Mining for Closure

Sustainable Mine Practices, Rehabilitation and Integrated Mine Closure Planning

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Thesis Abstract

Australia has been burdened with a legacy of unplanned mine closures, hazardous mine sites and unreclaimed and rehabilitated lands. In the past mining companies used irresponsible mining methods with no regard for environmental protection and mine rehabilitation. Inadequate and inefficient mine closure policies, legislative controls, and past mining practices have resulted in a legacy of abandoned and derelict mine sites, which can have substantial impacts on environmental liabilities and mine rehabilitation costs in the absence of appropriate legislative frameworks and controls.

Until recently mine decommissioning and mine closure planning were not a requirement or regulated within the mining industry and the environmental, social and economic impacts were not identified or considered within the initial mine site development. Planned mine closure and completion is still at an early stage of development in Australia, with few examples of mine closure planning applied from conception to completion of mining operations.

The Australian mining industry and relevant government organisations have failed to develop comprehensive best practice standards and mining legislation respectively, which regulates and controls mine closure planning and completion. The current inefficiencies in mine closure planning and mining legislation illustrate the need for an integrated approach to mine closure and improved mining legislation and closure requirements. Legislation and mine closure requirements must incorporate the social, environmental and economic considerations within the overall mine site operations, closure and completion practices.

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Chapter One

Thesis Introduction

Introduction

Mining operations are finite economic activities, which are usually relatively short term. The long term environmental and social performance of a site is noticeable once mine closure and mine site operations have ceased, however the environmental, social and economic impacts are determined by the processes and procedures which occur during both the mining and mine closure phases. All mine operations will be required to close at some point, due to resource exhaustion or change in the economics of mining. Ineffective enforcement of mine reclamation policies and an absence of financial mechanisms and inadequate financial assurances can result have a significant impact on the success of mine site closure and completion (Peck, 2005).

Previous practices in mine planning, mine closure and rehabilitation have neglected the fundamental concepts of post mine land use development and integrated mine closure planning. Countries have been burdened with a legacy of unplanned closured, hazardous mine sites and unreclaimed lands, which have occurred as a result of inefficient mining legislation which has failed to prevent or minimise the possible long term environmental impacts of mining operations and mine closure. Mine closure planning is a practice that is neither complete nor formalised for a large majority of companies. (Remy et al, 2002)

In contrast to countries that have developed and implemented good international mining practices, and despite significant progress in mine closure planning, various mining nations are still to develop sufficiently sophisticated corporate governance, regulatory frameworks, or financial insurance provisions to address mine closure planning and mine rehabilitation. In particular, it is apparent that few mining nations have developed and implemented specific mine closure and mine rehabilitation regulations and legislative controls (Dalupan, 2001).

In the past, it was common practice to abandon mine sites, once mineral extraction was completed. The mining site was left poorly vegetated and

exposed, and waste minerals remained untreated. There was little concern for the environment and social impacts associated with mine closure, and a lack of recognition of post mine land uses. This legacy of abandoned mines, their associated environmental, social and economic problems and the post mine land use development has led to an increased emphasis on mine closure planning. Mine closure and mine rehabilitation should commence within the initial mine planning process, with mine closure planning developed within the initial stages of mine operations and developed in a progressive manner as the mine site commences operation (Sassoon et al, 2002).

Project Setting

Until recently mine site decommissioning and mine closure planning were not required or regulated, and environmental, social and economic impacts were not considered within initial phases of mine site development. Past mining operations which included insufficient and inadequate mine closure practices have resulted in a considerable legacy of derelict and inadequately closed mine sites (QMC, 2001).

The long term environmental, economic and social performance of a site is apparent after mine closure and completion has occurred. However successful mine closure is determined by the initial mine planning process, which recognises the need for improved stakeholder involvement and community consultation. Mine site closure planning should occur within the initial mine planning and feasibility assessment phase prior to the commencement of mine site operations (Limpitlaw, 2004).

If mine closure and completion are not completed in a planned and effective manner, a mine site may continue to be hazardous and a source of pollution and disturbance, after mine operations have ceased. The overall objective of mine closure and completion is to prevent or minimize long term environmental, physical, social and economic impacts, and to create a stable landform suitable

for some agreed subsequent land use (Department of Industry, Tourism and Resources 2006).

Existing mine closure policies and practices fail to recognise the importance of mine closure planning and planning for closure. An integrated approach to mine closure, which takes into account the environmental, social and economic considerations at an early stage of mine operations and occurs throughout the mine process, is elementary in the development of long term sustainable development and effective mine closure and completion practices. In the past, the mining industry and relevant government organisations failed to establish best practice closure standards and specific mine closure legislation which encompasses the objectives of sustainable mining practices.

Mine closure and mine rehabilitation refers to the period of time when the operational stage and economic viability of a mine has ceased or ended, and the final decommissioning, mine rehabilitation and mine closure has commenced. Mine closure in some instances may only be temporary, or may lead into a program of care and maintenance. Mine completion is the overall objective of mine closure and rehabilitation. Mine rehabilitation is the process used to repair the impacts of mining on the environment. The long term objectives of mine rehabilitation include the conversion of a mine site and disturbed mine land to an environmentally safe and sustainable landform, and the restoration of the pre-mining conditions as closely as possible to support future sustainability of the site.

Mine rehabilitation and mine closure requires a holistic view of mining operations, where each operational stage and component of the mine, forms part of mining for closure which considers the complete operational life cycle of a mine such as planning, mine closure and rehabilitation, post mine land use and final end use of the site. The mine closure plan needs to be efficient and responsive to the mine site operations. The post mining land use for the mine site should be defined in consultation with relevant interest groups including government departments,

local government authorities, non government organizations and private landholders.

Comprehensive mine closure for abandoned, presently operating, and proposed mines remains a challenge for all mining nations and mining companies. To accommodate the need to close abandoned mines and to ensure that existing and proposed mines are appropriately closed and rehabilitated will require the cooperation of a diverse stakeholder community, new innovative methods of financing closure and significant policy and legislative amendments to ensure post mining sustainable development and economic viable post mine land use. (Peck, 2005)

The thesis research endeavours to establish an understanding of the prevalent mine closure and rehabilitation practices. The thesis will identify best practice mine closure standards and principles and provide a comprehensive analysis of current legislative framework.

Theoretical Framework

Planned mine closure and completion is still at an early stage of development in Australia, with few examples of integrated mine closure planning applied from conception throughout all phases of mine operations. Integrated approaches to mine closure, which takes into account the environmental and social considerations at an early stage of mine operations and throughout the mine process is elementary in the development of long term environmental and social perspectives and sustainable development within the mining industry.

Integrated mine closure planning is a dynamic process which is fundamental to the development of sustainable mine closure and mine rehabilitation practices. Mine closure planning should recognise that mining is a sequential land use (Refer to Figure One), and so the closure of a mine site and rehabilitation provides an opportunity for post mine land use development. Planning for mine closure should aim to alleviate or mitigate environmental damage, achieve a

productive use of the land, or return the land to its original condition or an acceptable alternative and provide for sustainability or social and economic benefits resulting from mine development and operations.

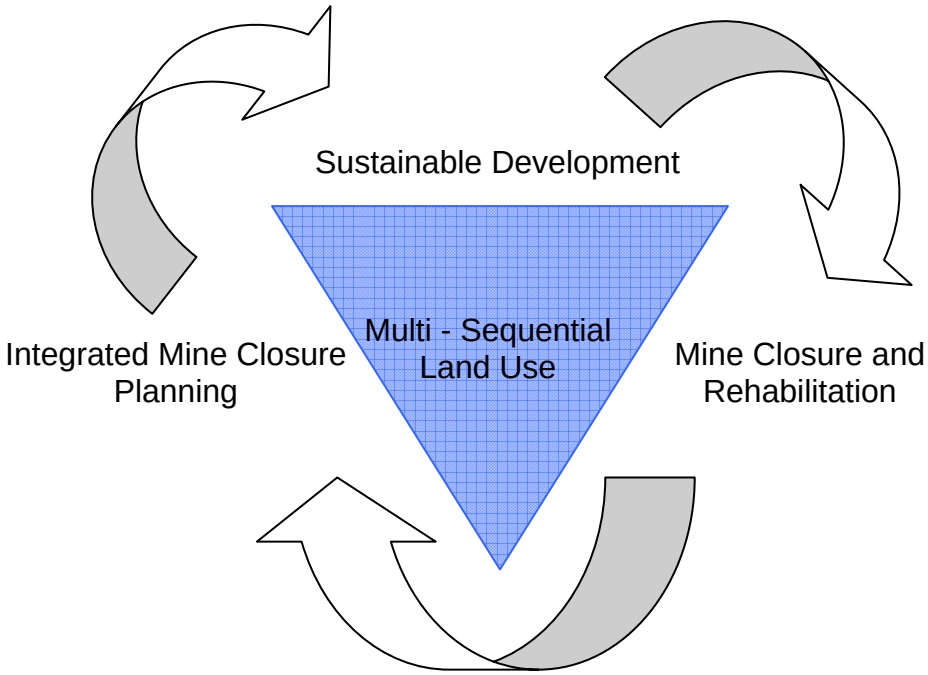

Figure One: Identifies the objectives of improved mine closure planning and completion

There is a need to develop guidelines and standards for mine closure planning, where possible best practice guidelines and mine closure procedures are enforceable and regulated by mining legislation. Current mine closure practices focus on the concept of avoiding future abandoned and derelict mines, which occurred as a result of previously poor mine planning and rehabilitation practices. The thesis is developed in response to existing mine practices which fail to ensure and recognise the need for an integrated approach to mine closure planning.

It has been established that the mining industry has the opportunity to develop sustainable mining practices and standards. The premises of the research is based on the assumption that mining for closure requires the recognition that

mining is a temporary use of the land, however the manner in which a mine is planned can have a significant influence on the magnitude and duration of impacts during mine operations and after mine closure (Carley, 2000).

The development of sustainable mining practices and integrated mine closure planning has recently become a prevalent planning issue, although planned mine closure and completion is still at an early stage of development in Australia. While the importance of integrated closure planning is intuitively evident, ways to manage the associated economic, environmental and social impacts are relatively new with few case studies on successful integrated mine closure planning (MMSD, 2002).

The development of integrated mine closure planning requires the commitment from professionals within the mining industry. Sustainable mine practices and mine closure planning requires the support from both the mining industry and relevant State and Commonwealth agencies. The establishment of best practice mine closure standards ensures that future mining procedures occur in a sustainable manner.

Research Objectives

The thesis aims to identify best practice mine closure planning principles and establish principles for the planned, structured and systematic closure rehabilitation and completion of mines and post mine land use development in the context of sustainable development. The overall objectives of the thesis is to develop policies and guidelines that support sustainable mine closure and rehabilitation practices and the integration of mine closure planning within the initial stages of mine development and planning. The thesis aims to develop comprehensive mine closure planning guidelines and best practice mechanisms for mine rehabilitation and integrated mine closure planning.

There is a need to develop guidelines and standards for mine closure planning, where possible best practice guidelines and mine closure policies should be

developed to provide closure planning provisions. Current mine closure practices focus on the concept of avoiding future abandoned mines, developed as a result of previously poor mine planning and rehabilitation practices. The thesis is developed in response to existing mine practices which fail to ensure and recognise the need for integrated mine closure planning (Peck, 2005).

The purpose of the thesis research is to address the above mentioned research objectives by understanding the following tasks:

- Develop an understanding and assess current mine closure, rehabilitation and completion practices, provide an assessment of best practice mine closure principles;
- Critically assess mine closure legislation and current legislative framework and determine which controls and policies are most relevant to the improvement of sustainable mine closure practices;
- Determine best practice mine closure and rehabilitation standards and procedures, compare relevant case studies of mine closure and mine site abandonment; and
- Develop comprehensive policy and best practice recommendations and provide legislative and mine closure regulation amendments, aimed at the improvement of sustainable mine closure practices in Australia.

The thesis will identify and demonstrate best practice mine closure and rehabilitation standards and principles, and hence establish guidelines to ensure improved mine closure practices and the development of sustainable mining operations within Australia. The thesis will establish best practice mine closure standards and requirements and identify the requirements which are crucial to the development of improved mine closure practices and establishment of sustainable mining procedures in Australia. The thesis will develop comprehensive principles and policy recommendations aimed at the

development of integrated mine closure procedures and successful mine rehabilitation and completion.

Research Statement and Questions

The thesis aims to demonstrate the following research statement:

> Current levels governance and mining legislation are inefficient in the establishment of mine closure and mine site completion standards and requirements, thus the industry requires improved mining legislation which regulates, controls and defines mine closure and rehabilitation practices within the Australian mining industry.

The purpose of this research is to answer the following questions to address the above research objectives:

- In terms of mining procedures and mine closure practices, do mining corporations consider both the economic, social and environmental issues within mine planning phases?
- Do mining corporations include sufficient details and information pertaining to mine closure policies within the initial mine planning and feasibility phase?
- Is the concept of sustainable mining recognised within the mining industry or within current mining legislation?
- Are Integrated Mine Closure Planning practices and the need to plan for mine closure recognised and accepted by the Australian mining industry?
- Is the current level of stakeholder and community involvement in mine planning and mine closure sufficient in ensuring successful mine closure and site completion?
- Are current mining legislation and controls effective in ensuring mine closure planning and successful mine site completion and rehabilitation?

- Are the Australian mining industry and relevant government organisations actively seeking to address sustainable mining through the implementation of mine closure legalisation and mine site completion standards and requirements?

It is identified that development of themes and patterns in response to the research questions will provide an understanding of current mine closure planning procedures and techniques. The research questions will provide an indication of the successfulness of current regulation and mine closure mechanisms and awareness of sustainable mining objectives within the Australian mining industry. The thesis questions will assist in the development best practice mine closure standards and requirements and provide a comprehensive assessment of relevant mine closure legislation and control.

Research Methodology

The thesis incorporated qualitative in-depth interviews with four professionals from the Australian mining industry, government regulating organisations and academics with expertise and experience within the mining industry. The qualitative interviews required ethics approval and consent from the interviewee's to participant in the thesis research. The respondents provided an opportunity to establish themes and an improved understanding of current mine closure techniques and relevant mining legislation and control. Secondary research data, which included government documents, case study examples, and journals provided a comprehensive understanding of best practice mine closure and completion and established themes and concepts for sustainable mining practices and integrated mine closure planning within the Australian mining industry.

The thesis is subject to considerable time and budget limitations. The thesis project is constrained a 15 week period, during which research, field work analysis, drafting and revision processes are required to be completed. The field

research and data collection represents the most detailed phases of the thesis research. The data and field research have involved time in the field, travel to interviews, including the transcribing and coding of data. The coding of research data has assisted in the development of research themes and patterns to further develop the thesis research.

It was apparent that there would be difficulties in obtaining case study examples of mine closure planning and rehabilitation. Planned mine closure and completion is still at an early stage of development in Australia, with few examples of mine closure currently being applied from mine site inception and design throughout the entire operational period of the mine, to mine site closure. The time frame of mining operations and the relatively recent development of integrated mine closure planning provide a limitation in terms of relevant case studies. The thesis presented limitations with respect to interview participant's time constraints and reluctance to participate in the interview process. Interview respondents expressed concern in terms of mentioning specific mining operations and mining companies.

Thesis Structure

The thesis is structured around the objectives and principles of integrated mine closure, and focuses on mining for closure and integrated mine closure planning principles and practices. The thesis is divided into six chapters, which are structured in three sections, representing the themes and patterns of the thesis. The thesis addresses mine closure, rehabilitation, completion, sustainable development and mine closure planning and post mine land use development.

The thesis project and research process is divided into three distinct phases. Phase one details the initial data collection and research, providing an introduction and detailing background data and information, developing the theoretical context to the thesis and establishing themes and patterns within current research and literature. The introductory chapters develop the thesis

topic and establish research themes and parameters and provide analysis of past mining closure and rehabilitation practices, principles and standards. The assessment of existing legislative controls and current mining operations provides a detailed background which establishes the practical and regulatory context for the thesis.

Phase two identifies the analysis and interpretation of literature and collected data. The assessment of current mine closure and rehabilitation practices and an analysis of case studies provides a comprehensive understanding of current industry practices and standards. Chapter three and four establishes mine closure and rehabilitation best practices and guidelines. The thesis provides a comprehensive assessment of relevant case studies in mine closure, mining for closure practices, mine completion and mine rehabilitation. Phase two of the thesis evaluates the operational processes of mine operations, following the operational sequence of mining operations such as consultation, stakeholder engagement, planning, operations and mine completion.

Phase three of the thesis provides a conclusive assessment of existing mine closure practices. The final phase develops possible policy and legislative recommendations and establishes guidelines to ensure improved mine closure and rehabilitation. Mine Closure Planning and Rehabilitation practices should be developed in response to the lessons learnt from previously poorly completed mine sites, which were often left derelict and abandoned. Chapter five and the concluding chapter identifies policy amendments and best practice guidelines, aimed at improving the integration of mine closure planning, sustainable mine operations, post mine land use developments and mine rehabilitation practices. The thesis concludes with the development of best practice principles for mine rehabilitation and completion, mining controls and legislative controls and mine closure and post mine land use policies.

The thesis intends to establish provisions to improve the integration of mine closure, mine rehabilitation and post mine land use development within the overall mine operations plans.

Chapter Summaries

Chapter one (1) provides a concise introduction to mine closure planning and rehabilitation and provides the context for the thesis research and assessment of mine closure practices, policies and principles.

Chapter two (2) of the thesis describes the concepts of Integrated Mine Closure Planning, and Mining for Closure as the theoretical context of the study. The main theories behind planning for closure and an integrated mine closure approach are explained and examined in order to establish the origins of derelict, abandoned and orphaned mine sites and the relevance for examining mine closure regulations and legislation within the parameters of the thesis research.

Chapter three (3) examines the large body of research that has been conducted investigating mine closure planning, including mine closure regulations and legislative framework. The chapter examines mine closure legislation within Australia and assesses international best practice mine closure and rehabilitation practices and standards. The literature provides a detailed assessment and comparison of different state regulations in terms of mine closure and rehabilitation guidelines. In addition, previous studies are further consulted as a basis for developing the methodology adopted for the purposes of addressing the questions posed and the objectives set as a part of this thesis.

Chapter four (4) presents an analysis of relevant case studies, exploring current mine closure regulations, and a review of mine closure and rehabilitation practices in Australia. Chapter four summarises the findings of the case studies and interviews in order to understand and develop best practice mine closure planning principles with regard to sustainable mine practices, pertaining to closure, completion, rehabilitation and post mine land use development. The

chapter establishes an understanding of best practice mine closure standards and requirements and current mining legislation and controls.

Chapter five (5) presents the findings of the interview data and assessment of relevant case studies in order to develop comprehensive mine closure best practice guidelines and standards. This chapter summarises the findings of the thesis project and details legislation and mine closure principles in order to ensure future sustainable mine closure and rehabilitation practices in Australia.

Chapter six (6) provides a comprehensive mine closure policy, best practice recommendations and guidelines for the future improvement of mine closure, completion and rehabilitation. The relevant policy recommendations and mine closure guidelines are fundamentally aimed at ensuring the development of sustainable mine closure practices and improved mine rehabilitation.

Summary

The thesis seeks to provide a comprehensive assessment of current mine closure practices, policies and legislative framework. The thesis aims to establish best practice principles in mine closure planning, rehabilitation and post mine land use development, and provide detailed policy and legislative recommendations to ensure the development of long term sustainable mine practices.

Chapter Two

Sustainability and Integrated Mine Closure

Introduction

In this chapter the fundamental concepts of the thesis research are examined, with the development of the concepts of Integrated Mine Closure and Planning for Mine Closure as a focal point, and their influence on the establishment of improved mine closure, rehabilitation and completion mining practices.

This chapter ascertains the fundamental concepts behind the establishment of Integrate Mine Closure Planning and its association within the planning profession and its importance in the formation of sustainable development objectives. The chapter establishes the relevance of Integrated Mine Closure Planning to mine operations, mine site closure and completion practices within Australia and the rationale for examining the past legacy of orphaned, abandoned and derelict mine sites.

Mine Closure & Rehabilitation

Australia is the world's largest exporter of coal, accounting for approximately one-third of the world trade, and the largest exporter of iron ore, lead, diamonds, zinc and zirconium, and the second largest exporter of gold and uranium. The value of Australia's mineral and energy exports is forecasted to be in the order of $110 billion in 2006-2007. The ability of the Australian mining industry to recognise and establish improved mine closure practices and mining regulations is fundamental for the development of a sustainable mining industry in Australia (Department of Industry, Tourism and Resources, 2006).

Mineral resources are finite ore bodies, and as a result all mine facilities will eventually close and the reputation of the mining industry dependant on the legacy in which it leaves. In recent years, responsible mining companies have identified the importance of sustainable mine closure and rehabilitation practices. Recently, 'the emphasis for management of the environmental aspects of mine closure and decommissioning has shifted towards the notion of planning for closure'. (Sassoon, 1996)

Various literature indicates that improved mine closure and mine site rehabilitation planning, in contemporary best practice mining procedures, identifies Mining for Closure as a 'sustainability issue, and is no longer simple an environmental issue' (Peck, 2005). The socioeconomic aspects of closure are issues that are yet to be captured in mine legislation, however are increasingly included in the mine closure procedures and plans of leading mining companies (Bass, 2001).

The development of strategic mine closure policies and practices is reliant on the development of improved mine closure and rehabilitation legislation and best practice guidelines, which ensure mine closure planning and completion are viewed as fundamental components of overall mine site planning and development. Legislation requires the 'development of stringent environmental protection measure and standards during mine operations and mine closure procedures' (Clark, 1998).

The realisation that past mining practices failed to identify and plan for mine closure and rehabilitation prompted an increased awareness and inclusion of environmental, social and economical issues within mine closure planning and mine site development. Mining operations and activities that in the past resulted in legacies of abandoned, derelict and orphaned mine sites, 'are now unacceptable, and require improved mining legislation and control to ensure mine site closure is completed successfully, in a sustainable manner' (Peck, 2005).

Mine closure planning and mine site rehabilitation now identifies the need to develop best practice mine closure mechanisms in response to the existing poorly closed mine sites, and the development and 'implementation of regulations, requirements and guidelines which particularly pertain to mine closure' (Smith et al, 2001).

Sustainable Mining Practices

The emphasis and importance of sustainable development and improved mine closure planning is accredited to the United Nations World Commission on Environment and Development. The United Nations World Commission on Environment and Development (Our Common Future, 1987)) defined sustainable development as, “a system of development that meets the basic needs of all people without compromising the ability of future generations to meet their own life-sustaining needs” (Department of Industry, Tourism and Resources 2006).

The United Nations instituted the 2002 World Summit on Sustainable Development (WSSD) which addressed the concept of sustainable mine operations and practices, and identified the need for increased awareness within the mining industry. The World Summit on Sustainable Development Plan of Implementation recognised the important contribution of mining and minerals to a sustainable development. The plan identified the need to support efforts to address the environmental, economic, health and social impacts and benefits of mining, minerals and metals throughout their lifecycles.

The World Summit on Sustainable Development identified the need for mining nations to further develop sustainable development principles and practices in mine closure planning. The evolution of effective sustainable development practises requires the developed and established mining nations to foster sustainable mining practices through the provision of financial, technical and capacity building support to developing countries and countries with economies’ in transition for the mining and processing of minerals. This includes small scale mining, and, where possible and appropriate, improvements in current practices in mine reclamation and the rehabilitation and completion of degraded sites (Campusano, 2002).

The Australian Government’s 1998 Minerals and Petroleum Policy Statement noted that the integration of environmental, social and economic outcomes is

imperative in the formation and development of sustainable mining principles (ANZMEC, 2000). Sustainable development needs to be recognised by the Australian mining industry, governments and broader communities as a fundamental element of sustainable mining practices. The mining industry must acknowledge sustainable development practices and the continued improvement and development of sustainable development guidelines and mine closure procedures. Mining, minerals and metals are important to the economic and social development of many countries, however such practices need to acknowledge the importance of sustainable mining operations.

A variety of sustainable development policy frameworks have been developed by industry and other stakeholder organisations that are now acting as drivers for improved mine closure practices. The International Council on Mining and Metals (ICMM), formed in October 2001, to represent leading International mining corporations, established a set of ten Sustainable Development Principles in 2003, to reinforce the mining industry's recognition and commitment to sustainable development within a strategic framework. The International Councils of Mining and Metals Ten Principles for Sustainable Development provide a framework to measure sustainable development performance. The ten principles for sustainable development are:

1. Implement and maintain ethical business practices and sound systems of corporate governance;
2. Integrate sustainable development considerations within the corporate decision-making process;
3. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities;
4. Implement risk management strategies based on valid data and sound science;
5. Seek continual improvement of our health and safety performance;
6. Seek continual improvement of our environmental performance;

7. Contribute to conservation of biodiversity and integrated approaches to land use planning;
8. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products;
9. Contribute to the social, economic and institutional development of the communities in which we operate; and
10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders (ICMM, 2003).

The Australian mining and minerals industry is aligned in the pursuit of sustainable development and improved mine closure practices. The mining industry through the Minerals Council of Australia (MCA) and relevant industry associations is committed to sustainability principles across all aspect of mine operations. For example, The Minerals Council of Australia developed *Enduring Value – the Australian Minerals Industry Framework for Sustainable Development (October 2004)*, which provides guidance for operational level implementation of the International Councils on Mining and Metals principles and elements on sustainable development by the Australian Mining Industry. Figure Two refers to the Minerals Council of Australia's principles for sustainable mining practices and mine closure practices.

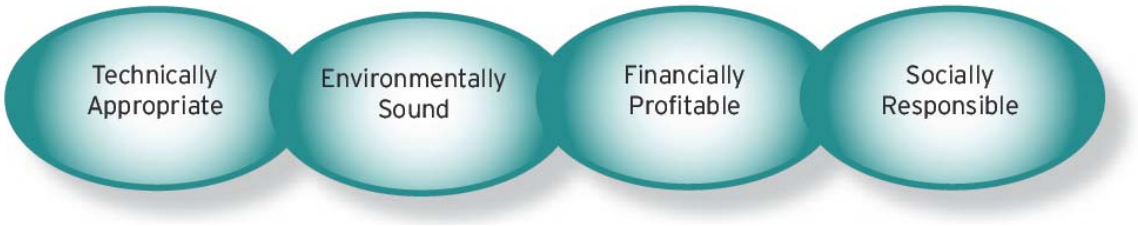

Figure Two: Sustainable Development Mine Operation Principles (Department of Industry, Tourism and Resources 2006)

Enduring Value identified the Australian mining industry's commitment to sustainable development principles and improved mine operations and mine site

closure and rehabilitation. *Enduring Value* translated the principles of sustainable development into practices that ensure the industry operates in an appropriate manner, which aims to maximise the long-term benefits to society that can be achieved through the effective management of Australia's natural resources.(Department of Industry, Tourism and Resources, 2006).

The Australian mining industry's recognition and acceptance of its contribution to sustainable development is apparent. The development of recent strategic guidelines and mine closure principles are in response to the industry and government regulators recognition of sustainable mine operations and the need for both regulators and operators to work in conjunction with each other to establish improved mine closure planning and mine completion practices.

Abandoned, Derelict & Orphaned Mines

Australia has been burdened with a legacy of unplanned mine closures, unsafe workings, hazardous mine site and unreclaimed lands. Until recently mine decommissioning and closure activities were not a requirement of mine closure practices and procedures. Poorly closed and derelict mines are a result of inadequate and non-existent mine closure practices and legislation, which provide difficult legacy issues for governments, communities and mining companies.

Planned mine closure and completion is still at an early stage of development in Australia, and there are only a few examples of mine closure planning being applied from conception through to the end of the mine life. Previous mine closure practices, which have often resulted in abandoned or derelict mines, were a result of inefficient mining legislation and control. Mine sites which have not been rehabilitated to standards that would be considered appropriate or acceptable in the mining industry's current context, are a direct result of such insufficient mine regulations and specific mine closure best practice standards. The concepts and standards underlying mine rehabilitation and mine closure are

now much more demanding and stringent than they were previously and reflect the change in public priorities and environmental awareness (Warhurst et al, 1999)

In the past, mining companies “used irresponsible mining methods with no regard towards protecting the environment and had often shirked their responsibility towards environmental rehabilitation by leaving an area unrehabilitated” (Allen et al, 1999). If mine closure and completion do not occur in a planned and effective manner, a site may continue to remain hazardous with limited opportunity for mine site rehabilitation and possible post-mine land use development.

The causes and implications associated with mine abandonment are presented in literature surrounding the mine industry and current closure practices (Environmental Protection Agency, 1995b; Mulligan, 1996; Nazari, 1999; Sengupta, 1993; Smith & Underwood, 2000; van Zyl *et al*., 2002a; WOM Geological Associates, 2000). The mining related elements that create the legacy of abandoned and orphaned mines are held to include:

- The general absence of mine reclamation policies and regulations until the latter part of the twentieth century;
- Ineffective enforcement of mine reclamation policies and regulations if, and where in existence;
- The absence of financial security mechanisms to ensure funds for parties such as governments to conduct remediation in the event a mining company going bankrupt and being unable to cover the costs of rehabilitation;
- Inadequate financial security to address remediation if, and where such funds were set aside; and
- Unforeseen economic events that caused early cessation of activity or left companies bankrupt, such as a sudden drop in metal prices, insurmountable difficulties with mining/milling, and/or infrastructure problems.

Since mine abandonment is usually sudden and unplanned, governments are often left responsible for mine closure and rehabilitation. It is evident that with the establishment of improved best practices principles and mine closure legislation, mine closure can occur in a planned manner to prevent the future occurrence of abandoned, orphaned or derelict mines. Prevention of future mining legacies can be achieved through the Mining for Closure activities and principles and the further development of comprehensive best practice principles.

Increased expectations for environmental protection, mine site completion and reclamation, competition for land, and the increasing value of the natural environment and recreational space have resulted in marked improvements in regulatory requirements and mining practices within the Australia mining industry. However, while mining companies now recognise the importance of sustainable mine practice, it was not until recently that mine companies introduced management policies, practises and procedures to significantly reduce environmental impacts caused by mine operations (Ricks, 1994).

Integrated Mine Closure Planning

The International Council of Mining and Metals defines Integrated Mine Closure Planning as the following:

> "best practice approach to mine closure and rehabilitation, the integrated approach to closure which considers environmental, social and economic aspects into account from an early stage within the mine development process and is maintained throughout the operational period of the mine" (ICMM, 2003).

Integrated Mine Closure, as defined previously in this thesis, should commence at the initial stage of mine planning and development. Mine closure plans are to be updated on a regular basis through the operational period of the mine, until mine operations have ceased and the closure plans and policies are implemented. Best practice requires the continued consultation with the

regulating authority, stakeholders and local community. A design for closure approach enables mine development that leads to a successful closure (Sheldon et al, 2002).

Integrated Mine Closure principles aim to address sustainable development objectives and recognise the environmental, social and economic implications of poor and ineffective mine site closure and rehabilitation. It is identified that successful mine closure is dependent on two sequential phases; planning and implementation. The coordination of these phases will result in well designed, systematic, safe and cost effective mine closure (Hordley, 1998).

The concept of mining for closure, is captured within the definition of Integrated Mine Closure Planning where a mine closure plan should be integrated within the mine operations and project life cycle and should be designed to ensure that post mine land use of the site is beneficial and sustainable in the long-term, any adverse socio-economic impacts are minimised and all social and economical benefits are maximised.

According to Sassoon, “Integrated Mine Planning”, a term which is indicated to capture the conceptual basis of ‘Mining for Closure’,

> “Should form a fundamental part of mine operations. Mine closure planning should be an integral part of a project life cycle and be designed to ensure that future public health and safety are not compromised, environmental resources are not subject to physical and chemical deterioration, the after use of the site is beneficial and sustainable in the long term, and any adverse socio– economic impacts are minimised” (2000).

Mine closure planning should commence within the initial mine planning process, with the development of conceptual mine closure plans within the initial phases of mine development, in a progressive manner as the mine site commences operations. Integrated Mine Closure Planning is a dynamic process which must

commence within initial mine planning and development phases. It includes a conclusive mine operations plan which encompasses mine closure plans, most mine land use opportunities and identifies environmental, social and economical considerations (Mudder et al, 1999).

Mine closure is an increasingly complex process, and given the concerns of relevant stakeholders regarding the environmental, social and economic impacts, best practice in mine closure is no longer seen as simply an environmental issue. Integrated Mine Closure Planning should integrate stakeholder involvement and community consultation within initial mine planning development, and maintain community consultation throughout the period of mine operations (ICMM, 2003).

A trilateral process of consultation and mine closure development, involving mining companies, government organisations and communities, is required for a mine site to be closed successfully. The process of mine closure and planning for closure should commence within the initial design stage and development of mine operations plan.

Conclusion

Integrated Mine Closure was devised in response to previously abandoned, derelict and orphaned mine sites and was established to provide improved mine closure practices and procedures. An integrated approach to mine closure planning aims to achieve the development of sustainable mine closure objectives that ensure the mine closure process and final end use of mining land is considered within the initial mine planning and development phases. ‘Mining for Closure’ is the term used to describe the manner in which mine closure and completion is to be addressed through the recognition of environmental, social and economic impacts associated with mine closure and the importance of improved sustainable mining procedures.

This chapter explored the context of Australia’s mine and minerals industries to provide the basis for developing research themes and the importance of

integrated mine closure planning in the context of ‘Mining for Closure’ (Sassoon, 2000). The thesis chapter assessed the theoretical framework of Integrated Mine Closure Planning and the establishment of improved mine closure procedures which incorporate sustainable mining objectives. The assessment of previous mine closure practices, demonstrated fundamental areas of mine closure practices and mining legislation which require improvement , in order to establish a sustainable mining industry which is regulated and controlled by specific mine closure legislation and best practice mine closure standards and requirements.

Chapter Three

Mining in Practice

Introduction

The previous chapter focused on Integrated Mine Closure Planning and mine site rehabilitation theory. It demonstrated the rationale for the thesis, by outlining the conceptual framework of Integrated Mine Closure Planning as the basis for addressing sustainable mining practices in conjunction with the development of the improved mine closure and rehabilitation planning principles. The present chapter progresses these themes by detailing the mine closure literature in practice. A large body of research has been conducted investigating current legislative controls and mine closure planning and rehabilitation practices within Australia.

This chapter will look at previous research, planning theories and studies conducted in the fields that relate to the importance of mine closure planning and rehabilitation. The chapter will provide a comprehensive assessment of current mine closure and rehabilitation practices and relevant Australian mining legislation and planning framework.

This chapter will assess industry standards and best practice and mine closure principles to establish a better understanding of the relevant requirements to ensure improved mine closure planning and rehabilitation within the context of current mining practices in Australia. The chapter will draw conclusions from best practice mine closure guidelines to further develop the important concept of Integrated Mine Closure Planning and its relevance within the development of sustainable mining practices.

Institutional and Legal Framework

Previously identified within this thesis, the concept of Integrated Mine Closure Planning evolved in response to previously abandoned or derelict mine sites which were a consequence of inadequate or non existent mine closure practices and legislation. The introduction of sustainable mining objectives and increased awareness of the apparent environmental, social and economic characteristics

associated with mine closure have identified a need within the mine industry for improved mine closure planning and established legislation and controls. The introduction of legislative and other forms of regulation of the mining industry has further developed the awareness for improved closure planning, which is now identified within the Australian mine industry as fundamental to the development of sustainable mine operations.

Mine closure, rehabilitation and mine site completion practices are determined by particular legislation and the ability of the authority to implement legislation and control. Mine closure and rehabilitation are becoming an important consideration in the assessment process for mining proposals in Australia which is identified within the recent development of specific mine closure and rehabilitation legislation. Mining legislation should recognise the need for specific mine completion criteria which reflects the environmental, social and economic impacts associated with the Australian mining industry (Limpitlaw, 2004)

A detailed review of relevant Australian mine closure legislation and frameworks disclose that there is significant diversity of legal mechanisms and requirements which specifically pertain to mine closure. There is a recent trend towards the development and implementation of regulations and guidelines which relate to mine closure, although 'few nations and there constituent states have enacted and implemented actual mine specific mine closure laws and controls' (Clark, 1999). Mine closure requirements are detailed within relevant mining legislation and controls, although rules and regulations which establish best practice mine closure standards remain inconsistent, with inefficiencies in the implementation and enforcement of mine closure best practice standards (Limpitlaw, 2004).

A clear legislative framework which establishes the parameters for mine closure is fundamental for the development of sustainable mine practices. Various countries and jurisdictions have established detailed mine closure requirements and procedures. However other countries, in particular developing nations, currently have few or no applicable laws, regulations and standards, or

institutions and government agencies with a mandate and the experience to support mining companies and communities in a trilateral cooperation necessary for successful mine closure (Sheldon, 2002).

In the absence of an effective legal framework for mine closure, mining companies are not aware of their obligations and potential future liabilities. The current deficiency in comprehensive legal frameworks for mine closure can also lead to inefficiencies and uncertainty among various government organisations and authorities. Legislation and policy are also drivers that control mining impacts through the decision making process. These may come in the form of laws, regulations, guidelines and government policy.

Legislation and Controls

Legislation implements policies and provides the standards for ensuring successful mine closure and mining operations. However with the failure to establish a legal framework for mine closure, mining corporations are not aware of their obligations and potential future liabilities. The absence of a comprehensive legal framework for mine closure can lead to inefficiencies and uncertainty between ministries and government organisations at federal, state and local jurisdictions. The failure to develop stringent legal frameworks controls and mechanism will result in poor mine closure practices and the unregulated rehabilitation and completion of mine sites.

A clear legislative and financial framework that establishes parameters for mine closure is imperative for the development of a sustainable mining sector where benefits are sustainable even after mine operations have ceased (Sheldon, 2002). Established mine closure legislation and legal frameworks will ensure mine closure occurs in a sustainable manner and that adequate monitoring of mine closure occurs. Government policy and regulative framework should encourage mining corporations to provide for and conduct physical mine closure

and establish provisions for mine rehabilitation within mine operations and procedures (ANZMEC, 2000).

The process of mine closure, the completion of mine sites, the release of company responsibility of a site and the rights of landowners and communities around the mine are all driven by legislative requirements. Appropriate planning and adequate provisions for mine closure are issues to be addressed by both regulators and the mineral industry across Australia. Clark identifies and discusses current inefficiencies in mine closure practices and international standards in mining legislation and control;

- Most countries have failed to develop comprehensive legislation for mine closure;
- Mine closure legislation and regulations are based on environmental aspects of a site, and fail to identify socioeconomic aspects of mine closure; and
- Regulation and legal frameworks specifically with respect to closure is not well developed in most agencies and government organisations.

Governments are now coming to realise that they have the most direct responsibility for defining and ensuring comprehensive mine closure within the broader context of sustainable mining objectives and Integrated Mine Closure Planning (Clarke et al, 2000). The development of legal and regulatory framework for mine closure should include specific mine closure procedures, environmental requirements and standards, and institutional responsibilities. Current legislation and regulatory framework has been developed in response to past mine closure practices which often occurred in an unregulated manner, and 'in response to bad practice, public outrage or inefficient mine site completion' (ANZMEC, 2000). Mine legislation development should be a responsive process and avoid the introduction of reactionary and prescriptive legislation that is often a reaction to past practices.

Future state and federal legislation should be framed to provide a clear and transparent process to protect the interests of all stakeholders through effective mine planning consultation. Mining legislation and regulation should be proactive and specify mine closure and rehabilitation requirements. With the establishment of comprehensive regulations and mechanisms which are clearly identifiable and enforceable by law, the Australian mining industry and government authorities will be able to develop stringent mine closure and rehabilitation controls which encompass the objectives of sustainable mining practices.

Mining legislation in Australia

The Australian mining industry has identified the importance of improved legislative control in the development of a sustainable mining industry; however as the following analysis of relevant legislation details, the current legislative control of mining operations within Australia contains various deficiencies and inconsistencies. The Australian mining industry's governance is administered by the State and Territories. Under Australia's federal system, Commonwealth legislation is only applicable in areas under national jurisdiction, on mine operations and projects where matters of national environmental significance are concerned, such as mining operations in national parks, or which may have impacts on threatened or migratory species (Limpitlaw, 2004).

The Commonwealth Governments Environment Protection and Biodiversity Conservation Act 1999, which came in effect in July 2000, established a nationally consistent framework for environmental assessment for new mine projects and variations to existing mine operations. Mine closure issues are an important consideration in the assessment process for mining proposals. All State and Territories have mine closure policies which require mining companies to develop site specific post mining rehabilitation plans for approval by the relevant organisation as part of the development assessment process (Campusano et al 2002).

A recent national initiative was the publication of the *Strategic Framework for Mine Closure,* published jointly by ANZMEC and the Minerals Council of Australia. The Strategic Framework for Mine Closure identified the objective of mine closure and rehabilitation "is to prevent or minimise long-term environmental damage, and to create a self-sustaining natural ecosystem or other land use based on agreed set objectives" (ANZMEC, 2000). The Strategic framework established a set of general guidelines and standards for mine closure and rehabilitation and addresses the principles of stakeholder involvement, planning, financial provisions, implementation, standards and relinquishment.

The strategic framework, which addresses objectives and principles of mine closure and rehabilitation, is applicable to Australian mining companies operating both within and outside Australian jurisdiction. The framework provides definitive best practice principles and operational recommendations, although the specific objectives contained with the framework are suggested provisions and are not enforceable. The framework includes guidelines on stakeholder engagement and advises that "closure planning should be integral to life of mine planning" and therefore advocates integrated mine closure planning (ANZMEC, 2000).

The strategic framework is intended to promote a nationally consistent approach to mine closure management in all Australian jurisdictions (Warhurst et al, 1999). The framework will not necessarily result in identical legislation in each state and territory; however it will establish principles for mine closure that are agreed between regulating authorities and the mining industry. The principles are then able to be applied with greater consistency to the development of regulations by government and mine closure programmes.

Western Australia

Issues related to mine closure and rehabilitation are now identified as an important consideration in the assessment process for mining proposals in Australia. The Western Australian Government issued new *Guidelines for Mining*

Proposals in February 2006, which detailed specific objectives pertaining to mine closure and rehabilitation and require the submission of a mine closure plan during initial mine development.

The Guidelines for Mining Proposal recommend that,

> "mine closure planning must be commenced in the initial stages of mine planning, that mine closure plans should be revised annually and that post-closure land use options should be discussed with relevant stakeholders" (Western Australian Government, 2006).

The provisions for mine closure and rehabilitation detailed within the guidelines go beyond the traditional rehabilitation plans and requirements that are standard of mine closure planning regulations. The recent development of specific mine closure policies and guidelines provide a positive example of regulators working towards Integrated Mine Closure Planning and recognition of the need for improved sustainable mining practices.

New South Wales

The New South Wales Government has recently developed and published new planning policies and regulations which pertain to mine site operations, completion and approvals. The New South Wales State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007, details specific mine closure policies and consolidates existing mine planning provisions and legislation. The planning policy provided new mining assessment provisions to ensure that potential environmental and social impacts are adequately addressed during the assessment of mine development proposals.

The policy aims to provide for the proper management and development of mining and extractive mineral resources and "facilitate the orderly use and development of areas where resources are located, and to develop appropriate planning controls to encourage sustainable management of mineral resources"

(New South Wales Department of Planning, 2007). The planning policy establishes provisions for mine closure and rehabilitation, detailing requirements for the development of a transparent and upfront stakeholder involvement and community consultation process.

The policy incorporates recent recognition of sustainable mining practices and procedures within the New South Wales Mining Industry. The policy aims to establish appropriate planning controls which encourage ecologically sustainable development through the environmental assessment, and sustainable management of development of mineral, petroleum and extractive mineral resources. The policy attempts to establish improved environmental practices and sustainable development objectives, and provides specific provision pertaining to mine site rehabilitation, which requires the preparation of a “mine closure plan which identifies the proposed end use and landform of the land once rehabilitated” (New South Wales Department of Planning, 2007).

Queensland

The Queensland Government’s mining regulation and legislative framework provides guidelines and policy recommendations for mine site closures and operations. However, Queensland has failed to develop policies and regulations ‘that reflect current industry practices and recent standards in mine closure planning and procedures which are aimed at achieving sustainable mining objectives” (Clark, 2000).

The Queensland Mineral Council requires the submission of rehabilitation plans and stakeholder and community consultation on proposed mining projects, which are “standard procedures in all parts of Australia” (Clark, 2000). The Queensland Environmental Protection Agency requires the submission of an operations plan which includes rehabilitation actions, prior to the commencement of operations, and requires the mine rehabilitation and closure plan to be reviewed annually. The Queensland legislative requirements for mine closure do not specify or

mandate stakeholder engagement to occur within the mine operations plans or initial mine site development. The Environmental Protection Agency requires the submission of a mine rehabilitation plan and closure program, which must be submitted prior to the commencement of mining operations.

The Queensland Government has developed several mining practice guidelines and procedures which are aimed at the development of 'improved management of mine operations' (QMC, 2001). The Environmental Protection Regulation, 1998 provides the key regulatory framework and codes of environmental compliance for the Queensland mining industry. The environmental protection regulations require that all significantly disturbed lands be rehabilitated to meet the conditions of the Queensland Environmental Protection Authority. The Queensland Codes of Environmental Protection establishes additional provisions which provide a range of suggested actions to be undertaken in relation to mine rehabilitation and closure. The codes of compliance however fail to recognise or provide a framework for mine closure planning or mine site completion. The codes of compliance and environmental regulations demonstrate inconsistencies and contradictory mining regulations and controls.

The Queensland Mining Council published *Guidelines for Mine Closure Planning in Queensland, 2001* which identifies a practical mine closure framework that can be applied throughout a broad range of mine sites throughout Queensland. The document provides guidelines and standards which aim to develop and implement improved of mine closure plans for the Queensland Mining Industry. Through the recognition that planning for mine closure is fundamental to the responsible operation of a mine site, the Mining Council identifies the importance of mine closure planning which 'should be developed at the feasibility stage for new projects and implemented on commencement of mining operations' (QMC, 2001).

A review of Australian mining legislation identifies a recent development of improved mine closure regulations and controls however the relevant

government agencies are still yet to establish legislation and best practice standards which pertain specifically to mine site closure and completion. This legislation must be developed, as it is a crucial step on development of a sustainable mining industry. The contextual framework of Australian legislation which attempts to develop controls and policies which require improved mine rehabilitation and closure planning, however still fails recognise the need for Integrated Mine Closure Planning and the mandating of stakeholder and community consultation, review of mine closure plans and financial assurances and bond agreements for mine closure.

Mining legislation should be developed as an overall approach to mine operations which recognise the need to consider mine closure, rehabilitation and an end of life mine land use within initial mine site development and planning. The Australian context of mining legislation requires improved legal frameworks that regulate integrated mine closure which identifies the positive benefits associated with mining for closure and integrated approach to mine site operations.

Elements of Mine Closure Best Practice

Mine closure best practices and the recognition of sustainable mining objectives and principles is the result of improved mine closure legislation and controls. Mine closure legislation should be developed in a manner to limit future negative environmental, social and economic impacts of mine site closure and completion. Best practice mine closure mechanisms should be a set of clearly defined mechanisms and mine closure standards which are regulated through mine closure legislation.

Best practice mine closure legislation should provide comprehensive mine closure policies and associated legislation dealing with the development of specific provisions for reclamation and mine site rehabilitation. Mine Closure legislation should include regulations that address abandonment and post

closure activities, the requirement for environmental, economic and social impact assessment and the regulation of a comprehensive bonding and financial program. Mine closure legislation should provide regulations to ensure specific monitoring and enforcement procedures to ensure compliance with best practice mine closure standards and practices (Allen, 1999).

Mine closure plans, developed as part of the environmental impact assessment and initial mine development, must be included in the environmental management plan and implemented during mining operations. Mine closure planning must occur throughout the mine's entire operational phase to the development and implementation of the final closure plan. The Australian mining industry recognises the importance of sustainable mining practices and is aligned in the pursuit of sustainable development and improved mine closure practices (ANZMEC, 2000). Mine legislation and regulation of mine closure practices should be fundamental to the development of a whole of mine life plan and the development of improved mine closure and rehabilitation practices within the Australian mining industry.

Mine closure legislation should provide a broad regulatory framework for the closure and rehabilitation of the mine site. Closure related legislation should be non-prescriptive and objectives based, and should ensure that all reasonable and practicable measures are taken to protect and restore the quality of the environment. It should be clearly understood and accepted that the legislative requirements are the minimum standard required, which best practice should exceed wherever possible. Mine closure planning is an ongoing process that must commence at the pre-feasibility stage of a project and be an integral part of the environmental and social impact assessment and mine planning phase. To ensure a successful and cost-effective mine closure, it is essential to commence closure planning at the initial planning stages. Pre-mining planning should take into consideration the proposed post mining land use and the implementation of effective operational methodologies to achieve the final landform (Western Australia Department of Industry and Resources, 2006).

The fundamental aim of mine closure planning and design is to achieve an integrated mine systems design, whereby a mineral is extracted and prepared in a sustainable manner and at a minimum unit cost within acceptable environmental, social, legal and regulatory constraints. Mine closure planning is a multidisciplinary activity that must be regulated and controlled within the mining industry. Decisions made during the mine planning process will have significant and long-term consequences for the mine and its environment. A risk-based approach should be incorporated into the design phase so that a wide range of business risks are evaluated, including the long-term potential environmental and closure liabilities of the mine site (Sheldon et al, 2002).

In order to develop Integrated Mine Closure Planning practices within the Australian mining industry, legislation and legal frameworks are required which control and regulate mine site closure and rehabilitation, ensuring improved overall mine site operations and practices. Mining legislation and frameworks must identify the fundamental elements of good mine closure planning and mine site rehabilitation, and develop regulations and legal mechanisms which respond to best practice mine closure practices. Mine closure planning must integrate all aspects of sustainable development, and so the environmental, social and economic issues must be identified and addressed within integrate closure plans.

A site closure and completion policy should establish high-level aspirations and directions that a mining company requires for mine closure. Mine closure legislation and regulation should establish commitments and standards for the mine closure process, stakeholder engagement, environmental minimisation of risk, meeting regulatory requirements, social and community aspirations, and continuous improvement of mine closure practices. Mine closure policies should recognise that it is possible to anticipate some aspects of the legacy of a mine at its conception and include closure as part of mine planning. Furthermore, it must identify risks and opportunities for reliable financial planning and costing, and determine final land-use objectives and principles in consultation with the community. The above mentioned aspects of mine closure illustrate the need for

improved mine closure legislation, progressive rehabilitation and comprehensive stakeholder and community consultation in the development of mine site completion and closure objectives. (Sheldon et al, 2002).

Best practice mine closure planning requires the establishment of a performance framework for mine closure that enables success in closure to be measured and facilitates a consistent approach to closure. Best practice mine closure planning requires the regulation and control of practices through legal frameworks which consist of standards and principles, objectives and criteria which form the basis for assessing mine closure plans and proposed closure options, and identifying key performance indicators. Mine closure legislation should development standards and mechanisms which regulate mine closure practices and comprehensively address the following (Department of Industry, Tourism and Resources, 2006);

- Rehabilitation principles and objectives, including final land use
- Decommissioning requirements
- Community objectives and criteria
- Consent criteria
- Standards and issues related to whole-of-life considerations
- Financial costing and provisioning
- Legal requirements
- Environmental and social management requirements; and
- Safety considerations.

A risk and opportunity assessment is required to ensure a consistent approach to the identification and management of issues associated with mine closure. This

assessment needs to consider environmental, social, economic and regulatory risks; external and internal factors, not just address the mitigation of risk uncertainty; and should evaluate opportunities that sustainable mine closure options might present (Environment Australia, 1999). However a comprehensive mine closure approach at this time remains a theoretical notion and considerable work remains to the development and implementation of legal mechanisms that regulates Integrated Mine Closure Planning (Campusano, et al 2002).

The Australian mining industry has recently recognised the need for improved mine closure legislation, which controls and regulates mine closure practices and mine site rehabilitation. In order to establish improved mining practices, government organisations must further develop improved standardised controls and nationally consistent legal frameworks which encompass the objectives of sustainable mining and develop controls specifically with respect to mine closure, rehabilitation and completion.

Conclusion

The previous chapter stated that Integrated Mine Closure Planning was established in response to previously abandoned, derelict and orphaned mine sites and was developed to provide improved mine closure practices and procedures. Previously legislation and mining practices and standards were developed as cursory measures, to deal with any issues or events after they had occurred. The recent establishment of improved mining policies and standards are an initiative of various stakeholder and government organisations, and have occurred in reaction to previously unregulated and inefficient mining practices and procedures. The literature has identified possible additional policy developments and the noticeable need for more efficient and stringent legislation which incorporates the concept of integrated mine closure planning and sustainable mining practices.

This chapter explored the context of legislative controls, and the current Australian context of mining regulation and legal framework which demonstrated the recent acknowledgment of sustainable mining practices and amendments to existing mining legislation and control. Particularly, this chapter has provided a comprehensive assessment of Australian federal and government legislation, and established best practice provisions for mine closure and mine site rehabilitation.

Through identifying the possible environmental, social and economic effects associated with unregulated mining closure and rehabilitation practices and procedures, government and stakeholder organizations can endeavour to institute improved mine legislation and legal frameworks and provisions which maintain sustainable mining objectives and practices and standards which are enforceable by law. The assessment of current mining legislation has identified that, through the development of inclusive and detailed legislation and regulation of the mining industry, there is an opportunity for improved sustainable mining outcomes and practices.

In order to achieve such sustainable mining outcomes, the implementation of strategies which regulate and control mine site operations, closure and mine rehabilitation are imperative, as is the establishment of definitive controls and standards which ensure mine site closure and rehabilitation procedures are regulated and controlled practices.

Chapter Four

Case Studies and Mining Practices

Introduction

Best practice guidelines and mine closure standards provide strategic recommendations aimed at the improvement of mine site rehabilitation and mine closure, however such policies need to be “adopted and recognised by the relevant government agencies, regulatory authorities and the mining industry in order to develop a sustainable and regulated approach to mine site operations” (McLennan, 2007).

Accordingly, this thesis chapter assesses current industry practices, mine closure and rehabilitation procedures in order to establish a comprehensive understanding of best practice standards and the effectiveness of current mine closure legislation governing the development of sustainable mining operations and practices. The purpose of this thesis chapter is to develop an understanding of current mine closure practices, mine planning procedures and institutional frameworks which control and regulates the Australian mining industry.

The assessment of current industry practice and mine closure legislation will establish an increased awareness of best practice mine closure planning and the effectiveness of mining regulation. The assessment of relevant case studies will establish policy recommendations and mine closure provisions and develop mine closure specific guidelines and standards for mine closure and rehabilitation and address the principles of stakeholder involvement, planning, financial provisions, implementation, standards and relinquishment.

The chapter provides an assessment of data and information obtain from in-depth qualitative interviews. The interview respondents provided a comprehensive assessment of current mine closure practices and developed themes and patterns which attribute to the establishment of successful mine closure practices within the Australian mining industry. The interview respondents illustrated the main components of mine closure, and identified possible mining legislation amendments and recommendations which will assist

in the establishment of improved mine closure practices and a sustainable mining industry.

Mining legislation and frameworks must identify the fundamental elements of effective mine closure planning and mine site rehabilitation, and develop regulations and legal mechanisms which respond to best practice mine closure practices. The ability to develop stringent mine closure legislation which imposes standards and regulates mine closure and completion practices has important implications for policy amendments which will be discussed in chapter five (5).

Integrated Mine Closure – Interview Perspectives

"Integrated Mine Closure" as defined by The International Council of Mining and Metals is a

> "*best practice approach to mine closure and rehabilitation, the integrated approach to closure which considers environmental, social and economic aspects into account from an early stage within the mine development process and is maintained throughout the operational period of the mine" (ICMM, 2003).*

Mine closure and mine site rehabilitation is a dynamic process which must be performed within initial mine site development, planning and feasibility assessment of a mine site. The mine closure process must include progressive or concurrent mine site rehabilitation, which must be incorporated within initial mine site planning and feasibility assessment phase.

To ensure that Integrated Mine Closure Planning is achieved, the development of specific mine closure legislation and mine closure guidelines are required. Mine closure planning needs to be regulated within the Australian mining industry, specific mine closure and rehabilitation legislation is imperative for the future development of sustainable mining operations and procedures. It is fundamental that the mining industry is familiar with and recognises the benefits associated

with an Integrated Mine Closure Planning approach. In response, a series of in-depth qualitative interviews were completed that provided a comprehensive indication of current best practice mine closure standards and mine rehabilitation issues within the context of the Australian mining industry.

In order to develop a successful and cost effective mine closure, it is essential to commence mine closure planning at the initial planning stages. Planning which occurs prior to the commencement of mine site operations should include considerations of proposed post mining land use and the implementation of effective operational methodologies to achieve a sustainable post mine land use. The concept of an integrate approach to mine closure, which identifies mine closure and rehabilitation within initial mine feasibility and mine development phase needs to be recognised by the industry and the regulatory authorities.

An important point identified by Laurence, is that “more can be done in terms of mine closure research to demonstrate the need for an integrated approach to mine closure”. [Integrated Mine Closure Planning] was previously neglected by the mining industry and was not identified as an important process” (Laurence, 2007). This observation was endorsed by the interview participants who identified the apparent need for improved mine closure planning and rehabilitation practices.

The development of best practice standards and guidelines, and the regulation of mine closure though improved mining legislation is fundamental for future sustainable mine closure. Mine closure and rehabilitation considerations need to commence within the initial feasibility assessment and mine site development. The interview respondents illustrated the need for an integrated approach to mine closure and mine site rehabilitation. The Australian mining industry and relevant government agencies must “identify mine closure as an issue within the initial phases of mine development, prior to the commencement of mining operations” (Laurence, 2007). The best practice approach is to establish legislative controls which regulate mine closure practices and considerations,

and the “development of mine closure specific standards and completion requirements” (Kirkby, 2007).

In terms of integrated mine closure, mining corporations have a crucial role to play in the development of initial planning and trilateral cooperation, “both of which are key elements of successful mine closure” (McLennan, 2007). Mining companies must be made aware of best practice elements and procedures of mine site closure operations and the potential post closure implications if mine closure processes are not implemented in an effective manner. Integrated mine closure, which identifies the environmental, economic and social impacts within the initial mine planning, design and feasibility assessment, is “the most suitable approach for the development of successful Integrated Mine Closure Planning” (McLennan, 2007). The dynamic nature of closure planning requires regular and critical review to reflect changing circumstances. McLennan identifies that “integrated mine closure planning allows for the annual review and monitoring of mine closure plans and mine site operations” (McLennan, 2007). To ensure a successful and cost-effective mine closure, it is essential to commence closure planning at the initial planning stages.

The development of mine closure plan within initial mine planning and development provides an opportunity for the closure plan to be “modified as a result of any operational change, new regulations or new technology, and should be comprehensively reviewed on a regular and pre-determined cycle” (McLennan, 2007) The most effective mine closure plans are those that are integrated with the long term operational plans for the mine and are subject to regular review to accommodate regulatory, technological and economic change.

The interview participants identified the need for improved mine closure practices and mine rehabilitation within the Australian mining industry. The conceptual framework of Integrated Mine Closure Planning is the most “suitable approach to ensure improved mine site completion and closure” (Laurence, 2007). In order to ensure improved closure practices and the establishment of an integrated mine

closure approach, this requires improved regulation and control of mine operations and the apparent need for sustainable mining objectives to be included within mining legislation and legal frameworks.

Best Practice in Mine Closure

Case Study – Misima Gold Mine, Papua New Guinea

Misima Gold Mine located in Papua New Guinea commenced operations in 1987 and operated until 2004. Final mine site closure and mine site rehabilitation was completed in April 2005 (Placer Dome, 2001,) The case study identifies the potential conflicting objectives associated with mine closure and minimising cost associated with mine site rehabilitation, maximising economic benefits, and minimising environmental liabilities associated with mine operations. Mine site closure and detailed mine closure planning of Misima Mine commenced five years prior to completion of mine site operations.

The mine closure plan included a risk assessment of the site, which involved considerable stakeholder and community consultation to develop views for rehabilitation planning for the site. The Misima Mine closure identified that the “ultimate success of the mines closure is dependent on participation of all stakeholders who will actively support and contribute to the planning and development of mine closure plans” to achieve the community and stakeholders requirements (Placer Dome, 2001). A structured holistic approach to mine closure planning allows all potential social, economic and environmental issues to be identified and incorporated into the mine planning processes.

Discussion

In order to achieve best practices in mine closure, the respondents identified the need for improved strategic frameworks which set guidelines and standards for mine closure and rehabilitation and addressed the principles of stakeholder involvement, planning, financial provisions, implementation, standards and

relinquishment. Mine operations and closure procedures are currently in a period of “transition were mine rehabilitation and mine closure where not considered important issues or identified as fundamental components of mine closure operations” (McLennan, 2007). The Australian mining industry was previously unregulated or uncontrolled; the relevant government agencies had failed to develop effective legal mechanism which control mine closure procedures and standards.

The interview participants identified past failures of the Australian mining industry and acknowledged the significant implications associated with previously unregulated or uncontrolled mine operations or mine site completion practices;

> “Mine rehabilitation was not regulated or controlled, government legislation failed to recognise mine closure planning and did not require community consultation, or progressive rehabilitation ” (Kirkby, 2007)

> “There needs to be established mine closure standards, or guidelines which mandate mine closure procedures. Mining legalisation must stipulate requirements for community consultation and financial assurances for mine closure” (Doyle, 2007)

> “The level of public consultation and stakeholder engagement was limited, this process was not regulated and it effects the overall successfulness of mine closure in a negative manner” (Laurence, 2007).

The interview participants established the link between previous examples of abandoned and derelict mine sites and a mining industry that was unregulated and a regulatory framework that failed to incorporate legislation which established mechanisms to control mine site operations and mine closure. The respondent’s identified that mining legislation must develop provisions and establish requirements for stakeholder involvement, planning, financial provisions, implementation, standards and site relinquishment. The development of mining legislation that requires mining corporations to consider these factors,

will result in successful mine closure and completion aimed at the development of a sustainable mining industry.

Mine Closure Specific Policies

Case Study – Greystanes Estate

The Greystanes Estate, is a 330 hectare mine site which has been used as a quarry. The quarry site reached the end of its economic life and ceased operations in 1999. The site has since been identified by the New South Wales Government as part of the Central Western Sydney Economic and Employment Area for urban development including land proposed for employment generating and residential land use. The New South Wales Government established State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) – No. 59 which established legislative planning framework for the redevelopment of the land. The planning policy identified closure procedures and developed provisions for comprehensive community consultation and post mine land use considerations. The policy established the framework for the detailed planning and redevelopment of the mine site and provided controls and regulations specifically focused on mine closure and completion.

Development and rehabilitation of the site has already commenced, land rehabilitation and reclamation will provide approximately 200 hectares of employment lands and 110 hectares of residential land. The Greystanes case study provides a detailed assessment of current industry practices and mine closure legislation. The planning policy, which contains specific requirements for mine site closure and post mine land use identifies the current trend towards improved mine closure practices and specific mine closure legislation. McLennan stated,

> “Mining operations do not consider the economic value of a mine to extend beyond mining operations, the identification and consideration of

> possible post mine land uses within initial mine development planning, in terms of redevelopment can provide a viable and economic post mine land use" (McLennan, 2007).

The Australian mining industry has recently identified the need for an integrated approach to mine closure planning and rehabilitation which recognises and considers possible post mine land use options and mine closure requirements. The Greystanes case studies establishes the recent development of sustainable mining objectives which acknowledges the economic post mine land use and benefits associated with improved mine closure legislation. The successful closure and redevelopment of the Greystanes mine site is attributed to the development of specific mine closure legislation and a regulated approach to mine closure and rehabilitation. The development of "efficient and effective mine closure planning and assessment can provide an economic viable land use after the mine operations have ceased" (McLennan, 2007).

Discussion

The respondents recognised that mine closure practices should be regulated, mine operations and mine closure and completion of mine sites needs to be controlled. "There is a need to improve mine closure standards, legislative controls and guidelines to improve post mine land use opportunities and mine rehabilitation" (Kirkby, 2007). The Australian mining industry requires the development of specific mine closure policies and site completion requirements;

> "Mine closure processes and standards for completion should be mandated" (Kirkby, 2007)

> "There is a need to develop consistency and specific standards for mine closure requirements" (Doyle, 2007)

> "More openness and transparency in the planning approval process, and greater involvement of the community and relevant stakeholders will improve final outcomes" (Laurence, 2007)

> "Mining legislation governs all aspects of mine operations, without the development of mine closure requirements mining companies will have no legal requirement to close and rehabilitate mine sites" (Kirkby, 2007).

These comments from the interviewees indicate the mining industry's acknowledgment that successful mine closure and rehabilitation is dependent on the development of specific mine closure legislation. The respondents believe that there is a need for improved consistency and specific performance criteria for mine closure. Mining legislation should establish specific requirements and assessment criteria in order to ensure that mine closure is completed to a satisfactory level.

Mining legislation should be established in a manner to ensure that mining companies are required to implement mine closure considerations within initial feasibility and mine planning stages and mandate the annual review of mine closure objectives. Mine closure policies and requirements should be aimed at the development of sustainable mining industry, one that incorporates environmental, social and economic considerations within mining legislation.

A Sustainable Mining Industry

Case Study – Beenup Mine Site

The Beenup Mine site identifies best practices in mine closure planning and the development of a detailed rehabilitation plan. The mine site operator developed a progressive rehabilitation plan and established an overall mine closure philosophy. The mining operator viewed mine operations as a "temporary use of the land and recognised that the development on sufficient stakeholder consultation would be critical to the success of mine closure and completion"

(BHP, 2003). The establishment of a comprehensive mine closure plan, which incorporates sufficient levels of community consultation and stakeholder involvement throughout the entire operational period of the mine, needs to be controlled and regulated throughout mine closure legislation. The community consultation processes “played a significant role in the selection of the preferred rehabilitation process and developed provisions to ensure a viable post mine land use” (Weber-Fahr, 2002).

The Beenup Mine project identified fundamental components which influence successful mine closure operations. The establishment of an integrated mine closure approach which included “early stakeholder involvement and continued community consultation within the mine closure process” (Weber-Fahr, 2002). The case study exemplified the fundamental need to establish progressive and comprehensive mine closure plans and consider mine closure and rehabilitation opportunities within the initial mine planning stages and development of the mine site. The case studies have illustrated best practice approaches which are fundamental to the establishment of improved mine closure and mine rehabilitation within the Australian mining industry.

Discussion

The current context of Australian mining legislation, still fails to regulate or develop requirements for an integrated approach to mine completion. The assessment of current mine closure practices, provides a detailed understanding of current mining practices and identifies the fundamental components which attribute to successful mine site closure and mine completion. The Australian mining industry, in cooperation with the relevant government agencies must develop specific mine site closure requirements and standards, in order to ensure mining operations are closed and rehabilitated in a efficient and effective manner.

The objective of this thesis project is to not only understand mine closure and rehabilitation practices, but to also understand the manner in which sustainable mining is being addressed by planners at the government level. A series of questions were asked as an indicator of the sustainable mining objectives or specific mine closure policies and controls. The participants believed that previous mine closure practices did not recognise the need for a sustainable mining industry; consequently there has been a significant failure to recognise and incorporate the environmental, social and economical impacts of mining operations.

> “In the past environmental impact assessments did not include sufficient levels of information pertaining to all aspects of mine operations, the assessment of social, environmental and economic issue and considered but not to a sufficient level” (McLennan, 2007).

> “Mine rehabilitation and closure is an evolving process and should be developed in response to the annual review of mine operations, it needs to include sustainable development procedures that improve land uses after mine operations have ceased” (Kirkby, 2007).

> “There is a need to identify all possible issues and impacts of mine operations early in the initial mine planning process, the consideration of mine closure early in the mine planning stages can assist in achieving sustainable mining operations and closure procedures” (Doyle , 2007).

The interview respondents illustrate the need for mine closure planning to consider the possible environmental, social and economical impacts associated with mine site closure and completion. Mining legislation should develop specific mine closure controls and regulations, and incorporate the controls which encourage sustainable mining practices and procedures. The environmental, social and economical impacts of mine closure should be considered within the initial mine site feasibility phase and monitored throughout the entire operational

period of the mine. The Australian mining industry needs to recognise the need for improved mining operations which incorporate sustainable mining objectives, however, the most suitable approach to ensure such operations occur, is an industry which is regulated and controlled with specific mine closure legislation.

Control through Regulation

Integrated Mine Closure Planning acknowledges the relationship between the mining industry and sustainable mine closure objectives, and identifies that improved mine legislation and control can significantly contribute to improved mine operations and mine site closure and rehabilitation practices. Planned mine closure and completion is still at an early stage of development in the Australian mining industry, with few cases of mine closure planning applied from initial mine conception through to end of mine operations. The limited examples of an integrated approach to mine site closure are substantially due to the timeframe of most mining operations and the relatively recent development of Integrated Mine Closure Planning (Limpitlaw, 2004). As Integrated Mine Closure Planning is a relatively new approach to mine closure and completion, the majority of mining practices are yet to recognise the significant benefits associated with such an integrated approach to mine site closure and completion.

Mining for closure requires recognition from the Australian mining industry that mining is a temporary use of the land, but the nature of potential impacts can be exceedingly long term (Clark et al, 2000). The development of an integrated approach to mine closure is fundamental for the successful closure and completion of mining operations; however such practices require the development of mine legislation which provides provision to control and regulate mine closure practices. Whilst current mining legislation has failed to develop controls which regulate mine closure practices and development consistent requirements and mine closure legal frameworks, the interview respondents have provided a comprehensive understanding of the importance of control through mining legislation. The interview participants further identified that there is a need

within the Australian mining industry for “regulated mine closure practices and to develop greater consistency and detail in terms of mine closure requirements” (Doyle, 2007)

Mine closure legislation and the recent development mine closure policies which now incorporate sustainable objectives, should ensure that all reasonable and practicable measures are taken to protect and properly rehabilitate and complete mine site closure. Statutory controls and regulations have developed in response to bad practice, poor mine closure or failure to recognise the social, economic and environmental implications of mine site completion. “Mine closure legislation should control mining practices and develop controls which deal specifically with mine closure issues” (Doyle, 2007). The respondents reiterated the importance of a regulated and controlled mine industry, with polices and standards that are developed specifically in response to mine closure, rehabilitation and completion. “It is in the interest of all parties and stakeholders to avoid the introduction of reactionary and prescriptive legislation” (Kirkby, 2007).

The respondents and the case study examples reveal that the mining industry now recognizes sustainable mining objectives and the importance of mine closure and rehabilitation procedures and best practice standards. The Australian mining industry recognises that such mine closure practices and sustainable mining operations need to be embedded within current mining legislation and controls, and that mining legislation and planning principles have failed to regulate the mining industry and develop strict mine closure requirements. The Australian mining industry and the relevant government agencies need to develop improved mining legislation, the industry and all mine closure practices need to be regulated to ensure that the industry operates in an environmentally, economic and socially sustainable manner.

Conclusion

The qualitative data and analysis of relevant case studies in mine closure and completion have provided a comprehensive analysis of current industry standards and best practices in mine closure planning and rehabilitation. The interview respondents have identified that the Australian mining industry has recently identified and adopted an integrated approach to mine closure planning and rehabilitation. The respondents revealed that the industry requires improved legislation and legal mechanisms to establish best practices guidelines and mine closure requirements.

There is currently a failure on behalf of the relevant government organisations and an absence of recognition of sustainable mining objectives with the Australian mining industry, which has produced infrequent and inconsistent mine closure practise and mine rehabilitation procedures. The most significant influence currently adversely impacting mine closure practices is the failure to control and regulate mine closure requirements. “Current mining legislation requires considerable improvements to ensure improved mining operations and closure procedures” (Doyle, 2007). As a whole the results show that the understanding and implementation of Integrated Mine Closure Planning and sustainable mining objectives are not consistent between the Australian mining industry and government organisation and regulatory authorities.

The implications of the current deficiency in mine closure legislation and mine closure standards and requirements are addressed in chapter five (5), which also provides comprehensive recommendations to improve current mine closure within the Australian mining industry.

Chapter Five

Findings and Recommendations

Introduction

The previous chapter presented the results and findings of the primary research collected from the qualitative interviews and case study analysis which was conducted for this thesis. The analysis of the qualitative data and case study assessment was discussed to develop a comprehensive understanding of current mine closure planning mining, legislation and control. The qualitative research posed questions which aided in addressing the research objectives and aims of this research project.

To reiterate, the objectives of this study are as follows:

- Develop an understanding and assess current mine closure, rehabilitation and completion practices, provide an assessment of best practice mine closure principles;
- Critically assess mine closure legislation and current legislative framework and determine which controls and policies are most relevant to the improvement of sustainable mine closure practices;
- Determine best practice mine closure and rehabilitation standards and procedures, compare relevant case studies of mine closure and mine site abandonment; and
- Develop comprehensive policy and best practice recommendations and provide legislative and mine closure regulation amendments, aimed at the improvement of sustainable mine closure practices in Australia.

This chapter draws from the assessment of relevant case studies and qualitative data and identifies possible policy responses and establishes comprehensive principles and strategies aimed at the development of a sustainable mining industry. It is the mining industry's past legacies and practices that will influence prospective policy development and strategic responses to mine closure planning and the establishment of a regulated and controlled industry. This thesis chapter

reveals and acknowledges the industries previous short comings and failures, and identifies the need for the regulation of financial provisions, stakeholder engagement, mine closure planning and a greater commitment to sustainable mining operations.

The Way Forward – Successful Closure

The Australian mining industry accepts and identifies that mine closure requires the return of land to a viable post-mining use, such as agriculture. It is not even sufficient to simply physically reclaim mined lands anymore as the socio-economic impacts of the closure must also be assessed and managed. To close a mine successfully, a trilateral consultation and problem solving process is required between mining companies, governments and communities. This process needs to commence at the design stage of the project. If conducted effectively, closure can be the mechanism by which capital generated through mineral extraction is transferred to future generations.

Mine closure planning should be considered in a much longer time frame than the period needed to operate the mine. Sustainability throughout the complete mine life cycle, from exploration to post closure, is the best preparation for successful mine closure and completion. If environmental management has been a priority during the life of the mine, then environmental management on mine closure and rehabilitation will be able to be administered in a cost effective manner. If provisions are made within mine closure legislation for community consultation and stakeholder engagement and relationships have been developed prior and during the life of the mine, then there is an established basis for sound consultation in planning for issues associated with mine closure. If financial resources have been established, then mine closure planning can be implemented and communities are presented with opportunities for economically viable post mine land uses.

The World Bank (2002) identifies the need for early, constructive action by mining companies to ensure that the memory of mining is not one of negative environmental and social impacts, a reputation that will increasingly threaten future mining operations elsewhere. The World Bank discusses the need for the proactive involvement by local communities and stakeholder to ensure that the benefits from mining are sustainable for future generations. Also identified is the need for improved legal frameworks, which establish mine closure planning and support to local communities to ensure that government authorities are not left to manage large environmental and social problems. The analysis and assessment of mine closure case studies and relevant qualitative data has provided a comprehensive understanding of existing and current mine closure practices and identifies current inefficiencies in mine closure planning and mining legislation.

Stakeholder Involvement

The process of community consultation and stakeholder involvement should commence within the initial stages of mine planning, and continue throughout the operational period of the mine site and occur during mine closure and completion. Consultation should not occur on a selective basis, the process should involve all parties with a stake in the project and the post-mining land use. “Proper mine closure is the result of a combination of innovative concepts, long term commitments and stakeholder cooperation” (Mudder & Harvey, 1998). The fundamental objective of stakeholder involvement is to ensure that all stakeholders have the necessary information and resources to participate and be actively involved in the mine closure planning process. This allows for the interests of all stakeholders to be considered during the mine closure process.

With the establishment of effective stakeholder engagement and community consultation and its integration into overall mine operations and closure processes, it is possible to develop innovative approaches to long term post mine land uses. Ultimately, an integrated approach to closure planning is required whereby joint action of stakeholders, mining companies, government and

communities, assume responsibility for the long term sustainability of close mine operations (Clark et al, 2000).

The requirement or opportunity for involvement of stakeholders in mine closure planning and implementation is inconsistent within current legal frameworks and legislative controls. Community consultation and stakeholder involvement is still to be standardised or regulated within Australian mining legislation, a mechanism for participatory engagement is absent in current mine closure legislation. Improved stakeholder engagement in mine closure planning and decision making provides for a more informed development of strategies and programs to address impacts, ideally as part of a community development approach from early in the operational period of the mine (Campusano et al, 2002)

The post mining land use for an area should be defined in consultation with relevant interest groups including government departments, local government councils, community organisations and private landowners. The future use of reclaimed mine site should be clearly identified through a participatory process so that the public and relevant stakeholder groups can evaluate the possible end of mine site land uses. The timing for development of the closure plans, throughout the project life, must take into account the input from stakeholders. The objective of stakeholder involvement is “to enable all stakeholders to have their interests considered during the mine closure process” (Kirkby, 2007). The stakeholders must be identified prior to the commencement of mine operations and effective consultation must be implemented to establish post mine land use objectives and completion criteria.

Completion criteria are the basis on which successful rehabilitation is determined, and should be developed in consultation with stakeholders. This ensures that there is broad agreement on both the end land use objectives and the basis for measuring the achievement of that objective. Ideally, completion criteria should reflect the specific environmental and socioeconomic

circumstances of the site. Completion criteria should be flexible enough to adapt to changing circumstances without compromising the agreed end objective.

The qualitative data and case studies demonstrated that in order for effective stakeholder involvement and community consultation to occur, the process must regulated and controlled with the development specific mine closure legislation. The legislation must establish specific requirements, objectives and criteria pertaining to successful mine closure and stakeholder and community involvement within the mine planning and closure process. Stakeholder involvement must form part of an integrated approach to mine closure which recognizes the Australian mining industry's commitment to the establishment of sustainable mining practices.

Planning

Planning for closure aims to ensure that the process of closure occurs on an orderly, cost effective and timely manner. Proper mine closure planning should occur during the "feasibility and design stage and permitting phase of a mine, and be upgraded during the operational period of the mine" (Mudder & Harvey, 1998). The failure to develop an effective and up-to-date mine closure plan which recognises the environmental, social and economic impacts of mine closure can have significant consequences upon final end of mine land uses and successful mine closure.

Mine closure planning provides an opportunity to identify and assess possible constraints and environmental, social and economic impacts of mine closure and allows for post mining land use options to be identified. Mine closure plans should be developed to reflect the status of mine site or project operations. Mine closure requires two different types of closure planning which is required during mining operations: a conceptual closure plan during the project assessment and development phases, and the main closure plan which needs to be developed during mine operations and continually monitored.

Mine closure planning should commence during the initial feasibility assessment design and preparation of a mine operations plan, and be reviewed throughout the operational life of the mine. Mine closure planning fundamentally aims to reduce or eliminate adverse environmental, social and economic effects associated with mine site operations. Mine closure planning aims to reduce the need for long term monitoring and maintenance of the mine site once mine operations have ceased and establish conditions which are consistent with the pre-determined end land use objectives as identified within the initial mine site planning.

The mine closure plan requires regular and critical review to reflect changing circumstances. A mine closure plan should be a responsive document, which is modified in response to any operational change, legislative amendments and should be comprehensively reviewed on a regular, predetermined cycle. Mine closure plans should be a regulated process, which requires the integration of mine closure planning within initial mine site development and throughout the entire operational period of the mine. Mine closure planning includes a commitment to progressive rehabilitation and detailed plan development and implementation. The plan provides a framework against which short term actions can be measured during mine life operations to ensure a successful final closure and completion.

Mine closure planning should encompass the objective of an integrated approach to mine closure, which recognises the need to develop comprehensive mine closure and completion plans and progressive or concurrent rehabilitation procedures. Mine closure planning needs to establish statements or mine closure objectives which identify's specific commitments and outcomes for the completion and closure of mining operations. Effective mine closure planning, which occurs towards the commencement of mine site development and design provides an opportunity to assess and identify possible post mine closure options. Mine closure planning must be integrated with a comprehensive consultation process involving local communities, regulators and relevant

stakeholders to determine the preferred and most suitable long term use for the mine and all associated lands.

Financial Provisions

Providing adequate funds and monetary amounts for mine closure is a vital part of mine closure and rehabilitation. The costs of physical mine closure varies, and is dependent on the age, location and the type of mining operations and mineral extraction. The requirement for financial provisions must reflect the real costs associated with mine closure and is subjected to continue review and assessment of perceived mine closure costs. Financial provisions and bond agreements should be developed to provide mechanisms and financial capability to ensure the proper closure and completion of the mine site. Financial surety and assurance provide a mechanism to ensure mine site closure is completed.

“Financial surety” is defined as a “guarantee issued by a bonding company, an assurance company, a bank or financial institution, which agrees to hold itself liable for the acts or failures of a third party” (Miller, 1998). It provides a mechanism which has been established to guarantee that adequate financial resources are available to complete mine site completion in a successful and sustainable manner. It is evident that financial assurance instruments can be effective in the promotion or enforcement of environmental protection. Financial assurances whilst not yet commonly accepted within the mining industry, are increasingly accepted by the Australian mining industry as perhaps the most effective manner in which to ensure that the protection of the environment is achieved and public expectations for mine closure and completion are recognised (ANZMEC, 2000).

Environmental surety instruments can be established to guarantee environmental performance after closure through the funding of mine closure, site reclamation or rehabilitation. Financial assurances and bond agreements ensure that mine closure practices and effective mine site closure are fulfilled. It is identified that a

financial insurance instrument that is specified and regulated within mining legislation provides greater certainty for the completion of mine site completion and rehabilitation. The objective of financial securities and fiscal bond agreements ensure the cost of mine site closure is adequately represented and identified by the mining company and guarantees that the mining company is liable for all cost incurred as a result of mine site closure and rehabilitation. Mine closure costs must be estimated for complete mine closure, and it needs to be recognised that the cost of mine closure is not limited for mine site reclamation and rehabilitation.

The development of financial provisions and requirements which are established during initial mine feasibility assessment and planning provide controls, which stipulate the relinquishment of a company's responsibility to a mine site will occur after the relevant regulatory organisation has established that rehabilitation has been satisfactorily completed. The financial surety should not be a fixed amount throughout the operational period of the mine, but developed in response to environmental issues as they occur, as regulatory amendments occur and community expectation in relation to final mine land use develop.

The objective of providing financial provisions for rehabilitation is to ensure that adequate funds are available at the time of mine closure. A schedule for financial provisions should form part of all mine closure plans. The amount provided for mine site rehabilitation should be consistent with the degree of disturbance during mine closure. The regulation and requirement for financial assurances and estimation of mine closure cost to be included within initial feasibility development will provide greater consistency and assurances within the Australian mining industry. The control and mandating for financial assurances and provisions within the relevant mining legislation ensures that mining companies are made accountable and will mitigate possible future experience of abandoned, derelict or orphaned mine sites.

A fundamental element in the achievement of comprehensive mine closure is requiring bonds be imposed to ensure that there is adequate financial resources available so that mine closure is completed successfully. Legislation relating to this aspect of mine closure needs to be enacted. The Australian mining industry in conjunction with Commonwealth and State government agencies needs to develop legislative requirements which are consistent across all jurisdictions which provide for improved mine closure and completion procedures. The establishment of financial provisions and assurances guarantee the environmental performance after mine closure through the funding of mine site reclamation and rehabilitation. It is imperative that mining legislation, which has recently developed in response to previously derelict and abandoned mine sites, incorporates provisions which require financial assurance and bond agreements within the initial mining approval and development process.

Legislation and control / Standards and Requirements

Current mine site rehabilitation and closure standards focus on the relinquishment of mine site responsibilities and the establishment of stable landforms. Insufficient attention is being directed towards the establishment of a regulated and controlled mining industry, and legislation which promotes and encompasses the objectives of sustainable mining practices and standards. Mine closure legislation should be non prescriptive and should ensure that all practicable measures are taken to ensure mine closure and rehabilitation is completed to adhere to particular mine site completion criteria and requirements. Mining legislation should be clearly understood and accepted within the Australian mining industry as the minimum standard required, which best practice should adhere to and exceed where possible.

Future mine closure legislation should be framed to provide a clear and transparent process which is accessible and protects the interests of relevant stakeholders with a regulated consultation and stakeholder engagement process. Mine closure legal frameworks should be non prescriptive and specify objectives

to be attained and legal requirements which regulate mine closure and rehabilitation procedures. The mining industry, due to the possible environmental, economic and social impacts that can occur as a result of poor and inefficient mine closure, requires specific mine closure standards that are acceptable, achievable and enforceable. Mining legislation should include mechanisms which detail codes of practices and industry standards that are able to regulate and control mining operations and develop requirements for mine closure and completion. Mine closure control provides a legal framework which can assist in the establishment of industry standards and best practice procedures.

A legal and regulatory framework for mine closure should clarify issues associated to mine closure planning as part of the initial mine approval process. Mining legislation should be developed to effectively control and regulate mine closure process within the initial mine assessment and approval process. Legal frameworks for mine closure should specify mine closure procedures to ensure that effective and meaningful consultation occurs with relevant stakeholders as part of mine closure preparation and planning. The legal framework for mine closure should include regular updates, monitoring and reviewing of performance criteria of the mine closure planning throughout the life of mine operations. Mining legislation should include specifications and mine closure requirements and allocate responsibilities for the provision of adequate financial resources to cover closure costs.

Mining legislation should recognise the need for specific mine completion criteria which reflects the environmental, social and economic impacts associated with the Australian mining industry. Mine completion criteria provides the basis on which successful rehabilitation is determined, and should be developed in consultation with stakeholders. The development of specific mine completion criteria ensures that the end of land use objectives are identified within initial mine planning and development. Mining legislation, control and standards should incorporate sustainable mining objectives and recognise the need for a regulated

and controlled mining industry. Mine closure specific legislations provides an opportunity for specific controls which regulate the mine closure and rehabilitation practices within the Australian mining industry.

Conclusion

The Australian mining industry recognises the influence and impact of mining legislation and regulations on mine closure and rehabilitation practices. However there still remains the need for a controlled mining industry, where mine closure, rehabilitation and completion practices and procedures are regulated and enforced through specific mine closure legislation and legal frameworks. In order for sustainable mining industry to be realised and implemented within the Australian mining industry, further assessment and analysis of effective mine closure standards and practises are required.

Mining for closure encompasses the definition of a vision of the end result for mining land that establishes completion criteria and objectives for implementation, and ensures inclusion of environmental, social and economic aspects in the planning for mining operations. Mine closure planning should be regulated to form an integral part of mining operations which is reviewed throughout the pre mine planning process, operations and development, mine closure and post mine land use development. The Australian mining industry and relevant government organisations need to develop a better understanding of past mining and closure procedures and the issues that influenced abandoned, derelict and orphaned mine sites.

Appropriate planning and adequate provision for mine closure is an issue which needs to be addressed by both regulators and the mineral industry across Australia. In addition mine closure regulations and legal frameworks which establish requirements for stakeholder involvement, mine closure planning and financial provisions are required for the establishment of a sustainable Australian mining industry. Australian mining companies and relevant regulatory bodies

need to acknowledge the relationship between Integrated Mine Closure Planning and its importance and relevance to the current mining industry. However its implementation and recognition is yet to be fully realised, and so initiatives need to be established for further research into the implementation of sustainable mining practices, policy and legislation, in order to improve mine closure, completion and rehabilitation practices throughout Australia.

Chapter Six

Conclusion

Introduction

The purpose of this thesis has been to examine mine closure practices and procedure and current mining legislation within the context of establishing a regulated and controlled mining industry which encompasses the objective of sustainable mining industry. Specifically the thesis analysed current mine closure practices and case study examples of mine closure and rehabilitation, and assessed current mining legislation and legal frameworks that are applicable to mine closure practices and procedures within Australia. The thesis research adopted the rationale that mining for closure requires the recognition that mining is a temporary land use, however the nature of potential impacts can be exceedingly long term, and so mining is a sustainability issue not just an environmental issue (Clark et al, 2000) .

The thesis identified the fundamental importance of site rehabilitation and rehabilitation which aims ensure that the closure of a mine will not compromise environmental quality in the future and will not limit the extent of any prospective liabilities for both operator, the government and the community (Sasson, 1996). The development of a sustainable mining industry is dependent on the development of a regulated and controlled mining industry. The subsequent findings and implications of the research are summarised in this chapter, which also details policy and best practice recommendations for the future of sustainable mining practices within Australia.

The Findings – What Next for the Australian Mining Industry

Successful mine closure is premised on the establishment of transparent and complete consultation between all relevant stakeholders during the closure planning, implementation and design feasibility processes. It is fundamental to ensure that mine closure planning and implementation are part of an integrated mine plan and are identified and considered throughout the entire operational phases of the mine. Mine closure planning is not limited to the end of the mine

site process: it is important to recognise the need to consider mine site closure within initial mine site development, planning and design.

The mine closure plan and the operational processes of the mine site must be regulated and controlled, and enforceable by the appropriate regulators during mining operations, mine closure and post closure phases. The most effective mine closure plans are those that are integrated with the long term operational plans for the mine and are subject to regular review and monitoring to accommodate regulatory, technological and economic change. Integrated Mine Closure Planning, the conceptual framework which incorporates the objectives of best practice mine closure, must incorporate social, environmental and economic aspects. An integrated approach to mine closure must ensure that the communities are consulted and that planning is conducted within initial mine site development process and integrated throughout the entire operational period of the mine.

Planning for mine closure is fundamental to the responsible operation of a mine and successful mine site completion and rehabilitation. The objective of mine closure planning is to prevent or minimise adverse long term environmental, social and economic impacts, and to establish a self sustaining ecosystem or land use based on an agreed set of objectives. Mine closure is a continuous series of operations that should commence within initial mine site development and feasibility assessment prior to project commencement. Successful mine closure planning identifies the environmental, economic and social influences of mining within a holistic approach to mine site operations and mine closure. The regulation and establishment of mine site closure requirements and standards will result in the development of a sustainable mining industry.

The development of best practice principles which provide specific standards for mine closure need to be acknowledged and accepted, by both regulating authorities and the Australian mining industry. Best practice mine closure standards should provide greater consistency and standardisation of mine

closure practices and requirements within the mining industry. Mining legislation provides the legal mechanism for which such best practice mine closure procedures and standards are able to be enforced by. An integrated approach to mine closure planning is required which identifies a holistic approach to mine closure and incorporates the involvement of stakeholders, mining companies, government and communities. Successful mine closure requires mining companies to assume and recognise their responsibility for the long term sustainability and continued monitoring of close mining operations.

It apparent, in the development of recent mining legislation and control that state and Commonwealth regulators have now recognised that mine closure planning, is more then the environmental protection and completion of mining operations. Mine closure was largely regarded by the mining industry, and until recently by most governments, as primarily an environmental issue which failed to adequately recognise its economic and social implications. Recently, the emphasis for management of the environmental aspects of mine closure and decommissioning identified the need for an integrated approach to mine closure planning. The mining industry, due to the possible environmental, economic and social impacts that can occur as a result of poor and inefficient mine closure, requires specific mine closure standards that are acceptable, achievable and enforceable.

The thesis research and data has identified that the Australian mining industry, understands and recognises the relationship between sustainable mining operations and the regulation of an integrated approach to mine closure planning. However, additional research is required into the implementation of sustainable mining objectives and mine closure legislation within the Australian mining industry to ensure that in the future proposed mining operations are conducted in environmentally, social, and economically sustainable manner.

Recommendations and Findings

The Australian mining industry needs to embrace the concept of completion of mining as a defined end point rather than just closure when the operational stage of a mine ceases and mine site decommissioning is complete. Inadequate and non existent mine closure practices have presented a significant legacy of derelict and abandoned mine sites and inadequately closed mines. The thesis research has identified best practice responses and particular issues which are required to be address in order to establish a sustainable mining industry and further develop the conceptual framework of integrated mine closure.

- Planning: Mine closure planning should be integrated within the overall mine operations plan, and should be integral to the operational life cycle of a mine. Planning for mine closure should commence at the feasibility phase of mine operations, which allows mining operations to identify future constraints and costs of mine closure.
- Financial Provision: Financial provisions and assurances ensure that the costs of mine site closure are adequately represented and identified by the mining company and guarantees that the mining company is liable for all cost incurred as a result of the mine site closure and rehabilitation.
- Legislation and Control: Should be developed to effectively control and regulate mine closure process within the initial mine assessment and approval process. Legal frameworks for mine closure should specify mine closure procedures to ensure that effective and meaningful consultation occurs with relevant stakeholders as part of mine closure preparation and planning.
- Stakeholder Involvement: Community consultation and stakeholder involvement should commence within the initial stages of mine planning, and continue throughout the operational period of the mine site and occur during mine closure and completion. Successful stakeholder engagement and community consultation needs to be

integrated within the overall mine operations and closure processes. Stakeholder involvement and community consultation is a continuous process that should occur throughout the entire operational period of the mine. Stakeholder involvement provides an opportunity to develop innovative approaches to long term post mine land uses.

The Australian mining industry in conjunction with the relevant government organisations needs to develop mine closure specific guidelines and standards for mine closure and rehabilitation that addresses the principles of stakeholder involvement, planning, financial provisions, implementation, standards and relinquishment. The development and implementation of improved mining legislation provides an opportunity for the establishment of sustainable mining practices which are regulated and controlled. The Australian mining industry, in cooperation with the relevant government organisations needs to develop specific mine closure and mine completion regulations and supporting best practice standards. Mine closure practices need to be better regulated to ensure that the industry operates in an environmentally, economic and socially sustainable manner.

Further Research

The interview respondents acknowledged the importance of fiscal bond agreements and assurances, stakeholder engagement and mine closure planning. The thesis project identified the need for further assessment and understanding of international legislation and mine closure practices. Future government initiatives and mining legislation should incorporate examples of best practice international mining legislation.

The further development of standardised and consistent relinquishment and completion criteria, which detail specific standards and requirements for successful mine closure and completion. The development of mine closure instruments which detail best practice mine site completion and ccompletion

criteria can provide standards and requirements which determine the success of mine rehabilitation. Further studies should explore international examples of mine site relinquishment and completion criteria, which would provide an opportunity for the development and implementation of Australian best practice mine closure procedures. This should ensure that there is clear accountability and adequate resources for the implementation of mine closure planning within Australia.

There is an opportunity to further explore best practice mine closure practices to assist in the development of standardised and consistent mining legislation. The respondents identified the current inefficiencies and discrepancies of Commonwealth and State Government mining legislation, which established the main components which are fundamental to successful mine closure. Additional studies should explore the constraints and opportunities for the development of sustainable mining practices and procedures and provide recommendations for best practice measures to ensure implementation and monitoring of integrated mine closure planning within the Australian mining industry.

Conclusion

Successful mine closure planning and restoration ensures that the closure of a mine will not compromise environmental, social and economic benefits of mine site operations, during and after mine site closure, and limits the extent of any prospective liabilities for both operator, the government and the community. (Sassoon, 1998). The development of a regulated, controlled mining industry provides an opportunity to establish improved mine closure planning practices and mine site rehabilitation procedures. Mine closure planning should be regulated to form an integral part of mining operations which is reviewed throughout the pre-mine planning process, operations and development, mine closure and post mine land use development.

The assessment of the relationship between the mining industry and relevant mining legislation and control has identified the opportunities for improved mine

closure planning, rehabilitation and mine site completion. Successful mine planning for environmental protection avoids or minimises potentially adverse environmental impacts during the operational period of the mine and once mining operations have ceased. Mining for closure is a fundamental component to ensure successful mine site completion and rehabilitation. The process must integrate community expectations and concerns, governmental requirements, and profitability of the mining project, while minimising the environmental, social and economic impacts.

This thesis has comprehensively examined past mine closure practices and previous examples of abandoned, orphaned and derelict mine sites as a means of establishing best practice mine closure procedures. The Australian mining industry was previously unregulated or controlled; the relevant government agencies had failed to develop effective legal mechanisms which control mine closure procedures and standards. The Commonwealth and state governments in conjunction with the Australian mining industry need to develop a regulated and controlled mine closure and completion process. The regulation and control of mine site operations, closure and rehabilitation need to be policed through the adoption of best practice standards to ensure that the industry operates in an environmentally, economic and socially sustainable manner.

In particular, the thesis examined the conceptual framework of Integrated Mine Closure Planning as the fundamental response to successful mine closure and mine site completion. In addition, recommendations have been provided as to how mine closure planning practices, mine site rehabilitation and mining legislation and controls can be improved. The thesis has demonstrated the need for the improved mining legislation, which establishes consistency in terms of mine closure planning and completion procedures and regulation specifically pertaining to mine site closure.

The Australian mining industry and relevant government organisations have failed to develop comprehensive best practice standards and mining legislation

respectively, which regulates and controls mine closure planning and completion. The current inefficiencies in mine closure planning and mining legislation illustrate the need for an improved mining industry which encompass a sustainable mining industry and incorporate the social, environmental and economic considerations within the overall mine site operations, closure and completion practices.

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Interview Participants Included:

- Peter Doyle, interview conducted on;13-08-07
- Gordon Kirkby, interview conducted on;16-08-07
- David Laurence, interview conducted on;22-08-07
- Brett McLennan, interview conducted on'23-08-07