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A jurisdictional maturity model for risk management, accountability and continual improvement of abandoned mine remediation programs

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ABSTRACT

Abandoned mines can pose risks to the natural environment, humans and economies and prevent multiple or sequential uses of affected land. They range in size from individual shafts to large polluting open cut mines. Across Australia, there are over 50,000 abandoned mines on public and private land. A coordinated, effective management response is required to remediate these sites and reduce liabilities. We propose a novel maturity model for the evaluation of abandoned mine remediation programs and by applying it to Australian jurisdictions, demonstrate the potential for the model to be applied globally. The model incorporates 14 hierarchical evaluative criteria (including social, environmental and economic factors) which are each assessed against five performance indicators. These were derived from prior research and an Australian national policy for abandoned mines. We used the model to compare Australian jurisdictions to a leading practice benchmark jurisdiction, British Columbia, Canada, using web-accessible information and – in two cases – self-evaluation. The amount of publicly-available information varied widely between jurisdictions. Most Australian jurisdictions were ranked as less mature than the British Columbia program for most criteria. We then explain how the maturity model can be used to implement an existing regulatory framework specifically, the Australian Strategic Framework for Managing Abandoned Mines in the Minerals Industry, and discuss how the model can be applied to evaluate progress and prioritise improvements to abandoned mine management programs globally. A systematic approach to monitoring and evaluating abandoned mines programs is essential for improved accountability and to demonstrate change in liability over time. A systematic approach will also support shared learning and continual improvement within, and across, jurisdictions.

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Introduction

Abandoned mines are alternatively termed ‘derelict’, ‘orphan’, ‘former’ or ‘legacy’ mines. These terms mean slightly different things in different jurisdictions. For example, orphan mines are those where the owner of the mine is unknown and untraceable, in contrast to abandoned mines which are “...mines where mining leases or titles no longer exist, and responsibility for rehabilitation cannot be allocated to any individual, company or organization responsible for the original mining activities” (Ministerial Council on Mineral and Petroleum Resources and Minerals Council of Australia (MCMPR/MCA), 2010). As there is no individual, company or organization responsible for managing abandoned mines, this task falls to the government and private landholders. Regardless of terminology, an

attribute that all sites have in common is incomplete remediation. This can occur for a range of reasons including, but not limited to, premature cessation of operations, inadequate regulatory requirements, insufficient funds set aside for remediation, or inadequate community engagement to agree upon and meet closure expectations. While recognizing that different definitions are used for these sites, the term ‘abandoned’ will be used in this paper to represent all forms of mining legacies which by default have become the responsibility of governments and the community.

Abandoned mines (AMs) have accumulated in many countries globally over decades or centuries. Most originated in times when mining environmental standards and community expectations were much lower than at present. In Australia responsibility for abandoned mines can be unclear, however with a few exceptions in the Northern Territory (Department of Mines and Energy, Northern Territory (DME NT), 2013; Fawcett, 2012; Waggitt and Fawcett, 2008) state and territory governments have become responsible for abandoned mines on government owned land. Despite current freehold landholders not having mineral rights or

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Table 1Risks and opportunities commonly associated with abandoned mines (adapted from [Eden Project Post-Mining Alliance, 2008](#); [Unger et al., 2012](#)).

Key risk or opportunity	Common examples
Human health/Safety risk	Exposure of local communities to contaminants Open pits and shafts
Environmental risk	Failure of tailings containment facility or other impoundments Contaminated land and water Biodiversity loss
Socio-economic risk	Communities left without livelihoods
Economic risk	Liabilities to state and landholders Litigation risk to the State Rehabilitation cost
Reputational risk	Loss of mining company social license to operate Loss of confidence in governments' ability to regulate mining
Beneficial opportunities	Domestic waste disposal in voids Mining heritage and geo-tourism Secondary mining opportunities Alternative land uses

the ability to prevent access to those minerals by third parties approved by the State government, it was the opinion of departmental staff that freehold landholders are deemed responsible for abandoned mines on freehold land in Queensland ([Queensland Flood Commission of Inquiry, 2012](#)).

Abandoned mines pose a challenge to governments and societies striving towards the sustainable development concept of inter-generational equity. There is global recognition that “some impacts [from abandoned mine sites] can be long-term and that society is still paying the price for natural capital stocks that have been drawn down by past generations” according to the report by the International Institute for Environment and Development and World Business Council for Sustainable Development ([IIED/WBCSD, 2002](#)).

The scale of the issue is significant, both in terms of the number of sites and estimated remediation costs, and compounded by the complexity and potential range of impacts ([Table 1](#)). A recent report found over 161,000 abandoned hard rock mine sites in the US (Government Accountability Office ([GAO](#)), 2011). The United States Environmental Protection Agency Office of Inspector General determined that cleanup of 63 hardrock mining sites on the National Priorities List would cost up to \$7.8 billion ([Lovingood et al., 2004](#)). In Canada, a major review of contaminated lands, including abandoned mines, estimated liabilities for abandoned mine sites at over C\$555 million for sites under federal jurisdiction alone ([Office of the Auditor General of Canada, 2002](#)). Even in Australia with its shorter mining history, it is estimated that there are in excess of 50,000 abandoned mines ranging in size from individual shafts to large polluting mines ([Unger et al., 2012](#)). However, abandoned mines may also leave positive values such as voids suitable for domestic waste disposal, heritage features for tourism and secondary mining opportunities as well as new, alternative land uses ([Eden Project Post-Mining Alliance, 2008](#); [Unger et al., 2012](#)) ([Table 1](#)).

Recent rapid growth in the resources sector globally, and particularly in countries such as Mongolia and Australia ([Lechner et al., 2014](#); [Petkova et al., 2009](#)), has placed significant demands on regulatory personnel responsible for the approval of new mines and upstream petroleum industries, resulting in far less attention being applied to environmental management of abandoned mines. Factors contributing to this include competing priorities for human resources and funding within government and industry, the costs of managing legacy issues associated with abandoned mines, jurisdictional ambiguity over responsibilities and an absence of legislation to set the standard for their management ([Queensland Flood Commission of Inquiry, 2012](#)). Abandoned mine remediation planning at a jurisdiction level is challenging

because it requires a thorough understanding of abandoned mine causes, impacts and legal contexts to develop policies. Multi-disciplinary teams are then required to formulate technical solutions embedded in a sound framework for prioritization.

The aim of this paper is to propose a model of leading practice abandoned mine management that is integrated into an existing regulatory process. The model draws upon leading practices globally to aid in the implementation and improvement of abandoned mine programs. This model is based on a graded maturity model, whereby performance is assessed for a range of evaluative criteria such as the quality of an abandoned mine inventory and risk assessment tools. This method is consistent with the trend in many other sectors, which use scales or rubrics for evaluation purposes ([Davidson, 2005](#)). We then apply the maturity model to Australian jurisdictions, as a case study, assessing the progress of abandoned in management for seven states and territories. This assessment is based on a web search, using publicly available information and self-assessments conducted by two of the jurisdictions. We compare these results to the contaminated sites program in British Columbia, Canada ([BCCSCP, 2012](#)), which is considered a benchmark for leading practice globally ([Unger, 2009](#)). Using this case study, we demonstrate how a maturity model can assist jurisdictions by indicating how advanced their programs are along the maturity path. This information can allow jurisdictions to identify where they are positioned now and where they want to be in the future. Finally, we show how the maturity model could also be used as a basis for supporting existing regulatory processes through the development of an implementation plan for Australian jurisdictions and industry.

Method

Background to the maturity model

Monitoring is the regular collection and analysis of information to provide an indication of progress towards a desired end-point or objective. Evaluation is a process that seeks to determine the merit or worth of an object, program or policy as systematically and objectively as possible ([Owen, 2006](#)). Monitoring and evaluation are used within government and the private sector to: ensure accountability for resource expenditure; inform strategic decisions; and to improve future performance through learning from past experiences (e.g. [Department of Agriculture, 2009](#), [Caring for our Country, 2014](#)). Monitoring is also a vital component of risk management to ensure early detection of problems and to guide preventative actions ([Kusek and Rist, 2004](#)).

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