Research brief – research scoping and stakeholder feedback
February 2022

Effective cover systems for waste rock dumps and tailings storage facilities

The role of mine waste cover systems in rehabilitation

Rehabilitating mine waste, whether held in tailings storage facilities (TSFs), waste rock dumps (WRDs) or heap leach piles (HLPs), remains a critical challenge for the mining industry globally. Effective management of mine wastes requires an understanding of how local climate affects the weathering and leaching of waste material, to potentially impact the surrounding environment. Cover systems are an integral part of controlling this interaction and therefore a key component of effective mine rehabilitation planning.

Best practice priorities for mine waste covers in Queensland

Preliminary research and stakeholder engagement highlighted the need for best practice advice regarding cover systems for mine wastes in Queensland with the potential to generate acid and/or metalliferous drainage (AMD). The majority of mines with this risk profile in Queensland are located in north and central Queensland, with the largest concentration of mines in the North West Minerals Province near Mount Isa. Advice relating to cover systems for coal and bauxite mining wastes is considered lower priority for rehabilitation guidance as the risks from these mine wastes relate primarily to geotechnical stability (for tailings) for which there are demonstrated examples of successful tailings covers to improve stability and support post-mining land uses (Williams and King, 2016). Research related to best practice for rehabilitation of coal mine WRDs which have the potential to generate saline runoff (Hilton et al., 2019) are considered medium priority given the scale of these systems and potential cumulative impacts on waterways from the concentration of coal mines in the Bowen Basin for example. At present cover design in these systems is relatively simple compared to covers for potentially acid forming mine wastes, and mostly focuses on erosional stability at the surface with little or no monitoring of drainage water quality required.

Despite a wealth of published information about cover system design and the prevention of AMD from mine waste (Australian Government, 2016a, 2016b; INAP, 2020), convincing examples that demonstrate cover performance and good rehabilitation outcomes from metal mines in Queensland are scarce. On the contrary there are numerous examples of AMD from covered and uncovered mine wastes in Queensland, many of which are now abandoned sites (e.g., Mt Morgan, Mt Oxide, Mt Chalmers, Herberton TSF, Croydon Federation Mine WRD). Among other things, the purpose of a cover over potentially acid-forming material is to prevent water and/or oxygen ingress and reaction with the underlying sulphide-rich material. The Global Acid Rock Drainage Guide (INAP, 2009) recommends store-and-release covers for semi-arid climates with high average evapotranspiration rates such as in Queensland. Store-and-release covers are designed to hold water in a layer of benign material during the wet season, preventing deep drainage and reaction with the underlying mine waste, and allowing for subsequent evapotranspiration during the dry season. However, store-and-release covers are often designed based on average evaporation to rainfall rates, resulting in much higher net percolation rates during the wet season than expected (Schneider et al., 2010; O'Kane and Ayres, 2012). This approach can underestimate design requirements and result in a high potential for seepage particularly in north and central Queensland where infrequent but high intensity rainfall events occur. Cover design may also include a compacted layer directly over the reactive waste material that maintains saturation and reduced oxygen permeability (low permeability layer), and/or a coarse layer to prevent capillary rise of salts from the underlying waste (capillary break layer). There is considerable debate among experts regarding the necessity and effectiveness of these additional layers in Queensland conditions. As construction costs increase with cover design complexity, it is important that covers perform as intended without being unduly complex.

A recent Land Court case [EPA032-20] demonstrated the sensitive nature of the details about cover design and performance, both for the regulator and for industry. During the case, a metal mining company in the North West Minerals Province disputed the Estimated Rehabilitation Costs (ERC) amount calculated by the Department of Environment and Science for capping of their WRD and TSF. The ERC calculator assumes a 0.6 m thick capillary break and a 0.5 m low permeability layer is necessary in covers over 'high risk' mine waste. The company proposed an alternative cover (no capillary break over the WRD and 0.3 m capillary break over the TSF) and after much debate, technical experts agreed that the alternative proposed cover should suffice. The outcome of the Land Court proceedings was that an alternative cover design and ERC reduction of approximately $46.5 million, was appropriate.

Stakeholder perspectives on research relating to mine waste cover systems in Queensland

Consistent with the recent Land Court decision [EPA032-20], multiple stakeholders have expressed the urgent need for clear guidance about mine waste covers that are appropriate for Queensland conditions and allow for site-specific flexibility in application. Recognising that there is no one-size-fits all approach to cover design in Queensland, stakeholders have indicated that climatic region and commodity-specific best practice advice would be invaluable to support the Progressive Rehabilitation and Closure (PRC) plan transition, inform ERC and residual risk calculations and improve environmental outcomes from mines with potential AMD risks. There was consensus among stakeholders that covers for tailings dams and covers for waste rock landforms needed to be considered separately. Current research supports this position and suggests that WRDs contribute to the majority of acid generation on sites (INAP, 2020) and are therefore a more urgent priority than TSFs. INAP (2020) has identified six distinctive management strategies for minimising acid generation from WRDs. Some of the approaches can also be applied at brownfield operating sites and will therefore have value in supporting PRC planning for existing mines in Queensland; others are appropriate only for new sites and need to be designed into mine operations. Stakeholders acknowledged that leading practice in mine waste management in the future will include approaches that may eliminate the need for covers entirely (e.g., dewatering to eliminate slurry tailings, co-disposal of tailings and waste rock and 'design for closure' WRDs), but which can only be implemented early in the life of mine. As such, stakeholders highlighted the importance of prioritising research and guidance relevant for already operating and/or legacy mines, to support PRC planning. A critical challenge for older sites is insufficient quantity of stockpiled non-acid forming material to be able to effectively implement best practice cover designs.

Both regulatory and industry stakeholders requested guidance around research trials that companies undertake when comparing various cover systems on site. Specific questions raised related to appropriate timeframes for cover performance demonstration, minimum modelling requirements and parameters, and how water balance influences geotechnical and geochemical stability of final landforms. Concerns were raised about performance demonstration of covers in general, with agricultural and regulatory stakeholders requesting guidance on how to demonstrate that post-mining land uses are able to be sustained on these structures. This relates directly to rehabilitation milestones and milestone criteria needed in PRC plans. Conversely, industry stakeholders raised concerns about unrealistic expectations that low angle slopes be achieved e.g., to support grazing outcomes, and suggested that effort should be directed into research on steep rock-armoured slopes and analogous steep natural landforms as acceptable rehabilitation outcomes. Regulatory and research stakeholders indicated that quality assurance and quality control (QA/QC) processes during cover construction are paramount. Anecdotal evidence tends to suggest that cover design differences are a less significant driver of rehabilitation outcomes than ensuring appropriate QA/QC of any design i.e., ensuring a similar level of rigour in the QA/QC process to that used in civil construction works.

A number of research and industry stakeholders recognise the potential economic value in tailings as a resource and were concerned that emphasis on cover systems and rehabilitation to post-mining land uses may sterilise future resources.

Research plan

The Office of the Queensland Mine Rehabilitation Commissioner is seeking to develop guidance that will support best practice management of mine waste in Queensland. Best practice advice will be underpinned by development of an objective categorisation framework for mine waste structures (WRDs, TSFs, HLPs) in Queensland, that reflects the risks of AMD and contaminant migration to sensitive receiving environments. From this platform, design objectives for mine waste cover systems will be outlined. Best practice cover design principles to meet design objectives will be exemplified, with an initial focus on mine wastes with a high risk of AMD and/or contaminant

migration. It is anticipated that through the research program there will also be opportunity to provide guidance on the risk-based situations that warrant cover design components that extend on the base method (MEND 2001) design for a store-and-release cover, i.e., reduced permeability layers, capillary break layers and thicker inert material layers, to support post-mining land uses and minimise the maintenance burden of these structures for post-mining landowners.

References

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