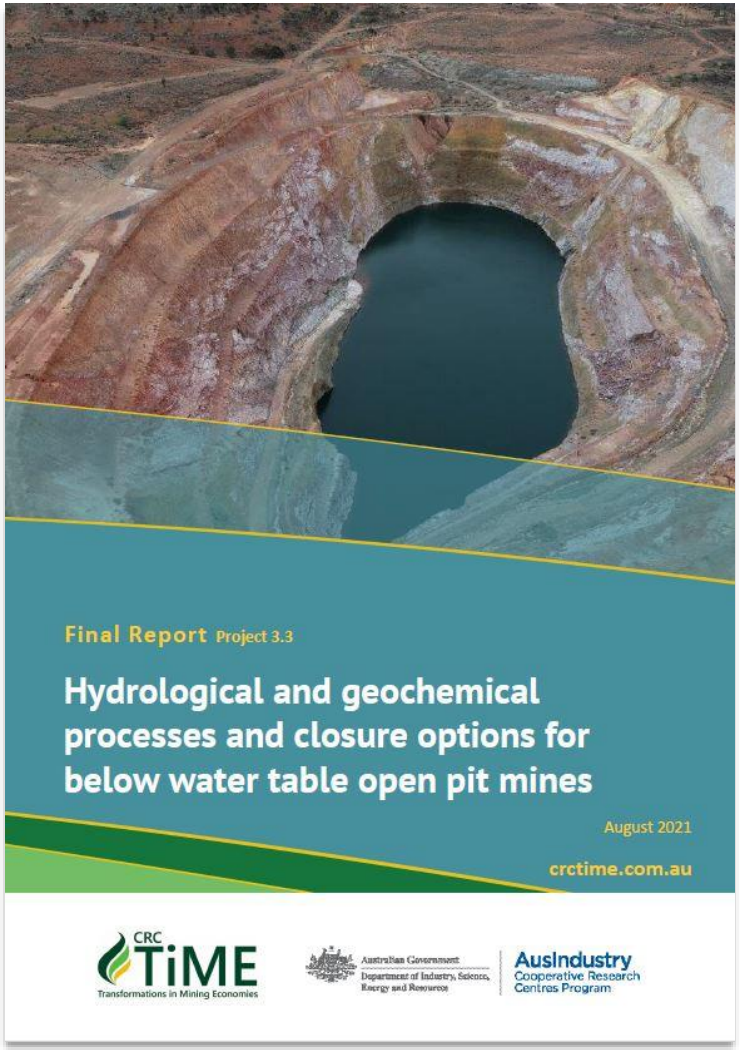
# The Problem: WHAT VALUE DO MINE PIT LAKES HAVE POST-MINING?

- Water management at closed mines can incur significant ongoing costs and/or environmental legacy issues - makes it very difficult, if not impossible, for proper mine closure and lease relinquishment.
- Are there opportunities for pit lake water to become a resource post-mining rather than constitute a liability?

# The Objective




- To develop a roadmap for mine closure that can satisfy environmental goals and deliver value from water in the post-mining environment.

- Review of issues related to water management in mine closure for open pit mines that extend below the natural water table.
  - Impact of mine dewatering on the groundwater system, and its evolution post mine-closure.
  - Potential impacts on groundwater-dependent ecosystems due to water table lowering.
  - Hydrology of open and backfilled pits post-mine closure and components of the pit water balance.
  - Water quality issues both for backfilled pits and for pit lakes that develop where mine pits are not backfilled to above the natural water table level.
  - Innovative and integrated strategies for minimising post-closure environmental impacts and the potential for delivering beneficial and economic use from pit lakes in the post-mining landscape.

Cook, P.G[a]., Black, S[b]., Cote, C[c]., Kahe, M.S[d]., Linge, K[e]., Oldham, C[f]., Ordens, C[g]., McIntyre, N[h]., Simmons,C[i]. & Wallis, I[j]. (2021). Hydrological and geochemical processes and closure options for below water table open pit mines. CRC TiME Limited.

# Pit Dewatering, Groundwater Drawdown and Recovery

- Pit dewatering depletes the groundwater surrounding the mine pit, with potential impacts on springs, river and groundwater-dependent ecosystems
- Drawdown cone continues to expand after pumping ceases
- Accurate prediction of water table drawdown after mine closure requires detailed information on the aquifer system beyond the region directly impacted by water table drawdown during mine operations.

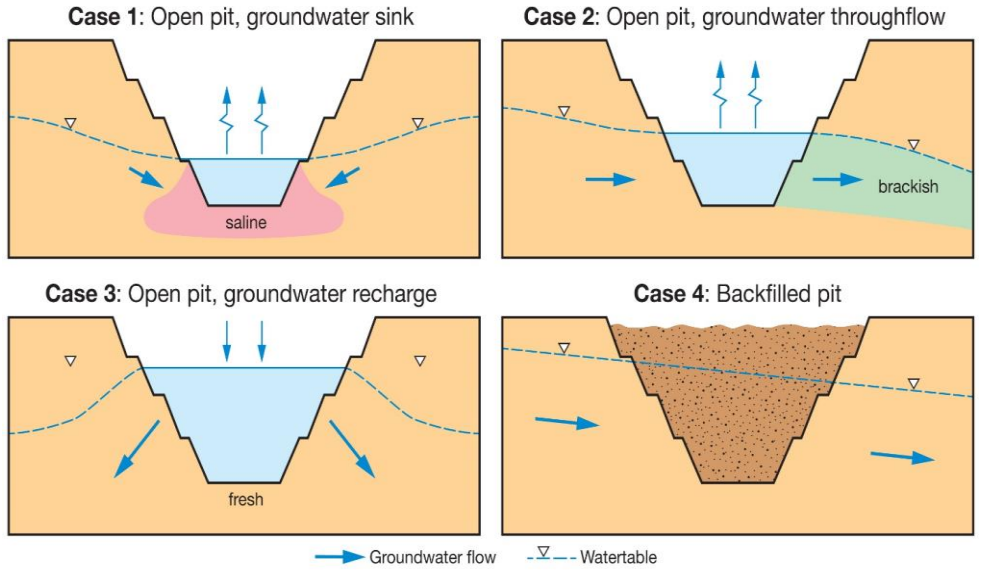
**Key Issues**

- If pits are backfilled, the water table will eventually recover
- If pits are not backfilled, and evaporation is greater than precipitation, then the water table will eventually stabilise but will NEVER recover
- Final pit water level largely determined by the evaporation rate
- Uncertainty of modelling evaporation rate

# Post-Closure Hydrology of Mine Pits

Accurate prediction of pit lake water level and time to stabilisation requires understanding of:

- Pit lake evaporation rates
- Lake stratification cycles
- Changes to groundwater and surface water inflows over time




**Key Issues**

- Pit lake models and numerical groundwater models are rarely linked
- The simplifying assumptions used for independent models (e.g. pit lake evaporation in groundwater models or groundwater inflow in pit lake models) have not been tested.
- How will climate change impacts interactions between pit lakes, regional groundwater and surface water?

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# Water Quality Considerations

- Beneficial reuse of pit lake water is governed by water quality
- Pit lake water quality will depend on complex interactions between: limnological processes, oxygen status of the lake, pH, hydrogeological flows, water quality of any inflows and wall rock composition
- Numerical modelling of lake processes is an experimental methodology for scenario simulation under different environmental conditions, to better understand the system under investigation

**Key Issues**

- Hydrochemical evolution of pit lakes may take centuries, and there has been little long-term monitoring of pit lake water quality.
- Contamination of mine sites, and of mine pit water, with persistent mining operation chemicals such as PFAS has not yet been comprehensively investigated.

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# Innovative Management Strategies

Reducing the environmental footprint on groundwater:

- engineered barriers to limit groundwater connections between mines and adjacent ecosystems,
- managed aquifer recharge during mine operations and/or diversions of river water into pits post-closure to enhance water table recovery,
- modification of pit backfill, revegetation, and evaporation to achieve desired pit water levels,

Improve water quality outcomes

- amendment of pit backfill materials to reduce oxygen levels and the development of acidic conditions in backfilled pits,
- the use of bioremediation to improve pit lake water quality.

**Key Issues**

- Few examples of publicly documented case studies


Shade balls on a small reservoir. https://energyvulture.com/2016/02/14/shade-balls-roll-their-way-into-the-spotlight/

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# Knowledge Gaps and Recommendations

| Hydrological Processes | Modelling | Exploring New Solutions | Monitoring and Data Sharing |
|---|---|---|---|
| • Analysis to understand how groundwater, surface water and pit lake water interacts post-mine closure<br><br>• Identify best practice models for predicting evaporation rate | • Explore the simplifying assumptions required to link groundwater and pit lake water models<br><br>• Develop a guidance document detailing advantages and limitations of different numerical models | • Explore potential management solutions (e.g. manage aquifer recharge, rapid filling) using generic modelling<br><br>• Assess the effectiveness of different geochemical interventions to improve pit lake water quality, particularly focussing on pH and salinity amelioration | • Explore whether monitoring data from nearby existing pit lakes can be used to evaluate model predictions for new mine pits.<br><br>• Document case studies of innovative closure options. |

# How can Industry use these Findings?

- **Miners**
  - identify innovative strategies for closure
  - better understand data collection and monitoring needs
  - better understand how hard it is predict final water levels and sources of uncertainty
  - direct financial and human resources to water management
- **METS**
  - better understand challenges of modelling water quality and quantity over the long term, data collection and monitoring needs
- **Indigenous**
  - begin conversations about opportunities for Indigenous METS to be involved in mine monitoring and maintenance post-closure
  - begin conversations of how traditional water knowledge can enhance water management strategies
- **Regional development**
  - begin conversations about new opportunities (e.g. energy, recreation, reuse) for water bodies post-mining
- **Government**
  - better understanding of groundwater recovery challenges at regional scale
  - understanding the challenges in providing definitive guidance on mine closure requirements,
- **Research**
  - identify areas for research focus
  - development of collaborative partnerships between and across CRC TiME research organisations


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# Next Steps

- A national research collaboration to identify best practise for pit lake management and beneficial post-mining uses
  1. Identify priority mine pit lake settings nationally and their risk and opportunity profiles
  2. Explore fit-for-purpose water quantity and quality modelling
  3. Developing the business case for reducing post-closure risks during mine operations
  4. Prioritising and evaluating post-mining management options
  5. Developing educational resources on relevant aspects of pit lakes, hydrogeochemistry and associated risks
  6. Integrate information and uncertainty assessments to develop best practice guidance

- Research Partners: ChemCentre, CSIRO, Flinders University, UWA, Curtin University, UQ
- Seeking feedback and collaboration from industry and regulatory partners.



Greg Davis, Groundwater Contamination & Remediation (CSIRO)


Peter Cook, Hydrogeology (Flinders University; NCGRT)


Carolyn Oldham, Environmental Engineering,/Cross-disciplinary integration (UWA)


Kathryn Linge, Water Quality & Management (ChemCentre WA)


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Mike Mouritz, Water Resources and Sustainable Development (Curtin Uni)

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# THANK YOU

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