



Factors Contributing to Unsuccessful Rehabilitation: A Case Study Investigating the Rehabilitation Practices in Opencast Coal Mines in the Mpumalanga Province, South Africa

By

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ABSTRACT

The coal mining industry has played a significant role in the development of the South African economy. Coal supplies about 70% of South Africa's primary energy and is likely to remain the country's major source of energy despite the increasing trends towards renewable energy. Even though the industry has significantly contributed to the development of the country, it has also caused significant impacts on the environment with concomitant socio-economic impacts. Historically, once a coal measure was exhausted, mining companies would cease production and abandon the mines without proper rehabilitation of the environmental degradation caused by their mining activities. As a result of this, the South African government introduced mining and rehabilitation legislation to mitigate the environmental and associated socio-economic impacts of mining. Rehabilitation guidelines for opencast coal mines were developed to provide detailed guidance for achieving successful and sustainable rehabilitation, to mitigate pollution post-mining. Despite the legislative framework, the development of international standard rehabilitation guidelines and inclusion of sustainable development principles in governance structures and mining company procedures, successful mine rehabilitation remains a challenge. This research project aims to develop a better qualitative understanding of the factors that contribute to unsuccessful rehabilitation in the case of opencast coal mines in the Mpumalanga Province of South Africa. The dissertation draws on a comprehensive review of published literature and an analysis of semi-structured interviews with rehabilitation experts. The study found that the current rehabilitation practices in the Mpumalanga opencast mines are not to the standard required by the legislative framework nor prescribed by rehabilitation guidelines. As such, the current rehabilitation practices are not yielding successful and sustainable rehabilitation. According to the findings, the rehabilitation practices are hampered by physical and non-physical systemic challenges that thwart the achievement of successful rehabilitation. The study analysis shows that shortcomings in the application and enforcement of the legislative framework contributes to the legislation not achieving its intended objectives as well as the development of other physical and non-physical systemic challenges that hamper the achievement of successful rehabilitation.

STATEMENT OF ORIGINALITY

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TABLE OF CONTENTS

| | |
|--|------|
| ABSTRACT..... | i |
| STATEMENT OF ORIGINALITY..... | ii |
| ACKNOWLEDGEMENTS..... | iii |
| LIST OF FIGURES..... | vii |
| LIST OF TABLES..... | viii |
| ABBREVIATIONS AND ACRONYMS..... | viii |
| CHAPTER 1..... | 1 |
| INTRODUCTION..... | 1 |
| 1.1 Background..... | 1 |
| 1.2 Problem Statement..... | 4 |
| 1.3 Scope of Study..... | 4 |
| 1.4 Dissertation Structure..... | 4 |
| CHAPTER 2..... | 6 |
| LITERATURE REVIEW..... | 6 |
| 2.1 Mining and the Impacts of Mining on Landscapes..... | 6 |
| 2.2 Mine Rehabilitation..... | 9 |
| 2.3 Mine Rehabilitation Guidelines..... | 14 |
| 2.3.1 International Council on Mining and Metals (ICMM) Integrated Mine Closure Guidelines 14 | |
| 2.3.2 South African Land Rehabilitation Guidelines for Surface Coal Mines..... | 17 |
| 2.4 Land Capability..... | 20 |
| 2.5 Overview of Mining and Rehabilitation Legislation in South Africa..... | 24 |
| 2.5.1 Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002..... | 25 |
| 2.5.2 National Environmental Management Act (NEMA) 107 of 1998..... | 26 |
| 2.5.3 Other Legislation Relevant to Rehabilitation and Mine Closure..... | 28 |
| 2.5.4 The One Environmental System..... | 30 |

| | | |
|--|---|----|
| 2.6 | Current State of Mine Rehabilitation in South Africa..... | 30 |
| 2.7 | Summary and Synthesis | 32 |
| CHAPTER 3 | | 34 |
| METHODOLOGY | | 34 |
| 3.1 | Research Questions | 34 |
| 3.2 | Study Approach..... | 35 |
| 3.2.1 | Description of the Interview Participants | 35 |
| 3.2.2 | Description of the Mining Companies | 37 |
| 3.2.3 | Interview Process | 37 |
| 3.3 | Ethics..... | 38 |
| 3.4 | Case Study Area | 39 |
| 3.4.1 | Coal Mining in the Mpumalanga Province | 39 |
| 3.4.2 | Agricultural Context of the Mpumalanga Province..... | 40 |
| CHAPTER 4 | | 45 |
| RESULTS AND DISCUSSION..... | | 45 |
| Rehabilitation Expert Perspectives and Experiences | | 45 |
| 4.1 | Progression and Standard of Rehabilitation Practices | 45 |
| 4.2 | Application and Relevance of Rehabilitation Practice Guidelines | 47 |
| 4.3 | Rehabilitation Challenges | 49 |
| 4.3.1 | Shortage of Topsoil..... | 51 |
| 4.3.2 | Soil Compaction..... | 52 |
| 4.3.3 | Secondary Subsidence | 52 |
| 4.3.4 | Legislation..... | 53 |
| 4.3.5 | Corporate Culture and Priorities | 55 |
| 4.3.6 | Lack of Capacity and Expertise | 56 |
| 4.3.7 | Limited Cross-Sectoral Collaboration | 58 |

| | |
|--|----|
| 4.3.8 Lack of Clear Long-Term Rehabilitation Objectives | 59 |
| 4.4 Gaps and Opportunities | 60 |
| 4.5 Summary and Synthesis | 63 |
| CHAPTER 5 | 66 |
| CONCLUSIONS AND RECOMMENDATIONS | 66 |
| 5.1 Summary and Analysis of Key Research Findings | 67 |
| 5.1.1 Progression and Standard of Rehabilitation Practices | 67 |
| 5.1.2 Relevance and Application of the South African Land Rehabilitation Guidelines for Opencast Coal Mines | 67 |
| 5.1.3 Rehabilitation Challenges | 68 |
| 5.1.4 Rehabilitation Practices Gaps | 70 |
| 5.1.5 Rehabilitation Practices Opportunities | 70 |
| 5.2 Concluding Remarks | 71 |
| 5.3 Recommendations | 71 |
| REFERENCES | 73 |
| APPENDICES | 82 |
| Appendix A: Informed Consent Form | 82 |
| Appendix B: Interview Questionnaires..... | 83 |
| B.1 Mine Representative Interview Questionnaire | 83 |
| B.2 Specialist Consultant Interview Questionnaire | 84 |
| B.3 DMRE Representative Interview Questionnaire..... | 85 |
| B.4 DPME Representative Interview Questionnaire | 85 |
| Appendix C: Ethics Clearance | 86 |

LIST OF FIGURES

| | |
|---|----|
| Figure 1-1: Schematic illustrating the dissertation structure | 5 |
| Figure 2-1: Basic schematic representation of a lifecycle of a mine | 6 |
| Figure 2-2: Aerial photos of opencast coal mine operations in Mpumalanga | 7 |
| Figure 2-3: Tension cracks representing the primary impact of surface subsidence and a sinkhole also showing openings into underground workings | 8 |
| Figure 2-4: Integration of land rehabilitation through the various stages of a mining life cycle | 12 |
| Figure 2-5: Stages of rehabilitation planning and implementation..... | 13 |
| Figure 2-6: Land capability classes, land use options and land capability groups | 21 |
| Figure 2-7: DAFF land capability classification of South African | 22 |
| Figure 3-1: Map of the South African Coalfields | 39 |
| Figure 3-2: Map of the South African biomes. The Grassland Biome is in the darker shade of green..... | 40 |
| Figure 3-3: Mpumalanga land agricultural capacity | 41 |
| Figure 3-4: Mpumalanga land mining potential | 42 |
| Figure 3-5: Mpumalanga operational mines and mining applications in 2012 | 42 |
| Figure 3-6: South African collieries and their respective operators | 44 |
| Figure 4-1: Schematic Illustration of the rehabilitation experts' perspectives concerning the progression of rehabilitation | 47 |
| Figure 4-2: Physical Challenges of Opencast Coal Mining Rehabilitation | 50 |
| Figure 4-3: Non-physical Challenges of Opencast Coal Mining Rehabilitation | 50 |
| Figure 4-4: Current Rehabilitation Practices Gaps identified by the interviewed Rehabilitation Experts | 61 |
| Figure 5-1: Illustration of the gaps that exist in the current rehabilitation practices (Figure created by author using stock images) | 70 |

LIST OF TABLES

Table 1: Land capability classes and associated pre-mining and post-mining classification criteria against which rehabilitation objectives should be set.....22

Table 2: Summary of Interviewed Rehabilitation Experts’ Details.....36

ABBREVIATIONS AND ACRONYMS

| | |
|--------|--|
| AMD | Acid Mine Drainage |
| BFAP | Bureau for Food and Agricultural Policy |
| CARA | Conservation of Agriculture Act |
| CCSI | Columbia Centre for Sustainable Investment |
| CEP | Closure Execution Plan |
| CER | Centre for Environmental Rights |
| COF | Certificate of Fitness |
| CSR | Corporate Social Responsibility |
| CTL | Coal-to-Liquids |
| DALRRD | Department of Agriculture, Land Reform and Rural Development |
| DEA | Department of Environmental Affairs |
| DEFF | Department of Environment, Forestry and Fisheries |
| DMRE | Department of Mineral Resources and Energy |
| DPME | Department of Planning, Monitoring and Evaluation |
| DWS | Department of Water and Sanitation |
| EBE | Engineering and the Built Environment |
| EIA | Environmental Impact Assessment |
| EiRC | Ethics in Research Committee |
| EMP | Environmental Management Plan |
| GDP | Gross Domestic Product |

| | |
|---------|--|
| GN | General Notice |
| GNR | General Notice Regulation |
| ICMM | International Council on Mining and Metals |
| IEA | International Energy Agency |
| LaRSSA | Land Rehabilitation Society of Southern Africa |
| LOM | Life-of-Mine |
| LPSDP | Leading Practice Sustainable Development Program |
| MDGs | Millennium Development Goals |
| MHSA | Mine Health and Safety Act |
| MPRDA | Minerals and Petroleum Resources Development Act |
| MRDs | Mine Residue Deposits |
| Mt | Million Tonnes |
| MWA | Mines and Works Act |
| NEMA | National Environmental Management Act |
| NEM:AQA | National Environmental Management Air Quality Act |
| NEM:BA | National Environmental Management Biodiversity Act |
| NEM:WA | National Environmental Management Waste Act |
| NWA | National Water Act |
| OES | One Environmental System |
| OHSA | Occupational Health and Safety Act |
| PGMs | Platinum Group Metals |
| ROM | Run-of-mine |
| RMF | Responsible Mining Foundation |
| SDGs | Sustainable Development Goals |
| SEMAs | Supporting environmental management acts |
| SLP | Social and Labour Plan |

| | |
|--------|---|
| SMART | specific, measurable, achievable, relevant and time-bound |
| SPLUMA | Spatial Planning and Land Use Management Act |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environmental Program |
| WCED | World Commission on Environment and Development |
| WEF | World Economic Forum |
| WWF | World-Wide Fund for Nature |

CHAPTER 1

INTRODUCTION

1.1 Background

The metals and minerals industry contributes significantly to national economic development worldwide, through its contribution to government revenues and the creation of employment (Ericsson and Löf, 2019). According to the third edition of the International Council on Mining and Metals' (ICMM) '*role of mining in national economies*' (2016), economic development in low- and middle-income countries depends significantly on mining. Research by Ericsson and Löf (2019) also demonstrated progress in socio-economic development indicators of the low- to middle income mineral-rich countries. South Africa has an abundance of mineral resources; with the largest known reserves of platinum-group metals (PGMs; 88%), manganese (80%), chromite (72%) and gold (13%) in the world¹. It is ranked second in Titanium minerals (10%), Zirconium (25%) and Vanadium (32%)¹. South Africa also mines coal, iron ore, diamonds and copper amongst many other mineral resources (Minerals Council of South Africa, 2020). The South African mining industry has come a long way since the construction of the first mine in 1852, a copper mine in Springbok in the Northern Cape (Casey, 2019). The mining industry has been pivotal in the development of South Africa and remains instrumental in the country's economy. Despite a decline in its contribution to the Gross Domestic Product (GDP) over the years, with a peak of 21% contribution to the GDP in 1970, the mining sector continues to contribute significantly to the South African economy. Particularly in the creation of employment, economic activity and foreign exchange earnings (StatsSA, 2017; Antin, 2013). In 2019 the mining industry contributed approximately R361 billion towards the GDP, an estimated 8.1% of the overall GDP (Minerals Council of South Africa, 2020). In addition, the mining sector employed 454 861 people and contributed approximately R95 billion to fixed investments (Minerals Council of South Africa, 2020).

Globally, coal accounts for approximately 27% of the energy used and about 38% of electricity generated. It also plays a significant role in the iron and steel industries (IEA, 2018). South Africa hosts approximately 3.5% of the world's coal resources and is the seventh largest coal-producing nation in the world (Smith, 2018). South Africa has a mature coal mining industry, that can be traced back to the dawn of gold mining in the late 19th century where it played an

¹The South African mining sector. Available from <https://www.wits.ac.za/wmi/about-us/the-south-african-mining-sector/>, accessed 10/07/2020.

instrumental role in providing energy to the growing gold mining industry (Jeffrey *et al.*, 2014). Coal supplies about 70% of South Africa's primary energy (Minerals Council of South Africa, 2018). It is an abundant, affordable, safe and secure source of energy; which increases the likelihood of it being a preferred energy source in a country with an increasing demand for energy and an economy characterised by significant levels of poverty and inequality (Akinlabi *et al.*, 2019). Despite the increasing trends towards renewable energy, coal is likely to remain the country's preferred source of energy (Minerals Council of South Africa, 2018). About 80% of the electricity generated by state-owned power generator, Eskom, is from coal-fired power stations. It is also estimated that coal provides 25-30% of liquid fuels through the conversion of coal-to-liquids (CTL) by Sasol (Minerals Council of South Africa, 2018). According to the Minerals Council of South Africa (2020), coal is the country's largest component of mining by sales. In 2019, the total coal sales amounted to about R139 billion and approximately 260 million tonnes (Mt) of coal was produced, 39% of which were exported. The coal mining industry had 92 230 direct employees in 2019, 20% of the total number of people employed in the mining sector (Minerals Council of South Africa, 2020).

Despite the mining industry's significant contribution to the economy, it is widely criticised for its negative impacts on the environment, both locally and globally (ICMM, 2016; Mabey *et al.*, 2020). Mining, particularly opencast (surface) mining causes significant alterations to the environment (Kuter, 2013). Some of the environmental impacts of mining include the disturbance of landscape and drainage systems, soil erosion, air and water pollution, as well as loss of biodiversity (Nzimande and Chauke, 2012). These environmental impacts in turn affect human health and habitation² (Kuter, 2013). To mitigate some of the adverse impacts of mining, it is vital that mine sites are rehabilitated to a state that is safe, non-polluting and capable of supporting stipulated post-mining land use (Manero *et al.*, 2020). Over a hundred years of coal mining in the Mpumalanga Province has resulted in extensive negative environmental and social externalities (CER, 2018). Historically, once coal reserves were depleted mining companies would terminate production, pack up and abandon the mines without proper rehabilitation of the environmental degradation caused by their mining activities (Limpitlaw and Briel, 2014). Previous studies, including those by the Benchmarks Foundation (2014) and Shongwe (2018), highlight some of the historic impacts of coal mining on the environment and the wellbeing of citizens in the Mpumalanga Province. The impacts of poorly rehabilitated or unrehabilitated coal mines have long-lasting effects that pose daily threats on

² "Habitation" refers to a place of human occupancy or dwelling (Merriam-Webster dictionary).

the environment and human health long after mining operations have ceased (Benchmarks Foundation, 2014). According to a case study by Shongwe (2018); which details community experiences and concerns over the environmental and social impacts of coal mining in the Mpumalanga Province; degradation and the loss of soil fertility that affect land use and quality of crop production are a major issue for communities concerning impacts on land. Community members also report that coal mining causes air pollution as a result of the dust generated by active mining operations as well as gaseous emissions from spontaneous combustion of mineral residue deposits and old mine workings (Shongwe, 2018). Water quality, affected by acid mine drainage and air pollutants from coal mining, is another major concern amongst community members (CER, 2018). The environmental impacts, particularly the air and water pollution, have been reported to affect human health (Shongwe, 2018). Studies indicate that that exposure to pollutants contained in coal may be associated with respiratory and cardiovascular diseases (Olufemi *et al.*, 2019).

In an effort to mitigate the environmental and social impacts of mining, stringent legislation around mine closure and rehabilitation, including the financial provisioning policies, have been implemented by Governments globally (Blommerde *et al.*, 2015). The South African government, like other mineral producing nations across the globe, has introduced increasingly stringent mining legislation over the past three decades and incorporated sustainable development principles in its policies to address mining legacies and minimise the environmental and social impacts of mining (Watson and Olalde, 2019). In South Africa, mine closure and rehabilitation activities are primarily regulated under the Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002 and the National Environmental Management Act (NEMA) 107 of 1998 (McKay and Milaras, 2017). In line with the efforts to encourage rehabilitation of mine sites, the Chamber of Mines (now referred to as the Minerals Council of South Africa) published rehabilitation guidelines to provide mining companies with detailed and “best practice” guidance for rehabilitation, particularly opencast coal mining rehabilitation (Tanner, 2007). These guidelines have been updated as the legislation and sustainable development principles evolved.

Despite the implementation of legislation and development of rehabilitation guidelines, successful rehabilitation and mine closure remain a challenge in South Africa (Perkins *et al.*, 2020). In 2017, an estimated 5700 derelict and ownerless mines that need to be rehabilitated across the country were identified. No mine closure certificates were issued under the Minerals Act of 1991 or the MPRDA between 2011 and 2016 (van Druten and Bekker, 2017). This is

evidence that effective rehabilitation remains a challenge and therefore closure is not attained as envisaged by legislation (Watson and Olalde, 2019). According to the law, closure is attained and a closure certificate issued when a mine is rehabilitated to an agreed standard by the rights holder and an application for closure made (Watson and Olalde, 2019). Whilst studies highlight a number of systemic issues and challenges in terms of effective rehabilitation in South Africa, the current status and challenges in terms of the rehabilitation of opencast coal mines in Mpumalanga are still not receiving the detailed attention they require (Shongwe, 2018).

1.2 Problem Statement

Coal mining has been and continues to be a significant driver of development in South Africa, particularly in the Mpumalanga Province. However, the nature of coal mining, especially opencast coal mining, is destructive and has negative environmental and socio-economic impacts. A lack of or poor rehabilitation to a large extent contributes to these impacts. Despite increasingly stringent rehabilitation and mine closure laws, the inclusion of sustainable development principles in government and mining company policies and the development of rehabilitation guidelines, the achievement of successful mine rehabilitation remains a problematic challenge in the South African mining sector. There is a need to understand the factors that contribute to the challenge of ineffective rehabilitation, in an attempt to tackle the issue and therefore alleviate its environmental and socio-economic impacts.

1.3 Scope of Study

The overarching aim of this study is to develop a better qualitative understanding of the factors that contribute to unsuccessful rehabilitation in the case of opencast coal mines in the Mpumalanga Province of South Africa. This is achieved by conducting semi-structured interviews with rehabilitation experts who work on coal mining rehabilitation in their roles within mining companies, as rehabilitation consultants, or within government departments. The findings of this study are based on the experiences and perspectives of these experts; with specific focus on the progression and standard of rehabilitation practices, the application and relevance of rehabilitation practice guidelines, the factors constraining effective rehabilitation, and opportunities that can be leveraged to improve the rehabilitation practices and outcomes.

1.4 Dissertation Structure

This dissertation is presented in five chapters (Figure 1-1), that are outlined below.

Chapter 1 gives an introduction of the study, a background to the problem statement and also presents the overarching aim, as well as the scope of the study.

Chapter 2 reviews and analyses published literature. This includes literature on the impacts of mining throughout the mining lifecycle, methods of coal extraction and their impacts on the environment. Literature on mine rehabilitation: the definitions, approaches and stages. Literature on international and local rehabilitation guidelines. A review of the South African mining and rehabilitation legislative framework. Finally, a review of the literature on the systemic challenges that inhibit successful rehabilitation and mine closure.

Chapter 3 presents the research questions, outlines the study methodology and details the stakeholder interview process, which includes an introduction of the interviewed rehabilitation experts. The case study area is also presented in this chapter.

Chapter 4 presents the results and discussion of the semi-structured interviews with the rehabilitation experts.

Chapter 5 presents a synthesis of the findings of the study, draws conclusions and makes recommendations for further studies and industry actions.

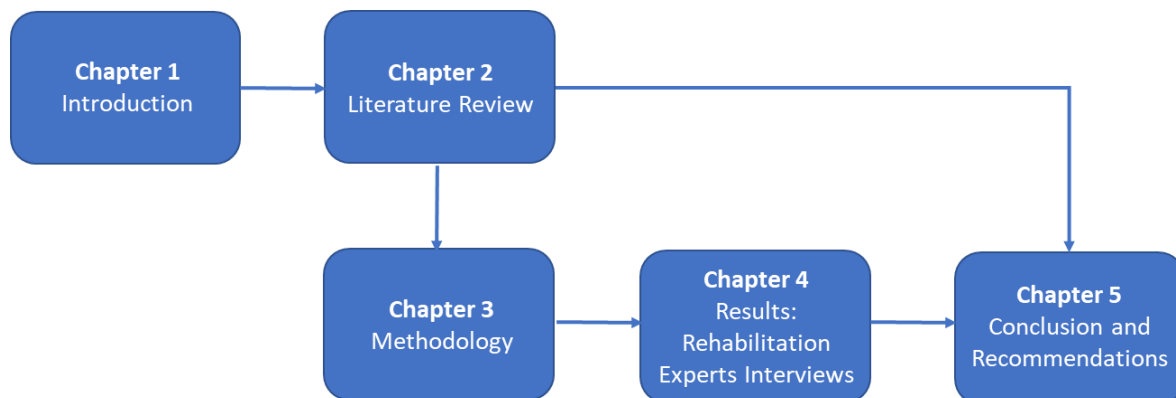


Figure 1-1: Schematic illustrating the dissertation structure

CHAPTER 2

LITERATURE REVIEW

Chapter 1 introduced the study by means of a background to the problem statement and presented the aim and scope of the study, as well as the structure of the dissertation. This chapter gives a review of literature on the land alteration caused by mining throughout the lifecycle of a mine, the impacts of coal mining on landscapes, mine rehabilitation, mine rehabilitation guidelines, mining and rehabilitation legislative framework and the current state of mine rehabilitation in South Africa.

2.1 Mining and the Impacts of Mining on Landscapes

The nature of mining is destructive to the ecological and aesthetic values of landscapes (Kuter, 2013). Some of the parameters affected by mining include topography and drainage; air, soil and water quality; noise levels and ground vibrations; as well as human health and habitation (Kuter, 2013). Mining and its related activities cause significant land alteration as a result of the deforestation, building of infrastructure, excavation and the storing of waste material (Shongwe, 2018). This land alteration often results in land degradation; which is defined by UNEP (2015) as the reduction or loss in the biological and/or economic productive potential of land. Land degradation can be temporary or permanent and is generally a result of human activities that is exacerbated by natural processes (UNEP, 2015). Land degradation is characterised by soil erosion, loss of vegetation and increased surface runoff and water contamination (Mbaya, 2013). Land alteration occurs throughout the life cycle of a mine (Figure 2-1), from exploration to closure (Sakuwaha, 2018). During the advanced stages of geological exploration, vegetation and topsoil are removed to conduct surveys; causing local land alteration. Multiple exploration studies in the same area can result in significant land alterations. During the development phase, more land alteration takes place during the construction of infrastructure (Sakuwaha, 2018).



Figure 2-1: Basic schematic representation of a lifecycle of a mine

During the extraction phase of the life cycle of a mine, further land alteration occurs as the mineral ore is extracted from the ground through opencast (surface) and underground

operations (Sakuwaha, 2018). In the case of coal mining, coal is mainly mined through opencast mining (~53%), underground bord-and-pillar mining (~40%), stoping (4%) and longwall mining (3%) (Jeffrey *et al.*, 2014). The opencast method, which is employed when the coal reserves lie at relatively shallow depths, is the preferred method because it is cheaper, safer and allows optimal exploitation of coal reserves. In instances where the coal seam depths occur within ranges that safely allow opencast mining (0-75m), underground mines are converted to opencast mines to achieve optimum production (Jeffrey, 2005). Opencast coal mining (Figure 2-2), even though the preferred method, completely obliterates landscapes and compromises land with high agricultural land capability, ecologically sensitive environments and development in surrounding areas (Platt, 2009). The large excavations that result in large scale deforestation, removal of soil and the production of high volumes of waste rock leave an unsightly landscape (Shongwe, 2018).



Figure 2-2: Aerial photos of opencast coal mine operations in Mpumalanga (Davies, 2014)

Underground mining has fewer physical alterations to landscapes as the excavations occur below the surface (Sakuwaha, 2018). However, it has latent land degradation in the form of subsidence; the sinking of the land surface as a result of underground extraction of the coal (Shongwe, 2018). The bord-and-pillar method of underground coal mining involves leaving behind pillars of coal to support the roof and the redistributed load of the overburden (Bell *et al.*, 2001). To successfully support the roof, the pillars have to be the optimal size; if the pillars

are too small, they collapse (Heath and Engelbrecht, 2011). Slow deterioration and pillar failure may take place years after mining operations have stopped (Bell *et al.*, 2001). Subsidence features, tension cracks and sinkholes (Figure 2-3), are primary consequences of pillar failure. Secondary effects include the spontaneous combustion of the remaining coal and a negative impact on groundwater resources in the area (Heath and Engelbrecht, 2011). The formation of tension cracks and sinkholes as a result of mining subsidence, affect land use such as farming and the construction of infrastructure such as roads and buildings (Shongwe, 2018).



Figure 2-3: Tension cracks representing the primary impact of surface subsidence and a sinkhole also showing openings into underground workings (Heath and Engelbrecht, 2011)

The beneficiation process which comes after the mining, produces high volumes of waste material that is stored on the surface, causing further land alteration (Sakuhawa, 2018). The impacts of mining and its waste deposits on land can outlast the lifespan of a mine (Krause and Snyman, 2014). Given the extent of land degradation that occurs throughout the life of a mine and the major threat it imposes on high agricultural land capability, ecologically sensitive environments and development in surrounding areas, it is vital that the science and practices of rehabilitation yield successful outcomes and meet environmental sustainability objectives (Weyer *et al.*, 2017).

In a 2016 land use study, coal mining and prospecting were estimated to make up 24.5% and 54.2% of the Mpumalanga Province land use applications respectively (Shongwe, 2018). This is a significant portion of the province's land use. Opencast coal mining in the province has extensively transformed the landscape (Figure 2-2), contributing to significant land disturbance and in turn soil degradation and loss of agricultural production (Davies, 2014). Other impacts linked to the land disturbance of opencast mining in Mpumalanga include water pollution and air pollution, which have concomitant health impacts (Benchmarks Foundation, 2014). The sources of water pollution in coal mining include acid mine drainage (AMD) from mining sites,

leaching of pollutants from mineral residue deposits (MRDs) and sediment runoff from mining sites (Shongwe, 2018). Opencast mining causes air pollution through blasting, exposure of coal seams and handling of coal during transportation (Aneja *et al.*, 2012). Mining of old underground workings through the opencast mining method, increases the likelihood of spontaneous combustion of the exposed coal. Studies have shown that spontaneous combustion of the coal in the Mpumalanga Coalfields emits gases such as sulphur dioxide (SO₂), carbon monoxide (CO) and hydrogen sulphide (H₂S), which are associated with negative effects on the environment and on human health (Shongwe, 2018). The scale of the landscape devastation and its associated impacts is staggering and has adversely affected communities (Davies, 2014).

2.2 Mine Rehabilitation

Rehabilitation, in the mining context, is defined as returning land impacted by mining activity to a stable, productive, beneficial and self-sustaining condition as established in the mine plan and closure plan (ICMM, 2019). According to the mine rehabilitation handbook, *Leading Practice Sustainable Development Program for the Mining Industry*, “rehabilitation encompasses the design and construction of landforms as well as the establishment of sustainable ecosystems or alternative vegetation, depending upon desired post-operational land use” (Australian Government *et al.*, 2016). The purpose of mine rehabilitation is to achieve a safe, stable and sustainable landform that will support the next land use (Lechner *et al.*, 2016). Rehabilitation does not aim to restore the ecosystem to its pre-mining state and function but aims to reinstate the ecosystem functionality and productivity. The land use and species composition of the reinstated ecosystem may differ to that of the pre-mining state (Australian Government *et al.*, 2016; Hattingh, 2019).

A number of other terms are often used to describe the process of ‘repairing’ land disturbed by mining; including restoration, remediation and reclamation (Limpitlaw and Briel, 2014). Globally, the term *rehabilitation* is sometimes confused and interchangeably used with these other terms; it is therefore important to clarify their definitions. Restoration is the re-establishment of an ecosystem structure and function to a copy of its pre-mining state or replication of a desired reference ecosystem (ICMM, 2019). Remediation is the environmental clean-up of land and water contaminated by organic, inorganic or biological substances; this term is commonly used in industrial-related activities such as processing and manufacturing plants (Hattingh, 2019). Reclamation is the overarching process of converting disturbed land to a different established usable state that is appropriate to surrounding land uses and conditions

(Limpitlaw and Briel, 2014). According to Hattingh (2019) rehabilitation, restoration and remediation are all aspects of reclamation.

Generally, the objectives for rehabilitation vary between the various guidelines published by Governments, mining companies and rehabilitation organisations. However, internationally there are three overarching objectives that rehabilitation should fulfil:

- The long-term stability and sustainability of the landforms, soils and hydrology of the site
- The partial or complete restoration of ecosystem capacity to provide habitats for animal and plant life, as well as services for people
- The prevention of pollution of the surrounding environment (Australian Government *et al.*, 2016).

In the South African context, the rehabilitation objectives defined in the various documents published by Government, mining companies and rehabilitation organisations generally encompass the internationally recognised objectives (Hattingh, 2019). In South Africa, rehabilitation objectives are expected to align with the Environmental Management Plan (EMP) and Closure Plan objectives and commitments. Agreement on these commitments must be reached through a public participation process before permission is granted to the mine (Tanner, 2007).

Hattingh (2019) describes the rehabilitation of land disturbed by mining as highly challenging and dynamic in nature. It requires the understanding and integration of ever-changing environmental, social, economic, political and cultural aspects (Hattingh, 2019). It is for this reason that rehabilitation requires a multi-disciplinary and integrated approach (Weyer *et al.*, 2017). Historically, minimum effort was put into land rehabilitation on mines with mining companies often aiming to merely comply with current legislation (Limpitlaw and Briel, 2014). However, the growing global awareness of the environmental impacts of mining, which in turn have significant socio-economic impacts without proper rehabilitation, has led to the integration of sustainable development principles into legislation, governance structures and mining company operating procedures (Hattingh, 2019). Rehabilitation is an integral part of a mining company's sustainable development strategies and is a key performance indicator against which the company's environmental performance is assessed (Australian Government *et al.*, 2016).

2.2.1 Progressive Rehabilitation

Rehabilitation, a very important component of mine closure, requires a continuous improvement approach throughout the mining lifecycle. This is known as progressive rehabilitation and starts before mineral extraction right through to closure (Australian Government *et al.*, 2016). Before mining, the rehabilitation process starts with integrated planning, involving the development of a rehabilitation plan. During the mining stage, one area of the mine can be rehabilitated as other areas are being mined; this is commonly known as concurrent rehabilitation (Decipher, 2019). The progressive rehabilitation that can be undertaken during mining is determined by site-specific conditions and the mine plan (ICMM, 2019). Progressive rehabilitation activities include soil management (e.g. stripping, stockpiling, placement), strategic placement of uneconomic materials (e.g. mineral residue deposits), diversion of waters unimpacted by mining, revegetation, demolition of unneeded infrastructure, improvements to water management infrastructure, and in-pit placement of waste rock material (ICMM, 2019). Post-mining, mining companies continue undertaking rehabilitation in preparation of post-closure land use. This requires continuous engagement with communities, in order to ensure that the land is reinstated in a way that also brings benefits to them (Decipher, 2019).

Studies have shown that progressive rehabilitation has several benefits. One of the benefits is that it allows mining companies to establish the effectiveness of their rehabilitation activities at operating sites and demonstrate their commitment to achieving successful rehabilitation and closure. This can enhance the operator's social licence to operate at the operational mine, as well as other sites (ICMM, 2019). Progressive rehabilitation also provides the operator an opportunity to develop valuable administrative, technical and practical experience at a smaller scale before carrying out a large scale programme during final implementation (Australian Government *et al.*, 2016). Through this, rehabilitation practices can be evaluated and improved. Better certainty in technical approaches leads to improvements in the rehabilitation plan; including feasible rehabilitation activities and cost estimates, risk reduction and enhanced definitions of success (ICMM, 2019). Another benefit of progressive rehabilitation is that it reduces the area of land disturbed by mining. This reduces the overall closure liability and the effort required at closure (ICMM, 2019).

Figure 2-4 is an illustration by Hattingh (2019) of the integration of land rehabilitation through the various stages of a mining lifecycle. The illustration highlights that rehabilitation is a critical component of a mining operation, from project planning right through to receipt of a

closure certificate. It is therefore important that monitoring of the rehabilitation and closure process is started before the land is disturbed and maintained until regulators sign-off that the mine-related site impacts are acceptable (Hattingh, 2019).

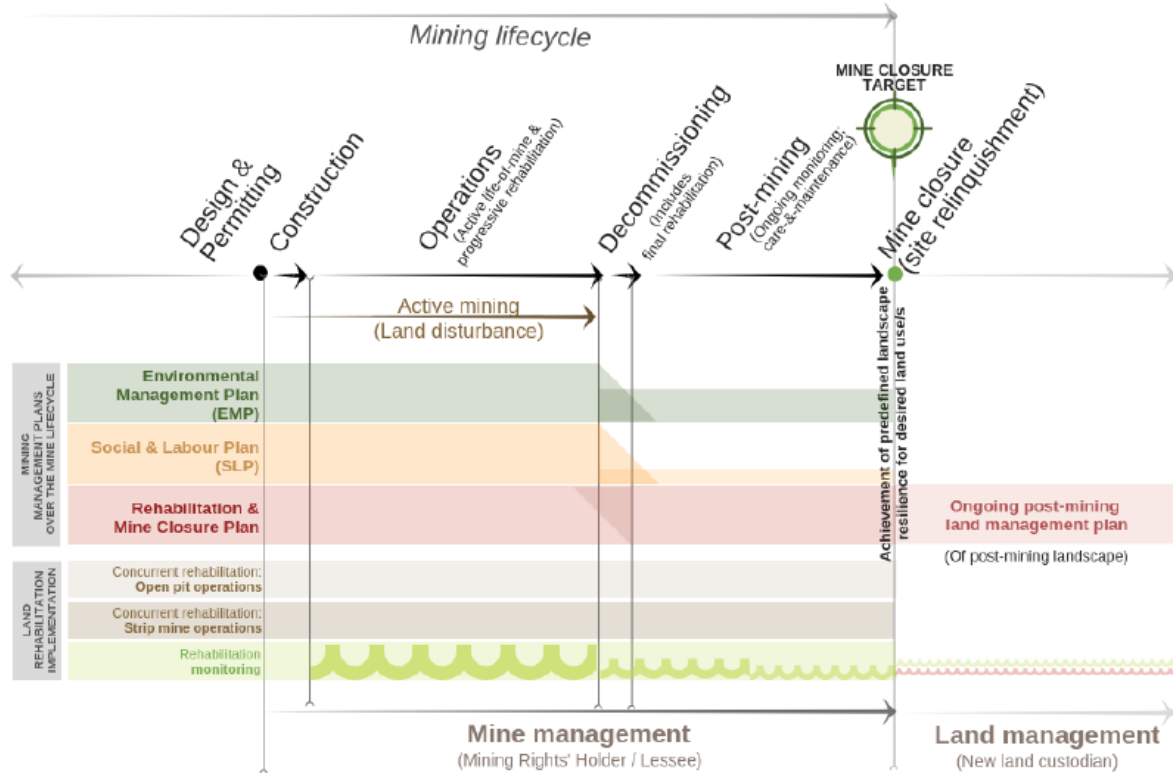


Figure 2-4: Integration of land rehabilitation through the various stages of a mining life cycle (Hattingh, 2019)

2.2.2 Rehabilitation Stages

The identification of stages of land rehabilitation, like the objectives for rehabilitation, varies between the various guidelines published by Governments, mining companies and rehabilitation organisations. There are three generic stages that are identified in most frameworks; these are the planning, implementation and monitoring stages. Specific frameworks may identify additional stages to these three. The rehabilitation stages identified in the *South African Land Rehabilitation Guidelines for Surface Coal Mines* are discussed in Section 2.3.2. Even though stages are identified in the rehabilitation process, it is important to note that the rehabilitation process is not linear but iterative; with continuous improvement to the process throughout the life of the operation (ICMM, 2019). The planning phase is very crucial as it directs the entire rehabilitation process. Early planning for rehabilitation and mine closure is vital for a successful outcome. It reduces the possibility and consequences of environmental impacts, and in turn reduces the likely unwanted operational costs and post-mining costs (Australian Government *et al.*, 2016). Rehabilitation planning must be continuous

and the plan must be improved throughout the lifecycle of the operation (ICMM, 2019). Consequently, rehabilitation planning cannot be undertaken just prior to operation decommissioning or every 3-to-5 years (Hattingh, 2019). The implementation phase involves the application of the rehabilitation plan. The monitoring phase sets out to verify that the rehabilitation activities are applied according to the plan and delivering the expected outcome. The monitoring phase also ensures that any identified corrective measures are implemented timeously (Hattingh, 2019).

Figure 2-5 illustrates the five stages of rehabilitation identified in the mine rehabilitation handbook, *Leading Practice Sustainable Development Program for the Mining Industry* (Australian Government *et al.*, 2016). Stage 1 involves defining rehabilitation objectives and targets. Stage 2 is rehabilitation planning. Stage 3 is the implementation of rehabilitation techniques; which is split into five categories: (i) landform design and construction, (ii) reconstruction of the soil profile, (iii) selection of suitable species, (iv) establishment of vegetation and (v) fauna recolonization. Stage 4 involves the process of signing off on meeting the completion criteria. Stage 5 is undertaking rehabilitation management and monitoring (Australian Government *et al.*, 2016).

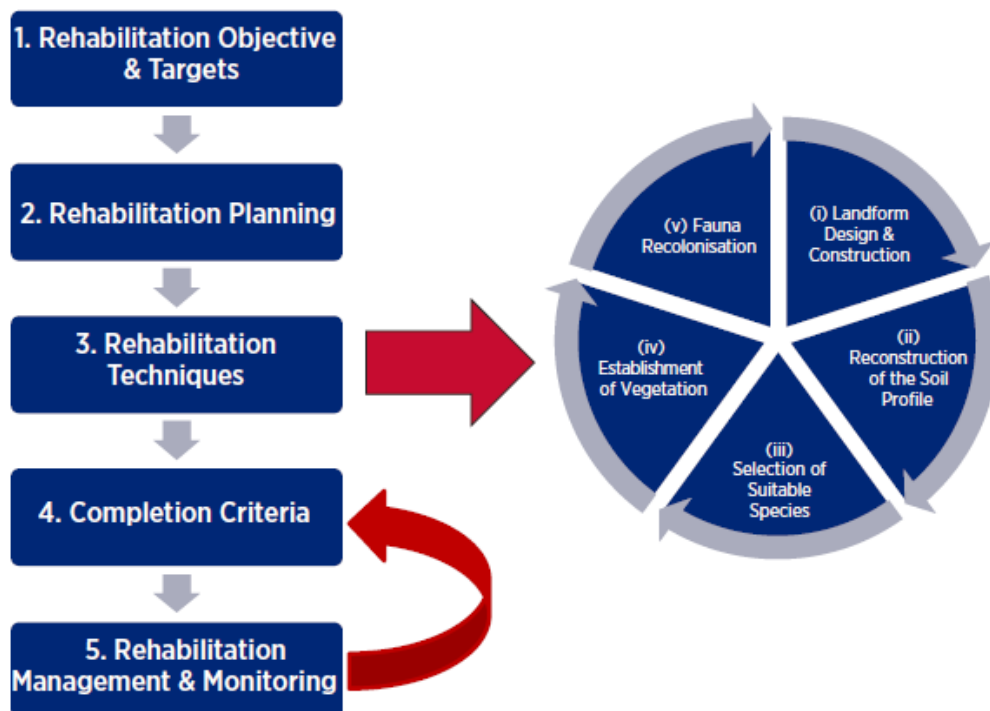


Figure 2-5: Stages of rehabilitation planning and implementation (Australian Government *et al.*, 2016)

2.3 Mine Rehabilitation Guidelines

Rehabilitation is very costly, it is therefore very important that the effort put into rehabilitation yields successful outcomes (Australian Government *et al.*, 2016). Rehabilitation guidelines are developed to assist mining companies to plan and implement successful rehabilitation programmes. There are a number of mine rehabilitation guidelines that have been published. Internationally, the International Council on Mining and Metals (ICMM) has published a few guidelines including, *Good practice guidance for mining and biodiversity* (ICMM, 2006), *Planning for integrated mine closure: toolkit* (ICMM, 2008) and *Integrated mine closure: good practice guide* (ICMM, 2019), which is an update of the 2008 toolkit. At a national level, the *Land rehabilitation guidelines for surface coal mines* (Chamber of Mines, 1981; Tanner, 2007; Hattingh, 2019) provide detailed, best practice guidance for rehabilitation of opencast coal mines. Most well-established mining companies also have their own inhouse rehabilitation guidelines.

2.3.1 International Council on Mining and Metals (ICMM) Integrated Mine Closure Guidelines

The ICMM developed the *Integrated mine closure: good practice guide* to provide mining companies with support as they plan for closure. The first edition was published in 2008 and the second and latest edition in 2019 (ICMM, 2019). The guidebook gives detailed guidelines for integrated closure planning and intends to promote the uniformity of good practices across the mining industry. It is equally applicable to small and big mining companies (ICMM, 2019). Rehabilitation is a very critical and big component of component of mine closure (Australian Government *et al.*, 2016). This guideline, although gives guidance overarchingly on mine closure, gives relevant guide for rehabilitation as well. The ICMM mine closure guide outlines sixteen fundamental elements of the dynamic process of integrated closure; these are summarised below.

- 1. Integration into life of mine planning:** closure should be part of a mine's business plan and be fully entrenched in the life of mine planning. This yields better results as expectations, risks and opportunities can be proactively managed and achieved for the mining company and stakeholders.
- 2. Knowledge base:** a knowledge base is a database compiled throughout the life of the mine, that is regularly updated as information is collected and evaluated. This information will instruct site specific closure planning; and includes the environmental and socioeconomic

setting, environmental reference data, operational data (such as volumes and types of waste currently deposited and planned to be deposited), obligations and legislative requirements.

- 3. Closure vision, principles and objectives:** the goals of the closure plan are defined through the closure vision, principles and objectives, which should be established early in the closure planning process and modified throughout the life of the operation, with contribution from stakeholders and the knowledge base. The closure vision describes what is overarchingly hoped to be achieved with mine closure, it incorporates a summary of the post-closure land use and must align with legislation. The vision will change as more data is obtained. Closure principles guide the basis of a closure plan, such as encouraging physical and chemical stability, complying with the legislative requirements and facilitating social transition. The closure objectives specify in detail site-specifically what the implementation of the closure activities intends to achieve.
- 4. Post-closure land use:** a clear definition of the post-mining land use significantly enables the closure planning process. A defined post-closure land use, or an array of potential post-closure land uses and required land capabilities, will inform the closure plan, especially the definitions of the closure vision and objectives. It is therefore critical that post-closure land used is defined in the early stages of closure planning. The knowledge base assists in the process of identifying post-closure land options.
- 5. Engagement for closure plan development:** effective mine closure planning and implementation takes into consideration the views of all relevant stakeholders. Stakeholder engagement should take place throughout the closure planning process and feedback from that engagement must be used to establish key elements of the closure plan. Stakeholder engagement is vital for managing social risks of closure.
- 6. Identifying and assessing risks and opportunities:** risk assessments are a way of life in the mining industry. Risk assessments help minimise risk and maximise opportunity. A formal risk assessment process also forms part of closure planning. A range of physical, social, economic and environmental risks and opportunities are identified and evaluated in order to set priorities and better define the closure plan.
- 7. Closure activities:** in the implementation of the closure plan, specific physical tasks have to be carried out to meet certain closure objectives and achieve set success criteria. These tasks are known as closure activities and are executed progressively throughout the life of

the mine or post-mining at closure and post-closure. These activities include reshaping waste dumps, commissioning of a water treatment plant and removal of contaminated soil.

- 8. Success criteria:** these are the quantitative indicators that if met, indicate that the closure plan has been implemented successfully. Success criteria must be specific, measurable, achievable, relevant and time-bound (SMART). For success criteria to be meaningful it is important to get the buy in of external stakeholders, particularly regulators. They must therefore be established and deliberated early in closure planning.
- 9. Progressive closure:** refers to the implementation of closure activities throughout the life of the mine. This allows for closure activities to be assessed and improved at a small scale before final closure and the learnings can be integrated into knowledge base.
- 10. Social transition:** requires early and proactive planning and management to minimise the negative socioeconomic impacts on host communities, including the employees, at closure. For investments in social transition to have sustainable and resilient community outcomes, the various stakeholders (mining companies, government, community and other partners) must be involved in the decision making, responsibility and process of closure.
- 11. Closure costs:** correctly estimating the costs of implementing closure and evaluating the cost estimates and updating them as the closure plan evolves and more information becomes available is a critical part of integrated closure planning. Types of closure cost estimates include life of asset cost estimate, financial liability cost estimate, sudden closure cost estimate and regulatory cost estimate.
- 12. Closure execution plan (CEP):** whilst the closure plan describes the actions that will be carried out as part of implementing site closure, a CEP details the specific tasks that must be undertaken during the life of mine in support of closure planning and application of closure activities. A CEP must be developed and updated often through the closure planning process. The CEP should distinctly define lines of authority and responsibility for implementing actions.
- 13. Monitoring, maintenance and management:** the completion of closure activities must be followed by monitoring. This is to assess and record the effectiveness of the closure activities in accomplishing the specified closure objectives and success criteria. Monitoring of sites against success criteria may lead to the need for maintenance where success criteria are not being met. Management of rehabilitated areas, such as controlling invasive plant species, may also be required.

- 14. Relinquishment:** once closure activities are completed to the satisfaction of the success criteria, the ownership of the operation and residual liabilities can either be completely or partially transferred to another party. This is known as relinquishment, which is not always the end goal for the life of mine but is a specified objective for many operations. Achieving relinquishment requires detailed planning and engagement with the correct legislative framework. Continuous stakeholder engagement, particularly focusing on the agreed success criteria, is essential leading up to relinquishment.
- 15. Temporary or sudden closure:** various factors can cause the temporary or unplanned closure of an operating mine. Such factors include financial pressures, environmental incidents such as floods and earthquakes, social incidents such as civil unrest, structural failure such as failures of tailings facilities and legislative changes. It is important to establish what the implications of a temporary or sudden closure would be on the closure plan and develop a contingency closure plan. This should be established at each stage of the life of mine.
- 16. Closure governance:** closure planning and implementation requires multidisciplinary resources from across the mining company, including site resources and corporate support. Closure governance ensures the effective allocation of resources to closure planning and reconciles the closure goals with the overall goals of the company. Establishing company closure policies that will define closure expectations, roles and responsibilities and a closure committee that will facilitate the closure planning process and its integration into operational planning is part of corporate governance.

2.3.2 South African Land Rehabilitation Guidelines for Surface Coal Mines

The Chamber of Mines of South Africa, now referred to as the Minerals Council of South Africa, first published a guideline for the rehabilitation of land disturbed by opencast coal mining in 1981. The objective of this guideline was to provide exceptional guidance for rehabilitation of opencast mines (Tanner, 2007). As the mining legislative framework and rehabilitation objectives and procedures changed significantly, the Minerals Council in conjunction with the Coaltech Research Association updated and published the guidelines in 2007. The second edition of the guidelines provided mining companies with detailed, local and international “best practice” guidance for achieving “satisfactory and sustainable” rehabilitation of opencast coal mines (Tanner, 2007). Since the publication of the second edition of the guidelines, there have been significant changes to the South African mining

rehabilitation regulations and there has been an enhancement in the drive to achieve sustainable development and meet SDGs by 2030 (Hattingh, 2019). The second edition of the guidelines was updated to address these changes and develop site-specific rehabilitation procedures. The Land Rehabilitation Society of Southern Africa (LaRSSA), endorsed by the Coaltech Research Association and Minerals Council of South Africa, updated the guidelines and published the third edition in 2019 (Hattingh, 2019). The third and latest edition of the guidelines (*Land Rehabilitation Guideline for Surface Coal Mines, 2019*) aims to:

- Provide an updated and consolidated document addressing the key aspects of good practice planning, implementation and ongoing management of land rehabilitation of surface coal mines.
- Provide standardised guidance for corporate standards and policies, and site-specific land rehabilitation plans.
- Emphasise the importance of conducting rehabilitation planning before mining operations commence. This planning must focus on setting suitable rehabilitation targets that will achieve an established post-mining landscape capable of supporting various future land uses; and which will ultimately rationalise and optimise business expenditure.
- Provide technically sound, simple, and practical approaches for implementation by all levels of land rehabilitation practitioners, mine planning teams, and administrating regulators responsible for mining-related land stewardship (Hattingh, 2019).

The *Land Rehabilitation Guideline for Surface Coal Mines* (2019) identifies four stages of the land rehabilitation process; planning, implementation, monitoring and adaptive land management. Although the process has stages, it is not linear but iterative. Below is a summary of the rehabilitation stages from the South African guidelines (Hattingh, 2019).

1. Planning

The planning phase defines the need for dedicated upfront land rehabilitation planning and design, integrated with operational mine planning. The planning phase involves:

- Understanding and meeting relevant legislative requirements.
- Stakeholder engagement.
- Defining potential post-mining land uses, which is essential for establishing rehabilitation goals. Understanding the land use, landform and land capability is vital when defining potential post-mining land uses.

- Establishing the rehabilitation goal, which is a description of what an operation wants to achieve at closure. The rehabilitation goal must be realistic, clear and based on the operation's physical, environmental and socio-economic properties. The entire operational team must be represented when developing the operation's rehabilitation goal, to ensure alignment and commitment from the whole team.
- Defining the rehabilitation principles in order to specify the operation's rehabilitation objectives and actions.
- Conducting risk assessments to identify and quantify risks to the rehabilitation process and develop risk mitigations.
- Specifying SMART (specific, measurable, achievable, realistic and time-bound) rehabilitation objectives, that specify what needs to be achieved to attain the set rehabilitation goal.
- Establishing relinquishment criteria, also known as success criteria, completion criteria, closure criteria or release criteria. Relinquishment criteria provide standards against which the success of the rehabilitation objectives can be evaluated and enable the mine to determine when it should proceed with an application for closure.
- Detailing the specific rehabilitation activities that will be undertaken to achieve the rehabilitation objectives. These must be undertaken concurrently with mine operations and not left until final closure.
- Establishing roles and responsibilities for the rehabilitation process as it requires multidisciplinary inputs.
- Developing a monitoring plan and data management strategy. Continuous monitoring of rehabilitation activities against established rehabilitation action plans and relinquishment criteria enables tracking of rehabilitation progress. This way any unsuccessful outcomes or unintended secondary impact can be detected early and corrected accordingly.
- Refining, correcting and re-planning.

2. Implementation

The implementation stage provides practical guidance for the main in-field land rehabilitation activities, to ensure proper land rehabilitation of opencast coal mines where the ecosystem functionality is reinstated and the post-mining land use is sustainable and economically viable. The practical guidance is a collation of data from years of practical experience. The guideline gives practical guidance for:

- Surface landform design and profiling

- Soil stripping, stockpiling and replacement
- Soil amelioration
- Revegetation

Rehabilitation implementation should be initiated as soon as land disturbance occurs and it must be ongoing throughout the life of the mine.

3. Monitoring

Rehabilitation monitoring is a check of whether the rehabilitation planning and implementation activities are being executed according to plan and yielding the desired outcomes. Through monitoring, corrective measures can be implemented well in time if rehabilitation actions are not producing the expected results. Monitoring also verifies the achievement of relinquishment criteria. Rehabilitation monitoring should be initiated before land disturbance, this will allow for the operation to establish a reference point to measure the rehabilitation progress against as the system recovers towards the pre-defined land capability and land use.

4. Adaptive Land Management

The adaptive land management phase involves continuous care and maintenance of the rehabilitated land to ensure that the land has production potential. Adaptive land management should be continuously maintained and the operation should make an allowance that it is included in the transfer agreements with post-mining landowner(s). Mismanagement of rehabilitated land can result in the degradation of the implemented land capabilities. Adaptive land management aims to:

- Ensure that the rehabilitated land is well maintained and that its use aligns with the quality of land capabilities achieved by the rehabilitation, even when it is transferred to a new land owner/user.
- Empower the new land owner to manage residual and latent risks of rehabilitated land by providing them with detailed guidance. This in turn limits the mining companies long-term financial liability for the rehabilitated mine.

2.4 Land Capability

Mine rehabilitation aims to recreate the best possible land capabilities across the rehabilitated site, that can support and sustain a variety of land uses (Lechner *et al.*, 2016). The poorer the land capability, the less land uses it can support (Hattingh, 2019). Schoeman *et al.* (2002)

define land capability as “the extent to which land can meet the needs of one or more uses under defined conditions of management”. Land capability is determined by the physical, chemical and biological properties of the soils, which are naturally dependent on the underlying parent rock, the climatic conditions and other landscape properties such as slope and drainage patterns (Hattingh, 2019). Identifying the pre-mining and post-mining land capability is a very crucial component of the rehabilitation process (Hattingh, 2019). A study by Schoeman *et al.* (2002), *Development and application of a land capability classification system for South Africa*, identified eight land capability classes, based on the capability of soils to sustain crop production, grazing, forestry and wildlife without damage to the soils. Land capability classes I - IV are suitable for arable land, classes V – VII for grazing purposes and class VIII for wildlife (Figure 2-6).

| Land Capability Class | Land Use Options | Land Capability Groups |
|-----------------------|---------------------------|------------------------|
| I | W F LG MG IG LC MC IC VIC | Arable Land |
| II | W F LG MG IG LC MC IC | |
| III | W F LG MG IG LC MC | |
| IV | W F LG MG IG LC | |
| V | W F LG MG | Grazing |
| VI | W F LG MG | |
| VII | W F LG | |
| VIII | W | Wildlife |

W – Wildlife
 F – Forestry
 LG - Light Grazing
 MG - Moderate Grazing
 IG - Intensive Grazing
 LC - Poorly Adapted Cultivation
 MC - Moderately Well Adapted Cultivation
 IC - Intensive Well Adapted Cultivation
 VIC - Very Intensive Well Adapted Cultivation

Figure 2-6: Land capability classes, land use options and land capability groups (Schoeman *et al.* (2002))

Very different to the Schoeman *et al.* (2002) classification, the Department of Agriculture, Forestry and Fisheries (DAFF) identifies fifteen land capability classes (Figure 2-7). Land capability classes 6 - 9 are suitable for arable land, classes 3 – 5 for grazing purposes and class 2 for wildlife (Collet, 2017).

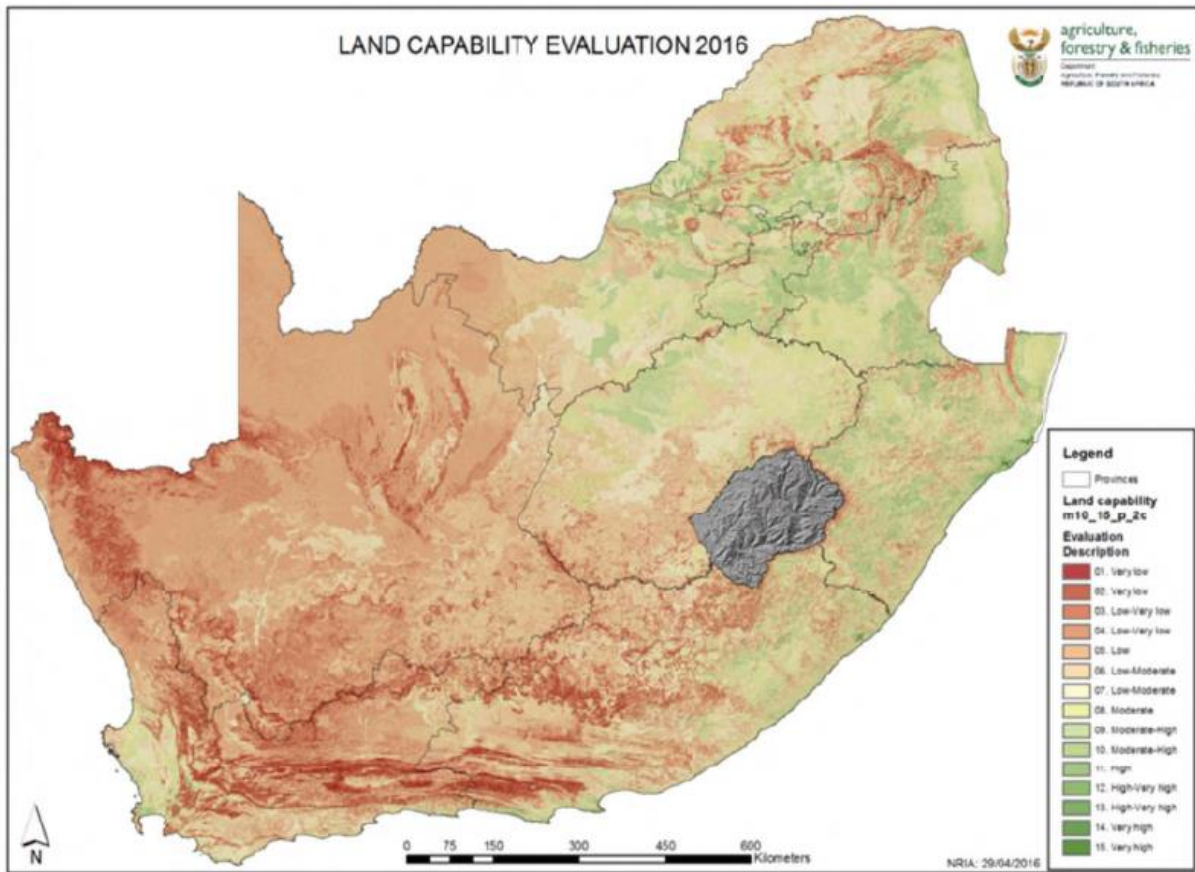


Figure 2-7: DAFF land capability classification of South African (Collet, 2017)

The South African mining industry simplified the classification and made provision for four land capability classes; wetland, arable land, grazing land and wilderness land (Tanner, 2007). To reinstate or establish the desired land capability on rehabilitated land, the critical properties such as soil type, soil depth, soil texture, soil density, soil chemistry, topographic slope and soil microbiology must be re-created (Hattingh, 2019). Failure to properly manage the soil during rehabilitation can cause land capability to be reduced or lost. Topsoil is particularly important for establishing land capability (Limpitlaw *et al.*, 2005). Table 1 shows the set criteria for pre-mining and post-mining land capabilities as was initially defined by the *Chamber of Mines Handbook of Guidelines for Environmental Protection* (1981). The criteria have been updated along with the rehabilitation guidelines (Hattingh, 2019).

Table 1: Land capability classes and associated pre-mining and post-mining classification criteria against which rehabilitation objectives should be set (Hattingh, 2019)

| Land Capability Class | | Classification Criteria | |
|-----------------------|---------|--|--|
| | | Pre-mining | Post-mining |
| I | Wetland | <ul style="list-style-type: none"> • Usually a water table present at shallow depth in the soil (vleis, swamps, marshes, peatbogs, etc.). • A diagnostic organic (O) horizon at the surface. | <ul style="list-style-type: none"> • Soil depth >250 mm. • Specific wetland soil used, • as stockpiled from pre-mining • delineated wetland • areas. |

| | | | |
|-----|-----------------|---|--|
| | | <ul style="list-style-type: none"> • A horizon that is gleyed throughout more than 50% of its volume and is significantly thick, occurring within 750 mm of the surface. | |
| II | Arable | <ul style="list-style-type: none"> • Does not qualify as wetland. • Has soil that is readily permeable to the roots of common cultivated plants throughout a depth of 750 mm from the surface. • Soil pH value between 4,0 and 8,4. • Electrical conductivity (EC) of the saturation extract less than 400mS/m at 25°C, and an exchangeable sodium percentage less than 15 through the upper. • Soil depth of ≥ 750 mm of soil. • Permeability of at least 1,5 mm per hour in the upper 0.5 m of soil. • <10 percent by volume of rocks, or pedocrete fragments larger than 100 mm in diameter in the upper 750 mm of soil. • Slope (in percent) and erodibility factor¹⁰ (K) such that their product is less than 2,0. • Occurs under a climate regime which permits, from soils of similar texture and adequate effective depth (750 mm), the economic attainment of yields of adapted agronomic or horticultural crops that are at least equal to the current national average for those crops. • Is either currently being irrigated successfully or has been scheduled for irrigation by the DAFF. | <ul style="list-style-type: none"> • Soil depth > 600 mm • Soil material must not be saline or sodic. • Slope (%) will be such that when multiplied by the soil erodibility factor K, the product will not exceed 2,0. • For typical coal fields' soils, slopes must be flatter than 1:14, and free draining. |
| III | Grazing Land | <ul style="list-style-type: none"> • Does not qualify as wetland or as arable land. • Has soil or soil-like material, permeable to the roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks, or pedocrete fragments larger than 100 mm diameter. • Supports or is capable of supporting a stand of native or introduced grass species or other forage plants utilisable by domesticated livestock or game animals on a commercial basis. | <ul style="list-style-type: none"> • Soil depth ≥ 250 mm • Slopes between 1:7 and 1:14 |
| IV | Wilderness Land | <ul style="list-style-type: none"> • Does not qualify as wetland, arable land or grazing land. | <ul style="list-style-type: none"> • Does not qualify as wetland, arable land or grazing land. |

The pre-mining land capability assessment should be used to establish the goals for post-mining land capability and inform the rehabilitation plan. Although mining companies are not required to reproduce the pre-mining land capability spatial distribution, it is expected that the rehabilitated mine land should have comparable proportions of arable, grazing and wetland land as the pre-mined land. Rehabilitation does not have to upgrade the original land capability; however, the mining companies must ensure that they not unnecessarily reduce land capability (Hattingh, 2019).

2.5 Overview of Mining and Rehabilitation Legislation in South Africa

In the last century, mining has played a vital role in the growth, transformation and development of South Africa. However, mining has also had environmental impacts that have left South Africa with significant social, environmental and economic legacies (Swart, 2003). Mining and rehabilitation legislation were implemented to minimise the impact of mining on the natural environment (Blommerde *et al.*, 2015). Before 1956 mine closures were not subject to legislative closure requirements; they were governed by the inadequate environmental regulations under the Mines and Works Act (MWA). ‘*The rehabilitation of land disturbed by surface coal mining*’ guideline, which was published by the Chamber of Mines (now referred to as the Minerals Council) in 1981 presented the first significant literature contribution on environmental protection in the mining industry. This rehabilitation guideline was referenced a decade later in the Minerals Act of 1991 (van Druten and Bekker, 2017). The Minerals Act (50 of 1991) provided the inaugural legal requirements that enforced environmental protection, the management of environmental impacts and the rehabilitation of the affected environment of prospecting and mining in South Africa (Swart, 2003). The South African mining statutory framework has come a long way since the Mines and Works Act of 1956. Over the past six-and-a-half decades the South African legislative framework has become robust and encourages environmentally responsible mining and mine closure (McKay and Milaras, 2017). Mining and prospecting right holders have a responsibility to comply with the mineral and petroleum resources legislation; with non-compliance deemed a criminal offence (Paterson and Kotzé, 2009).

Responsible mining and mine closure that ensures that there is no environmental degradation that poses a threat to the well-being of people, is in line with a requirement of the Constitution of South Africa (Diale, 2014). According to Section 24 of the Constitution (Act No. 108 of 1996), which supersedes all other legislation, everyone has a right to an environment that is not harmful to their well-being. Chapter 2 of the Bill of Rights in the Constitution of the Republic of South Africa, 1996, Section 24(b) states: ‘*Everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that – prevent pollution and ecological degradation; promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development*’ (Constitution of South Africa, 1996). To achieve the objectives of Section 24 of the Constitution, a number of regulations were passed (Sibanda, 2019). The main regulations governing mining rehabilitation activities are the Minerals and

Petroleum Resources Development Act (MPRDA) Act 28 of 2002, which is enforced by the DMRE and the National Environmental Management Act (NEMA) 107 of 1998, which is regulated by the Department of Environmental Affairs (DEA) (McKay and Milaras, 2017).

2.5.1 Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002

The DMRE's Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002 succeeded the Minerals Act No. 50 of 1991, which for the first time in South African history provided the fundamentals for environmental management (van Druten and Bekker, 2017). The MPRDA, which was passed in October 2002 and came into effect on 1 May 2004, regulates the prospecting for and extraction of minerals in South Africa (Rogerson, 2011). Notably, the MPRDA recognises the State's right to exercise authority over the country's mineral and petroleum resources, as is the case with other World-leading mineral producing countries (Rogerson, 2011). The Act has six main objectives; the first being the recognition of Government's custodianship of all the country's mineral and petroleum resources. Second, to promote equitable access to the country's mineral and petroleum resources, especially amongst historically disadvantaged South Africans. Third, to contribute to the country's economic welfare through promoting investment and employment opportunities in the minerals industry. Fourth, to provide security of tenure for existing prospecting and mining operations. Fifth, to ensure that the country's mineral resources are developed in an "orderly and ecologically sustainable manner" while promoting justifiable social and economic development. Sixth is to ensure that holders of mining rights contribute towards the socio-economic development of their host communities (Rogerson, 2011).

The MPRDA requires that rehabilitation be sustainable and support environmental, social and economic development. MPRDA 28 of 2002 Section 38 (1) (d) states: *The holder of a reconnaissance permission, prospecting right, mining right, mining permit or retention permit must as far as it is reasonably practicable, rehabilitate the environment affected by the prospecting or mining operations to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development* (MPRDA, 2002). Section 41 of the Act stipulates that the holder of a prospecting and mining right must make financial provision for mine rehabilitation and closure through the mechanisms and by determining the quantum (amount) in accordance with MPRDA Regulations 53 and 54. MPRDA 28 of 2002, Section 41 states:

(1) An applicant for a prospecting right, mining right or mining permit must, before the Minister approves the environmental management plan or environmental management

programme in terms of section 39 (4), make the prescribed financial provision for the rehabilitation or management of negative environmental impacts.

(2) If the holder of a prospecting right, mining right or mining permit fails to rehabilitate or manage or is unable to undertake such rehabilitation or to manage any negative impact on the environment, the Minister may, upon written notice to such holder, use all or part of the financial provision contemplated in subsection (1) to rehabilitate or manage the negative environmental impact in question.

(3) The holder of a prospecting right, mining right or mining permit must annually assess his or her environmental liability and increase his or her financial provision to the satisfaction of the Minister.

MPRDA Regulation 53 stipulates the methods for the financial provision; which include a trust, a financial guarantee, a cash deposit, or any other method as the Director General may determine (Petty and van Dyk (2018). MPRDA Regulation 54 details the methodology for determining the quantum (amount) of the financial provision for premature closing, decommissioning and final closure of the operation, and post closure management of residual and latent environmental impacts (Eversheds-Sutherland, 2019). The financial provision process detailed under MPRDA Regulations 53 and 54 was acceptable to most mining companies, however it was immensely criticised by environmental lobby groups for not providing sufficient amounts to cover the costs for rehabilitation in general, as well as premature closure and “ownerless mines” (Eversheds-Sutherland, 2019). In 2015, all environmental-related requirements under the MPRDA, including the rehabilitation financial provisioning regulations, were repealed and provided for in the amendment to NEMA 107 of 1998 (Hattingh, 2019).

2.5.2 National Environmental Management Act (NEMA) 107 of 1998

The DEA’s National Environmental Management Act (NEMA) 107 of 1998 and its associated regulations provide principles for decision-making on matters affecting the environment (NEMA, 1998). The Act mandates the owners, managers or land occupiers to implement reasonable pollution prevention measures and makes provision for the polluter to pay for rehabilitation (McKay and Milaras, 2017). NEMA is the primary piece of legislation that requires environmental management plans (EMPs) for managing environmental impacts (Hattingh, 2019).

The NEMA (Act 107 of 1998) General Notice Regulation (GNR) 1147 “Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations” were published in 2015, replacing the financial provisioning regulations under the MPRDA (Section 41 and Regulations 53 and 54) (Hattingh, 2019). The objective of these regulations is to regulate the provision for the costs associated with the implementation and management of rehabilitation of environmental impacts from prospecting, exploration, mining or production operations through the lifespan of the operations, as well as latent or residual environmental impacts that may become known in the future (NEMA, 2015). GNR1147 Financial Provisioning Regulations of 2015, Chapter 2 states:

(4) *‘An applicant or holder of a right or permit must determine and make financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of prospecting, exploration, mining or production operations, as contemplated in the Act and to the satisfaction of the Minister responsible for mineral resources’.*

(5) (a) *‘An applicant or holder of right or permit must make financial provision for rehabilitation and remediation’.*

The regulations require that before any prospecting, exploration and/or mining can take place rights applicants or holders must make financial provision for:

- Annual rehabilitation, as stipulated in an annual rehabilitation plan
- Final rehabilitation, decommissioning and closure of the prospecting, exploration, mining or production operations at the end of the life of operations, as stated in a final rehabilitation, decommissioning and mine closure plan
- Remediation of latent or residual environmental impacts which may only be known in the future (this third requirement now includes specific provision for the pumping and treatment of polluted or extraneous water (NEMA, 2015).

According to Petty and van Dyk (2018), the NEMA Financial Provisioning Regulations, 2015 (GNR1147) were a significant shift from the simpler longstanding financial provisions process under MPRDA (Section 41 and Regulations 53 and 54). The Financial Provisioning Regulations, 2015 were meant to address the concerns that the MPRDA financial provisions process did not make sufficient provisions for rehabilitation. However, soon after their promulgation numerous interpretational challenges that caused concern amongst many stakeholders were highlighted (Eversheds-Sutherland, 2019). A consultation process that involved various stakeholders, including the Mineral Council of South Africa, resulted in the

publication of the “*Proposed Financial Provision Regulations 2017*” (Petty and van Dyk, 2018). The proposed 2017 regulations were met with discontent from numerous stakeholders, including the environmental lobbyists, for different reasons. This called on further stakeholder engagement, which culminated in the publication of the “*Proposed Regulations Pertaining to Financial Provision for the Rehabilitation and Remediation of Environmental Damage caused by Reconnaissance, Prospecting, Exploration, Mining or Production Operations*” (the “*Proposed Financial Provision Regulations 2019*”), on 17 May 2019. The “*Proposed Financial Provision Regulations 2019*” are considered to be significantly better than both the “*Financial Provision Regulations 2015*” and the “*Proposed Financial Provision Regulations 2017*”, because they are clearer concerning who needs to comply with them, how to calculate the total liability, and the basis on which the provision that needs to be made available at any point in time is calculated (Eversheds-Sutherland, 2019).

There has been, and there still is, a lot of uncertainty around the financial provision regulations as they have been undergoing amendments for a long time (James, 2019). In January 2020, the South African government gave a notice extending the transitional timeframe for compliance to the “*Financial Provisioning Regulations, 2015*” (Mining Review, 2020). According to the extension notice, the applicable MPRDA rights holders now have until 19 June 2021 to comply with the Financial Provisioning Regulations. Until this date, right holders will be regarded as having complied with the Financial Provisioning Regulations if compliant with the financial provisioning requirements applicable under the approved MPRDA right (Mining Review, 2020).

2.5.3 Other Legislation Relevant to Rehabilitation and Mine Closure

The National Water Act, No. 36 of 1998 (NWA), which is governed by the Department of Water and Sanitation (DWS), regulates the way the nation’s water resources are managed. Through the ‘Duty of Care’ principle, the Act imposes a duty on anyone who owns, controls, occupies or uses land to take all reasonable measures to prevent the pollution of a water resource from occurring, continuing or recurring (NWA, 1998). The use of water for mining and related activities is regulated through the NWA regulations, General Notice (GN) 704 on the “*Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources*” of 1999 (Hattingh, 2019). The regulation requires an operation to adequately manage clean and dirty water impacted by, and/or generated and originating from its site (Hattingh, 2019).

The Mine Health and Safety Act, No. 29 of 1996 (MHSA) is the main piece of legislation that regulates occupational health and safety in the South African Mining industry³. Chapter 2 of the Act states: (2) *‘the employer of a mine that is not being worked, but in respect of which a closure certificate in terms of the Minerals and Petroleum Resources and Development Act has not been issued, must take reasonable steps to continuously prevent injuries, ill-health, loss of life or damage of any kind from occurring at or because of the mine’*(MHSA, 1996). This places occupational obligations on mines that are temporarily closed or in the rehabilitation phase (Hattingh, 2019).

Other relevant bodies of legislation that are relevant to rehabilitation are the supporting environmental management acts (SEMAs) which support the implementation of NEMA. These include the National Environmental Management Waste Act, No. 59 of 2008 (NEM:WA) that requires the reduction, re-use, recycling, recovery, treatment and disposal of waste; the National Environmental Management Biodiversity Act, No. 10 of 2004 (NEM:BA) that requires a commitment to the eradication and management of listed invasive flora and faunal species on rehabilitated land and the National Environmental Management Air Quality Act, No. 39 of 2004 (NEM:AQA) provides for the protection and enhancement of the nation’s quality of air and the prevention of air pollution and ecological degradation. The SEMAs provide legislative requirements for the operational, post-mining and post-closure landscapes (Hattingh, 2019).

The Conservation of Agriculture Act, No. 43 of 1983 (CARA), which is administered by the Department of Environment, Forestry and Fisheries (DEFF), regulates the utilisation of the nation’s natural agricultural resources to promote conservation of the soil, the water sources and the vegetation; as well as managing invader plant species (CARA, 1983). DAFF officials are consulted during the public review process of the compilation of a mine’s environmental impact assessment (EIA)/environmental management plan (EMP), before an environmental authorisation and a mining right can be issued (Hattingh, 2019). However, Hattingh (2019) states that DAFF has limited influence on the identification of suitable post-mining land use(s).

The Spatial Planning and Land Use Management Act, No. of 2013 (SPLUMA), which is governed by the Department of Agriculture, Land Reform and Rural Development (DALRRD), provides a national framework for spatial planning and land use management. According to the Act, every local municipality must, after public consultation, develop and implement a land

³Mining Legislation. Available from <https://www.mhsc.org.za/mining-legislation>, accessed 18/06/2020.

use scheme (SPLUMA, 2013). The Spatial Planning and Land Use Management Act states that the land use-related decisions taken at a local level cannot be overruled at the national level except in the case of agricultural land. This could have implications for the post-mining land use plans and relinquishment of mining operations (Hattingh, 2019).

2.5.4 The One Environmental System

The South African government implemented the One Environmental System (OES) in December 2014. It is a legislation system that was implemented to address the fragmented, contradictory and ineffective mining and environmental legislation structures (Fischer *et al.*, 2015). The OES is a treaty between the DMRE, DWS, and DEA, which govern various aspects of mining activities (Becker, 2015). The OES aims to align the following pieces of legislation, the MPRDA, NEMA, NEM:WA, NEM:AQA and NWA. As part of the OES, all environmental-related requirements under the MPRDA were repealed and provided for in the amendment to NEMA in 2015. The OES is expected to reduce the assortment of regulations as well as institutional requirements and arrangements (Sibanda, 2019).

2.6 Current State of Mine Rehabilitation in South Africa

In South Africa successful rehabilitation and mine closure remains elusive, even with the existence of a robust legislative framework that should ensure that outcome (Perkins *et al.*, 2020). The consequences of the ineffective rehabilitation and mine closure include the thousands of abandoned mines and operations on extended care and maintenance, the selling of mines to less well-resourced companies to close and increasing illegal mining activities (Watson and Olalde, 2019). According to Perkins *et al.* (2020) systemic challenges, topmost being the shortcomings in the application of the legislation, prevent the achievement of successful rehabilitation and mine closure.

The South African mining legislation is generally regarded to conform to international expectations for best practice (Alberts *et al.*, 2017). However, the legislative framework involves several pieces of legislation governed by various government departments with overlapping requirements and different interpretations of the regulations (Alberts *et al.*, 2017; Watson and Olalde, 2019). This causes a lack of coherence in the legislation, which has resulted in a disconnect between the regulations governing rehabilitation and mine closure and the practices on the ground (Perkins *et al.*, 2020). The lack of capacity and competence of the government to effectively enforce legislation has led to the dysfunction of the legislative framework and in turn ineffective rehabilitation and mine closure (Watson and Olalde, 2019).

van Druter and Bekker (2017) identify the ‘shortage of relevant mine closure skills and knowledge within the regulator’ as one of the main causes of unsuccessful rehabilitation and mine closure. Inconsistencies in the regulation and enforcement of the laws cause confusion and different interpretations of the law. There are different views on the ground about what signifies compliance and sustainable end-state, deterring successful rehabilitation and mine closure (Perkins *et al.*, 2020). Other shortcomings of the legislative framework that Perkins *et al.* (2020) identify as stumbling blocks for the achievement of successful rehabilitation and mine closure are that the legislation does not resolve historical legacies and the *Financial Provision Regulations* do not make adequate financial provisions for rehabilitation.

The lack of a “whole of government” approach to mine closure is a systemic issue that prevents the achievement of successful rehabilitation and mine closure (Perkins *et al.*, 2020). Van Druter and Bekker (2017) state that mine closure requires multidisciplinary expertise, as well as contributions from the national, provincial and local government levels. The disconnection between government departments dealing with the different aspects of mining and rehabilitation lead to the uncoordinated application of the legislation (van Druter and Bekker, 2017).

The avoidance of rehabilitation and mine closure responsibilities, a common practice in South Africa, is another systemic challenge that contributes to ineffective rehabilitation and mine closure (Perkins *et al.*, 2020). Watson and Olalde (2019) state that when the mining assets of some of the larger companies are no longer profitable and near depletion, they sell them to marginal operators to transfer rehabilitation and mine closure responsibilities. This is metaphorically referred to as “passing-the-parcel” (Perkins *et al.*, 2020). The on-selling of mining assets is allowed on condition that it is authorised by the Minister of Mineral Resources and Energy and that the new holder of the mining right can comply with legal obligations of the mining right. However, the marginal operators are usually not well-resourced, decreasing the likelihood of proper rehabilitation and mine closure (Watson and Olalde, 2019). Another practice that enables avoidance of rehabilitation and mine closure is the placement of mines under “care and maintenance”, which costs much less than the practices for achieving closure (Perkins *et al.*, 2020).

The failure by mining companies to plan for rehabilitation and closure or embarking on the process when it is too late to have a significant impact also thwarts successful rehabilitation and mine closure (Perkins *et al.*, 2020). Effective rehabilitation and mine closure planning requires integrated planning to start before the commencement of mining operations and

continue until the final closure of a mine (van Druter and Bekker, 2017). Early rehabilitation and closure planning and implementation allow for the development of technical expertise and capacity required to achieve a successful and sustainable outcome (ICMM, 2019). Successful rehabilitation and mine closure require a continuous-improvement approach that is established on site-specific knowledge, research and monitoring (Australian Government *et al.*, 2016). Gaps and opportunities must be identified early so that mining operations do not affect rehabilitation options. Therefore, a delay in the planning and implementation of rehabilitation leads to delayed relinquishment, adding to costs and possibly the retention of liabilities for years longer than necessary (Australian Government *et al.*, 2016).

2.7 Summary and Synthesis

Coal mining, like all mining, causes significant land alteration throughout the mining lifecycle. This land alteration often results in the reduction or loss in the biological and/or economic productive potential of land. Opencast coal mining in the Mpumalanga Province is destructive to landscapes and compromises the agricultural land capability and ecosystems. The environmental impacts of opencast mining in Mpumalanga have concomitant socio-economic impacts that extend way beyond the life-of-mine. Effective mine rehabilitation is fundamental to mitigating the long-term negative environment and associated socio-economic impacts of mining. In order to be effective, rehabilitation needs to be progressive and integrated into the mine life cycle in an iterative manner that allows for continuous improvement. One of the objectives of rehabilitation is to ensure that land impacted by mining activity is returned to a stable, productive, useful and self-sustaining condition as prescribed in the mine and mine closure plans. A key aspect of rehabilitation is to establish the best possible land capability, through the correct soil management, that can support and sustain a variety of land uses.

Mine rehabilitation is highly challenging and dynamic in nature, and as such requires a multi-disciplinary and integrated approach. A series of rehabilitation guidelines have been developed over the past three decades, both at an international and local level, to assist mining companies to plan and implement effective rehabilitation. At an international level, the International Council on Mining and Metals (ICMM) has published several guidelines to provide support to mining companies as they plan for closure. These guidelines include, *Good practice guidance for mining and biodiversity* (2006), *Planning for integrated mine closure: toolkit* (2008) and *Integrated mine closure: good practice guide* (2019). At a local coal mining level, the *South African Land Rehabilitation Guidelines for Surface Coal Mines* were first published by the Chamber of Mines of South Africa (now referred to as the Minerals Council of South Africa)

in 1981. Two more editions of the guidelines were published in 2007 and 2019, to factor in the significant changes in the mining and rehabilitation legislation and sustainable development principles. The objective of these guidelines is to provide mining companies with detailed, “best practice” administrative and practical guidance for achieving effective and sustainable rehabilitation of opencast coal mines.

Prior to the enactment of the Minerals Act of 1991, mining and rehabilitation were governed by inadequate regulations that did not enforce environmental protection, the management of environmental impacts and the rehabilitation of the affected environment of prospecting and mining. This resulted in significant environmental and socio-economic legacies. The South African government implemented stringent mining and rehabilitation legislation in an effort to mitigate the negative impacts of mining; to protect the environment, society and economy. There have been significant developments in the legislative framework over the past three decades since the Minerals Act of 1991, aimed at improving the adequacy of the legislation. Literature shows that the South African mining and rehabilitation legislative framework is robust and conforms with international expectations of best practice.

Despite the world-class legislation and the detailed rehabilitation guidelines, literature shows that effective rehabilitation remains problematic in the South African mining industry. Successful rehabilitation implementation in the case of opencast coal mines in the Mpumalanga Province seems elusive, with thousands of mines remaining unrehabilitated. A number of generic systemic issues have been identified to contribute to ineffective rehabilitation; topmost being inadequacies in the application of the legislation, as well as the “pass-the -parcel” culture and the lack of early integrated rehabilitation planning by mining companies. The poor application of the world-class legislation is due to a lack of collaboration of the various government departments that govern the several pieces of legislation concerning mining and rehabilitation. These various government departments have overlapping requirements and different interpretations of the legislation. Another cause of the poor application of the legislation is the lack of capacity and expertise of regulators. Without the expertise, the regulators are unable to effectively apply the regulations.

Effective rehabilitation of opencast mines can mitigate the environmental and associated socio-economic impacts of mining. However, effective rehabilitation remains a challenge. To date there have been no detailed studies on the extent to which current guidelines are implemented in the case of the Mpumalanga opencast coal mines or the shortcomings, gaps and opportunities in this regard.

CHAPTER 3

METHODOLOGY

Chapter 2 presented a review of the published literature review of literature on the land alteration caused by mining throughout the lifecycle of a mine, the impacts of coal mining on landscapes, mine rehabilitation, mine rehabilitation guidelines, mining and rehabilitation legislative framework and the current state of mine rehabilitation in South Africa to provide a context for the research study. This chapter presents the research questions, outlines the study approach used to conduct the research study, details the participants of the study and briefly outlines the ethics of the research. This chapter also presents the study area.

3.1 Research Questions

The literature review shows that robust mining and rehabilitation legislation was implemented in an effort to mitigate the long-term environmental impacts and associated socio-economic impacts of mining. Rehabilitation guidelines have also been developed to assist mining companies to plan and implement effective rehabilitation, which is expected to subsequently mitigate long-term environmental impacts. Despite this, successful rehabilitation remains a challenge in the South African mining industry. As discussed in Chapter 1, this study sets out to interrogate the perspectives and experiences of rehabilitation experts on opencast coal mining in the Mpumalanga Province, with a view to developing a better qualitative understanding of the status, shortcomings, gaps and opportunities of the current rehabilitation practices, and in doing so, to establish why successful rehabilitation remains a challenge. In line with this objective, the following research questions were formulated in the context of opencast coal mining in the Mpumalanga province of South Africa:

- i. What is the standard of current rehabilitation practices and how has this progressed over the past three decades?
- ii. Are the *South African Land Rehabilitation Guidelines for Surface Coal Mines* relevant and what is the current status in the implementation of these guidelines?
- iii. What are the key factors hindering effective rehabilitation?
- iv. What opportunities can be leveraged to improve the rehabilitation outcomes?

3.2 Study Approach

The formulated research questions were interrogated through a case study research methodology, which employed semi-structured interviews with rehabilitation experts. The semi-structured interviews with rehabilitation experts were used as a source of primary data, as interviews are a popular and effective way of understanding stakeholder perspectives and experiences (Stander and Broadhurst, 2019). Expert interviews allow a researcher to gain current and vital organisational and field specific insight from stakeholders that cannot be obtained from literature or document reviews or other technical research methods (Stander and Broadhurst, 2019). The experts were targeted based more on their relevance and expertise, rather than the statistical representation. This is key in the case of expert interviews (Stander and Broadhurst, 2019).

3.2.1 Description of the Interview Participants

The semi-structured one-on-one interviews were conducted with rehabilitation experts actively engaged in coal mining rehabilitation projects in their roles within mining companies, as rehabilitation specialist consultants, or as Government officials. The intent of the interviews was to investigate the rehabilitation experts' perspectives and experiences concerning current rehabilitation practices in opencast coal mining in the Mpumalanga province of South Africa; focusing on the progression and standard of the rehabilitation practices, the application and relevance of the South African rehabilitation guidelines, the challenges that prevent the achievement of desired rehabilitation outcomes in opencast coal mines, as well as gaps and opportunities of rehabilitation practices.

The interview participants were selected based on their involvement and expertise in the planning, execution and auditing of rehabilitation in the mining industry, particularly coal opencast mines in the Mpumalanga Province. The participants were specifically targeted to give representation of the relevant experts to enhance understanding of the research study. The relevance and expertise of the experts, rather than the statistical representation, was key for the study (Stander and Broadhurst, 2019). A total of eleven participants were interviewed (Table 2). Participants 1 to 6 were employees of three coal mining companies, referred to as Mining Company A, B and C. Participants 7 to 9 were rehabilitation consultants who have in-depth knowledge of rehabilitation in the coal mining industry and have done extensive work in the Mpumalanga Province. Participants 10 and 11 were Government employees. Participant 10 was a Department of Mineral Resources and Energy (DMRE) official responsible for auditing

rehabilitation compliance in coal mines in the Mpumalanga Province. Participant 11 was a Department of Planning, Monitoring and Evaluation (DPME) official involved in facilitating sustainable developmental partnerships between mining companies and their host communities.

Table 2: Summary of Interviewed Rehabilitation Experts' Details

| Participant # | Organisation | Organisational Role |
|---------------|--|--|
| 1 | Coal Mining Company A | Rehabilitation and Land Manager. Responsible for rehabilitation, land use projects planning, implementation and reporting across all the companies' coal mining operations. |
| 2 | Coal Mining Company A | Rehabilitation Specialist. Directly oversees the rehabilitation being done by contractors on the opencast operations. |
| 3 | Coal Mining Company A | Projects Specialist. Responsible for coordinating the post-rehabilitation land use projects. |
| 4 | Coal Mining Company B | Rehabilitation and Land Manager. Responsible for rehabilitation, land use projects planning, implementation and reporting across all the companies' coal mining operations. |
| 5 | Coal Mining Company B | Rehabilitation Specialist. Directly oversees the rehabilitation being conducted by contractors at a particular operation, as well as post-rehabilitation land use projects. |
| 6 | Coal Mining Company C | Environmental Superintendent. Oversees the rehabilitation on a particular operation. Also coordinates stakeholder engagements for post-rehabilitation land use projects. |
| 7 | Environmental and Rehabilitation Consultancy | Senior Rehabilitation Consultant and Advisor. Advises companies and organisations on rehabilitation of coal mines. Assesses rehabilitation. Author and reviewer of coal mining rehabilitation guidelines. |
| 8 | Rehabilitation and Land Use Consultancy | Rehabilitation Practitioner. Undertakes rehabilitation studies on coal mines. Assesses rehabilitation. Author and reviewer of coal mining rehabilitation guidelines. |
| 9 | Academia and Rehabilitation and Land Use Consultancy | Professor and Rehabilitation Consultant. Runs rehabilitation and land use studies. Advises organisations on rehabilitation. Assesses rehabilitation. Experience in compiling rehabilitation and land use guidelines. |

| | | |
|----|------------|---|
| 10 | Government | Senior Environmentalist at the DMRE. Monitors coal mine rehabilitation within the Mpumalanga Province. |
| 11 | Government | Senior official for the 'Special Presidential Package for the Revitalisation of Distressed Mining Communities' at the DPME. Facilitates sustainable development partnerships between mining companies and their host communities. |

3.2.2 Description of the Mining Companies

Mining companies A and C are major coal producers and company B is a junior producer. Mining company A is a multi-national and multiple commodity mining company. It has five opencast operations in Mpumalanga, four of which are operational and one is in the closure stage since 2018. Mining company B is a South African, majority Black-owned emerging coal mining company. It has one operational opencast mine in the Mpumalanga Province; the mine has an estimated 9 years of life of mine (LOM). Mining company C is a Black-empowered South African coal and heavy metals mining company, with operations across the globe. It has four operational opencast mines in Mpumalanga, that each have more than 10 years remaining in LOM.

3.2.3 Interview Process

The interviews were conducted according to the guidelines summarised in Stander and Broadhurst (2019). Following the identification of the interview participants, they were contacted by means of email correspondence requesting their participation in the research study. The participants were provided with the study synopsis and research objectives, as well as the relevant interview questionnaire. They were also presented with a consent form and ethics clearance documentation (see Appendix for this data). Three different questionnaires were designed dependant on the respondent's professional role (mining company representatives, rehabilitation consultants and Government officials respectively). The questionnaire format was similar and was intended to guide the semi-structured interviews and allow the participants to express their views and elaborate on the topics relevant to the research. These questionnaires all investigated the participants' perspectives on the rehabilitation of opencast coal mines; focusing on the guidelines being used, the progression and standard of rehabilitation practices, the challenges, as well as the gaps and opportunities.

Once the participants agreed to take part in the study there was follow-up communication through email and telephonically, to set up the interviews. The interviews were conducted

either face-to-face or telephonically. At the beginning of each interview, the synopsis and objectives of the research study as well as the purpose of the interviews were again explained to the participants. They were also assured of their anonymity and their rights to stop and withdraw from the interviews at any point if they felt uncomfortable. The participants were requested to sign the informed consent form (Appendix A) as an indication that they understood the research objectives and agreed to being interviewed. The length of the interviews varied between half-an-hour to an hour and they were recorded. The recorded interviews were transcribed by the researcher for accurate interpretation and quoting. During the interviews, the researcher made note of recurring points and specific themes. The themes that emerged during the interviews were analysed and captured in categories during the transcription process, as a means of data interpretation. The interviews indicated that responses to questions by the different participants within the same group (i.e. mine representatives, specialist consultants or government representatives) were similar; indicating “theoretical saturation” levels (Stander and Broadhurst, 2019) had been reached. No new or disparate information was likely to have been obtained from additional participants .

3.3 Ethics

As required by the University of Cape Town’s (UCT) Faculty of Engineering and the Built Environment (EBE), the researcher submitted an ethics clearance application to the EBE Ethics in Research Committee (EiRC) prior to data collection. The ethical clearance was approved as the EiRC was satisfied that the interview process, the primary source of data, would be compliant with ethical research practices. The approved ethics application form is found in Appendix C.

As the study aims to aims to portray the perspectives and experiences of mining company and Government representatives as well as rehabilitation specialists/practitioners, this poses potential ethical issues. To address this, participation in the study is completely voluntary and consent from participants is received. In addition, the anonymity of the interview participants as well as the mining companies they work for will be protected. Pronouns, indicating gender will not be used; the interview participants have been allocated numbers and are referred to by the numbers in the results section of this dissertation. The mining companies are referred to by letters. The interview transcripts are not added to the Appendices as they contain information that could reveal the identities of the participants.

3.4 Case Study Area

3.4.1 Coal Mining in the Mpumalanga Province

The Mpumalanga Province hosts a majority of South Africa's coal reserves and mines. This province hosts the Ermelo, Highveld and Witbank Coalfields (Figure 3-1), also referred to as the Central Basin (Eberhard, 2011). Coal mining in the Mpumalanga Province can be traced back to the dawn of gold mining in the late 19th century. The 1970s saw the advancement of the coal mining industry as a result of an increase of investments in electricity generation and export demands. With over a century of mining, the hub of coal production is moving away from the renowned Central Basin as it fast approaches depletion (Jeffrey *et al.*, 2014). A study in 2011 estimated that there was approximately 12 000 Mt (million tonnes) of run-of-mine (ROM) coal remaining in the Ermelo, Highveld and Witbank coalfields (CER, 2018). Coal mining has been instrumental in the development of the Mpumalanga Province; contributing to the growth of the economy and the creation of jobs.

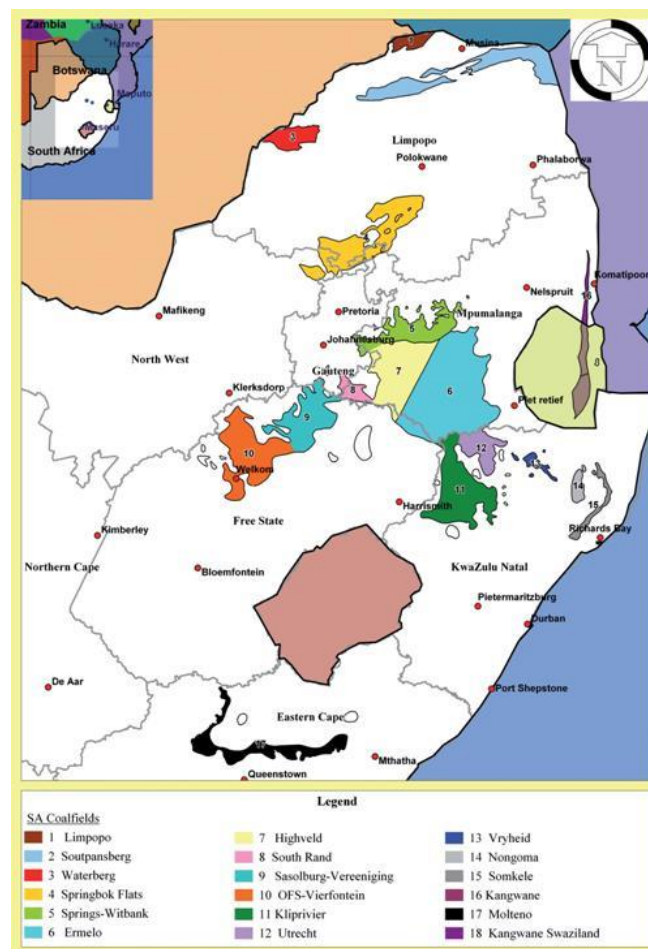


Figure 3-1: Map of the South African Coalfields (<https://www.miningreview.com/top-stories/the-easy-pickings-mostly-gone-in-southern-africa-s-coalfields/>)

3.4.2 Agricultural Context of the Mpumalanga Province

The Mpumalanga coalfields lie within the critically endangered South African grassland biome (WWF, 2011). The South African grassland biome, which is the most agriculturally productive of the South African biomes, is identified as critically endangered because of the total habitat loss, extent of fragmentation and the predicted future threat (Neke and du Plessis, 2004). The grassland biome lies mainly on the high central plateau of South Africa and covers an area of approximately 339 237km² (Figure 3-2), which is about 30% of South Africa's 1 220 000 km² land surface (WWF, 2011). According to Neke and du Plessis (2004), the impacts of surface mining activities on the grassland biome include alteration of the drainage patterns, loss of topsoil, hill destabilisation, erosion and pollution of ground and surface water. Subsequently, this results in the loss of vital grassland species and the development of invasive species that affect the land use capability.

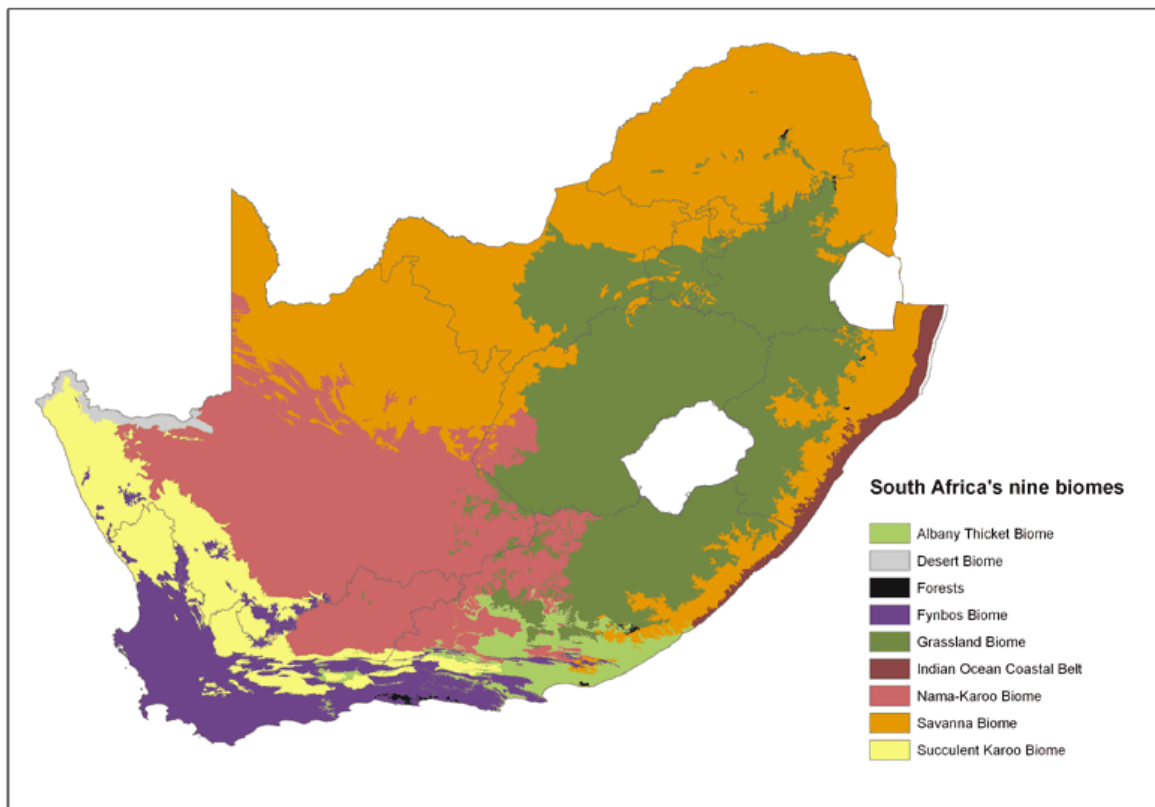


Figure 3-2: Map of the South African biomes. The Grassland Biome is in the darker shade of green (<http://redlist.sanbi.org/stats.php>)

According to a study by the Bureau for Food and Agricultural Policy (BFAP) on the impact of coal mining on agriculture, South Africa only has 1.5% high potential arable soils. The Mpumalanga Province hosts 46.4% of South Africa's total high potential arable soils. Approximately 12% of these soils have been transformed by coal mining activities; with a

further 14% subject to coal prospecting applications. Figures 3-3 to 3-5 show the Mpumalanga Province's agricultural capacity, coal mining potential and the mining applications and operational mines as at 2012 (van der Burgh, 2012). These images show that Mpumalanga's arable lands are underlain by a significant portion of coal resources. This poses a big threat to food security in South Africa (Davies, 2014). With the increasing world population and climate change, preserving arable land has become even more critical. This further indicates the urgency with which these grasslands need to be rehabilitated and the importance and relevance of the current study. It is worth noting that even though the study highlights the Mpumalanga Province's agricultural context, the biodiversity, water, socio-economic, etc. contexts are not of less importance and relevance.

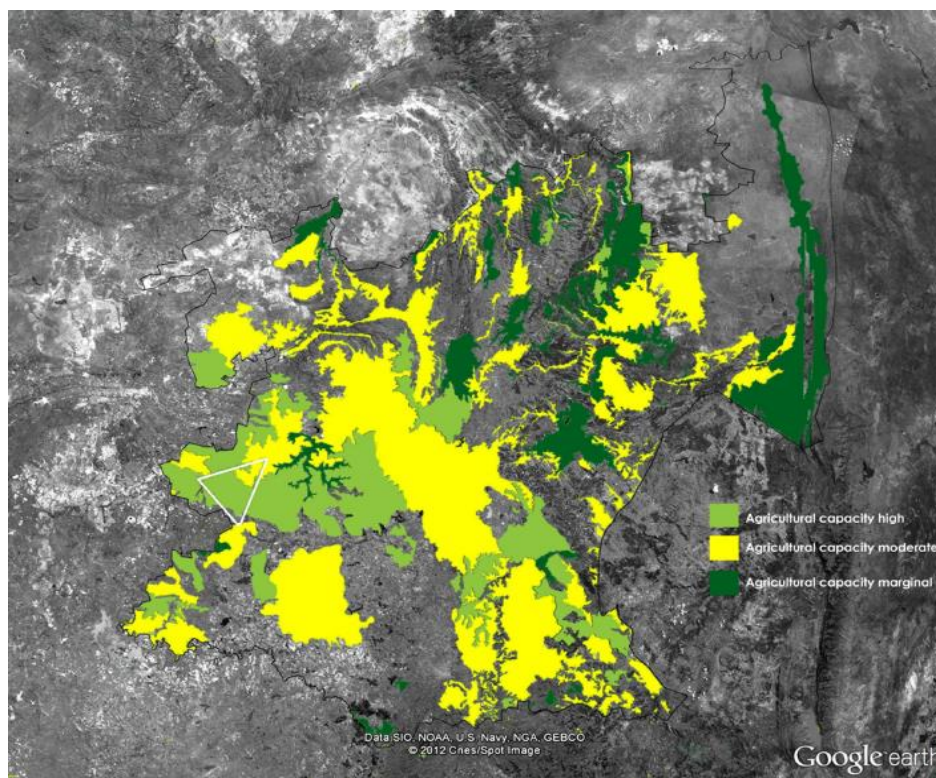


Figure 3-3: Mpumalanga land agricultural capacity (van der Burgh, 2012)

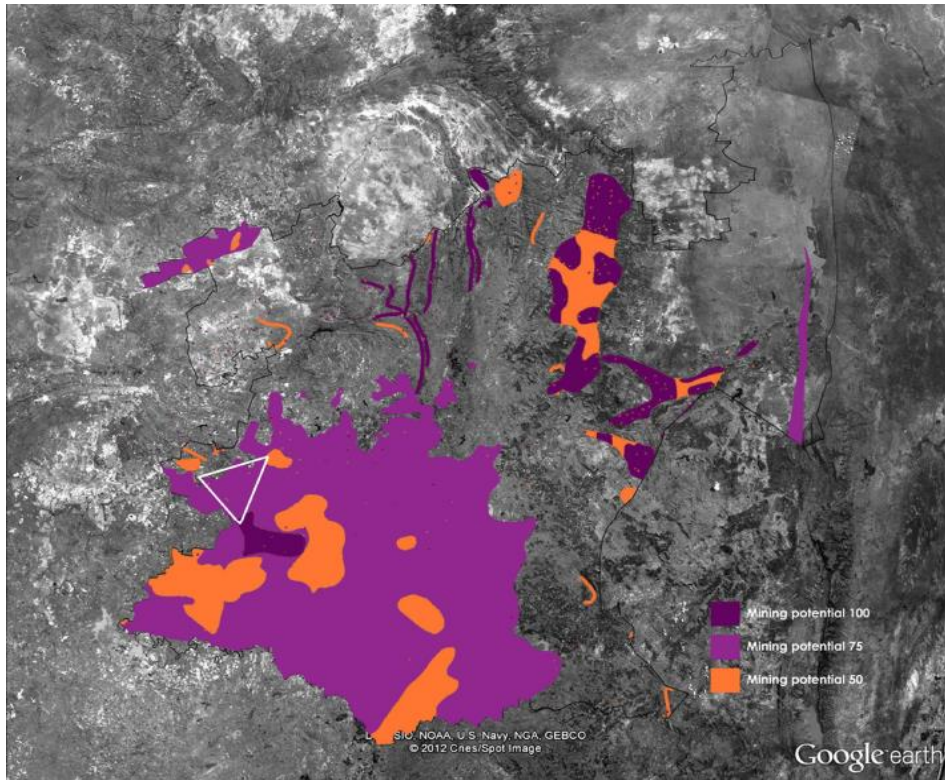


Figure 3-4: Mpumalanga land mining potential (van der Burgh, 2012)

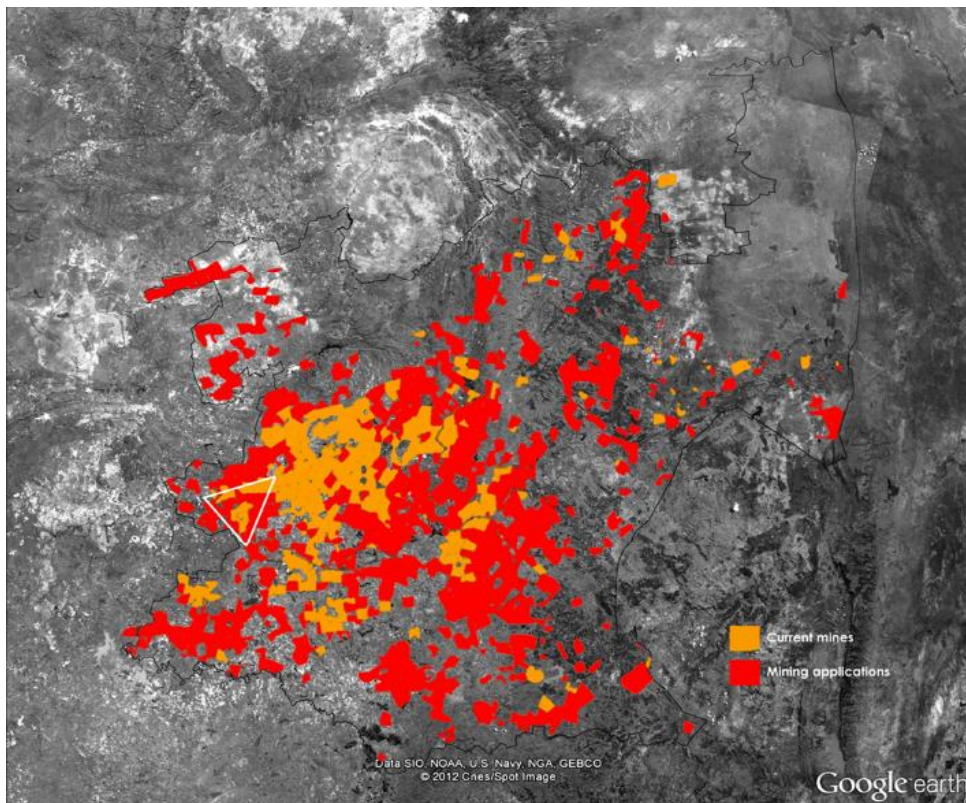


Figure 3-5: Mpumalanga operational mines and mining applications in 2012 (van der Burgh, 2012)

3.4.3 Coal Producers in the Mpumalanga Province

The main coal producers within the Mpumalanga coalfields include Anglo American Coal SA, Exxaro, Glencore, Sasol Mining and Seriti Resources⁴. Seriti Resources became a major player when they acquired majority shareholding of all of South 32's South Africa Energy Coal assets in 2019, adding to the coal assets purchased from Anglo American in 2017⁵. Figure 3-6 is a map showing some of the South African collieries and the respective companies. In 2019 Exxaro reported a coal production volume of approximately 45.3Mt; about 17.5Mt of this was from its Mpumalanga operations. The export coal volume was approximately 9.1Mt (Exxaro, 2020). Anglo American Coal SA reported a coal production volume of 17.8Mt for 2019 from its Mpumalanga operations, a decrease from the 18.4Mt reported in 2018. The export coal sales volume was approximately 18.1Mt (Anglo American, 2020). Anglo American Coal SA's coal production has significantly decreased since the sale of the Eskom-tied operations to Seriti Resources. In 2015 Anglo American Coal SA reported a coal production volume of approximately 50.3Mt (Anglo American, 2016). South Africa has numerous medium- to small coal producers; in 2016 there were approximately 120 junior coal producers, most of whom have taken over the mining of old underground workings (Shongwe, 2018). The junior producers include Universal Coal, MC Mining, Canyon Coal, Wescoal, Kuyasa Mining and Mbuyelo Coal⁵.

⁴Coal Mining in South Africa. Available from <https://www.mineralscouncil.org.za/sa-mining/coal>, accessed 03/06/2020.

⁵Seriti concludes agreement with South32 on the acquisition of SAEC. Available from <https://seritiza.com/seriti-concludes-agreement-with-south32-on-the-acquisition-of-saec/>, accessed 03/06/2020.

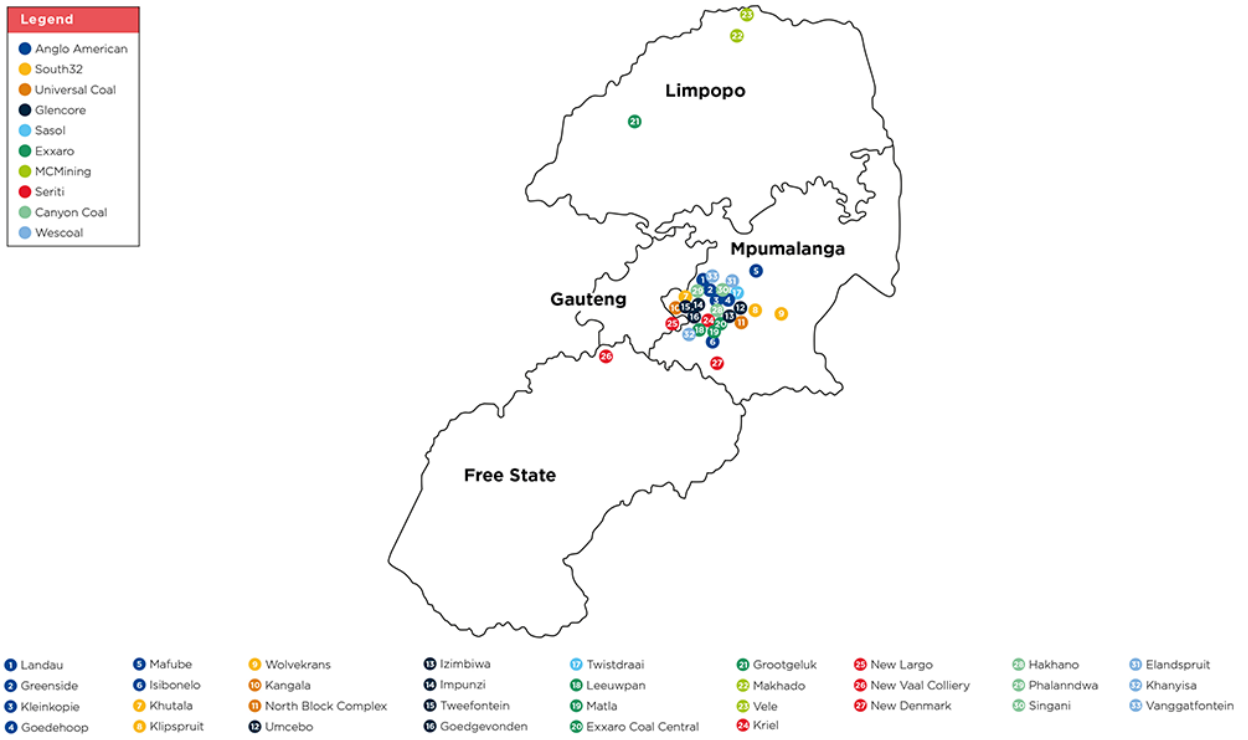


Figure 3-6: South African collieries and their respective operators (<https://www.mineralscouncil.org.za/sa-mining/coal>)

CHAPTER 4

RESULTS AND DISCUSSION

Rehabilitation Expert Perspectives and Experiences

Chapter 3 presented the research study questions, case study area and the research methodology applied in this study. This chapter presents the findings and discussion from the semi-structured interviews outlined in Section 3.3, which were aimed at interrogating the perspectives of rehabilitation experts concerning the current rehabilitation practices in opencast coal mines in the Mpumalanga Province. The outcomes of the interviews are presented in terms of the progression and standard of rehabilitation practices (Section 4.1), the application and relevance of rehabilitation practice guidelines (Section 4.2), rehabilitation challenges (Section 4.3) and the gaps and opportunities of the current rehabilitation practices (Section 4.4). The results are summarised and synthesised in Section 4.5.

4.1 Progression and Standard of Rehabilitation Practices

This study's interviews aimed to establish the viewpoints of the rehabilitation experts concerning the progression and standard of rehabilitation practices in opencast coal mines in the Mpumalanga Province over the past almost three decades, since the enactment of the Minerals Act No. 50 of 1991, which provided the fundamentals for environmental management for the first time in South African history (Van Druten and Bekker, 2017). The rehabilitation experts have varying perspectives about the development of rehabilitation practices in opencast coal mines in the Mpumalanga Province. Five of the six interviewed mining company representatives (Participants 1, 3, 4, 5 and 6) and the DMRE official (Participant 10) believe that there has been an overall improvement in rehabilitation practices over the past thirty years. However, Participant 2 (Company A rehabilitation specialists) and the three rehabilitation consultants (Participants 7, 8 and 9) do not believe that there has been an overall improvement in rehabilitation over the past thirty years. According to these experts there was a progression in rehabilitation practices between the early 1990's and the early to mid-2000's however, there has been a stagnation and to some extent a regression between the mid-2000's to the present.

Participants 1 (Company A rehabilitation manager), 3 (Company A post-closure projects specialist), 4, (Company B rehabilitation manager), 5 (Company B rehabilitation specialist), 6 (Company C environmental superintendent) and 10 (DMRE official) are of the opinion that there has been an overall improvement in rehabilitation practices and outcomes over the past

three decades, despite ongoing challenges. According to Participant 10 (DMRE official) there are “pockets of excellence” in the rehabilitation in the coal sector however, “best practice” standards have not yet been attained. The DMRE official attributes the improvement in rehabilitation to the introduction of more stringent laws. Stating that in the past when mining companies were not held accountable by the government they hardly bothered with rehabilitation. Participants 1, 3 and 4 believe that the improvement in rehabilitation has been driven by the significant advancements in rehabilitation research, which has seen the development of innovative ways of overcoming rehabilitation challenges such as topsoil shortage and acid mine drainage.

Contrary to the view of Participants 1, 3, 4, 5, 6 and 10; Participants 2 (Company A rehabilitation specialist), 7, 8 and 9 (rehabilitation consultants) are of the opinion that rehabilitation practices and outcomes have been stagnant and that to a certain extent they have regressed over the past fifteen years – from the mid-2000’s to the present. Participant 8 believes that the regression in rehabilitation practices since the mid-2000’s is “largely due to regulatory uncertainties around important rehabilitation related legislation and mining companies reducing their in-house technical experts which limits the research required to close knowledge gaps”. This view is contrary to Participant 10’s view concerning the role of the legislative framework and Participants 1, 3 and 4’s views concerning the advancements in rehabilitation research within mining companies. Participant 8 further states that rehabilitation is often sacrificed when there is a decline in commodity prices, which results in significant rehabilitation backlogs. Participants 2 and 7 link the lack of progression of rehabilitation practices to mining companies allocating insufficient resources (personnel, equipment and funding) for rehabilitation. According to these experts mining companies no longer invest in a dedicated rehabilitation team that focuses on rehabilitation research and implementation at each of their sites. According to Participant 2, “I think over the years there has been a dip in the quality of rehabilitation. Nowadays, we are just trying to meet the standard, that’s all we have budget for. Whereas twenty or so years ago they were going above the standard”. Rehabilitation consultant, Participant 9 believes that rehabilitation has not progressed in the past decade-and-a-half, despite the significant advancements in rehabilitation research as stated by Participants 1, 3 and 4, because the developed research and enhanced “*Guidelines for the Rehabilitation of Mined Land*” are not assimilated into legislation. Participant 9 states that mining companies tend to focus on merely complying to rehabilitation legal obligations and do not spend enough time on rehabilitation.

Despite the varying perspectives (Figure 4-1) concerning the progression of rehabilitation practices that emerged during the interviews, all the interviewed rehabilitation experts are of the view that the quality of current rehabilitation practices remains a challenge. The experts further state that because of this, the rehabilitation outcomes are often not to the desired standard.

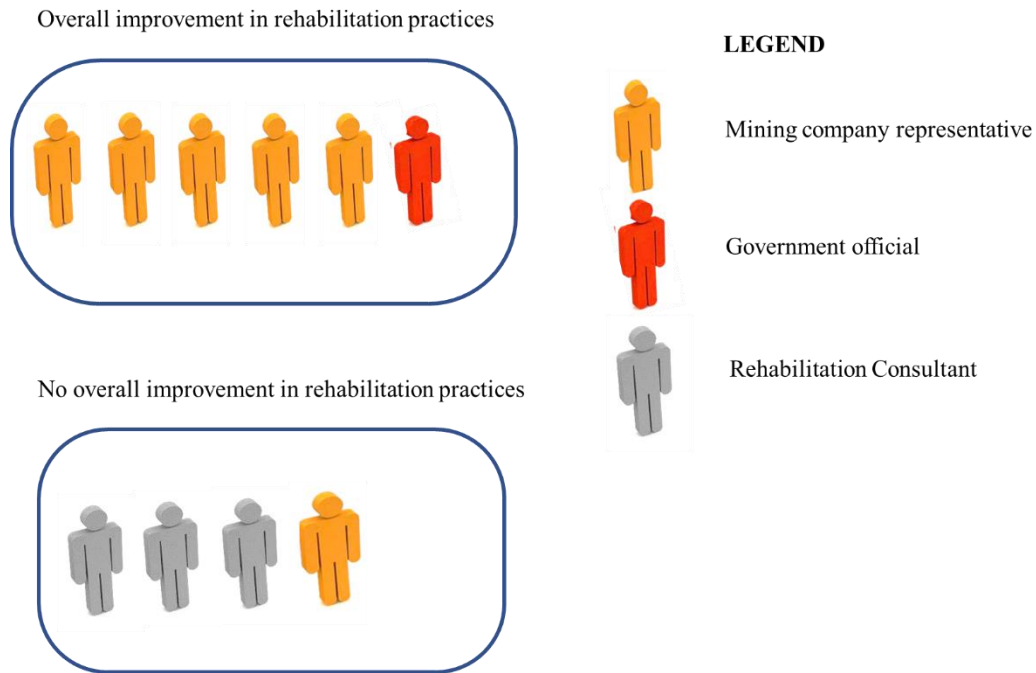


Figure 4-1: Schematic Illustration of the rehabilitation experts’ perspectives concerning the progression of rehabilitation⁶

4.2 Application and Relevance of Rehabilitation Practice Guidelines

As discussed in Chapter 2, South Africa through the Minerals Council, Coaltech and Land Rehabilitation Society of Southern Africa (LaRSSA) have published three editions of the “*Guidelines for the Rehabilitation of Mined Land*” that aim to provide guidance for the planning, implementation and management of rehabilitation of opencast coal mines. During the semi-structured interviews, one of the objectives was to determine the perspectives of the rehabilitation experts concerning the application and relevance of the “*Guidelines for the Rehabilitation of Mined Land*” in the context of current rehabilitation practices.

According to Participants 1 and 4 (rehabilitation managers for mining Company A and B respectively) as well as Participants 2 and 5 (rehabilitation specialists for Company A and B respectively) the “*Guidelines for the Rehabilitation of Mined Land*” are used for their

⁶ The actual roles of the rehabilitation experts are detailed in Table 2 on page 36.

rehabilitation practices as they form the foundation of all their site rehabilitation practices. According to Participant 4, “The Minerals Council/Coaltech guidelines form the backbone of our internal ‘best practice’ guidelines.” Participants 1, 2, 4 and 5 state that in addition to the Minerals Council guidelines, Companies A and B use in-house procedures and frameworks which are site specific. According to these experts, these procedures are based on the “*Guidelines for the Rehabilitation of Mined Land*” but are primarily tailor made to address specific site challenges such as topsoil shortage and spontaneous combustion. Participants 2 and 5 mention that the in-house guidelines are also guided by what is prescribed in the Environmental Management Plan (EMP). Overall, the mining company representatives consider the application of the “*Guidelines for the Rehabilitation of Mined Land*” to be good. On the contrary, all the consultants (Participants 7, 8 and 9) with expert knowledge and experience in auditing opencast coal mine rehabilitation in Mpumalanga consider application of the “*Guidelines for the Rehabilitation of Mined Land*” by the mining sector to be poor. According to these consultants most of the small mining companies do not use or even know of the existence of these guidelines. A majority of the big mining companies partially use the Minerals Council/Coaltech/LaRSSA guidelines, but generally develop and apply their own guidelines. Participant 9 states that the need to develop site-specific rehabilitation guidelines in addition to the “*Guidelines for the Rehabilitation of Mined Land*” is understandable as the Minerals Council guidelines are generic. Participant 9 however, highlights that the application of the in-house guidelines also tends to be poor. Participants 7, 8 and 9 believe the poor application of the “*Guidelines for the Rehabilitation of Mined Land*” is largely due to budget constraints. Participant 9 states, “the bigger companies implement the Coaltech guidelines as best as possible. But they also tend to think that budget dictates more than a guideline. And sometimes the guidelines fall by the way if the budget does not allow”. The rehabilitation consultants also attribute the poor application of the “*Guidelines for the Rehabilitation of Mined Land*” to a lack of capacity and expertise, as well as poor legislation enforcement (discussed in detail in Section 4.3).

Concerning the relevance of the Minerals Council/Coaltech/LaRSSA “*Guidelines for the Rehabilitation of Mined Land*”, all the rehabilitation consultants consider the guidelines to be relevant and sufficient to ensure effective rehabilitation if followed meticulously. Participant 7 states, “The Minerals Council/Coaltech guidelines are quite sufficient, they must just be generally adopted by mining companies. The cause of poor rehabilitation outcomes is the failure to accurately follow the guidelines”. According to Participant 8, the “*Guidelines for the*

Rehabilitation of Mined Land” provide a good foundational guide and have been updated to incorporate current terminology, planning and rationale -“the technical implementation aspects of the guidelines are still relevant and they provide the ‘101’ learnings for rehab from a soil and vegetation perspective”. Participant 9 states that the “*Guidelines for the Rehabilitation of Mined Land*” assist with integrating the different aspects of rehabilitation and provide mining companies and rehabilitation practitioners a guide to address the major rehabilitation issues on the mines. This rehabilitation consultant emphasises the need for comprehensive understanding of the “integrated science of rehabilitation” to ensure correct implementation. “They say ‘the devil is in the detail’. Even though the guidelines tell you how to strip and handle soil, if you don’t know the soil types - that is the devil in the detail - you might find yourself doing things according to the guidelines and only managing to get it 60% right”. The company representatives, as in the case of the rehabilitation consultants, consider the “*Guidelines for the Rehabilitation of Mined Land*” to be relevant. Participants 1 and 4 state that these guidelines form the foundation of all of Company A and B’s rehabilitation practices; including the development of in-house guidelines. Participant 10 (DMRE official) is also of the view that the Mineral Council/Coaltech/LaRSSA guidelines are relevant and are endorsed by the DMRE.

4.3 Rehabilitation Challenges

The interview participants identified challenges that prevent the achievement of effective of rehabilitation in opencast coal mines in the Mpumalanga Province. The challenges discussed by the rehabilitation experts are split into two categories, physical and non-physical challenges. The physical challenges, which are mostly soil related include topsoil shortage, soil compaction and secondary subsidence (Figure 4-2). Of the eleven interviewed rehabilitation experts, nine (82%) identified topsoil shortage as a physical challenge of successfully implementing rehabilitation. Soil compaction and secondary subsidence were identified by six (55%) and five (45%) participants, respectively. The non-physical challenges include legislation, corporate culture and priorities, lack of capacity and expertise, limited cross-sectoral collaboration and the lack of clear long-term rehabilitation objectives (Figure 4-3). Nine of the eleven (82%) interviewed experts respectively mentioned shortcomings in the legislative framework, corporate culture and priorities and the lack of capacity and expertise as challenges to effective rehabilitation. Limited cross-sectoral collaboration and the lack of clear long-term rehabilitation objectives were identified by ten (91%) and eight (73%) participants, respectively.

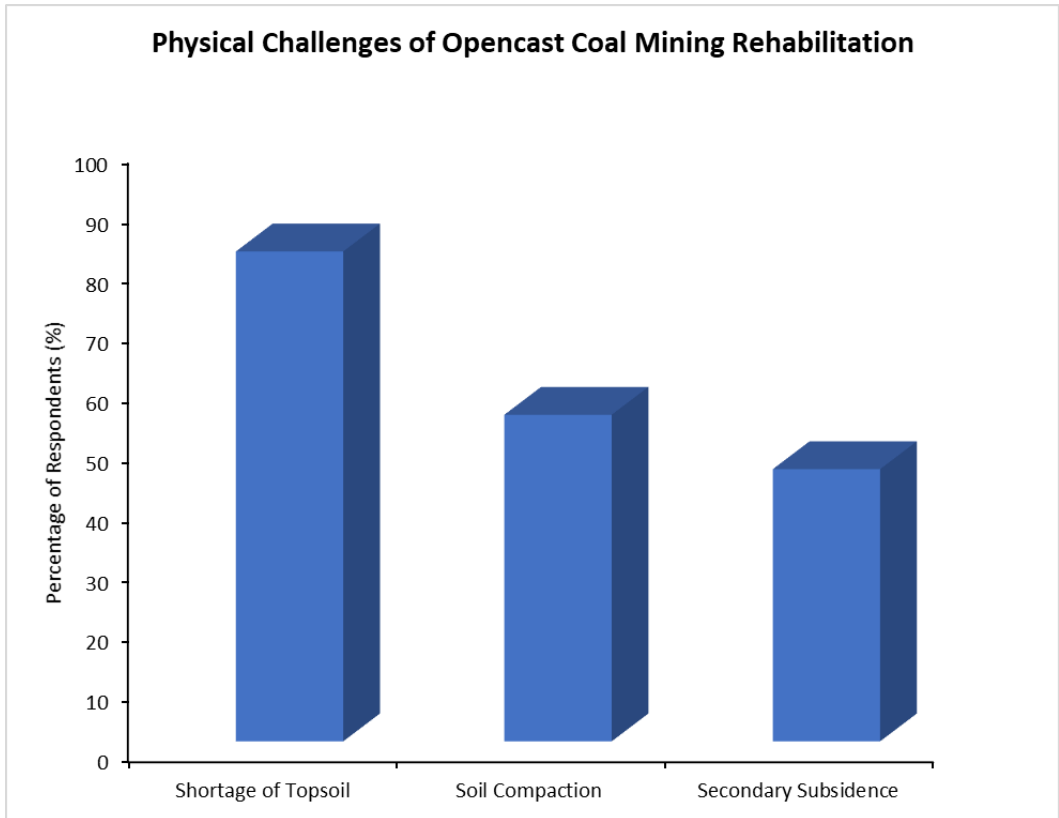


Figure 4-2: Physical Challenges of Opencast Coal Mining Rehabilitation

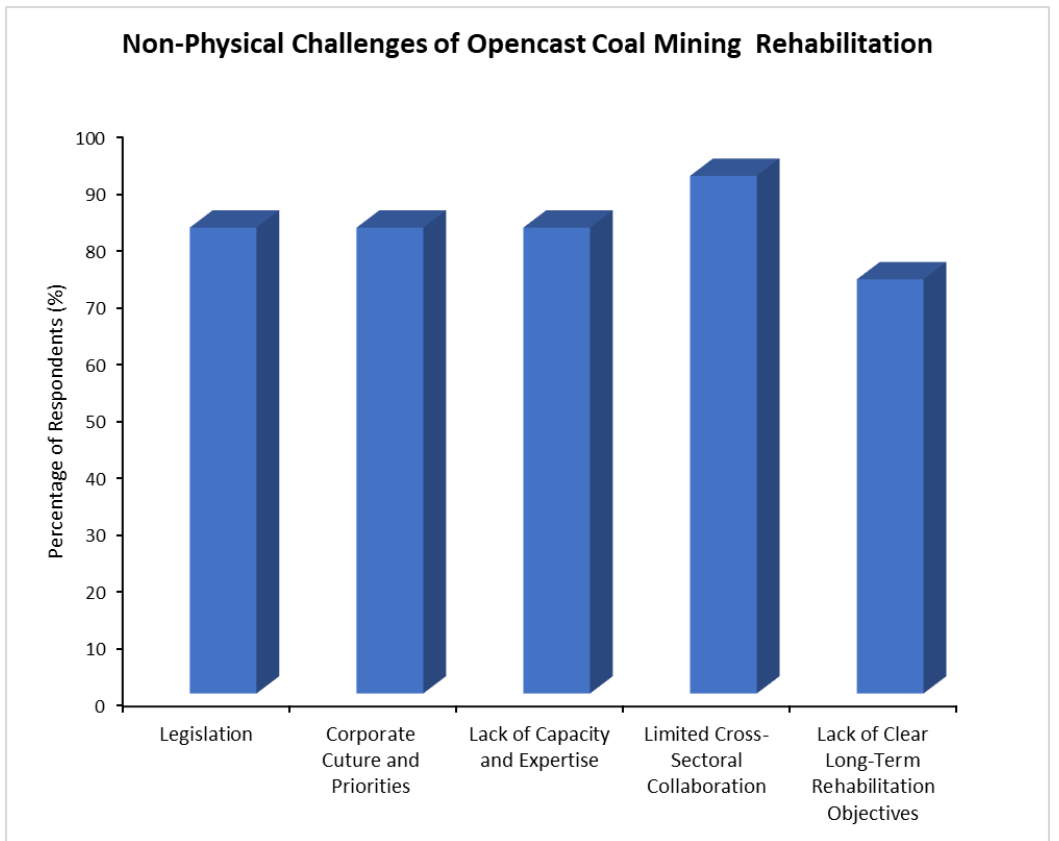


Figure 4-3: Non-physical Challenges of Opencast Coal Mining Rehabilitation

4.3.1 Shortage of Topsoil

According to nine of the eleven participants, all the mining company representatives and rehabilitation consultants, the shortage of topsoil as a rehabilitation challenge in the Mpumalanga opencast coal mines. According to Participant 1 (Company A rehabilitation manager), “the most significant challenge we have at this stage is topsoil shortage”. The participants mention three main factors that cause topsoil shortage; namely, poor management and/or misuse of topsoil stockpiles, incorrect soil stripping, as well as poor soil separation. Poor management and misuse of topsoil stockpiles are mentioned by all the mining company representatives and rehabilitation consultants as a major cause of topsoil shortage. According to Participant 7 (rehabilitation consultant) the incorrect placement of topsoil stockpiles which often leads to soil erosion or personnel being unaware of where stockpiles are placed are examples of the poor stockpile management observed at opencast coal mines. Participant 4 (Company B rehabilitation manager) believes the lavish use of topsoil during rehabilitation in the past is another example of poor stockpile management that has contributed to the shortage of topsoil in the long-term. Participant 6 (Company C environmental superintendent) mentions that the misuse of topsoil is common, stating that topsoil is often used for the filling of holes and building of roads instead of overburden material. Participant 2 (Company A rehabilitation specialist) states, “topsoil has been thrown away over the years or used for road building or berms in the pit. Come rehabilitation time, we don’t have enough topsoil”.

In addition to the poor management and misuse of topsoil stockpiles, Participant 7 considers incorrect soil stripping as another cause of the shortage of topsoil. According to this expert in the past topsoil deficit was due to insufficient topsoil being stripped, but this has now improved significantly particularly in the big mining companies. A third major cause of topsoil shortage that Participants 7 and 8 (rehabilitation consultants) mention is poor soil separation. The experts say that the topsoil and subsoil are not always separated. Participant 7 stated, “they do not separate topsoil from the subsoil. So, you end up with a mixed medium being put back on top of the overburden material which has a very low organic matter content on average”.

Participant 8 states that the topsoil shortage results in significant growth medium deficits for suitable rehabilitation, as topsoil is the best media for restoring land capability and achieving vegetation growth. Participant 2 shares Participant 8’s sentiments and further states that topsoil shortage makes meeting the prescribed EMP land capability (arable or grazing) commitments onerous.

4.3.2 Soil Compaction

All the rehabilitation consultants (Participants 7, 8 and 9) and four of the mining company representatives (Participants 1, 2, 4 and 6) identified soil compaction as a rehabilitation challenge. According to Participant 7, compaction occurs when large machinery is used to replace soils and dozer rippers are not commissioned to carry out deep ripping which will decompact the soils afterwards. “The rehabilitation guidelines state that deep ripping after the soils have been replaced must be done. This has been understood for the last 30 years, but the mines still do not delegate dozer rippers to rip the soil afterwards”. Participant 7 further states that agricultural machinery is not designed to carry out deep ripping, it only manages to decompact a small layer of the topsoil leaving the soil beneath highly compacted and unable to support any plant growth. This expert emphasises the need for dozer rippers to ensure deep ripping of the soil. Participants 2 (Company A rehabilitation specialist), 4 (Company B rehabilitation manager), 6 (Company C environmental superintendent) and 8 (rehabilitation consultant) echo Participant 7’s sentiments concerning the limited availability of dozer rippers to carry out proper soil ripping. They state that mine production tends to take precedence over rehabilitation projects and therefore the machinery and personnel required to carry out deep ripping of the soils is available for very limited time. This often leads to soil not being properly ripped and in turn soil compaction.

4.3.3 Secondary Subsidence

According to five of the experts, Participants 2 (rehabilitation specialist with Company A), 7, 8, 9 (rehabilitation consultants) and 10 (DMRE official) secondary subsidence is generally latent and is only noticed after rehabilitation as undulations in the land that do not allow free drainage. Participant 7 believes that the mining techniques used, “the pyramid-trough technique”, contribute to secondary subsidence. According to Participant 7, minor subsidence can occur within a short-term (<5 years) after the completion of rehabilitation; but the major secondary subsidence can occur 10-20 years after rehabilitation when the groundwater levels naturally re-establish. Participant 8 states that the rehabilitation guidelines recommend that a soil reserve is kept to fill and repair subsidence; post rehabilitation monitoring and maintenance is therefore crucial. Participant 2 mentions that in the older collieries there is a shortage of topsoil and no reserve soil to fix secondary subsidence. According to Participants 2, 7 and 8 mining companies do not have the capacity for rehabilitation monitoring and maintenance nor do they have any soil reserves soil for fixing secondary subsidence.

4.3.4 Legislation

The review of the legislation governing mining and rehabilitation in Section 2.4 indicates that South Africa has robust legislation that is of international standard. Participants 1, 4 (rehabilitation managers with Company A and B respectively), 7, 8, 9 (rehabilitation consultants), 10 (DMRE official) and 11 (DPME official) agree with the literature findings, mentioning that South Africa has well developed good legislation. Participants 7 and 8 state, “[South Africa has world class regulations](#)”. However, 91% of the participants, including all the participants with the exception of Participant 10, mention that the application and enforcement of the legislation are a challenge. This leads to the legislative framework not achieving its objectives.

Participants’ concerns in terms of legislation include the uncertainties created by continuous amendments to legislation and the lack of consultation when the amendments are made. According to Participant 1, “[the most challenging regulations currently](#)” are the NEMA “*financial provisioning regulations*”; stating that this is mainly due to the several amendments to the regulations that have created uncertainty for mining companies. Participants 4, 5 (Company B rehabilitation manager and specialist respectively), 7, 8 and 9 (rehabilitation consultants) share Participant 1’s sentiments. Participant 8 believes that these uncertainties have contributed to the regression in rehabilitation practices. Participant 1 further states that when changes are made to the regulations the process is not always well thought through in terms of the impact to the industry and that there isn’t proper consultation with mining companies. “[The problem is that the regulations change, but we do not always have any input towards these changes](#)”.

The experts’ view is that the lack of alignment of legislation, particularly the Mine Health Safety Act (MHSA), with field practices hampers rehabilitation practices. According to Participants 2 (Company A rehabilitation specialist), 3 (Company A post-closure specialist), 5 (Company B rehabilitation specialist), 6 (Company C environmental superintendent), 7 and 9 (rehabilitation consultants) the MHSA requirements; such as obtaining a certificate of fitness (COF), completing site inductions and licenses, as well as completing several other admin requirements; which must be completed before any of the rehabilitation contractors or consultants can set foot on an operational mine property often cause delays in rehabilitation and post-rehabilitation land use projects. Participant 3 mentions that these legal requirements are applicable even on sites where there is no active mining taking place because until a mine closure certificate is issued, the site is considered as an operational mine. “[It is a challenge to](#)

get people on site at an early stage because it is still considered a mining area, everything still falls under the MHSA and the process of getting all the required documents in place often takes a long time and causes delays to the implementation of projects”, states Participant 3. Participant 2 shares Participant 3’s views, stating that bringing in external stakeholders such as farmers and other community members to use rehabilitated mine land for crop production or animal grazing is an onerous task since the rehabilitated areas fall under a Mining Right that must comply to the MHSA. According to Participants 2, 3 and 6 bringing in external stakeholders on mining property is conceived as an additional risk that many mining managers are not always willing to take due to the legal implications of their legal appointments and responsibilities (MHSA stipulation). According to Participant 2, post-rehabilitation land use by external stakeholders could be a great opportunity for mining companies to prove land capability restoration after completing their rehabilitation. In addition to contributing to rehabilitation delays, Participant 9 believes that MHSA significantly affects rehabilitation maintenance; stating, “the legislation – MHSA - does not allow free-moving activity of anybody other than the mine employees. And as understandable as this legislation is, it is a huge shortcoming because if you do not maintain rehab, it starts degrading. And by the time you want to close the mine, all the rehabilitated land will be degraded and you will have to redo the process”. Participants 4 and 5 mention that in light of the challenges around the lack of alignment of the MHSA, some of the mining companies have been engaging the DMRE about obtaining legal permissions/exemption (Section 79) from the Minister of Mineral Resources and Energy to exclude rehabilitated areas from a Mining Right with MHSA requirements and move it to the Occupational Health and Safety Act (OHSA). According to the respondents, even though OHSA also has several safety requirements they are less onerous than the MHSA requirements.

The lack of consistent and adequate enforcement and policing of legislation is according to Participants 7, 8, 9 and 11 a major challenge that leads to the regulations not contributing positively towards rehabilitation. Participant 7 states, “the laws are well developed and world class. The only issue is that they are not well enforced or policed. We have great laws in place, but they are not fulfilling their intended role”. Participant 8 believes that companies are able to get away with not carrying out proper rehabilitation because of the poor enforcement and monitoring of legislation.

Contrary to the views of all the other participants about legislation uncertainties, lack of alignment as well as inconsistency and inadequacy of enforcement, Participant 10 (DMRE

official) believes that the mining and rehabilitation legislation, including the financial provisions regulation, are clear and fit for purpose. According to Participant 10, the financial provisions regulations are insurance for the government to ensure that rehabilitation is done at the cost of the mining companies even if a company has an untimely shutdown.

4.3.5 Corporate Culture and Priorities

Nine of the eleven interview participants believe that “the way in which things are done” within mining companies often hampers rehabilitation projects. The conflicting priorities between mining production and rehabilitation is a corporate practice theme that emerges significantly from the interviews. According to all the Company A, B and C representatives (Participants 1 to 6), in their experience mining production requirements are often prioritised over rehabilitation requirements. Participant 2 (Company A rehabilitation specialist) mentions that personnel and machinery are often re-allocated from rehabilitation work to production work to meet production targets. Participant 4 (Company B rehabilitation manager) echoes Participant 2’s sentiments stating, “rehabilitation machine allocation is constantly put on the back burner”. Participant 4 further states that it is not only rehabilitation machinery and personnel allocation that is often sacrificed at the expense of mining production, but budget as well. When budget cuts have to be made, rehabilitation tends to be cut at the expense of the mining production budget. Participant 4’s concern is that the rehabilitation budget cuts can lead to companies compromising on technical expertise and appointing contractors that do not have proper rehabilitation background and expertise to conduct rehabilitation, as those with the necessary expertise are considered too costly. According to the experts representing mining companies A, B and C the prioritising of mining production over rehabilitation causes rehabilitation delays and in turn rehabilitation backlogs. Rehabilitation consultants, Participant 7, 8 and 9, agree with the mining company representatives. “During commodity-based economic downturns, companies tend to sacrifice rehabilitation, and this has resulted in significant rehabilitation backlogs across the country”, states Participant 8. Participants 2, 4, 7 and 8 question whether the corporate culture of prioritising mining production over rehabilitation is due to the perception that rehabilitation is not a revenue producing component of the business.

According to Participant 3 (Company A post-closure projects specialist) the onerous internal administration and red-tape that one must go through in order to get rehabilitation contractors or consultants on to site, is another corporate practice that frustrates rehabilitation efforts. Participant 3 states that the administrative process can take up to months to complete and that this is a practice that has been normalised and is quite onerous to challenge. “It can take months

to get the contractors signed-on in order to start working on the mine”, states Participant 3. Participant 7 agrees with Participant 3 in this regard, stating that the legal requirements alone are onerous but the slow rate in which it takes to process internal administration makes rehabilitation even more challenging. The rehabilitation consultants (Participant 7, 8 and 9) attest to the onerous internal administration and red-tape from their experiences working as consultants at opencast coal mines in Mpumalanga.

Another constraining corporate culture highlighted by Participant 8, a rehabilitation consultant, is the perception that rehabilitation is an “end-of-pipe” activity. There is a lack of integrated early rehabilitation and post-rehabilitation land use planning. According to Respondent 8, “rehabilitation and post-rehabilitation land use do not receive the upfront planning attention it needs”. Participant 9, also a rehabilitation consultant, agrees with Participant 8, stating that rehabilitation is often not a strategic focus at the beginning of mine planning. Participant 9 proceeds to say that if there is early and continuous focus on planning, rehabilitation will be easier and the optimum post-mining land use plan would be easier to clearly define.

4.3.6 Lack of Capacity and Expertise

The semi-structured interviews indicate that nine of the participants believe that the limited personnel and the lack of appropriate training of the personnel overseeing the implementation and monitoring of rehabilitation within mining houses and Government departments hamper the achievement of desired rehabilitation outcomes. According to Participants 2 (Company A rehabilitation specialist), 4 (Company B rehabilitation manager), 5 (Company B rehabilitation specialist), 7, 8 and 9 (rehabilitation consultants), mining companies no longer have rehabilitation departments or teams led by a person with rehabilitation expertise, with an understanding of the integrated science behind rehabilitation. The general perception amongst the participants is that in the past the big mining companies had a dedicated rehabilitation department at each of their operations. The sole responsibility of the rehabilitation department was implementation and maintenance of rehabilitation, as well as collaboration with researchers and overseeing research trials on their sites. The participants further mention that nowadays the big mining companies have one or two rehabilitation coordinators overseeing the rehabilitation of several operations. These rehabilitation coordinators are assisted by environmentalists who have numerous other responsibilities and do not have an integrated knowledge of rehabilitation. Participant 7 states, “back in the early 90’s every mine had a rehabilitation officer. You don’t have a rehabilitation officer now; you have an environmental officer who usually has no agricultural experience whatsoever and has so many other tasks that

they do not have time to focus on the rehabilitation”. The rehabilitation consultants (Participants 7, 8 and 9) mention that the smaller mining companies often do not even have any rehabilitation personnel. Participant 8 links this reduction in the in-house technical experts and focus on required research to the corporate culture of not prioritising rehabilitation (Section 4.3.5) and believes it is largely responsible for the regression in the quality of rehabilitation practices (Section 4.2). Participant 9 believes that it is difficult for people tasked with rehabilitation to carry out the correct implementation and maintenance of rehabilitation if they do not have an integrated understanding of rehabilitation. This rehabilitation consultant is of the opinion that the poor application of rehabilitation guidelines (Minerals Council and in-house) is largely due to the lack of technical expertise of those tasked to carry out rehabilitation (Section 4.1). This lack of expertise is Participant 4’s concern about the contractors who are appointed to carry out rehabilitation; stating that they often do not have the expertise to properly carry out rehabilitation practices such as soil stripping or topsoil profiling. According to Participant 4, “the new guys coming into the industry have earth moving equipment but they have not been exposed to the quality and scale of the rehabilitation we require of them”. Three of the mining company rehabilitation specialists (Participants 2, 4, 5) and all the rehabilitation consultants interviewed (Participants 7, 8 and 9) believe that the lack of capacity and expertise within mining companies is due to their budget restrictions (Section 4.3.5).

All the specialist consultants interviewed (Participants 7, 8 and 9) argue that government departments, in particular the DMRE, also do not have enough well-trained people to conduct proper policing of rehabilitation at mines. According to Participant 7 the lack of knowledge and expertise in government departments is one of the biggest challenges concerning rehabilitation because the government officials who are sent out to audit rehabilitation at opencast coal mines may not be able to distinguish that the levelled land with grass growing is not anywhere near the rehabilitation standard that was committed to. Participant 9 states, “I don’t think Government has the capacity or training to do the job well enough. I don’t think they have the background, nor do they know how to align the legislation with what is actually happening in the field”. Participant 11, a Government official, agrees with the rehabilitation consultants that most government departments do not have the capacity and integrated knowledge to monitor that rehabilitation has the desired and sustainable outcomes. In direct contradiction to Participants 7, 8, 9 and 11, Participant 10 (DMRE official) is confident that Government has the capacity and expertise to conduct rehabilitation audits and enforce legislation.

4.3.7 Limited Cross-Sectoral Collaboration

The interviews indicate that ten of the eleven (91%) participants think that collaboration around rehabilitation and post-rehabilitation land use between the different sectors - mining companies, rehabilitation specialist consultants/organisations and government departments, is inadequate. These participants believe that this is another constraint to the achievement of desired rehabilitation outcomes. Participant 8 (rehabilitation consultant) believes, however, that the development and growth of rehabilitation support organisations such as LaRSSA over the past eight years is indicative of an improvement in collaboration between mining companies and rehabilitation consultants and/or research institutions. Participants 2 (rehabilitation specialist with Company A) and 9 (rehabilitation consultants) agree with Participant 8, stating that mining companies have a reasonably good level of research consultation and engagement with organisations such as Coaltech and LaRSSA. Participant 2 states, “researchers can do research, we give them the trial sites for their research work at no charge. We get the benefit of the data collected”. Despite the improvement in research and development collaborative efforts that the mining industry has supported, rehabilitation consultant (Participant 9) mentions that these collaborative efforts are often limited by company budget constraints. Participant 9 states, “I think there is some collaboration between rehabilitation specialists/organisations and mining companies, particularly the big companies. But it boils down to what companies are willing to pay for that collaboration”. This rehabilitation expert further states that the lack of effective collaboration between research developers and adopters/implementers (Government) means that the research outcomes are not integrated into regulations and consequently not adopted by the mining industry that is largely reactive to regulatory requirements. According to Participant 9, “if Government does not adopt and harness the new research and incorporate it in the legislation and monitoring in some way, then the mining companies will not implement it”.

Participant 7’s concern is that mining companies have discontinued the collaborative practice of inviting specialist consultants to conduct annual reviews of the status of the rehabilitation at their opencast coal mine operation. According to this expert this was common practice, until about a decade ago, and provided mining companies with technical expertise and guidance to ensure successful rehabilitation. Participant 7 states, “one wonders whether the mining companies do not bring in rehabilitation specialists to review their rehabilitation because they think they know it all, or whether they are scared to show the external rehabilitation specialists the status of their rehabilitation”. Participants 2, 8 and 9 however highlight that companies with

operations approaching decommissioning are the ones placing the most effort in collaborative actions to achieve closure. This speaks to the corporate culture of not giving rehabilitation as much attention in the early stages of the life of mine (see discussions in Section 4.3.5 on corporate culture and priorities).

Concerning collaboration between mining companies and the government, Participant 8 believes that “[there remains mistrust between industry and regulators, which limits the potential for valuable collaboration between them](#)”. Participant 7 agrees with this view, stating that many projects that would have ensured greater productivity from rehabilitated land have been hampered by the very poor relationship that has existed up until recently between mining companies and Government. All the mining company representatives (Participants 1 to 6) agree that there needs to be an improvement in the collaboration with Government. Participant 3’s perspective is that the inadequate collaboration with Government is largely due to a lack of effective communication, with neither party being prepared to take the initiative. Participant 11 (DPME official) believes that collaborative work between industry and Government is often challenging because they tend to have different and often conflicting priorities.

Participant 9 states that the misalignment and lack of cooperation between the various Government departments (the DMRE, the Department of Environmental Affairs (DEA) and the Department of Water and Sanitation (DWS)) also contributes to the multi-sectoral collaboration challenges. According to this expert, the different departments focus on their own areas of responsibility and there is no integration between the different departments, which poses a challenge when it comes to an integrated science such as rehabilitation.

4.3.8 Lack of Clear Long-Term Rehabilitation Objectives

According to Participants 2 (Company A rehabilitation specialist), 3 (Company A post-closure projects specialist), 4 (Company B rehabilitation manager), 5 (Company B rehabilitation specialist), 7, 8, 9 (rehabilitation consultants) and 11 (DPME official) without a clear long-term rehabilitation end-goal or vision, rehabilitation efforts are usually futile. Four of the six mining company representatives interviewed (Participants 2, 3, 4 and 5) mention that despite the existence of the Environmental Management Plan (EMP), which stipulates the land capability commitment that must be adhered to when carrying out rehabilitation, there is a lack of clear long-term objectives that will ensure that rehabilitation has sustainable outcomes that will be of value to the host communities beyond the life of mine. Participant 3 states, “[we grapple with how we can provide something of value to the communities which have been impacted by our](#)

mining activities”? Participant 5 agrees stating, “I find the biggest challenge to be ensuring that the rehabilitation done during the life of the mine is done in such a way that it can be sustainable and benefit the communities even after mine closure”.

Participant 2 is of the opinion that in addition to the EMP legal obligation of restoring land capability, there needs to be legal requirements for mining companies’ closure objectives to incorporate clear post-closure land use. Participant 8 (rehabilitation consultant) states that post-closure land use must be established early, not 2-5 years before closure as is currently the common practice. According to Participant 8, “the lack of clear relinquishment (closure) criteria to use for mine closure approval allows for regulators to constantly shift goal posts”. Participants 2 and 4 believe that the lack of a clear long-term rehabilitation goals also allows for mining companies to “constantly shift goal posts”, stating that different managers tend to have different strategies. Participant 2 states, “often someone will start a rehabilitation project and that project is the brainchild of that person and not that of the company or operation. When that person leaves the project tends to fall apart”. Rehabilitation consultant, Participant 7, echoes the need for concrete long-term rehabilitation objectives, stating that this should include advanced management techniques to ensure that responsible post-rehabilitation /closure land handover is done and that the subsequent land user understands land capability and does not run the land down to degradation. Participant 7 further emphasises that the Minerals Council/LaRSSA rehabilitation guidelines clearly stipulate this. Participant 9 is concerned that mining companies are mainly focused on meeting annual rehabilitation targets and do not focus on the long-term rehabilitation success criteria until just before closure.

4.4 Gaps and Opportunities

During the interviews the rehabilitation experts identified gaps in the current rehabilitation practices in opencast coal mines in the Mpumalanga Province (Figure 4-4). The gaps that emerged are: the lack of an overarching regional rehabilitation and land use framework, which was identified by seven of the eleven participants (64%); the lack of Government support for research and innovative solutions, identified by six participants (55%); limited availability of rehabilitation status data, mentioned by three participants (27%); the lack of sharing of learnings (good and bad) between mining companies, identified by five participants (45%); creating sustainable rehabilitation outcomes, identified by four participants (36%) and proper mine rehabilitation auditing, identified by two participants (18%). These gaps were identified as current shortcomings in terms of effectively addressing the challenges outlined in Section 4.3 and can be seen as providing opportunities for improving current rehabilitation practices.

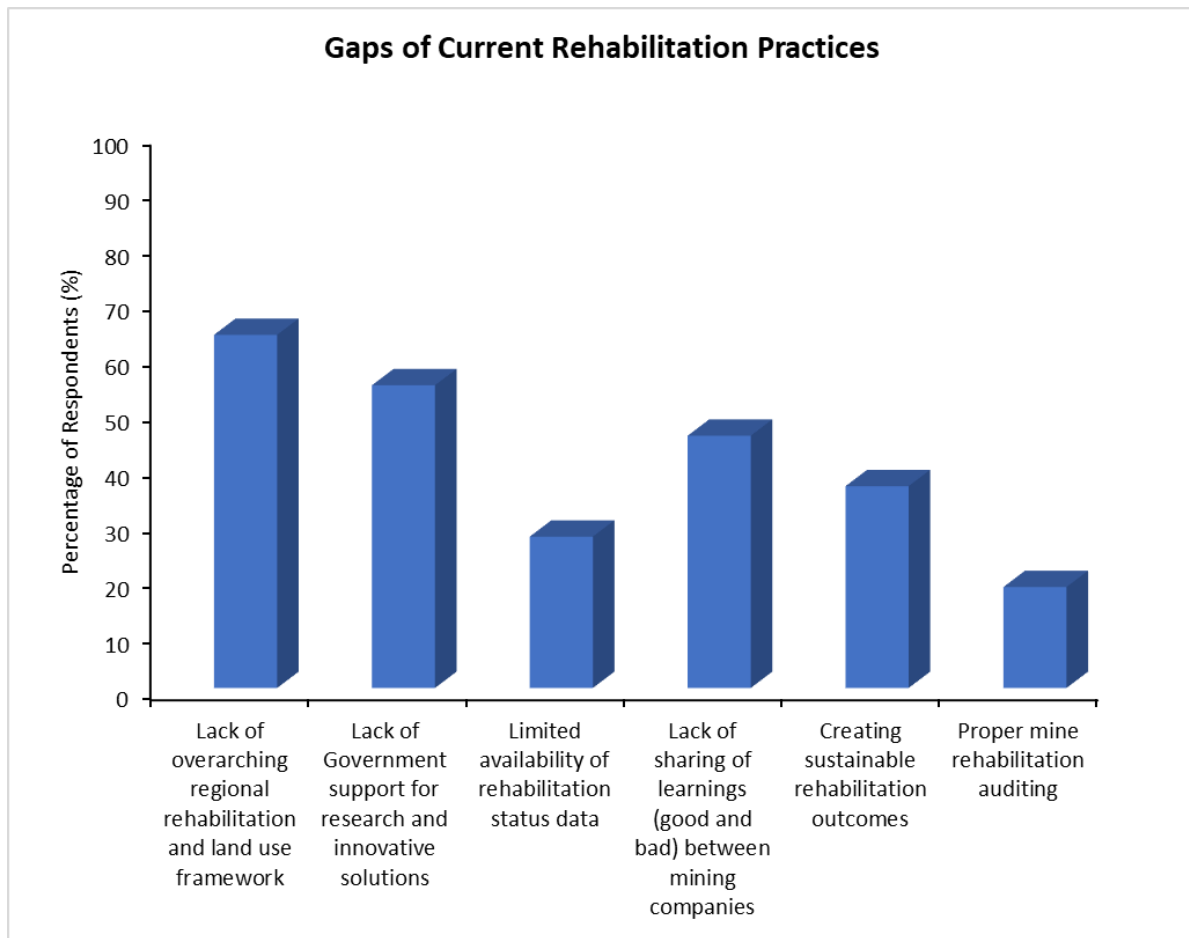


Figure 4-4: Current Rehabilitation Practices Gaps identified by the interviewed Rehabilitation Experts

Participants 2 (Company A rehabilitation specialist), 3 (Company A post-closure projects specialist), 5 (Company B rehabilitation specialist), 7, 8, 9 (rehabilitation consultants) and 11 (DPME official) mention the lack of an overarching regional rehabilitation and land use framework, which will guide all the mining companies’ mine closure objectives, as a major gap. The lack of Government support for research and innovative solutions by industry and research institutions, is another gap that is identified by Participants 1 (Company A rehabilitation manager), 2, 3, 7, 8 and 9. Participants 8 and 9 further state that this lack of support from Government leads to a “[lack of appetite](#)” by industry to be innovative; Participant 8 states that industry feels like, “[will we ever even get closure, regardless of what we do](#)”? Participants 8, 9 and 11 consider the limited availability of defensible baseline and monitoring data that can be used to track and verify success of rehabilitation activities as a gap. Participant 9 states, “[we cannot even get the rehab status data submitted by companies from Government. This is public data. We don’t know who is handling or evaluating this data and we should know this. Data is being submitted by companies to Government but no one knows what happens with this data. And companies are submitting the data just to comply](#)”. Participant 8 further

states that the limited availability of data affects the quantitative risk assessments that are required for closure certification. The lack of sharing of learnings (good and bad) between mining companies is a gap that Participants 2, 5, 7, 8 and 9 believe is a cause of the lack of cumulative development of rehabilitation knowledge across the coal mining industry. Creating sustainable rehabilitation outcomes that will benefit host communities, which was identified as a challenge (Section 4.3.8), is a gap that was identified by Participants 2, 3, 4 and 5. Participants 7 and 11 also mention proper mine rehabilitation audits by internal and external parties with adequate expertise as a gap.

The rehabilitation experts further identified specific opportunities that industry and Government can leverage in an effort to achieve effective rehabilitation. Participants 8 and 9 consider the numerous mine operations fast approaching the end of life-of-mine (LOM) as an opportunity for the mining companies, researchers, consultants, community organisations and Government to collaborate and develop an overarching regional rehabilitation plan. Participant 8 states, “[the looming cumulative mine closures in and around eMalahleni and Middleburg will force industry, regulators and practitioners to develop regional solutions](#)”. All the mining company representatives (Participants 1, 2, 3, 4, 5 and 6) believe that research and development of rehabilitation approaches and technological solutions provide an opportunity for mining companies to effectively remedy challenges, particularly in the areas of topsoil and acid mine drainage management. Participant 1 cites, “[there is a lot of research technology out there for soil management and water treatment that can assist us with the rehabilitation challenges we face](#)”. Participant 5 further states that there are opportunities for mining companies to go past the trial phase and move on to implementation of the research solutions – “[we need to get over the trial paralysis](#)”. Participant 8 mentions that the recent (November 2019) publishing of the updated the “*Guidelines for the Rehabilitation of Mined Land*” provides an opportunity for the Minerals Council, Coaltech and LaRSSA to distribute and encourage wider and consistent use by industry. Participants 2, 3, 5, 7 and 8 state that rehabilitation projects offer mining companies opportunities to create employment and provide land and clean water. Participant 2 states that post rehabilitation land use (for crops, grazing, etc.) by community members not only allows the community members to create an income but also creates an opportunity the mining companies to prove land capability restoration after rehabilitation. Participants 7 and 8 also highlight that in a country where access to clean water is a challenge and the issue of land availability is contentious, there is an opportunity for the mining industry and Government to

collaborate and supply clean water treated by mines to citizens and properly rehabilitate land and hand it over to be used by members of the community.

The rehabilitation consultants (Participants 7, 8 and 9) believe that Government should be the main driver of any efforts to close gaps and turn the opportunities into reality. Participant 8 states that without Government endorsement, any opportunity idea is not likely to be translated into reality as the mining industry often reacts to regulatory requirements. Participant 9 believes that there is a need for Government to establish a “land rehabilitation research and innovation hub”, run by a collaboration of the various government departments in order to allow for all the aspects for rehabilitation (soil management, water treatment, etc.) to be integrated. Participant 9 envisions that this hub would demonstrate the effectiveness of the “*Guidelines for the Rehabilitation of Mined Land*” and other research technologies to mining companies, which would ensure that good research is implemented. It could also bring all the key stakeholders, who currently tend to work in isolation, together and harness the synergies and complementary functions without any competing priorities; to develop a cumulative knowledge hub and develop a regional rehabilitation framework.

4.5 Summary and Synthesis

This study investigated the perspectives of rehabilitation experts concerning the current rehabilitation practices in opencast coal mines in the Mpumalanga Province. This was achieved through analysing the semi-structured interviews with eleven rehabilitation experts in terms of the progression and standard of rehabilitation practices, the application and relevance of rehabilitation practice guidelines, the challenges that hamper the achievement of the desired rehabilitation outcomes, as well as the gaps and opportunities of the current rehabilitation practices at opencast coal mines. The mining company representatives consider the application of the Minerals Council, Coaltech, LaRSSA “*Guidelines for the Rehabilitation of Mined Land*” to be sufficient. However, the rehabilitation consultants believe that these guidelines are poorly used by industry. Stating that mining companies, particularly the larger companies, tend to develop and implement their own in-house guidelines, which are also often poorly utilised. It therefore seems that the issue is not the guidelines, but budgets that deter the accurate application of rehabilitation guidelines and in turn affect the quality of the rehabilitation practices. The “*Guidelines for the Rehabilitation of Mined Land*” are considered to be relevant by all mining company representatives, rehabilitation consultants and DMRE official. The rehabilitation experts had opposing perspectives concerning the progression of rehabilitation practices over the years. Five of the six mining company representatives and the DMRE

representative believe that there has been an overall improvement in rehabilitation practices over the past thirty years. However, the rehabilitation consultants and one mining company representative believe that there was a progression in rehabilitation practices between the early 1990's and the early to mid-2000's. Following this progression, the period between the mid-2000's to the present has not seen much improvement. They actually believe that there has been a regression; citing corporate practices such as the limiting of rehabilitation resources, poor legislation enforcement and uncertainties around rehabilitation legislation as contributing factors to this lack of progression.

The interviews indicate that the rehabilitation experts believe that the quality of current rehabilitation practices and their outcomes are not to the desired standard. The interview participants identify some of the major factors that in their experience hamper the quality of rehabilitation practices and in turn the rehabilitation end result. These include topsoil shortage, compaction, secondary subsidence, legislation, corporate culture and policy, lack of capacity and expertise, limited cross-sectoral collaboration and the lack of clear long-term rehabilitation objectives. Uncertainties created by continuous amendments to legislation, lack of alignment of legislation with field practice, as well as the lack of consistent and adequate enforcement and policing of legislation are identified by the all the rehabilitation experts, with the exception of the DMRE official, to be the reason why the country's world class mining and rehabilitation legislation is not fulfilling its intended role.

The rehabilitation experts also identified gaps in the current rehabilitation practices, as well as opportunities that industry, researchers, consultants and Government can work on to ensure that rehabilitation practices are improved and achieve the desired outcomes. The gaps that emerged from the interviews include the lack of an overarching regional rehabilitation and land use framework, the lack of Government support for research and innovative solutions developed by industry and research institutions, the limited availability of rehabilitation data that can be used to track and verify success of rehabilitation practices, the lack of sharing of learnings between mining companies, creating of sustainable rehabilitation outcomes and the lack of proper mine rehabilitation audits by internal and external parties with adequate expertise. The rehabilitation consultants consider the numerous operations fast approaching the end of life of mine in Mpumalanga as an opportunity for mining companies, researchers, consultants, Governments and other relevant stakeholders to collaborate and develop a regional rehabilitation plan. The participants believe that the looming closure of the mines also presents an opportunity for the implementation of rehabilitation research and technology solutions that

will effectively solve challenges such as topsoil shortage, compaction, acid mine drainage. It is also an opportunity for the distribution of the updated the “*Guidelines for the Rehabilitation of Mined Land*” to encourage wider and consistent use by industry. Rehabilitation projects offer opportunities to create employment and provide land and clean water for communities. The rehabilitation experts believe that Government should be the main driver and at the centre of any efforts to tackling the rehabilitation challenges and gaps and the leveraging of the opportunities to improve rehabilitation practices.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Successful rehabilitation of mine sites remains an intractable challenge in the South African mining industry. This is despite the passing of legislation aimed to ensure this, the inclusion of sustainable development principles in governance structures and mining company procedures, as well as the development of world class rehabilitation guidelines. The mining industry's continuous failure to carry out effective rehabilitation and successfully close mines as stipulated by legislation causes significant, long-lasting and often irreversible environmental impacts. Consequently, these impacts affect the health, quality of life and the livelihoods of the host communities.

There is a need to understand the factors that contribute to the challenge of ineffective rehabilitation, in an attempt to tackle the issue and therefore alleviate its environmental and socio-economic impacts. This study set out to develop a better qualitative understanding of the status, main challenges, gaps and opportunities of the current rehabilitation practices in the context of opencast coal mines in the Mpumalanga Province, and to interrogate why successful rehabilitation remains a challenge. This was undertaken through a review of published literature and analysis of semi-structured interviews with rehabilitation experts. In line with the study's overarching objective, the following research questions were formulated in the context of opencast coal mining in the Mpumalanga province of South Africa:

- i. What is the standard of current rehabilitation practices and how has this progressed over the past three decades?
- ii. Are the *South African Land Rehabilitation Guidelines for Surface Coal Mines* relevant and what is the current status in the implementation of these guidelines?
- iii. What are the key factors hindering effective rehabilitation?
- iv. What opportunities can be leveraged to improve the rehabilitation outcomes?

This chapter gives an analysis and synthesis of the study's key findings, with Sections 5.1.1, 5.1.2, 5.1.3, 5.1.4 and 5.1.5 addressing the formulated research questions. The chapter also gives concluding remarks and makes recommendations for further work.

5.1 Summary and Analysis of Key Research Findings

5.1.1 Progression and Standard of Rehabilitation Practices

A review of the literature showed that historically, mining companies were known to put in very little or no effort into land rehabilitation on their operations. Increased global awareness of the environmental impacts of mining and the subsequent significant socio-economic impacts that arise when proper rehabilitation is not done, has led to the development of a more stringent legislative framework and the integration of sustainable development principles into legislation, governance structures and mining company operating procedures. Despite the significant developments in the rehabilitation and mine closure legislative framework in the past three decades and the formulation of detailed guidelines, reports in the open literature indicate that rehabilitation of opencast coal mines remains elusive in the Mpumalanga Province. This was consistent with the views of the rehabilitation consultants and one mining company representative interviewed in this study, who do not believe that there has been an overall improvement in rehabilitation practices over the past thirty years. These experts believe that there was a progression in rehabilitation practices between the early 1990's and the early to mid-2000's, however between the mid-2000's to the present there has not been much improvement and to a certain extent there has been a regression. In contrast, the majority of the mining company representatives and the DMRE official believe that there has been an overall improvement in the rehabilitation practices in the past thirty years. These opposing views by the experts highlight a gap in the availability of rehabilitation baseline and monitoring data that can be used to accurately track and verify the progress of rehabilitation practices. The study also found that despite the participants' opposing perspectives concerning the progression of rehabilitation practices, they are all of the view that the quality of current rehabilitation practices in opencast coal mines in the Mpumalanga Province remains a challenge.

5.1.2 Relevance and Application of the South African Land Rehabilitation Guidelines for Opencast Coal Mines

The South African rehabilitation guidelines for opencast coal mines provide very detailed technical and administrative guidance for rehabilitation planning, implementation and ongoing management. The guidelines, which also factor in the latest legislative framework, are consistent with international guidelines that have been developed to restore land affected by mining activity to a safe and stable state post-mining. The rehabilitation experts all consider these guidelines relevant for the rehabilitation of opencast coal mines; this is consistent with

literature. Concerning the application of the rehabilitation guidelines, the mining company representatives believe that the application of the guidelines is relatively good. Contrary to the perspective of the mining company rehabilitation specialists, the rehabilitation consultants believe that the rehabilitation guidelines are poorly used by mining companies. The interviewed participants attribute the poor application of the rehabilitation guidelines mainly to mining companies constraining rehabilitation budgets and poor legislation enforcement, which were identified as rehabilitation challenges. Literature shows that poor enforcement of the legislation is one of the systemic issues that contribute to ineffective rehabilitation. The study also found that generally, the bigger mining companies know and use the guidelines, albeit poorly. However, the small companies do not use nor know of these guidelines. There is therefore a need for the guidelines to be assimilated in the legislative framework to ensure better distribution and usage.

5.1.3 Rehabilitation Challenges

The study identified physical and non-physical challenges that hamper the achievement of rehabilitation objectives. The physical challenges are topsoil shortage, compaction and secondary subsidence; which are all soil related. The non-physical systemic challenges from the study findings include legislation, corporate culture and priorities, lack of capacity and expertise, limited cross-sectoral collaboration and the lack of clear long-term rehabilitation objectives.

According to the findings of the study the physical challenges are mainly caused by incorrect or poor handling and management of soil during the lifecycle of a mine. As the rehabilitation guidelines give detailed guidance on soil handling and management, the physical challenges indicate that the application of the rehabilitation guidelines by the coal mining sector is poor, just as mentioned by the rehabilitation consultants. Training and expertise are required for the correct application of the rehabilitation guidelines. The lack of expertise and capacity therefore contribute to the physical challenges.

The uncertainties created by continuous amendments to legislation, lack of alignment of legislation with field practices, as well as the lack of consistent and adequate enforcement and policing of legislation emerged from the interviews as the issues concerning legislation that hamper rehabilitation practices. The study findings, both literature and the semi-structured interviews, show that these legislation application shortcomings are mainly due to a lack of

expertise and capacity within government departments as well as the disconnection and lack of alignment between the various government department.

The corporate culture of prioritising mining production over rehabilitation emerged notably in the interviews. According to the mining company representatives and the rehabilitation consultants, rehabilitation resources (budgets, personnel and machinery) are cut at the expense of mining production. This contributes to the poor application of the rehabilitation guidelines because of the budget constraints, lack of expertise and capacity, as well as limited availability of the machinery required to properly carry out rehabilitation activities. The corporate culture that sacrifices rehabilitation is enabled by poor enforcement of legislation.

The study found that the lack of expertise and capacity within mining companies and Government departments contributes to the poor rehabilitation practices. A lack of expertise and capacity in mining companies leads to incorrect and poor handling of soil – physical challenges and incorrect or poor execution of other rehabilitation activities. The lack of expertise and capacity within Government departments leads to the inconsistent and inadequate enforcement and policing of rehabilitation legislation.

Study findings show that 91% of the interview participants believe that there is inadequate cross-sectoral collaboration; between mining companies, Government, rehabilitation organisations/consultants and research institutions. Literature and the interviews show that the misalignment and lack of cooperation between the various Government departments that govern mining and rehabilitation (DMRE, DEA, DWS) contribute to the collaboration challenges in the sector. Rehabilitation requires multi-disciplinary expertise and integration.

Both literature and the interviews show that the lack of clear long-term rehabilitation objectives within mining companies hampers rehabilitation and can lead to unsuccessful rehabilitation. The rehabilitation guidelines stipulate, under the planning stage, that SMART long-term rehabilitation objectives and clear relinquishment criteria must be established and specified. The lack of clear long-term rehabilitation objectives as shown by the study, is again an indication of the poor use of the rehabilitation guideline by mining companies. The study findings show that mining companies do not establish the post-closure land use and relinquishment criteria early. This challenge is due to a lack of dedicated personnel (lack of expertise and capacity) to focus on rehabilitation work.

From the keys findings of the study, it appears that the challenges that hamper the achievement of successful rehabilitation are linked. Shortcomings in the application of the legislation allow

for the existence of the corporate culture that sacrifices rehabilitation within mining companies, which in turn leads to the poor application of the detailed rehabilitation guidelines and therefore substandard rehabilitation practices.

5.1.4 Rehabilitation Practices Gaps

The study identified gaps in the current rehabilitation practices in opencast coal mines in the Mpumalanga Province. These include the lack of an overarching regional rehabilitation and land use framework, the lack of Government support for research and innovative solutions developed by industry and research institutions, the limited availability of rehabilitation data that can be used to track and verify success of rehabilitation practices, the lack of sharing of learnings between mining companies, creating of sustainable rehabilitation outcomes and the lack of proper mine rehabilitation audits by internal and external parties with adequate expertise. All the gaps highlight the challenge of limited collaboration within the sector. The traditional way of the various stakeholders working in silos has not yielded an overall positive result for rehabilitation and closure. These gaps are summarised in Figure 5-1.

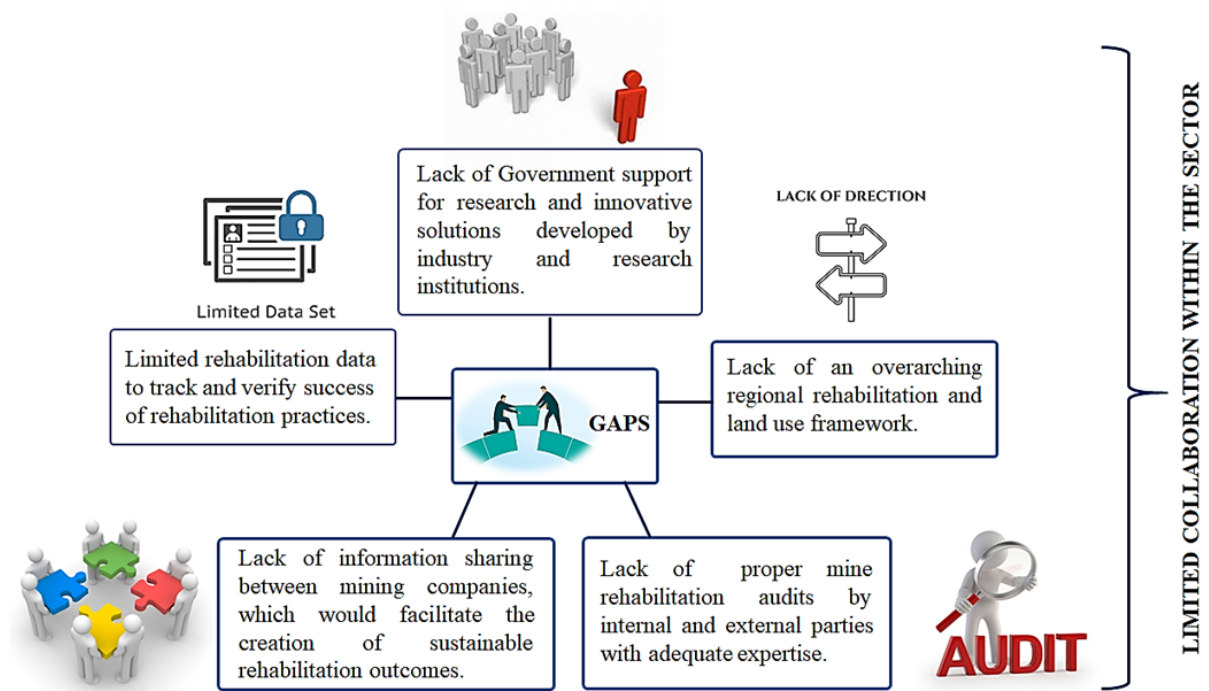


Figure 5-1: Illustration of the gaps that exist in the current rehabilitation practices (Figure created by author using stock images)

5.1.5 Rehabilitation Practices Opportunities

The gaps identified in the study provide opportunities for improving current rehabilitation practices. The numerous coal operations fast approaching the end of life of mine in the

Mpumalanga Province provide an opportunity for the mining companies, researchers, consultants, community organisations and Governments to collaborate and develop an overarching regional rehabilitation framework. It is also an opportunity for the distribution of the updated the “*Guidelines for the Rehabilitation of Mined Land*” to encourage wider and consistent use by industry and to implement rehabilitation research and technology solutions to ensure effective rehabilitation. The rehabilitation and mine closure processes also provide an opportunity to create employment and provide land and clean water. The study findings show that a collaborative approach to achieving successful rehabilitation requires Government to be the main driver, to provide clear regulation, guidance and a collective objective.

5.2 Concluding Remarks

The study found that the current rehabilitation practices in opencast coal mines in the Mpumalanga Province are not to the quality that is prescribed by international and local rehabilitation guidelines, nor to the level that is satisfactory to the regulators. To this regard, the current practices are not achieving the desired outcome; which is to create stable, sustainable and non-polluting landforms with re-established ecosystems that can support the prescribed land use. Shortcomings in the application and enforcement of the legislation lead to the legislation not achieving its objectives as well as the development of other physical and non-physical systemic challenges that hamper the achievement of successful rehabilitation. Unless the shortcomings with the legislative framework application and enforcement are addressed, it is unlikely that the challenge of ineffective rehabilitation practices that result in unsuccessful rehabilitation will be solved.

5.3 Recommendations

Based on the findings of this study, the following recommendations are proposed:

- i. **A detailed study on the shortcomings in the application and enforcement of the legislative framework in the coal mining sector.** The study found that the challenge of ineffective rehabilitation in the opencast coal mines in the Mpumalanga Province is largely due to the inadequacies in the application and enforcement of the robust, world-class legislation. It is therefore recommended that a detailed study be undertaken to understand the root cause of the shortcomings in the application and enforcement of the legislation and how they could be possibly addressed.

- ii. **The establishment of a coal mine rehabilitation research and innovation hub.** The study identified limited collaboration within the coal mining sector as a challenge that significantly hinders the achievement of successful rehabilitation. The traditional way of the various stakeholders working separately has not yielded an overall positive result for rehabilitation and closure. It is therefore recommended that Government facilitates the establishment of a collaborative hub that can bring all the key stakeholders together to harness synergies and complementary functions without any competing priorities. This could encourage cumulative development of rehabilitation knowledge across the coal mining industry.
- iii. **The development of a Mpumalanga regional rehabilitation framework.** The study identified the many opencast operations fast approaching the end of life-of-mine (LOM) as an opportunity for Government, mining companies, the community, rehabilitation consultants and research institutions to collaborate and develop overarching regional solutions to address unsuccessful rehabilitation. This could be enabled by the collaborative hub.
- iv. **The establishment of a rehabilitation database.** The study found the limited availability of baseline and monitoring rehabilitation data as a current gap in terms of effectively addressing the challenges that hinder successful rehabilitation. The availability of data will enable tracking and verification of the success of rehabilitation. The data can also be used for quantitative risk assessments that are required for closure certification. It is therefore recommended that a rehabilitation database be established by Government (DMRE, DWS and the DEA) as the regulator of mine rehabilitation. This could also be enabled by the collaborative hub.

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APPENDICES

Appendix A: Informed Consent Form

Project Title: Factors Contributing to Unsuccessful Rehabilitation: A Case Study Investigating the Rehabilitation Practices in Opencast Coal Mines in the Mpumalanga Province, South Africa.

I, the undersigned, confirm that (please answer yes/no):

| | |
|---|--|
| 1. I understand the objectives of the project, as explained by the researcher. | |
| 2. I have been given the opportunity to ask questions about the project and my participation. | |
| 3. I voluntarily agree to participate in the project. | |
| 4. The confidentiality procedures have been comprehensively explained to me. | |
| 5. I give consent to the audio recording of this interview. | |
| 6. I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agreed to the terms I have specified in the form. | |

Participant:

Name:

Organisation:

Role:

Signature:

Date:

Researcher:

Name:

Signature:

Date:

Appendix B: Interview Questionnaires

B.1 Mine Representative Interview Questionnaire

1. What rehabilitation guidelines are currently being used at your opencast mine(s)?
2. What is your take on your operation's current rehabilitation practices? (Are they best or standard practices?)
3. From your observations/experience, has there been an improvement in rehabilitation practices and funding over the years?
4. Are there clear long-term objectives for the rehabilitation on your operation? (Who and what is the land being rehabilitated for?)
5. What are the challenges of successfully implementing rehabilitation at your opencast mine(s)?
6. What is your take on the RSA rehabilitation legislation?
7. What are the gaps and opportunities identified with the current rehabilitation practices?
8. Why do rehabilitation projects fail? What do you think is the solution going forward?
9. Is there collaboration with rehabilitation specialists/organisations?
10. Is there collaboration with Government?
11. Does your operation have set annual rehabilitation targets? How well are these being achieved?
12. Are there any rehabilitation backlogs? (what are the causes of backlogs and what are the implications of these?)

B.2 Specialist Consultant Interview Questionnaire

1. How would you rate the application of the Mining Council/Coaltech/LaRSSA rehabilitation guidelines by mining companies?
2. How would you rate the relevance of the Mining Council/Coaltech/LaRSSa rehabilitation guidelines? (from the 1st to the 3rd editions).
3. What do you think of current rehabilitation practices? Are they best practice or are mining companies just merely complying?
4. Do you think there has been an improvement in rehabilitation practices over the years? (commitment and funding).
5. Is there any collaboration between rehabilitation specialists and mining companies to ensure that rehabilitation of opencast mines has sustainable outcomes?
6. Do mining companies call on independent rehabilitation specialists to audit their rehabilitation?
7. Is there any collaboration between rehabilitation experts and Government to ensure that rehabilitation of opencast mines has sustainable outcomes?
8. What are the opencast mine rehabilitation challenges?
9. Why do rehabilitation projects fail? What do you think is the solution going forward?
10. What is your take on the RSA rehabilitation legislation? Is it contributing positively towards rehabilitation? (particularly the rehabilitation financial provisions).
11. What innovative ways of rehabilitating opencast mines are currently being implemented?
12. What successes have been recorded to date?
13. What are the gaps and opportunities identified with the current rehabilitation practices?

B.3 DMRE Representative Interview Questionnaire

1. What do you think of the quality of the current rehabilitation practices?
2. Is there any collaboration with mining companies to ensure that rehabilitation of opencast mines is sustainable?
3. What are the challenges of ensuring that rehabilitation practices are sustainable and have socio-economic benefits?
4. Do you think your department has sufficient capacity and expertise to carry out its tasks?
5. What are the gaps and opportunities identified with the current rehabilitation practices?
6. Do you think the legislation around mining and rehabilitation is well enforced?

B.4 DPME Representative Interview Questionnaire

1. What does the work of the *Special Presidential Package for the Revitalisation of Distressed Mining Communities* entail?
2. What are the challenges of collaborating with mining companies?
3. What are the challenges of ensuring that the work you are doing has sustainable outcomes?
4. What are the gaps and opportunities identified?
5. What is your take on the RSA mining related legislation?
6. Is there alignment and collaboration between the various Government departments concerning revitalisation of distressed mining communities?

Appendix C: Ethics Clearance

Application for Approval of Ethics in Research (EIR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

APPLICATION FORM

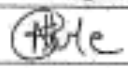
Please Note:



Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form before collecting or analysing data. The objective of submitting this application prior to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the EBE Ethics in Research Handbook (available from the UCT EBE, Research Ethics website) prior to completing this application form; <http://www.ebe.uct.ac.za/ebe/researchethics/>

| APPLICANT'S DETAILS | | |
|--|--|--|
| Name of principal researcher, student or external applicant | Nontobeko Gale | |
| Department | Chemical Engineering | |
| Preferred email address of applicant | glnont@yaho.com | |
| If Student | Your Degree: e.g., MSc, PhD, etc. | MPhil Specialising in Sustainable Mineral Resource Development |
| | Credit Value of Research: e.g., 60/120/180/360 etc. | 120 |
| | Name of Supervisor (if supervised): | Dr. Jennifer Broadhurst |
| If this is a research contract, indicate the source of funding/sponsorship | African Development Bank of Southern Africa | |
| Project Title | Prospects for Sustainable Land Use of Rehabilitated Opencast Mines in the Witbank Coalfield. | |

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practices that would constitute plagiarism.

| SIGNED BY | Full name | Signature | Date |
|---|----------------|--|-------------|
| Principal Researcher/ Student/External applicant | Nontobeko Gale |  | 18 May 2018 |

| APPLICATION APPROVED BY | Full name | Signature | Date |
|--|-----------------------------|--|--|
| Supervisor (where applicable) | Dr. Jennifer Lee Broadhurst |  | 24 May Click here to enter a date. 2018. |
| HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (including Honours). | Click here to enter text. | | Click here to enter a date. |
| Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions. | ADENIYI ISAFI ADE |  | 9 JULY 2018 |

P.P