# Assessing the management of closure provision for an open cast mining operation


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# ABSTRACT

In South Africa, there were in 2008 almost 6000 abandoned mines already with many nearing the end of life in the foreseeable future. This open cast mine fits into the category where the planned closure date is approaching in less than fifteen years. An enormous task and responsibility lie on managing mining operations for an open cast mine with closure in mind. This research study proposes to assess the management of closure provision for a specific open cast mine by interviewing nine senior specialists that are involved with mine closure directly or indirectly.

The literature review looks at the theoretical information of an open cast mine regarding the life cycle, contextualises the closure phase, managing the closure plan, investigating the legislation with regards to closure, sustainable mine closure and methods of closure cost estimations and reporting.

The qualitative study then interviewed a total number of nine senior specialists that influences the provision for mine closure. Most of the participants are situated at the open cast mine. Five themes emerged from the phenomenological research methodology design. The themes include closure planning, provision, stakeholder engagement, sustainability and the closure toolbox. The significance of these themes contributes to the management of closure provision for an open cast mine. This study follows a qualitative approach derived from the practical experience to explore this phenomenon. This phenomenological study could, in the future influence the management of closure provisions for an open cast mine operations.

The empirical evidence showed the importance, complexities and the benefit of integrated closure planning.



**KEYWORDS:** Mine closure management, concurrent rehabilitation, opencast mine, closure provision, sustainability

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AMD | Acid and metalliferous drainage |
| AMSA | Arcelor Mittal South Africa |
| BEE | Black Economic Empowerment |
| CAQDAS | Computer Assisted Qualitative Analysis Software |
| COA | Contracts of Affreightment |
| CRF | Closure risk factor |
| CSG | Council of Geoscience |
| DME | Department of Energy |
| DMR | Department of Mineral resources |
| EIP | Environmental Improvement Plan |
| EMP | Environmental Management Plan |
| GDP | Gross Domestic Product |
| GRI | Global Reporting Initiative |
| IAS | International Accounting Standard |
| MCP | Mine Closure Plan |
| MCT | Mine Closure Toolbox |
| MHSA | Mine Health and Safety Act |
| MPRD | Mineral and Petroleum Resources Development Act |
| MVM | Mineral Value Management |
| NECSA | South African Nuclear Energy Corporation |
| NEMA | National Environmental Management |
| NGO | Non-Government Organisations |
| NPV | Net Present Value |

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# 1 CHAPTER 1: NATURE AND SCOPE OF STUDY

## 1.1 INTRODUCTION

In the 1970s the mining segment contributed 21% towards the South African Gross Domestic Product (GDP) and employed about 760 000 individuals. This, however, declined to the fourth most significant GDP contributor at about 8% in 2016, and an employee estimated 490 146 individuals in 2015 (STATSSA, 2017). By considering the decline from the 1970s to 2016, mining is still one of the top 5 contributors towards the GDP and one of the largest employers in South Africa.

From the previous paragraph, it is clear that the mining of natural minerals and generating wealth has a long and rich history in South Africa. It has contributed to a large extent to the economic growth and development of infrastructure in South Africa. Traditionally mining activities were not as well regulated to minimise the impact on the environment (DME, 2005:1). It was previously not an obligation by government regulatory institutions to do concurrent rehabilitation as is currently prescribed by the Mineral and Petroleum Resources Development Act (MRDP). This caused that many mines did not consider this as a priority and created a negative legacy to the environment that needs to be restored to its original condition or better before mining commenced (Mackenzie *et al.*, 2006:58).

Historically the primary business model behind mines was to optimise production and to increase in profits. Profitability remains the primary objective as no business can be a sustainable business without sufficient funding. However, recently, the focus of mines also shifted to be more responsible towards the environment (ICMM, 2019b:43). This entailed a paradigm shift of traditional mining operations towards the conservation of the environment based on principles of sustainability, even considering post-closure latent concerns (Slight & Lacy, 2015:123). This then called for a more long-term approach with the amalgamation of social and environmental aspects into the strategy, with mine closure in mind (Morrison-Saunders & Pope, 2013).

As a result, the management of closure provision increasingly became the focus of mining houses. This liability, generated through obligations during mining operations consists of numerous calculations based on assumptions. As a responsible corporate citizen to many stakeholders, this provision must be managed to a minimum by the

integration of the closure plan into the operational activities and not deferring the obligation to rehabilitate and revegetate to closure when resources will be scarce (IOD, 2016:43).

## 1.2 BACKGROUND OF THE STUDY

Most of the South African mines have been producing minerals to the market for more than fifty years. With the availability of a finite amount of mineral resources and the increase of production cost more and more mines are approaching the final phase of the mine life cycle, which is the closure and decommissioning phase (Brodie, 2013). Together with the reality of mine closure, the focus of mine houses, government, Non-Government Organisations (NGO) and other stakeholders shifted more towards the management of the closure provision and the practical execution of mine closure.

This open cast mine is no exception to the legacy and has been nearly 70 years in production with an estimated remaining life of 14 years. During the production period, 14 963 ha was disturbed by mining activities of which about 532ha is available to do progressive rehabilitation (KIO, 2018b:65). It is located in the Northern Cape, approximately 30km from the mining community town, Kathu in South Africa (Marais & Cloete, 2013). Figure 1.1 illustrates the magnitude of the open pit.

**Figure 1.1: Satelite photo of the open pit**
**Source: (Google maps, 2019)**

The mine is part of a global diversified mining company and one of the largest single open cast iron ore mines in the world and the largest open cast mine in South Africa (AGL, 2018b:18). To date, the total product produced passed the mark of 900 million ton. In 2012, before the significant downturn in the price of iron ore, the mine house employed approximately 8000 full time and contract workers (Mobtaker & Osanloo, 2013).

Considering the remaining life of the open cast mine of 14 years, it is clear to see that the hourglass is running empty based on product reserves, and considering other external factors such as unpredictable economic climate; now will be an excellent time to assess the management of closure provision (AGL, 2018d:6).

### 1.2.1 A brief comparison of a project lifecycle and mine lifecycle

The starting point would be to understand the holistic lifecycle of the asset. The lifecycle of a mine can be compared to that of a project lifecycle due to the similarities of the approach (Laurence, 2001). These similarities of the different phases of the lifecycle of a project and that of a mine are illustrated in Table 1.1 below.

**Table 1.1: Comparing mine and project lifecycles**

| Mine lifecycle | Project lifecycle |
|---|---|
| Application for a mining license | Initiating |
| Prospecting and planning | Planning |
| Mining operations | Execution |
| | Controlling |
| Closure and decommissioning | Closing |

**Source: (Fourie & Brent, 2006:1085)**

The final phase of a project and mine lifecycle is the close-out phase. This phase has the potential to be very time consuming that leads to an increase in cost and frustration of different stakeholders that have different pre-existent expectations if not addressed early (Brodie, 2013:2). Planning the close-out phase must be done throughout the mine's life cycle to identify and minimise possible close out constraints. It entails early engagement alignment sessions with relevant stakeholders (Laurence, 2006b:285).

### 1.2.2 Considering the closure and decommissioning phase

The closure and decommissioning phase can be broken down further into smaller sub-phases, as indicated in Figure 1.2.


**Figure 1.2: Mine closure sub-phases**

**Source: (Fourie & Brent, 2006)**

The decommissioning phase entails the disposal or demolition of infrastructure, remediating the environment, and finalising agreements with stakeholders of infrastructure and the environment (Fourie & Brent, 2006:2). Closure phase will formally start when all rehabilitations have been completed according to the closure plan. It must also be managed and controlled according to the project plan to ensure the schedule is on track. The post-closure phase is when all government departments agree that the mine complies with closure requirements. It includes monitoring of the environment for a period after closure. A certificate of closure may then be issued upon fulfilling the prerequisites.

### 1.2.3 Managing the triple bottom line

Traditionally the main focus of mining was based on only the financial performance such as profits, return on investment, and generating shareholder value (Tate & Bals, 2018). This is no longer the most appropriate and sustainable way to measure a company's performance (Laing et al., 2017). A concept was developed that has a more holistic approach that will include indicators that measure the impact it has on the environment, social, and profit relations (Elkington, 1998). The board of the company needs to compile a strategy that will be aligned to improve sustainability in the short term as well as in the long term. The triple bottom line provides companies with a measurement tool of the three dimensions by taking into consideration different stakeholder needs.

Triple bottom line is managing the relationship and balancing the effect that the three concepts (The three P's, People, Planet and Profit) have on each other by board decisions and strategies of the company (O'Neil, 2018). The board of a company should provide leadership based on ethical principles and ensure that the company is seen as a responsible corporate citizen. King IV report has adapted and expanded the concept of the triple bottom line and moved away from a traditional quantitative to a more qualitative approach, and The King report elaborated on their behaviour as corporate citizens and sustainability (IODSA,2016:23).

Sustainability is very closely related to the triple bottom line principles. To be sustainable, the board must have a short as well as a long-term outlook and an integrating strategy balance of profit, planet, and people (Junior et al., 2018). Each one of the concepts is equally important and has its own merits.

Stakeholders consisting out of shareholders and investors, employees, suppliers, and business partners, and surrounding communities each have different interests and needs. These needs and interests must form part of the strategy of the business (Que et al., 2018).

## 1.3 PROBLEM STATEMENT AND CORE RESEARCH QUESTION

In 2008 already, there were almost 6000 abandoned mines that generated an additional liability of R20bn on the balance sheet of government (Auditor General, 2009:3). This is mainly due to the insufficient closure provision to restore the environment to its original condition or better (South Africa, 1996:1251). This raised the concern regarding the management of closure provision and the adoption of latter closure litigations and regulations promulgated and the obligations it generated.

Historically during the development phase of older mines, the provision for mine closure was not an obligation. Restoration of the environment only became an obligation with the implementation of environmental laws (Swart, 2003). The difficult task then arises of what the scope of closure entails regarding and the transparent reporting of it (Carlon et al., 2003). The management of these closure initiatives will have a significant impact on the provision for closure (Chambers, 2005).

The study aims to assess the direct and indirect influence and the perceived insights by different specialists have on managing mine closure for closure provision of the

mine considering sustainability after closure based on Triple Bottom Line (TBL) principles (Lodhia & Hess, 2014). The focus will be extended to determine the possibility of underlying benefits by the pro-active management of mine decommissioning and closure throughout the Life of Mine (LoM).

## 1.4 OBJECTIVES OF THE RESEARCH

The objectives of the study are split into primary and secondary objectives to achieve the main objective.

### 1.4.1 Main objective

The main objective of this study is to assess the management of mine closure procedures throughout the lifecycle of the mine and identify gaps. It will further assess underlying risks or opportunities related to the gaps that will influence the closure liability.

### 1.4.2 Secondary objective

The secondary objectives formulated to support the primary objective are as follow:

Secondary objectives in literature study

1. To explain the lifecycle of an open cast mine.
2. To contextualise the closure phase of an open cast mine
3. To investigate the management of the closure plan of an open cast mine
4. To investigate the legislation that drives closure of an open cast mine.
5. To investigate mine closure sustainable closure for an open cast mine.
6. To investigate different closure cost estimates and reporting for an open cast mine.

Secondary objectives in empirical study:

1. To describe the research method study.
2. To identify the population and the sample.
3. To identify the data collection technique.

4. To collect data and analyse the data.
5. After the analysis, a discussion of the results will follow.

## 1.5 RESEARCH METHODOLOGY

The research was conducted in two phases, namely a literature review and an empirical study. The literature review was compiled to give the necessary background and familiarise the reader with the complexities associated with the management of provision for mine closure. The empirical research assessed the management of mine closure provision processes and procedures of a specific mine in South Africa.

### 1.5.1 Literature review

A literature review was performed to familiarise the reader with the complexities associated with managing mine closure and rehabilitation. The literature review started by defining the lifecycle of a mine. Then the focus was shifted towards the management of mine closure and rehabilitation phase of a specific mine in South Africa.

In addition to managing mine closure and rehabilitation, the literature review also included information about the potential benefit of managing mine closure throughout the lifecycle of the mine.

Trusted and reliable sources will be consulted to conduct the literature review. Sources include the following:

- Academic articles
- Scientific journals and publications
- Internet websites
- News articles
- Books
- Dissertations, mini-dissertation and other papers on the subject

### 1.5.2 Empirical study

The study follows a qualitative research approach using semi-structured interviews to explore the management of mine closure. Interviews were conducted by scheduling

one-on-one sessions with pre-selected specialists in different fields who form part of managing the closure provision process.

Open-ended questions were formulated to allow for probing opportunity and contribution to improving comprehension of the management of mine closure, generating new ideas, and the opportunity for new solutions. The data collected will then be analysed by using the thematic approach together with computer software – Atlas.ti –to statistically analyse the data collected from the interviews.

#### 1.5.2.1 Research design

The interviews consisted of semi-constructed interview schedules that allowed for probing and discussion to gather additional information where deemed necessary and relevant. The interviews were then verbatim transcribed to conduct further analysis. The codes developed were grouped based on relevancy into themes and sub-themes.

The interviews assessed the management and practical execution required to create sustainable mine closure provision, reflecting on day-to-day mining operations. The interviews were further conducted to investigate the current gaps that the mining house face to ensure sustainability post-closure.

#### 1.5.2.2 Study population and sample

Due to the qualitative nature of this study, it falls into the category of purposeful sampling. The unit of analysis was on a specific open cast mine situated in a remote location in the Nothern Cape. The sample consisted of a variety of nine individual specialists with different fields of expertise relating to managing mine closures and rehabilitation. The selected experts were mostly in close proximity geographically and on the mine. This method is considered to be the most convenient and overcame logistical challenges. It had an additional benefit of face-to-face interaction with interviewees.

The following influential people were identified and preselected that would add the most useful data of managing the provision for mine closure and rehabilitation:

- Head of mine closure, custodian of the mine closure and rehabilitation strategy implementation for Anglo group-wide situated in Brisbane Australia

- Financial specialists that are responsible for following the accounting standards and reviewing the logic of provision calculation located at the specific mine.
- Safety, health, and Environmental specialists that are accountable for the environmental management plan and communication channel with DMR, situated at the mine.
- Mine management that is responsible for mine planning and mining operations, situated at the mine.
- General Managers of projects that are accountable for the stay in business projects, situated on the mine.

#### 1.5.2.3 Data collection

Data was collected utilising semi-constructed interviews. The interviews were arranged and held with managers involved in the mine closure and rehabilitation strategy. The questions were open-ended and allowed for probing by the researcher. This must allow for more in-depth insight into the management process of sustainable mine closure provision processes, calculations, litigations, regulations and integration with operations of the specific mine.

The interview meetings explaining the rationale of the research were arranged with ample time for the interviewee to respond and accommodate the interview in their busy schedules. The interview questions were not sent to the selected interviewee before the actual interview. The intent with this was to promote the informality of discussions that might lead to new discoveries or previous oversight issues.

The interviews will be one-on-one sessions and conducted in person or with the technology available whichever was most convenient for the interviewer and interviewee. The interview was digitally recorded to use later for verbatim transcribes and the analysing of data. In the case of an unclear recording, the applicable transcribed section was sent to the relevant interviewee to ensure the correctness and completeness of the information. This data collected from the interviews was then verbatim transcribed and coded.

#### 1.5.2.4 Data analysis

The most frequently used data analysis methods are analytical induction, grounded theory and thematic analysis (Bryman & Bell, 2014:342). This study was conducted using the thematic analysis approach. This accessible and flexible study approach does not prescribe a specific philosophical orientation but rather to systematically identify, analyse and describe patterns, or themes, across the data collected (Bryman & Bell, 2014:350).

Table 1.2 outlines the six phases thematic analysis approach suggested by Braun and Clarke (2019:60-69)

**Table 1.2: Six phases of thematic analysis and process**

| Phase | Process |
|---|---|
| 1: Familiarising yourself with the data | Transcribe the interviews. Then read and re-examine the data noting down initial ideas. |
| 2: Generating initial codes | Systematically make codes of interesting features of the data, and collect data relevant to each code. |
| 3: Searching for themes | Sort and group codes in potential themes and gather all relevant data for each theme. |
| 4: Reviewing potential themes | Check if the themes work in relation to coded extracts and the entire data set, then develop a thematic map of the analysis. |
| 5: Defining and naming themes | Refinement of specifics of each theme and define and name each theme |
| 6: Producing the report | Generate a scholarly report of the analysis by selecting distinct, compelling extracts examples that relate to the research question. |

**Source:(Braun *et al.*, 2019:60-69)**

It is clear to see from Table 1.2 that the coding process has a significant role in thematic analysis. The coding process consists of three phases namely open coding, axial coding and selective coding (Bryman & Bell, 2014:346). Generating the initial codes use open coding phase, searching for themes uses axial coding and reviewing potential themes uses selective coding.

The computer software Atlas.ti was utilised in the thematic analysis approach and assisted with the process of identifying, analysing and reporting themes within the data (Friese et al., 2018:8).

## 1.6 PROPOSED CHAPTER LAYOUT

The research study consists of four chapters. Below is the proposed outline of the chapters.

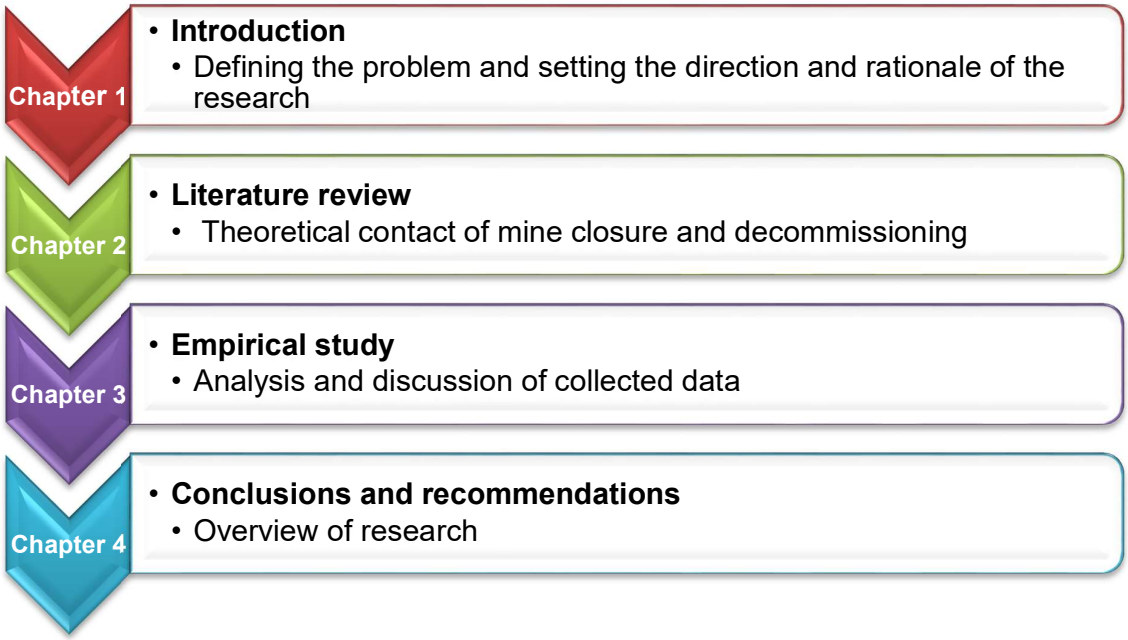


**Figure 1.3: Chapter layout**

**Source: Researcher compiled**

## 1.7 DELIMITATIONS AND ASSUMPTIONS

The study investigated literature from a broad spectrum of principles related to managing mine decommissioning and closure. The literature review was limited to information available on the internet as well as publications available in libraries in South Africa until 25 November 2019.

The limitations of the research are the following:

- The focus will be on a specific open cast mine in South Africa. The information gathered of management of the provision for mine closure was analysed to identify possible gaps.
- Eight of the nine interviews were conducted with interviewees selected on the specific open cast mine.

- Since this was assessing only the provision management of a specific open cast mine it is recommended that the research be extended to a broader sample for future research.

In consideration of the above-mentioned limitations, care should be taken in making generalised comments in the research.

## 1.8 CONCLUSIONS

Mines have the difficult task to adhere to all the national and international laws, regulations and to ensure sustainability prior and post-closure — this all by keeping the wide variety of stakeholders contented and satisfied.

Closure is considered to be the last phase of the mine lifecycle. Due to this, a tendency exists to procrastinate closure with an association of definition by name, to the end of life of mine. This has a significant increasing effect on the liability value, by obligations generated through disturbing the environment during the lifecycle of the mine. This liability can be reduced by integrating closure milestones such as concurrent rehabilitation into the mine operational plan and not postponing it to the end of life of the mine when resources will be limited.

With older open cast mines the approach to closure will be different from that of a new mine. This is due to the legacies inherited of older mine operations with the absence of closure in mind. To achieve the full benefit of concurrent rehabilitation and not sterilising ore bodies, the various departments must work very close together. This collaboration and management are to ensure that restoration of the environment occurs as per final designs.

# 2 CHAPTER 2: LITERATURE STUDY

## 2.1 INTRODUCTION

Mining is one of the most significant economic contributors that create short and long term wealth for a variety of stakeholders. In many cases mining was the main reason for the founding, existence, functionality, and sustainability of towns in South Africa (Louw & Marais, 2018:278).

However, recently, this concept of wealth has been questioned by mining communities and government in mineral-rich countries such as South Africa, with arguments that arise with regards to the proper allocations of wealth and cost. The growing of resource nationalism and the dispute over new projects highlight warning signals of the different expectations of the various stakeholders (WEF, 2013:4). The focus was no longer on only rehabilitating the environment, but also the sustainability of the community.

This then necessitated early engagement and stakeholder management considering prior and post-closure, of the mine, is therefore critical. As essential is the sufficiency of the accumulated provision provided to manage the expectations and challenges of the different stakeholders and the rehabilitation of the disturbed area and improve a sustainability environment prior and post-closure (WEF, 2013:6).

The following sections examine the literature of closure of an open cast mine. The chapter begins by illustrating the lifecycle of an open cast mine, explaining each phase of the lifecycle. It is then followed by focusing on the closure phase specifically. The third section is about managing the closure phase and what are the different approaches to managing the closure of an open cast mine. The fourth section alludes to all the legislation that needs to be considered for planning and executing closure initiatives. It discusses the impact and influence concerning the closure of an open cast mine. The last section looks at the different methods of estimations and transparent international reporting.

## 2.2 EXPLAINING THE LIFECYCLE OF AN OPENCAST MINE

This section will focus on the different phases of the open cast mine lifecycle. It will illustrate the influence each of the stages has on the environment. This level of disruptions will then adjust the focus towards the sustainability of pre- and post mine closure.

### 2.2.1 Overview of the lifecycle of an open cast mine

The lifecycle of an open cast mine consists of four main stages, and each one of the stages has a different impact on the sustainability of the environment. The level of disruption on the environment will, in the end, affect the amount of provision provided for mine closure rehabilitation (Fourie & Brent, 2006).

The mine lifecycle and the effect of sustainability are illustrated in figure 2.1.

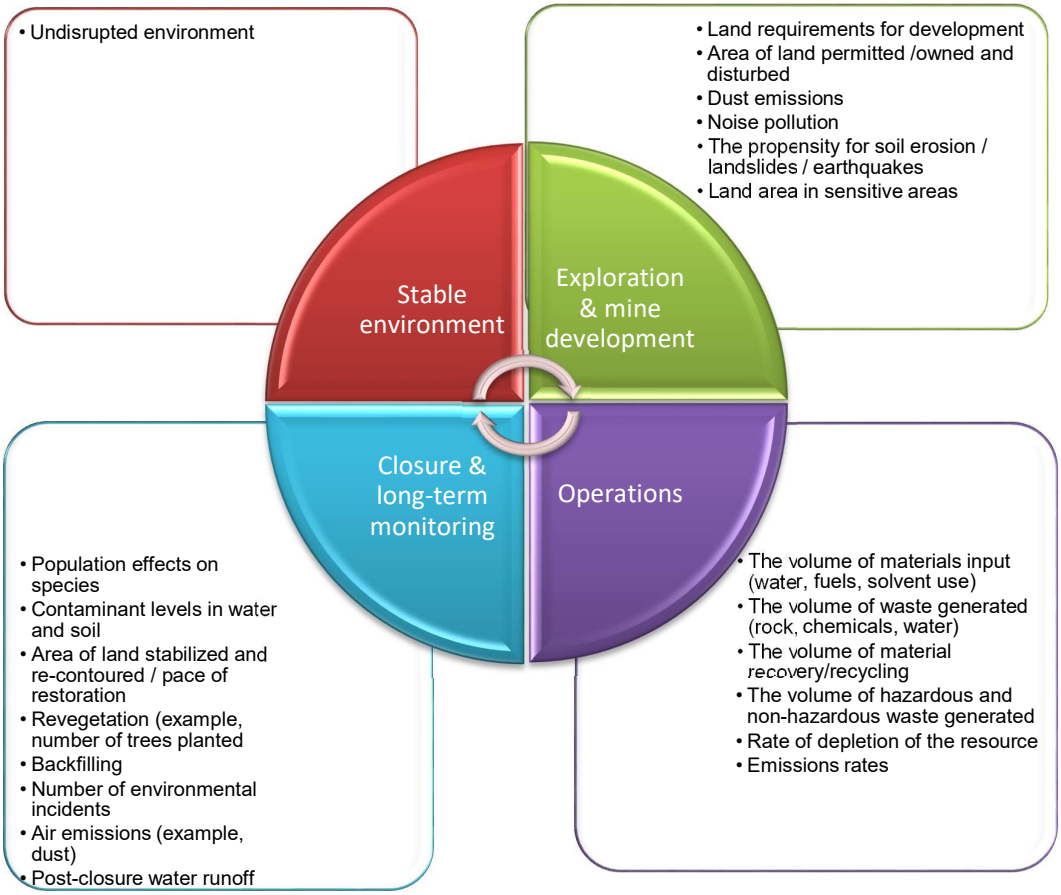


**Figure 2.1: Opencast mine life cycle and the critical environmental factors on sustainability**
**Source: (IIED, 2002; KIN, 2012; Marta *et al.*, 2005; WEF (World Economic Forum), 2013)**

The beginning of the lifecycle is where the environment is stable and before any mining activities have commenced. There is no restoration necessary and therefore, also no effect on sustainability. The second phase is the exploration and mine development. This is the stage when the obligation to restore the environment equivalent to the disruptions to the environment and sustainability accumulate. The stage physical comprises the acquisition of land and the emission of dust and noise pollution. An

environmental impact study is conducted to determine what the effect on the people, planet, and profits will be. This environmental impact study must include the closure plan as well. The third phase is where the actual mining operations commence. It is the phase where the impact on the environment is the most severe. The disruption subsequently increases the provision for closure. With open-pit mining, the effect on the environment and sustainability is visual. The last phase in the lifecycle is the closure of the open-pit mine and long-term monitoring. This is to ensure that the environment is restored as intended and is sustainable for future generations (IIED, 2002; KIN, 2012; Marta *et al.*, 2005; WEF (World Economic Forum), 2013).

### 2.2.2 Exploration and mine development phase

The first measurement of sustainability starts right at the beginning of the mining process, that is, the exploration and mine development phase. This phase entails prospecting the region for the possibility of mineral resources (Gorman & Dzombak, 2018). Then an exploration of the area is conducted by either a direct or indirect method. The direct approach is by examining the area visually for a mineral deposit, and the indirect process involves analysing geotechnical information of rock alterations and formations underground. The rock formation is then explored further by drilling to confirm the existence of minerals (UoA, 2019). The development phase consists of much pre-feasible planning and financial resources. Plans are developed to find a fit for purpose solution by considering the following items:

- Mining method – the mining process and the latest technology available to execute.
- The remoteness of location – determine the best method of transportation.
- Infrastructure – availability of electricity and water.
- Pilot plants – construction of processing facilities and disposal areas.

The compilation of the environmental impact study and early engagement with the different stakeholders also starts in this phase. However, this was not a legislative requirement a few years back and was only implemented recently in 2002 in the Mineral and Petroleum Resources Development Act (MPRD).

The magnitude of the environmental sustainability of this phase is quantifiable by the total land required for the project and the area impacted by mining activities as well as the various pollutant levels in the long run (Fourie & Brent, 2006). It is therefore critical to ensure proper environmental management is applied and not let future liabilities increase out of control that might damage the reputation of the mine as a responsible citizen (Dowd, 2005).

### 2.2.3 Operational phase

The second phase of the mine lifecycle is when the actual production of the mine starts. There are mainly three different types of mining methods, that is surface mining, underground mining and underwater mining (AGL, 2019a:1). Opencast mining is a type of above-ground mining method that extracts ore from the open pit in the ground. It is associated with massive mine machinery to move earth and expose natural resources and retrieving it (Velan & Prasad, 2018:347). This type of mining method is most common around the globe because it does not require extractive methods (Haldar, 2018:230). It is the preferred mining method when natural resources are found near the surface with an area that is large enough for heavy mine machinery to operate, without congestion (Velan & Prasad, 2018:229). Table 2.1 indicates the advantages and disadvantages of open cast mining.

**Table 2.1: Advantages and disadvantages of open cast mining**

| Advantages | Disadvantages |
|---|---|
| Minimal ore loss and visualisation of exposed natural resource | Large area needed for operational activities |
| Accessibility to the ore body | Surrounding stakeholders reimbursement |
| Improved blending and grade control | Generate substantial waste |
| Natural light and ventilation | Exposed to weather conditions |
| Safer | |
| Lower complexity of dewatering | |
| Less congested | |

| Advantages | Disadvantages |
|---|---|
| Less capital and operational intensive | |
| Less development | |

**Source: (Haldar, 2018:232)**

The operations process of open cast mining starts with the exploration and the dewatering of underground water. Dewatering must happen continuously to ensure that the operational activities will not be submerged. Haul roads are constructed around the pit with ramps down into the pit. This enables the heavy mining machines to haul the material from the pit. After the buildings and civil works are erected other production activities can proceed such as drilling, blasting, excavation, loading, and transportation of fragmented ore to beneficiation plants. The waste is dumped near the edge of the pit shell and bulldozed level over the area. The waste material from the beneficiating plants is then pumped into tailing damps where the water then evaporates, and only the diluents remain (AGL, 2019d:2). Figure 2.2 illustrates the mining process in a simplex format.


**Figure 2.2: The sequence of open cast mining**

**Source: (AGL, 2019a:3)**

This level of disruption to the environment correlates positively to the amount of provision provided for closure. The sustainability is measured according to the level of disturbances during operation (Gorman & Dzombak, 2018).

It is the first opportunity to check if compliance with the closure plan is executed according to initial designs and objectives (Dowd, 2005). Any deviations from the method can be investigated and managed appropriately to enhance sustainability prior to mine the final closure and reclamation.

### 2.2.4 Closure and long-term monitoring phase

The last and final phase of the mining lifecycle is the physical closure, reclamation, and remediation of the mine (AGL, 2019d:3). It is where the execution of rehabilitation commences, getting the environment back to its original state before mining began, and post-closure monitoring of the rehabilitated ecosystem for any deviations. The benefit of proactive management of stakeholders' expectations and adequate provision for closure of the environment will become evident (Dowd, 2005).

## 2.3 CONTEXTUALISE THE CLOSING PHASE OF AN OPENCAST MINE

This section will focus only on the closure phase of an open cast mine.

### 2.3.1 Sub-phases of the closure phase

The final phase of the mine lifecycle is the closure phase. This phase can be further cascaded into four sub-phases. Each one of the closure sub-phases has specific milestones to measure progress towards the sustainable closure of an open cast mine (Nehring & Cheng, 2016:228). This different phase is outlined in figure 2.3.

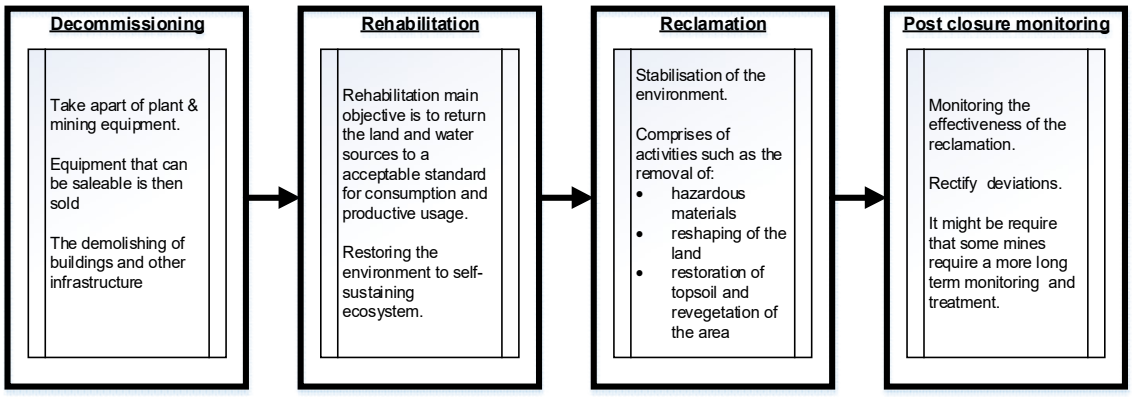


**Figure 2.3: Sub-phases of closure phase**
**Source: (MICA, 2018)**

Decommissioning is the first sub-phase of closure. This process includes firstly to distinguish what can be sold and what cannot be sold. The buildings and infrastructure that cannot be sold are then decommissioned and demolished. The second phase is restoring the ecosystem to its original condition or as far practical as possible that is acceptable and sustainable. The third phase is the stabilisation of the ecosystem through the reclamation and revegetation of the disturbed land. The fourth phase is

monitoring the restored area for an extended period post-closure to ensure there is no deviation and the closure is sustainable (MICA, 2018:2).

### 2.3.2 The closure risk factor (CRF)

With the closure provision of an open cast mine, there is a wide variety of risks that needs to be considered (Laurence, 2001:315). As with mine safety, the management of mine closure risks can be divided into two main categories: prescriptive and nonprescriptive. Prescriptive is when there are detail standards and procedures developed by a regulatory or accredited industry. Nonprescriptive is were no specific detail is prescribed, but managers take the necessary actions to mitigate or eliminate the risk (Sutton, 2015:2). More assumptions are needed with nonprescription since there is an increased level of uncertainty attached to it. These assumptions made by management will influence the magnitude of the provision for mine closure.

The triple bottom line concept that is associated with sustainability can also be divided into these management categories (Tate & Bals, 2018:803). The management of the risk of planet and profit will fall under the prescriptive category. This is because there are litigations and regulations prescribed for closure. With people quadrant, it is more difficult to determine. Therefore it will fall in the nonprescriptive category, and more assumptions need to be made.

The CRF indicator can be utilised for managing closure risk for both prescriptive and nonprescriptive categories. CFR is a quantitative tool that is used to determine the magnitude of the risk. It divides the risk component into smaller manageable categories that allow prioritising based on the context of the risk. Although every mine has unique challenges this systematic approach assessment, will assist to limit the omission of critical risks that will influence the cost drivers and the amount of provision for closure provided (Laurence, 2006b:288): The formula below illustrates the quantification calculation for CRF.

$$C_{RF} = \Sigma \left( R_E + R_{SH} + R_C + R_{LU} + R_{LU} + R_{LF} + R_T \right)$$

$(R_E)$ - Environmental risk

$(R_{SH})$ - Safety and health risk

($R_C$) - Community and social risk

($R_{LU}$) - Final land use risk

($R_{LF}$) - Legal and financial risk

($R_T$) - Technical risk

The categories are calculated by multiplying the probability with the consequence. The sum of this assessment is the result of the rehabilitation risk on the environment. The results can then be analysed and categorised and prioritised to direct the attention to each of the items it deserves. The risk factors can be mitigated or even avoided totally by collaboration between mining operations and environmentalists through regular landscape investigations (McCullough et al., 2018:398).

### 2.3.3 Challenges with closure phase

There are many challenges concerning mine closure, and the problems are unique, depending on the environment and location. What influences the level of complexity is that it also evolves through time as requirements and perceptions change (Australia, 2015:20).

This specific mine has been operating for almost 70 years and has a challenge with legacy liability waste dumps. Since concurrent rehabilitation was not priority previously, planning for closure was also less of a focus. The result of this was that operations were managed by removing the waste and extracting the ore and the obligation for rehabilitation increased. The management of waste was not a focus and dumped to be the most cost-efficient method, not having closure in mind. So there exists a backlog of old legacies (KIO, 2018b:66). What makes the situation more complicated is that the mine is still operating in the pit, and the risk of sterilising the ore areas must be prevented.

### 2.3.4 Closure scenarios

There are nine types of mine closure scenarios; each one of the situations has specific causes related to it. Table 2.2 elaborates on the different scenarios.

**Table 2.2: Closure scenarios and context**

| Scenario | Context |
|---|---|
| Closed mine | When a mine successfully obtained the closure certificate by adhering to regulations legislations prescribed |
| Temporary closure | The mine is facing a significant challenge and forced to stop with mining activities and close temporarily. These challenges include low commodity prices, technical complexities, severe environmental impact, and community unrest |
| Abandoned mine | Relinquished mine that is in a deplorable environmental state or financially insolvent. The mining operations are terminated completely, without any distinguishable legal entity or person. Rehabilitation and reclamation of the environment are minimal to none. There is no issued certificate to confirm closure |
| Passing the buck | This is where the mines are not taking accountability of reckless mining legacies and transferring it to other mining companies |
| Derelict and ownerless mine | There is no accurate traceability of ownership or holder of the mine |
| Conditional/provisional closure | The mine is closed based on terms and conditions agreed on |
| Partially closure | Sections of the mine obtained certificate of closure |
| Closure under other legislation | Mine was forced to close by regulations and litigations |
| Offshore closure | Instructions from offshore |

**Source: (Swart, 2003:490)**

What is clear from Table 2.2 is that mine closure in most scenarios might be an unplanned event. It is therefore essential that the management of the closure provision is accurate and sufficient funds are available when the time arrives to close the mine. The inclusion of the closure cost during the strategic mine planning process plays a significant role when simulating the mine plan and its related final design. This will keep the liability for rehabilitation under control and a substantial financial benefit with the integration of closure in mind during mining activities. This is, however, a challenge

to accurately incorporate the actual cost of closing in the iterative mine planning and cost estimation (Nehring & Cheng, 2016).

## 2.4 MANAGING THE MINE CLOSURE PLAN OF AN OPENCAST MINE

This section will focus on different planning methods and the available internal guidelines for mine closure.

### 2.4.1 Contextualising closure planning

In the perfect world, everything works according to plan. In this instance, it will be the most straightforward scenario to manage with minimal complications. However, when reality sets in and the plan are the mere guidelines towards managing the unplanned events to achieve the goal still, and the business must adapt to succeed (Laurence, 2006a). The process management is the same as the mine closure plan. As with projects, too often, the last phase becomes more difficult due to the lack of integration of closure during normal operations.

It might be on the contrary and unexpected, but the reality is that many mines close before the natural minerals are fully extracted from the earth. This can be for a variety of reasons, but the main culprit is financial constraints (Laurence, 2006b:43). The bottom line of business remains to generate sustainable profits. Without sufficient cash flow, the mining company will not be a sustainable business, not be able to exist without adequate cash flow. However, driving profits should not be made to the cost of sacrificing the people and of the planet's wellbeing.

The internal and external influences contribute tremendously to the unpredictability of the mining company’s sustainability. It indicates, even more, the event of mine closure can happen at any time, also before production commenced. That is why it is imperative to introduce the mine closure plan and incorporate it as early as possible in the mine life cycle to ensure that it is managed proactively. It will ease the closure process in times when the mining of natural resources has ceased, cash flow is minimal or absent, and material resources are no longer accessible (Dowd, 2005).

In Table 2.3 some of the internal and external factors that influence why mines need to close could be identified.

**Table 2.3: Main causes of mine closure**

| | |
|---|---|
| 1: Low commodity prices | In the sudden event of a significant collapse of the commodity price. The effect will be even worse on the smaller mine houses than that of the larger mine houses. |
| 2: High operating cost | When the operating cost increases by too much due to inefficiencies and ineffectiveness. This is also due to the underutilization of the assets and abusing of equipment. Also, the price received does not justify the mining business anymore. |
| 3: Reduced reserve estimates | It transpires due to the overstatement of qualities and quantities of the product. It is the main reason why mines close prematurely. |
| 4: Adverse geotechnical conditions | Geotechnical conditions that lead to catastrophic slope failure. This type of failure might also lead to fatalities. |
| 5: Equipment failure | The catastrophic failure of equipment that resulted in fatalities. |
| 6: Closure due to regulator pressure | The pressure is usually evolving around breaching of environment or safety regulations. |
| 7: Changes in government policy | Change in policies often develops in response to the outcry of communities. The mining charter 3 is an example of this. |
| 8: Community pressure | The pressure on mining activities from surrounding mining communities. |

**Source: (Laurence, 2006b:2)**

### 2.4.2 Management of unplanned closure

Unplanned mine closure is a much more significant financial liability than planned closure. It is estimated that planned closure is about five times less than that of unexpected mine closure and has a very deteriorating effect on the companies' reputation (Dowd, 2005). The benefit of progressive rehabilitation is estimated to be four times less when rehabilitated at the end of the life of the mine.

The management process of unplanned closure occurs at a more accelerated tempo than that of a planned mine. Figure 2.4 is a staged approach to managing unexpected closure at an accelerated pace (Mackenzie et al., 2006).

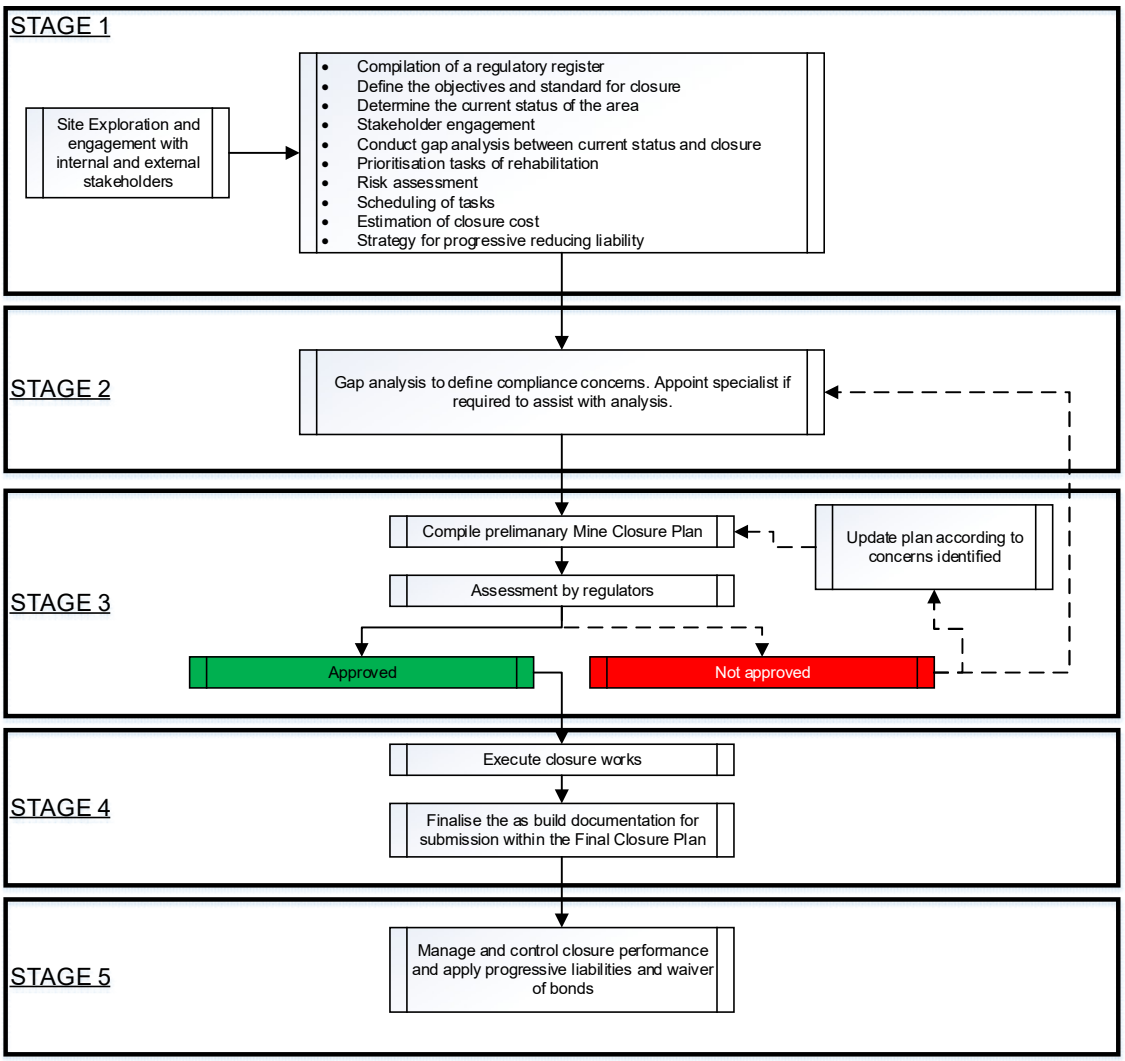


**Figure 2.4: A staged approach to managing unplanned closure**
**Source: (Mackenzie et al., 2006)**

The staged approach consists of five stages. The first stage is to conduct a rapid assessment and compile a project plan for it. The project should include the scope, cost, and timelines needed to manage the project. The second stage is to conduct a gap analysis to determine compliance concerns. The third stage is to draft a preliminary closure plan and submit it to regulators for assessment. If there are any concerns identified by the regulators, do the necessary amendment and re-submit for

review. Move to stage for if the closure plans are approved by regulatory authorities and start with closure execution and finalise the documentation required that must be submitted for the final closure plan. Manage and control the scope, cost, and timelines of the project to ensure a successful open-pit mine closure (Mackenzie *et al.*, 2006:3).

### 2.4.3 Internal mine closure standard

The standard prescribes the minimum requirements for the pro-active management of risks and opportunities associated with mine closure. It consists of six sections, each of the sections stipulating the process and outcomes. This standard should also be read in conjunction with the local legislation to ensure that the closing plan makes provision for any additional requirement. The emphasis of the different sections is the early integration of the mine closure plan into the long and short-term mining operations planning. This is to manage the liability to a minimum as the closure date approaches. It refers to the Mine closure toolbox as a supportive guideline to be used (AGL, 2018c:1).

### 2.4.4 Integrated closure rehabilitation

The idea behind integrated closure rehabilitation is to incorporate the closure plan and operational plan throughout the life cycle of the mine (Grant & Lacy, 2016:583). This is a continuous iterative process between the various stakeholders to ensure alignment. The benefit of entrenching the closure initiatives through the lifecycle of the mine is to provide an early opportunity to manage expectations, mitigate risk and seize opportunities (ICMM, 2019b:10).

An essential method of integration of operations with mine closure is concurrent rehabilitation. Concurrent rehabilitation can be defined as rehabilitation that occurs in conjunction with mining operations as the ore body is depleted in sections of the mine (Van Zyl et al., 2012:v). The aim and also the challenge is to do concurrent rehabilitation as soon and as much as possible but not to sterilise ore bodies and still to be sustainable.

The link between the solicitation of concurrent rehabilitation and closure liability is illustrated in Figure 2.5.

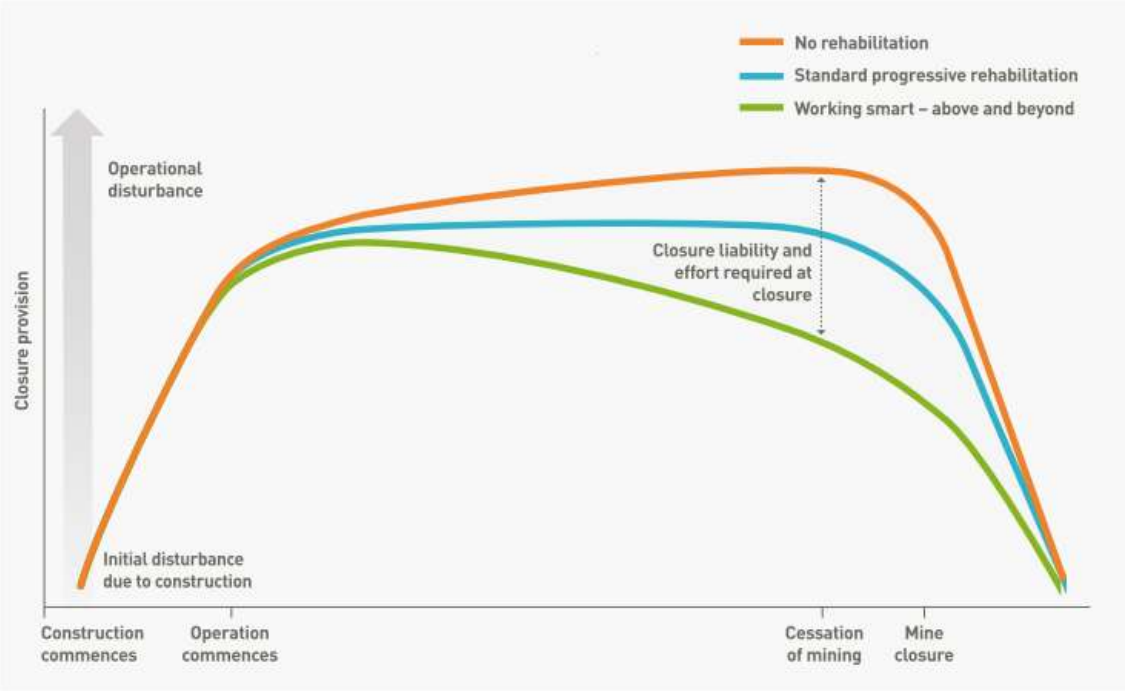


**Figure 2.5: The effect of concurrent rehabilitation on closure liability**
**Source: (ICMM, 2019b:41)**

The first scenario illustrates no rehabilitation throughout the lifecycle of the mine. It is evident how the liability keeps on increasing as the level of disturbance also increases. The second scenario illustrates where standard progressive rehabilitation was applied throughout the lifecycle. As the concurrent rehabilitation increases and the level of disturbances decline, so does the liability decrease throughout the lifecycle of the mine. Scenario three is working smart above and beyond which is the aim of this mine. This requires optimal collaboration between the operational plan and the closure plan. It is essential to keep in mind that as the mine closure approaches; resources will become more and more constrained especially financial resources (ICMM, 2019b:39).

### 2.4.5 Mine closure toolbox

Anglo American has the mine closure Toolbox as a general guideline to assist with the mine closure planning. The primary purpose of the Toolbox is to develop a holistic

mine closure plan that includes financial provision for rehabilitation and the physical methods that will be used for closure to ensure sustainability, even post-closure and leaving a positive legacy (AGL, 2013:3).

The toolbox consists of three main tools and is described in Table 2.4:

**Table 2.4: Mine closure toolbox**

| Tool | Process |
|---|---|
| 1: Strategic planning for mine closure | Identify the basic expectation and establish a baseline focusing on people, planet, and profits with a specific post-closure. |
| 2: Rapid assessment of the status of a mine's existing closure plan | Identify knowledge gaps in the current mine closure plan and determine the level of detail that the closure plan should include relative to the remaining life of the mine. |
| 3: Filling the gaps in the closure plan | Establishment and planning of the requirements such as technology, methodology, and resources. |

**Source: (AGL, 2013:4)**

The toolbox is a useful tool that is used by the mine to evaluate the current environment, conduct a gap analysis between current environmental status and aim. Then develop a closure strategy to close the gaps identified. The level of detail of the strategy will depend on the remaining life of the mine. It is recommended that this logic process is integrated throughout the lifecycle of the mine and not to leave it for closure (AGL, 2013:6).

## 2.5 INVESTIGATING THE LEGISLATION WITH REGARDS TO OPENCAST MINE CLOSURE

There are many legislation and regulation to adhere to and needs to be considered by management when planning is in process. The following sections will highlight the most critical laws that influence the integrated management approach of mine closure.

### 2.5.1 Contextualising closure legislation

From the earliest legislation implemented, the focus was mainly on the rehabilitation of surfaces (Swart, 2003:489). Mining companies implemented Environmental Management Plans (EMP), only to comply with the minimum requirements as proposed. The older mines that were in production before the implementation of the regulatory requirements are now behind with the process. Companies endeavouring to catch up, have to manage on a reactive basis to comply with regulatory requirements and provide sufficient provision for closure.

The origin of firmer litigation is that mines in the past made use of irresponsible mining methods with only financial gain to a mine with no regard for the impact on the environment. Mining companies often neglect the responsibility of protecting the environment and the rehabilitation, transferring the liability to the government (Swart, 2003:489).

### 2.5.2 Roles and responsibilities of stakeholders

Mine closure is a complex process. One of the facets included in the mine closure plan is the engagement with relevant stakeholders. The starting point would be to identify these different stakeholders and the roles and responsibilities of each one to manage the different expectations.

The summary below contains a table of stakeholder divided into three main categories with the different roles and responsibilities of each (Swart, 2003:489):

**Table 2.5: Roles and responsibilities of stakeholders**

<table>
<tr><th>Government</th><th>Holder of the prospecting right (Mining company)</th><th>Other stakeholders</th></tr>
<tr><td>It is the environmental protector and regulator of the constitutional rights and regulations.</td><td>Responsible and liable for complying with the relevant provisions of Minerals Act 50, 1991 and other applicable legislation and regulations until the holder has complied with requirements.</td><td rowspan="5">Other stakeholders included in the engagement process:<ul><li>Mine management</li><li>Mine employees</li><li>Shareholders</li><li>The surrounding community affected, which include:<ul><li>Landowners</li><li>Local authorities</li><li>Business and service providers</li><li>Community groups</li><li>Non-Government Organisations (NGOs)</li></ul></li></ul></td></tr>
<tr><td>To ensure a safe and healthy environment for the community of the country.</td><td>Application for the closure certificate.</td></tr>
<tr><td>Ensure a sustainable environment</td><td rowspan="3"></td></tr>
<tr><td>The inheritor of remaining environmental problems.</td></tr>
<tr><td>Regulator of the mining industry.</td></tr>
</table>

**Source: (Swart, 2003)**

### 2.5.3 Legislation applicable to mine closure

The following sections outline the laws applicable to mine closure. At the end of the section, all these regulations and litigations are summarised in a table.

#### 2.5.3.1 Constitution of South Africa 1996 and Common law

This law, in conjunction with Common law, requires that mines have to conduct their operations and closure activities with due diligence and care for the rights of others (Swart, 2003:490).

There are two sections applicable to mine closure. Sections 24(a) and 24(b) of the Constitution provides that everyone has the right to an environment that is not harmful to his/her life (South Africa, 1996:1251) and that the protection of the environment for the benefit of present and future generation, through reasonable legislative and other measures (South Africa, 1996:1253).

These two sections of the Constitution supersede all other legislation, including environmental law. It entails that a person suffering from harm caused by mining operations has the right to claim damages from the mine and/or its directors with the inclusion of shareholders in terms of company law even after the mine has closed (Swart, 2003:490).

#### 2.5.3.2 National Environmental Management Act, 1998 (Act No. 107 of 1998)

NEMA is environmental legislation applicable in South Africa and globally. Section 24 of the Constitution, which states that everyone has the fundamental right to a clean and non-harmful environment, lays down the foundation of the NEMA (South Africa, 1996:1251).

This litigation is used as an environmental management tool by not only individuals but also to institutions and government. It ties into the concept of integrated environmental management where the environment is the comprehensive concept that includes surroundings in which humans exist and consist of the land, water, and atmosphere (Van Nierop et al., 2016).

Sections 24P and 24R prescribe that an applicant for environmental approval that is relating to mining activities must meet the terms of financial provision (Centre for Environmental Rights, 2013:58) for closure and that holder remains responsible and liable for the rehabilitation of the environment (Centre for Environmental Rights, 2013:60).

These provisions should include rehabilitation and post-closure management cost for related environmental damages that might arise in the future. There are several remedial options available at the disposal of the regulatory body with regards to the discretionary application of provision for closure provided should this law be dishonoured.

Section 28 requires that the impact on the environment should be minimum. The degrading impact on the environment should be managed proactively to stop and discontinuing such events. There need to be action plans compiled and environmental assessments conducted about how the holder anticipates minimising the impact on the environment (Centre for Environmental Rights, 2013:63).

Section 32 and 33 is about judicial matters in search of relief available to apply when in breaching or threaten to violate any provision of this Act (Centre for Environmental Rights, 2013:88). It may even go to the level where an individual may be prosecuted in his or her capacity (Centre for Environmental Rights, 2013:89) in terms of the Criminal Procedure Act, 1977 (Act 51 of 1977).

#### 2.5.3.3 Mine Health and Safety Act, 1996 (Act No.29 of 1996)

The Mine Health and Safety Act (MHSA) was promulgated to protect the employee and that of other persons of the mine (South Africa et al., 2017:11). This act refers to numerous occasions to the reasonable man test. In essence, this is, the employer will do as much as reasonably possible to protect the health and safety of its employees.

Section 2 & 5 of the MHSA relates to measurements that employers put into place to ensure safety (South Africa et al., 2017:12) and maintaining a safe and healthy environment for the employees.

Section 6 elaborates on the responsibility of the employer to provide the employer with the correct health and safety equipment (South Africa et al., 2017:14) where Section 22 reflects on the responsibility of the employee to take reasonable care of the equipment provided (South Africa et al., 2017:27).

Section 10 requires that the employer must ensure that the employee is adequately trained and competent to do the work that is required (South Africa et al., 2017:17), where Section 11 describes the risk assessment and the response necessary of the employer to manage the risk in the working environment (South Africa et al., 2017:18). Section 23 allows the employee to refuse to do work that poses a high risk, unsafe of deteriorating to health (South Africa et al., 2017:27).

Section 12 prescribes that the employer has to ensure that proper hygiene measures are in place (South Africa et al., 2017:21) and according to Section 13, a medical

surveillance system must be established to build up a history of each employee (South Africa et al., 2017:22). The information must be available should the employee request such information according to Section 19 for a finite period (South Africa et al., 2017:24).

The same rules and regulations concerning the safety and health of employees during normal operation activities will be applied during the closure phase of the mine. This responsibility of the employer towards the employee will have a significant impact on the estimate of provision provided and must not be omitted. The health and safety management will specifically be investigated and addressed by the Chief Inspector when considering the issuing of a closure certificate (South Africa, 2002:47).

#### 2.5.3.4 Atmospheric Pollution Prevention Act, 1965 (Act No.45 of 1965)

The Atmospheric Pollution Prevention Act, 1965 refers to the management and mitigation of air pollution (South Africa, 1965:22). It is an essential factor considering the activities associated with open cast mining generate lots of dust. Currently, it is contained by spraying the roads with an environmentally friendly solution in the mining portion of the value chain, and the beneficiating plant dust suppression systems are installed to curb dust generation. The management of dust will continue during and after closure and will, therefore, have an impact on the provision for closure.

#### 2.5.3.5 Nuclear Energy Act, 1999 (Act No.47 of 1999)

The Nuclear Energy Act, 1999 is applicable when activities include the management of radioactive isotopes (South Africa, 1999:4). Currently, the mine makes use of radioactive isotopes in two sections of the plant. The one section of the plant uses the material as a measuring instrument to determine the level of bins. This method is in the process to be phase out and replaced with alternative technology. The other area has to do with the management of qualities where the ore is scanned and based on density properties how the quality of the ore is determined. There is currently a very well defined, controlled process in place where the radioactive isotopes get sent to the South African Nuclear Energy Corporation (NECSA) for rehabilitation. This

rehabilitation process of radioactive isotopes will have to be taken into consideration with mine closure and the provision.

#### 2.5.3.6 National Water Act, 1998 (Act No.36 of 1998)

The National Water Act, 1998 (Act No. 36 of 1998) makes provision for the sustainable and effective management of water (South Africa, 1998:1). It is especially relevant considering that South Africa and the location of this mine is considered to be water scarce area. This regulation consists of nine different sections; each one has an impact on the normal operations of the mine and also very relevant on mine closure.

Water management is one of the factors that has a very high probability for a more longer-term management approach, even post-closure. It, therefore, is a very critical component to consider in the mine closure and provision planning and execution. No closure certificate will be even considered without the Chief Inspector addressing the potential pollution to water resources (South Africa, 2002:46).

#### 2.5.3.7 Mine closure with regards to Minerals and Petroleum Resources Development Act and Regulation, 2002

The MRDP consists of two segments. The one is the Act itself, and the other is regulation on how to apply the Act on environmental management and provide specific guidance on mine closure and rehabilitation. The EMP consultation with the State departments are prescribed in Section 40 (South Africa, 2002:44)

Section 37, 38, 39 (South Africa, 2002:42) and Regulation 52 (South Africa, 2011:37) reflect on the compilation, setting objectives and the management of the EMP. It prescribes that mine, as a responsible corporate citizen, must manage the environment to be sustainable and with consideration to people, planet, and profits.

The EMP should include a section that describes explicitly the financial provision for closure and that it should progressively rehabilitate throughout the lifecycle of the mine. The other component for inclusion in the stockpile and residue deposit management according to the acceptable manner in Section 42 (South Africa, 2002:46) and Regulation 73 (South Africa, 2011:49) and included EMP.

Mine closure is the final phase of the lifecycle. Guidelines regarding closure are addressed further in Section 43 (South Africa, 2002:46) together with Regulations 56, 57, 61 and 62 (South Africa, 2011:42). Mine closure objectives form part of the EMP. The first objective of mine closure is to identify the critical elements.

These essential elements will be the guide to project design, development, and management of environmental impacts. The second objective is to provide broad options for future land use of the mining site, and the ultimate aim is then to give an estimated cost for the closure. A mine is only considered closed when a closure certificate has been issued according to Section 43.

It further describes the accountability related to environmental liability and when to apply for a closure certificate. The management of health, safety and water resources potential pollution is critical items that will be addressed by the Chief Inspector. It prescribes the process of retaining and returning of the provision for closure deemed appropriate when issuing a closure certificate. It indicates the minimum requirements that must be included in the application for mine closure. This minimum requirement consists of the following:

- Closure plan contents
- Environmental risk report
- Final performance assessments report

The mine must ensure that the closure process and the associated proactive risk management must start at the commencement of mining operations throughout the lifecycle. It should be done with the same health and safety requirements.

Residue and possible latent environmental impacts should are identified and quantified. The land must be rehabilitated as far as practicably possible to its natural state and conform to sustainable development. The closure and rehabilitation of the environment must be done efficiently and cost-effectively.

With mine closure, there is a financial provision risk for the long-term maintenance that needs to be taken into consideration. This risk report guideline is provided for in Regulation 60 (South Africa, 2011:43). The risk report contains the identification of the risk, then how to mitigate and implementing preventative management.

Section 44 describes the process regarding the removal and demolishment of buildings and infrastructure (South Africa, 2002:48). It may not be demolished or removed without the approval and agreement of the relevant stakeholders. This estimated value should also be included in the financial provision liability.

The financial risk converts into an environmental liability and is described in Regulation 58 and 59 (South Africa, 2011:42). This regulation elaborates on the accountability for environmental responsibility. The government will be the last owner in line for any remaining environmental liabilities. This is one of the main contributors to add to the complexity of mine closure process.

The mining company must ensure that sufficient provision is provided for mine closure. Defining and quantifying methods of the provision are described in Section 41 (South Africa, 2002:46) and Regulation 53 and 54 (South Africa, 2011:39). This financial provision is one of the items that must be included in the EMP.

This provision provided for in as a financial guarantee as prescribed by Section 89 (South Africa, 2002:78) and Regulation 53 (South Africa, 2011:38). Any of the following methods are an acceptable form of financial guarantee:

- Trust fund
- Financial guarantee
- Deposit
- As determined by the Director-General

The powers of the minister are stipulated in Section 45, 46 and 47 (South Africa, 2002:48) with regards to the rehabilitation of the environment. It describes the powers available to the Minister to recovering the cost for urgent remedial action that must be addressed. There are different methods available to collect the funds that are needed. The Minister reserves the right to remedy environmental damages and may do it by suspending or cancel rights, permits or permission.

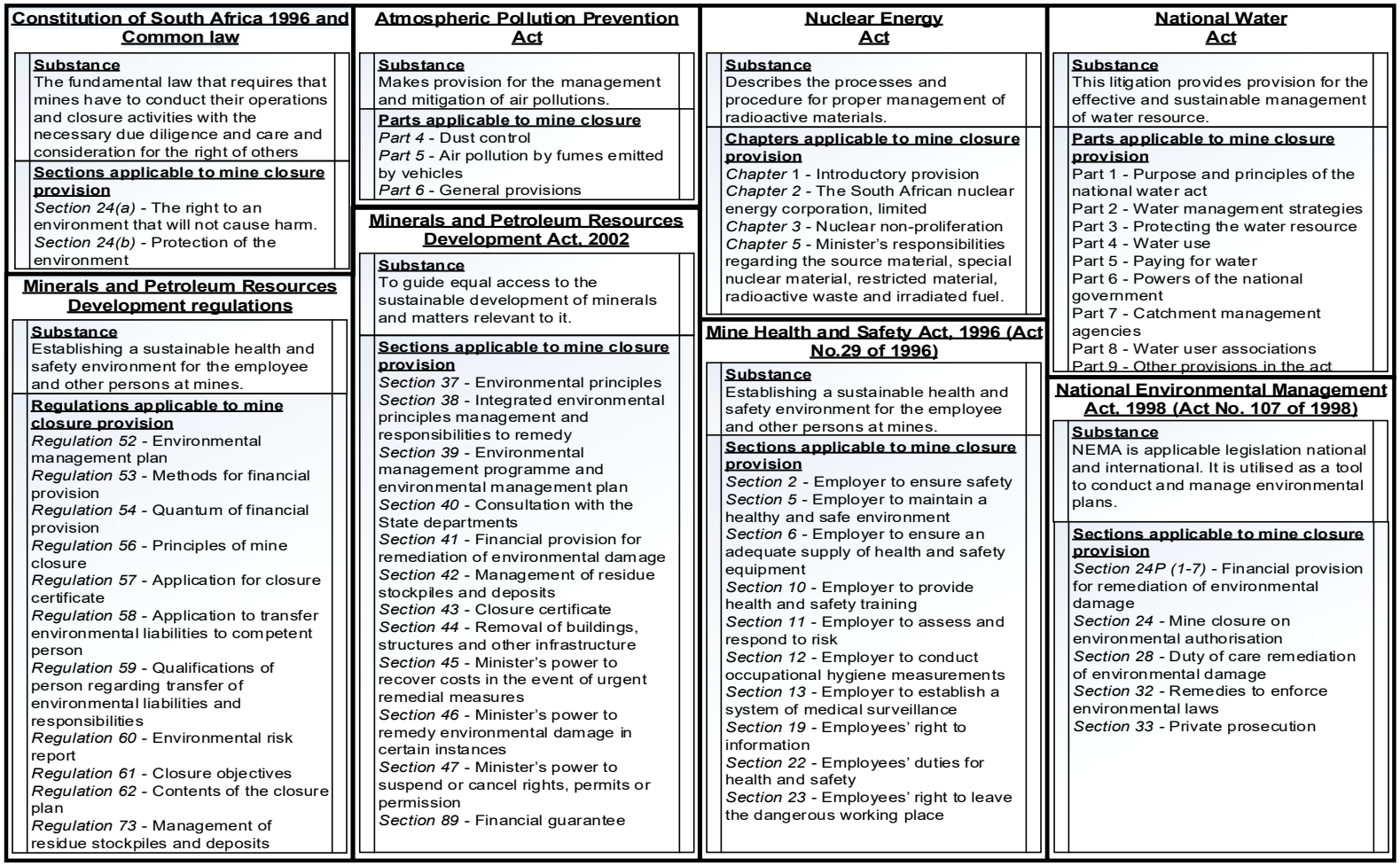


**Figure 2.6: Summary of litigation and regulation relevant to mine closure**
**Source: The author-adapted from litigations and regulations**

## 2.6 SUSTAINABLE CLOSURE FOR AN OPENCAST MINE

This section will focus on corporate citizenship and sustainability related to mine closure.

### 2.6.1 Reputation and perception management

A company's reputation is built on the perception of its stakeholders and managing the relationship cannot be underestimated (Hogarth *et al.*, 2018:375). This mine has performed and provided financially to so many stakeholders for almost 70 years. A sustainable closure and rehabilitation of the environment will be the final endeavour of the mining house to all stakeholders.

"*It takes 20 years to build a reputation and 5 minutes to ruin it. If you think about that, you'll do things differently*" (Buffet, 2019).

### 2.6.2 Corporate social responsibility (CSR)

CSR is a reflection of the dedication of a company to contribute towards not only the profits but also the people and planet (Fordham et al., 2017:366). It is a delicate balance between the three dimensions, social, environmental and economic.

Mine closure that is the last phase of the lifecycle of the line should not be seen as a task that can be left for someone else. All the stakeholders of the mine, during production, need to be mindful of those decisions which have a critical implication to maximise value and minimising the closure risk (McCullough et al., 2018:399). A responsible corporate citizen will do what it can to ensure sustainability, even post-mine closure.

### 2.6.3 Sustainability

The concept of sustainability accurately described as the propensity to meet the needs of today without compromising the needs of tomorrow for future generations (Anderson, 2002:1). We are only borrowing the environment from our future generations. This is in alignment with the Constitution (South Africa, 1996).

Sustainability comprises the interface between people, planet, and profit, also known as the triple bottom line principle (Elkington, 1998:37). A sustainable mine must on a continuous basis, develop and maintain the interface between the spheres. Neglecting one of the areas will impact one or both of the other areas negatively.

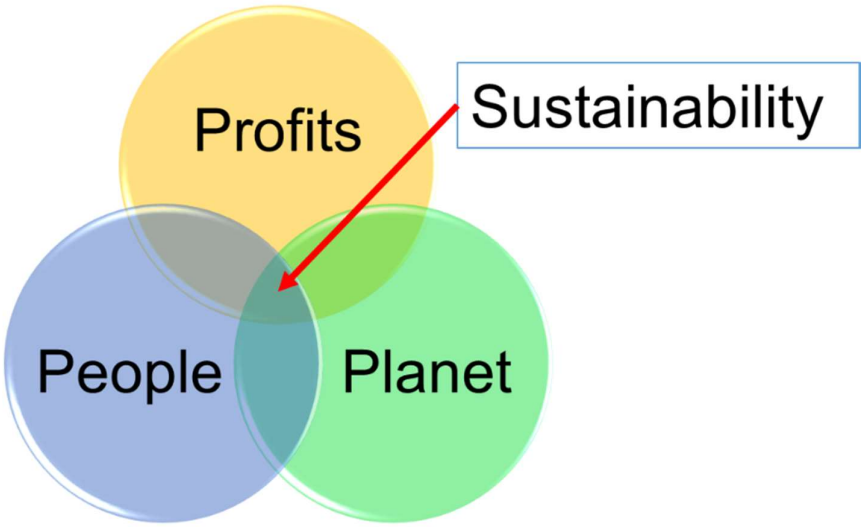


**Figure 2.7: Triple bottom and sustainability**
**Source: (Elkington, 1998:37)**

### 2.6.4 Profits

The profit dimension relates to the economics and financials of the mine. Although all of the concepts of the triple bottom line is very important, economic viability is the foundation. Without sufficient funds, the business would not be able to exist. It would not attract and retain the necessary capital of investors. The focus is, instead, the impact on the other components by generating profits in a responsible and sustainable manner.

The challenge would be sustainability post mine closure. The mine will then not be able to generate profits anymore and depended only on the provision provided to achieve sustainable closure of the mine.

### 2.6.5 Planet

The planet dimension focuses on the preservation of the environment in the long term. It consists of natural resources and ecosystems. Sustainability mining is often conflicting concepts due to the association with the disruption of the environment by extracting a finite amount of funds until it is depleted or not economically viable anymore. This impact on the environment is easy to see for an open cast mine in comparison to underground mining.

The focus of this mine is to achieve sustained economic benefits of mining beyond mine closure while remediating the environmental footprint. This can be achieved by providing adequate provision, integrating the mine closure planning into operational strategy (KIO, 2018b:64).

### 2.6.6 People

The people dimension relates to the responsibilities of the community and the employees. It is maintaining and enhancing the health of people and the surrounding communities (Murphy & Heyes, 2016:1). In the past, this dimension was neglected, but this can no longer be ignored due to conflicts (Nurmi, 2017:1).

The population of the Gamagara municipality was in 2015 almost 50 000. It has a budgeted income for property rates of nearly half a billion rand in 2017. The majority rates and taxes received are from urban properties. Kathu is very dependent on the surrounding mines for the source of income. This makes the town vulnerable to deteriorate into poverty and forsaken lands when the mine closes down. Currently, there is a drive to transfer the maintenance of Kathu from the mine to the Gamagara municipality. This is to prepare the municipality to be able to do the maintenance and that the town will still be sustainable after the mine has closed (Louw & Marais, 2018:1).

### 2.6.7 Technology and innovation

This mine demonstrates leadership in the development and adopting new technologies to be safer, more efficient and more sustainable. Technology has the potential to improve sustainability not only to increase profitability but also that of the people and planet. The mine’s portfolio includes technology projects that focus on

beneficiating of lower grade material and the improvement of the safety of employees. The benefit of these types of projects is to extend the remaining life of mine and protect people from getting injured (AGL, 2018a:1).

FutureSmart is the initiative of mining that integrates practical innovation with the sustainable mine plan to drive the future of mining. It comprises four focus areas. The first area is waterless mining. That is to reduce the water dependence in processing plant and tailings. The second area is concentrated mine. This involves technologies that target the ore precisely and resulting in a 30% reduction of water usage, energy, and the capital expenditure and delivering less waste. The third area is modern mining. This is hard-rock cutting innovations that remove the interaction of machinery and people and improving efficiencies. The last focus area is intelligent mining. This is to convert mega data into predictive information that eliminates uncertainty and minimising the process fluctuations (AGL, 2019b:1).

### 2.6.8 Recycling

To be sustainable alternative angles can be approached, such as the reuse and recycles material decreases the need for mining (Parameswaran, 2016). The added benefit to this usual altered way of mining operations is less disruption environment and subsequently contributing to prolonging reserves for future generations. This makes the concept of sustainable mining more realistic and achievable for a more extended period (Reuter, 2013).

For the sustainability of mining operations to improve, the following environmental performance characteristics can be categorised into four main elements. This need to be managed to have a minimum effect on the environment and curbed to a minimum (Gorman & Dzombak, 2018):

- Reduction of inputs
- Minimisation of land disruption
- Reduction of outputs
- Responsible reclamation rehabilitation of mine lands

## 2.7 METHODS OF CLOSURE COST ESTIMATIONS AND REPORTING FOR AN OPENCAST MINE

This section focuses on the different techniques of closure cost estimation and transparent reporting.

### 2.7.1 Different cost estimation methods

Closure cost should be included right in the beginning during the planning and policies phase in the lifecycle of the mine. Cost estimation over a long period can be a complex iterative. Determining which method of evaluation applicable for the mine to use is vital, since mistakes in the methodology cause use of discrepancies in the outcome of the social, environmental, and profits. The level of uncertainty to account for remains a concern for planners and mining engineers. Some of the aspects will only become known when the final phase approach (Nehring & Cheng, 2016).

There are different kinds of cost estimates for different scenarios of closure. The different cost estimations are indicated in Figure 2.8 below:

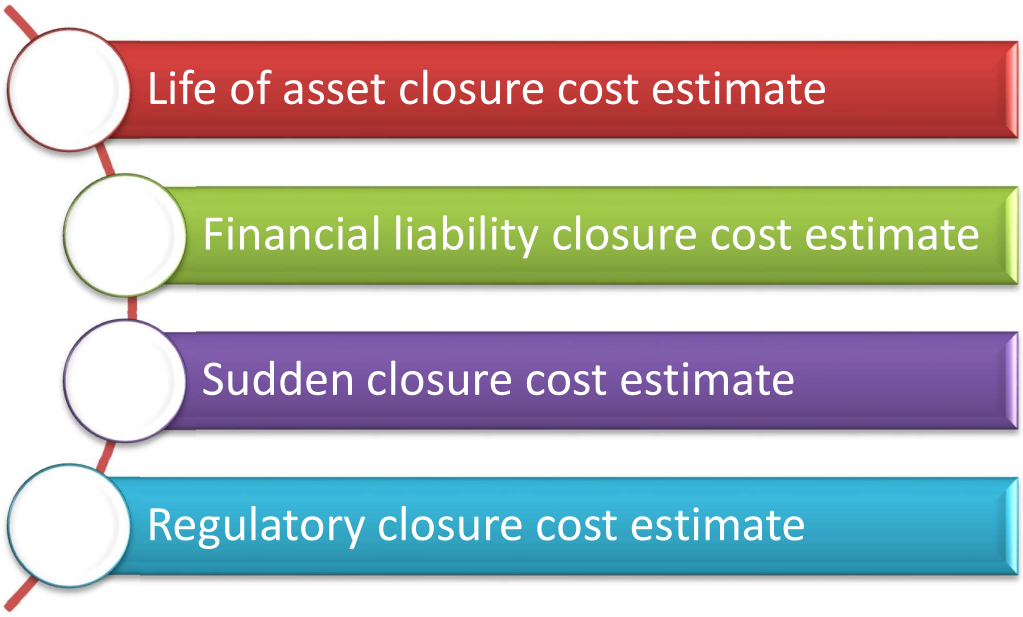


**Figure 2.8: Different types of mine closure estimates**

**Source: (ICMM, 2019a:10)**

### 2.7.2 Life of asset closure cost estimate

This is the estimation of cost that the mine expects to incur within the context of the current mine plan at the end of Life of Mine (LOM). It includes the forecast of the total costs for all the closure obligations to restore the disturbed footprint caused during all the phases of the life cycle of the mine. It is an internal estimation of the mining house that consists of asset valuation, business planning, budgeting purposes and reported through management up to executive level. This type of estimate assumes that the mining site will operate for the full duration and is based on the owner's cost of rehabilitation until the planned end of life. This is under normal circumstances not used for internal management and not for external reporting purposes to external stakeholders. It takes into account the total cost for closure, decommissioning and demolishing, rehabilitation and revegetation, post-closure management and relinquishment to the future landowner (ICMM, 2019a:10).

### 2.7.3 Financial liability closure cost estimate

The financial liability closure cost estimate is according to the international accounting standards requirements. It is used for taxation and accounting purposes and under normal circumstances not used for the governing cost estimates or financial declaration. It is a financial requirement and reported as a liability on the financial statements. This estimate is conveyed through management up to executive level and auditors before disclosed in financial statements. It is a representation of public disclosure to support the accounting and reporting requirements as defined by the owner of the mine’s internal reporting standard, based on the legal requirements, liability or compliance as a minimum. It illustrates the Net Present Value (NPV) for closure and rehabilitation cost of the current disturbing environment and the decommissioning of infrastructure at the time of reporting. It is the reasonable amount that the landowner and rational party pay to settle the liability on the reporting date or what will be transferred to a third party (ICMM, 2019a:13).

### 2.7.4 Sudden closure cost estimate

A sudden closure estimate is if the mine should close its operations in the current state. It is utilised for internal purposes to evaluate the business risk and establishment of an action plan for unforeseen and sudden changes in the macroeconomic conditions. It is to determine the cost of the mine should it close tomorrow.

Management uses this method to conduct option analysis, business planning and based on this make decisions and recommendations to the executive level. It is not generally used for regulatory purposes, although it might be a requirement by some jurisdictions for unplanned closure purposes (ICMM, 2019a:16).

### 2.7.5 Regulatory closure cost estimate

The regulatory closure cost estimate is the cost from the basis of guarantee as prescribed by the regulatory body. It is an estimate required by law to be included in the financial assurance against unforeseen or unexpected closure. It is used to establish financial assurance, bonds, bank guarantee or alternative financial mechanisms acceptable for the regulatory body. The calculation is done in all phases of the mine lifecycle, from exploration up to production activities. This estimate will be different from all the estimations due to the applicable laws and regulations and the different purposes of the other cost estimates. The estimate depends on the regulatory requirements within the specific jurisdiction. This amount usually based on the assumption by appointing an earthworks contractor (ICMM, 2019a:18).

### 2.7.6 Financial reporting

Responsible mining organisations must comply with legislation and regulations to rehabilitate the environment as far practically possible to its original state or even in a better condition before mining commenced. This obligation to restore the environment creates a liability. The value of the liability represents the associated cost of rehabilitation, decommissioning, post-closure monitoring and latent closure cost. Some of the decommissioning and rehabilitation cost is deferred to end of life of the mine. Although the cost is deferred the obligation is generated when these disturbances incur. The International Accounting Standard (IAS) 37 provisions, contingent liabilities, and contingent assets require that a provision must be created on the balance sheet as soon as the cost of settling the obligations incurred to date, discounted at present value. The mine liability is split into two groups, as indicated in Table 2.6 and defined according to activities that generated the obligation (AGL, 2019c:3).

**Table 2.6: Classification of mine's liabilities**

| Classification | Definition |
|---|---|
| Decommissioning liabilities | It consists of the cost associated with the dismantling and removing of property, plant, and equipment at the end of their useful lives that incurred as a result of the construction of the asset. The value represents the removal of plant and infrastructure and the rectification of preparation work performed prior to production phase. |
| Environmental restoration liabilities | Identify knowledge gaps in the current mine closure plan and determine the level of detail that the closure plan should include relative to the remaining life of the mine. |

**Source: (AGL, 2019c:3)**

### 2.7.7 Global Reporting Initiative (GRI)

The primary purpose of the GRI to report on the sustainability of a company by reflecting on the people, planet, and profits. This standard is not limited to a specific type of entity but applies to all kinds of organisations, including mines. It is considered to be the global language of organisations and the stakeholders with which sustainability can be communicated and comprehended. The standards are developed to make it possible for global comparability and improvement of quality of information, resulting in greater transparency and accountability of the organisations (GRI, 2016:3). It is a process of putting mitigation measures in place through the appropriate identification of present and future risks to improve sustainability (Van Zyl et al., 2012:41).

## 2.8 SUMMARY

This chapter started with explaining the lifecycle of an open cast mine. The different phases each have a different level of disruption to the environment and an impact on sustainability. The relationship between disruption and magnitude of closure provision provided was explained.

In section two, the focus was concentrated on the closing phase itself. The quantification methodology of the CRF was described. The challenges associated with the closure of an old open cast mine were also alluded to.

The following section enlightened on the management of the closure plan of an open cast mine. This includes a discussion of the closure planning process, working towards integrated planning throughout the lifecycle of the mine. The two-fold benefit that is controlling the liability and optimisation of operational cost of integrated planning was described.

The next section was extractions and explanations of the most important legislation and regulations related to the closure of an open cast mine. These laws and regulations will impact the magnitude of the provision and the endorsement of a closure certificate as described.

The sustainability pre- and post mine closure were then discussed by focusing on the three spheres principle of the triple bottom line. The aim is to find a balance between the three spheres not neglecting one of the spheres was described. The section further focuses on the management of technology and recycling has on the remaining life of the open cast mine.

The last section was delving into the different cost estimates and describing the utilization of each of the estimates. The section further focused on standard and transparent global reporting.

# 3 CHAPTER 3: EMPIRICAL STUDY AND DISCUSSION OF RESULTS

## 3.1 INTRODUCTION

This study follows a transcendental phenomenological approach to explore and more in-depth understanding of the influence that different specialists have on the management of mine closure provision.

The study follows a method of systematically identifying, organising and other offering insights into patterns of themes across the data known as thematic analysis (Braun et al., 2019:57). This provided the researcher with the opportunity to identify features within the collection of data and to categorise the salient features within the relevant themes recognised. The data was after that analysed to ensure the validity meets the research objective.

The second portion of the chapter includes the results from the empirical research in context with primary and secondary objectives mentioned in paragraphs 1.4.1 and 1.4.2 in chapter one.

The researcher discussed the insight of the data that was obtained from the study and considered those inconsistent with the literature as crucial for current and possible future studies related to the management of mine closure provision. The similarities and variances found in the study were assessed and discussed in more detail in chapter 4.

## 3.2 GATHERING OF DATA

This section outlines a detailed description of the data collection, the sampling and population method, the data collection techniques, the interview process, and analysing of the data.

### 3.2.1 Data collection process

Semi-structured interviews were conducted to collect data, which mean that the researcher had already compiled an open-ended questions list. The researcher used the questionnaire merely as a guideline during the interview process and provided the

interviewer with the necessary freedom to ask additional questions that may be required for a deeper understanding.

The interview was held at the mine in the offices of the different participants. The idea of the interviewer behind this was to ensure the undivided attention of the interviewee, that the participant was comfortable and to minimise interruptions. By the interviewer's preference of choice, interviews were conducted on a face-to-face manner to observe the participant's body language such as movements, uneasiness or confidence discussing the management of mine closure provision.

The one interview was conducted using Skype technology since the participant is situated in Australia. A convenient time was scheduled for the interviewer and the interviewee by taking into consideration the different time zones.

### 3.2.2 Population and sampling

The target population for this study were specialists from different fields of expertise. All of them influence the management of closure provision directly or indirectly. The variety of specialists were purposefully selected by using convenience sampling and non-probability sampling (Welman et al., 2006). It entails that the research was conducted by taking into consideration convenience and accessibility.

The original sample target was between 10-15 specialists, but taking into consideration the nature of the comprehensive interview process and time frames of the research, the researcher could only manage to conduct a total of nine interviews from selected departments on the mine and the one from Australia. This allowed the study to establish the contribution toward the deep understanding of the management of mine closure provision from the various departments.

### 3.2.3 Data collection technique

Data for the research were gathered by conducting face-to-face interviews to form part of a qualitative study. The data was collected from the primary source, the managers for a deeper understanding of the influences it has on the closure provision (Gill et al., 2008:291).

Semi-structured interviews were the preferred choice for deeper understanding and due to the flexibility to collect data from a broad experienced and variety of respondents. The interviews were conducted with each of the participants using an interview guide (Bryman & Bell, 2014:224). The questions were formulated in an open-ended manner to allow the participant to provide their unique point of view based on practical experience. Data was collected by recording and making notes to use for probing questions.

### 3.2.4 The interview process

Interviews with various specialists will be conducted to collect data. A pilot interview will be scheduled and examined before the rollout of formal interviews to test relevance to the research objective. The interview guide was amended with suggestions during the pilot interview.

Invitations were sent to the selected interviewees with limited but sufficient information, containing the rationale of the study. No further information was sent to leave the ambiguity discussion open to new exploration and development of ideas related to mine closure provision management. Only one participant requested additional information of which the reviewer then provided more background. This approach was a deviation of the norm, but the overall interview participation was still positively received and fruitfully conducted (Bryman & Bell, 2014:219).

With the introduction of the interview out of the way, the interviewer then explained in detail what the aim of the study was. The duration of the interviews varies from 13 to 60 minutes. The interviews were digitally recorded except for the one where an additional Skype recording was also used. This was to allow the functionality to do playbacks of the conversations recorded and perform verbatim transcribes. In the case of unclear audio, the transcribe was sent to the interviewee to ensure the correctness and completeness of the information.

### 3.2.5 Data analysis

The study was conducted using a thematic analysis approach. Thematic analysis is widely used but was not that well-defined an approach of qualitative research. But this paradigm was shifted to be a systematic and sophisticated strategy for qualitative

research. The accessibility, flexibility was well accepted by the researcher and fitted well to inductive data coding approach (Braun et al., 2019:57). The six phased method referred to in chapter 1, paragraph 1.5.2.4, however, increases with one phase, building a structured code system because of the utilisation of computer software (Friese et al., 2018:25). The seven phases is as follow, categorised into activities:

**Table 3.1: Seven-phased approach for thematic analysis and activities**

| Phase | Activity |
|---|---|
| Phase 1: Pre-analysis, becoming familiar with data | Contextualisation |
| Phase 2: Material exploration, generating initial codes | Encoding |
| Phase 3: Building a structured code system | |
| Phase 4: Searching for themes | Theme development |
| Phase 5: Reviewing themes | |
| Phase 6: Defining and naming themes | |
| Phase 7: Producing the report | Reporting |

**Source: (Friese et al., 2018:25-27)**

The seven phases were grouped according to the activities, contextualisation, encoding, and theme development and reporting initiated by the researcher. The first activity, contextualisation, is the process of making sense and develop a deep understanding of the data that was collected. This was achieved by attentively reading through the transcribes and putting it into context.

The second activity, encoding includes phase 2 and 3. This activity entails to take the verbatim transcribes and encoding it by using computer software. This was done by combining all the transcribed interviews and encoding each paragraph to make sure that all the codes were recorded and represent a full complement of the interview (Braun et al., 2019:60).

With the initial encoding, open-ended coding was applied to ensure that all the data that were captured salient features emerged. Codes were then assigned based on the identification of salient features of all the interviews. The process resulted in 275 initial

unique codes. An optimisation process was followed for the codes that were similar and reduced to 263. Codes that had the same description but different names were merged to form one code, and renamed to a more apt name.

The third activity includes the development of themes which is associated with axial coding and reviewing themes that are related to selective coding. All 263 codes were then inductively analysed to determine salient and emerging themes. This was done by the researcher by not distributing themes according to a pre-conceptualised theoretical frame known at the bottom-up approach (Bryman & Bell, 2014:351). The codes were then arranged in categories based on similarities known as a theme map. The theme map can be described as the result of a holistic conceptualisation of data configurations that provides for all the themes, subthemes and categories and the relationship between it (Braun & Clarke, 2006:89). To distinguish between themes, subthemes and categories, more prominent colour coding were used by the researcher.

The categories resulted in five-strong salient themes.

Theme 1: Closure planning

Theme 2: Provision

Theme 3: Stakeholder engagement

Theme 4: Sustainability

Theme 5: Toolbox

The last activity included the reporting of the data analysis. In support of the coding process and theme development, a decision was made to use computer software to assist with this process.

There are numerous computer software available in support of analysing qualitative data. These types of programs do not exclude scrutinising and comprehending the data. The need remains to read the data extensively to create new individual concepts and relationships from the data, but it streamlines the coding retrieval process tremendously. Most of these programs are developed primarily for categorisation analysis, of which thematic analysis forms part (Bickman & Rog, 2008:235).

The Computer-Assisted Qualitative Analysis Software (CAQDAS) Atlas.ti was the software chosen. The main reason was that the program has the functionality to create links among data sections, codes, and memos but also the ability to display the resulting networks (Bickman & Rog, 2008:237).

## 3.3 DISCUSSION OF THE RESULTS

In the following sections, the results will be discussed of the salient themes, subthemes and categories. It will be illustrated as mind map figures, followed by discussions that emerged from the data and referenced with sections from the transcribed interviews.

The sub-themes cascaded from the themes and substantiated by the evidence acquired. The names of the participants were replaced by the letter (P) followed by a unique number in no specific order due to the confidentiality and ethics agreed upon with all participants — the unique pseudonym ranges from P1 to P9.

The meeting was scheduled and conducted over a two-week period according to the following dates and times, as indicated in table 3.2.

**Table 3.2: Interview schedule**

| Pseudonym | Date conducted | Interview approach | Time scheduled |
|---|---|---|---|
| P1 | 12 Sep 2019 | Skype | 9:30 – 10:30 |
| P2 | 18 Sep 2019 | Face to face | 11:10 – 12:10 |
| P3 | 16 Sep 2019 | Face to face | 13:00 – 14:00 |
| P4 | 17 Sep 2019 | Face to face | 12:00 – 13:00 |
| P5 | 11 Sep 2019 | Face to face | 11:30 – 12:30 |
| P6 | 12 Sep 2019 | Face to face | 12:30 – 13:30 |
| P7 | 13 Sep 2019 | Face to face | 12:00 – 13:00 |
| P8 | 13 Sep 2019 | Face to face | 13:00 – 14:00 |
| P9 | 10 Sep 2019 | Face to face | 10:00 – 11:00 |

**Source: Researcher compiled**

### 3.3.1 The holistic view of themes

The mind map in Figure 3.1 indicates the five salient themes that came out the strongest after analysing the data with regards to mine closure provision management. These themes reflect on the wide variety of factors that needs to be considered for managing the closure provision of open cast mines.

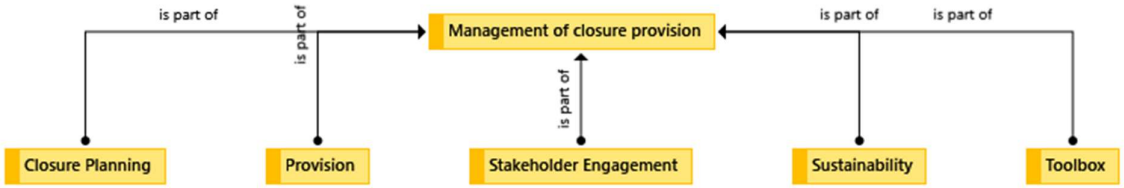


**Figure 3.1: Themes**

**Source: Researcher compiled**

The themes include the planning process, the quantification of the provision, the engagement and alignment with the stakeholders, the sustainability associated with the triple bottom line to be a responsible corporate citizen and a closure toolbox that is the current guideline utilised to manage mine closure.

### 3.3.2 Closure planning

The theme closure planning emerged from six different sub-themes indicated in Figure 3.2. These sub-themes influences planning throughout the lifecycle of the open cast mine. The aim of closure planning is to factor it in the day-to- day operations.

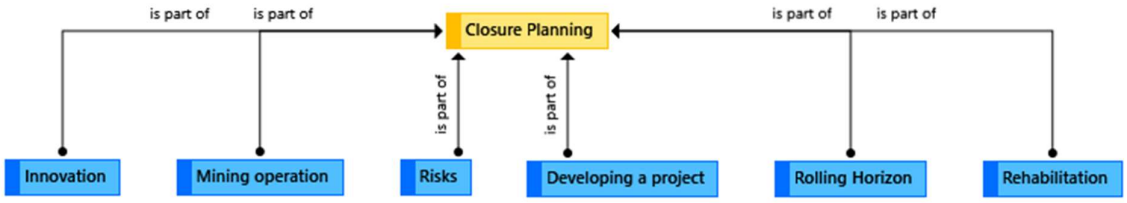


**Figure 3.2: Closure planning theme**

**Source: Researcher compiled**

#### 3.3.2.1 Innovation

The first sub-theme is the innovation regarding mine closure of an open cast mine. The two categories that emerged from the data were sustaining- and breakthrough

innovation. This innovation was established based on the domain- and problem definition (Satell, 2017:59). These quadrants of innovation illustrated in Figure 3.3 has an influential factor in the remaining life of the mine.


**Figure 3.3: Innovation sub-theme of closure planning**
**Source: Researcher compiled**

Technology and innovation have the potential to curb the liability further and optimise the operational expenditure, as mentioned by the participant.

*"Technology in the future or developments or efficient ways will make the provision not too big."* – P9

The mining group and the mine itself is very passionate about innovative thinking. Innovation and technology is one of the core values of the mine that reflects on the vision, mission and complements sustainability. There is a functional unit that is called FutureSmart Mining™ that commit their time and knowledge specifically to improve operations which also includes mine closure. The footprint of the mine is managed by exploring initiatives to reduce water usage, to only extract the target ore, limit disturbance on the environment and mining intelligent by converting mega data into useful artificial intelligence portrayed in the automation of equipment.

### Sustaining innovation

Sustaining innovation comprises the methods that can be utilised to do rehabilitation in a way that will reduce the provision for closure, while not impacting the production cost in such a way that the open cast mine is not profitable anymore. This entails the smart and integrated planning of operation activities with closure in mind.

The liability can be curbed and the optimisation of operational cost by moving the waste according to final designs and reduce the double handling of waste significantly with the closure of the mine shell. Initiatives such as mega dumping and backfilling were identified to support this vision.

*"Well look, you know there is… technology can touch closure in a whole heap of ways everything from reprocessing and tailings taking above ground dumps TSF*

*back filling them into voids something that we are gonna see a lot of in South America and elsewhere around the world following the mine tailings failures"* – P1

The process of mine closure and restoration traditionally has been seen as just the last phase of the mine lifecycle. There are numerous innovations and technology available and still to be explored to improve sustainability pre- and post mine closure. The closure of an open-pit mine is so multidisciplinary, and that's where the real potential is for innovations as the participant describes.

*" So there is a whole lot of things that could be done there. Through the rehab process, through the modelling and land form design and all the way through to you know remote monitoring using drone technology. So it really covers the full breath of closure and that is because closure is so multi-disciplinary it involves all of the different domains on the mine site and therefore the innovations that relate to each of those areas. Generally you find that some sort of application in closure whether it is indirect or direct."* – P1

One such innovative closure example is mega dumping. Mega dumping is the process of creating large area dumps. The benefit of this is fewer slopes to rehabilitate to prescribed angles and resignation of the dumps as explained by the participant.

*"The mega dumps is just all the dumps that we have just fill the gaps in between then you have one long dump like G80. That you need to rehab send you can save costs. Because you have got less sides to rehab"* – P2

Some of the participants discussed the opportunity that all infrastructure planning should comprise temporary infrastructure. This type of infrastructure has the flexibility to move it closer to the pit where operations occur. This will in the end reduce the demolishing cost substantially.

*"Which is all the (...) office space that they did is temporary office space there is no permanent structures. The plant as well as design so that it can be broken down easily."* – P2

**Breakthrough innovation**

The other innovation quadrant that influences the remaining life of the mine is breakthrough innovation. This is the type of technology that initiates the opportunity

what may be regarded as waste today might be the product of tomorrow. This is an exciting dimension where technology can be developed to enable and integrate concurrent rehabilitation while producing ore with minimal impact on the environment.

The mine management is currently busy to explore innovations that will allow for a more effective beneficiation process that will enable lower grade material that was previously considered to be waste can now be used to produce a saleable product. This will extend the remaining life of the mine substantially. The participant mentioned that operation has already stockpiled this material separately to have easy access when with the implementation of the new technology.

*"We also stockpiling lower and lower grade ores for future technology hoping that there is technology that beneficiate. So you are going to be sitting with stockpile that maybe one day somebody is going to come in and say now I got the technology to make this thing profitable. I think currently at the moment we got the plant discard heap that massive 500 million tons of size rock already."* –P4

With the successful implementation of this new technology, it won't then be necessary to rehabilitate the dumps with mine closure as mentioned by the participant. This waste dumps will then be converted in product to sell.

*"It is to be rehabilitated. It probably wouldn't make sense because at some stage, some day we will have technology that can extract more iron out of it."* – P4

The positive spin-off effect of the breakthrough innovation is that it will extend the remaining life of mines as mentioned by the participant.

*"Where we have got new projects coming online to extend the life of mine"* – P8

#### 3.3.2.2 Mining operation

The second sub-theme is mining operations that emerged from four categories. These categories reflect on the foundation of operational management, which is processes and people indicated in Figure 3.4 (Heizer *et al.*, 2017:42). The mining operational activities of an open cast mine correlate with the level of disturbance on the environment, which in turn affects the liability.

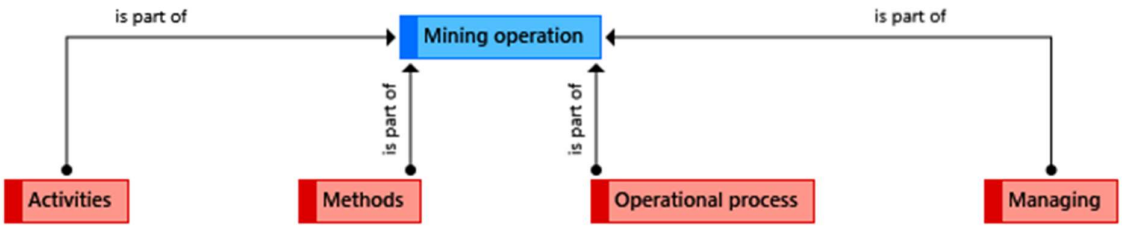


**Figure 3.4: Mining operation sub-theme of closure planning**

**Source: Researcher compiled**

### Activities

The first category of mining operations is the activities of open cast mining. These activities consisted of normal activities associated with open cast mining and included prospecting, drilling, blasting, hauling and dewatering. All of these activities affect the environment that generates the obligation to restore at mine closure as described by the participant.

*"so if you were to conduct mining in a way that creates or increase the liability every year it means the quantum that they have to provide for as a share is higher."* – P6

There was a specific focus on dewatering mining activity. Mainly because the mine is situated in water scarce area and is currently supplying water to many people. The conservation of the water resources is a high priority of the mine.

*"That water source is not for us. It is for all the people in the Northern Cape. Between us and the other group mine, we have got the biggest single source of groundwater in the Northern Cape so the responsibility lies very heavily on us to protect it and to look after it."* – P4

The continuous dewatering of the pit is necessary because the natural water level is higher than the ore body as described by the participant.

*"You can stop de-watering or whatever the process is the inside will start filling up with water"* – P3

**Methods**

The second sub-theme that was explored is the methods used for mining. This mine uses open cast mining because of the flexibility to do the blending and the availability of land. Although open cast mining has the benefit of blending, it makes concurrent rehabilitation more of a challenge. The challenge is not sterilising ore bodies which can still be mined to supply ore at required specifications. This might be a difficult task to achieve, but it is not impossible. Sequential mining lends the opportunity in some instances to mine particular sections of the pit, and could then be rehabilitated.

*"If you can sterilise ore and it is viable for the company not to mine that area it would be much cheaper for us to mine. But I also personally think that this mine was not really designed to be operated like that. Because ideally remember we do blend. So you do have different big pits but ideally you would mine one pit move over to another pit and backfill that pit."* – P2

*"So there is massive benefits there. The trick is you can't do it for all the waste all the time. We simply just don't have enough available void to fill it up with. So that is where my department is more involved with is to try and figure out. How do I sequence the pit so that I can mind this portion out move to a different portion and then take the waste from that portion that you now currently mining in and tip it back into the void."* – P4

**Operational process**

The operational process entails applying the activities, finding the most effective way to do the blending. This process is usually associated with only the negative impact it has on the environment. There will be an impact on the environment due to disturbances caused by mining processes. Nevertheless, the sustainability and the legacy left behind to future generations is in the hands of the current mine management.

The mining process has also evolved during the time to be environmental friendly not only to comply but be beyond compliance of prescribed litigations and regulations. There are a few progressive rehabilitation methods that can be utilised that will have a positive effect not only on the environment but also lower the operational cost. By

integrating closure initiatives into the operational process will result in the reduction of the operational cost and closure provision as the participant describes.

*"Firstly there is a benefit to it because that cost that we incurred in now, we wouldn't have been prepared for. Secondly, if there's certain areas that we can start rehabilitating or refilling we can use it for in-pit dumping which reduces our production cost because it reduces our all these things, so it improves the efficiency of our equipment and thereby improving our cost"* – P5

Successful progressive rehabilitation will not only be dependent on the operational division, but it will have to be a collaborative team effort from all the different departments.

*"So that efficiency so working together with the mining operation so that they actually understand and they produce with the rehabilitation in mind. They understand the importance of doing the right work at the right time to the correct specifications. Which strongly linked do why we have implemented the operating model principles at the mine. So those things to link tightly together."* – P8

**Managing**

There are a variety of factors needed to consider managing the value chain of mining operations. The first step in managing is to establish an environmental baseline as described by the participant.

*"It is good to always go to your baseline of environmental conditions currently"* – P2

It will be used as a compliance guideline to support the development of the closure plan. Any deviations from the plan will then be managed, as explained by the participant.

*"Part of it is to make sure that when you do that you comply with what is required to maintain either the original use capability of the land or you do it in such a way that you minimise the impact of that capability and in some way you need to make sure that at least that can be rehabilitated at the end"* – P6

Land disturbance, as required by the EMP, is to conduct operations in such a way to minimise the level of disruption and concurrently to curb the liability as explained by the participant.

*"There is always that because once it gets an environmental authorisation, there's a requirement in terms of the EMP aspect to make sure you manage for closure. So even though you are not doing closure you actually manage for closure."* – P6

#### 3.3.2.3 Risks

Risk is associated with the probability of an event from occurring and by early identification (Hopkin, 2018:15). This risk can be quantified by using the CRF that was discussed in the literature. That is quantifying the risk by multiplying the likelihood by the consequence.

The risk consists of two categories that have an impact on determining the provision for mine closure. It includes internal and external factors, as illustrated in Figure 3.5.


**Figure 3.5: Risk sub-theme of closure planning**
**Source: Researcher compiled**

### Internal factors

The most significant internal risk for the mine is that the amount value of provision provided will not be sufficient to restore a mine. There were quite a few contradictions between participants upon the exploration of the sufficiency of the provision, but most of them believed that the provision would be sufficient.

*"…very aware of it but I would suggest we still probably underestimating the requirement…"* – P1

*"I think it might be underestimated."* – P2

*"The validating increase it with CPI with the current rates that we have proven with our concurrent rehabilitation is more accurate and reliable and based on those two I believe that we will have sufficient provision for closure at the end of life."* – P3

*"I think the provision we have much higher confidence in that we had in previously because of the more detail planning we have done over the last two years, but there are still gaps and this water provision is one of them"* – P7

*"I think the provision will be sufficient. Because we involve consultants and people that are very experienced in this process, in this work. So it gets updated on a yearly basis of course we do a high level whereby we only change footprints and things that which we know."* – P9

**External factors**

The external risk factors that will have an influence on the planning for provision consist of the following.

**Political climate**

The political climate in South Africa is currently very volatile. This influences the current and future investment decision of local and foreign investors. In some cases, mining houses already started to withdraw capital from their mining assets by selling their mining assets in South-Africa, transferring the closure liability to the new owner.

**Availability of electricity**

In some of the rehabilitation processes, some form of energy will be required. Currently, the mine is very dependant on the use of electricity in the mining operations. When the time for closure arrives, electricity might be so expensive that it is unaffordable to use and have to investigate alternative energy resources to assist rehabilitation. The effect of load shedding might increase the rehabilitation period increasing cost.

*"Eskom situation because we do not know about electricity, which will influence us if we get to a point of closure*." – P2

**Diesel price**

The diesel price has a significant impact on the restoration of the environment since this mine is open cast mine and the highest cost haulage currently and so will the provisions for rehabilitation.

*"There was a drone attack on one of the oil fields that is influenced that is external things that will influence us so. The diesel price might go up significantly because of something happening out there. And that is now in terms of closure."* – P2

**Climate change**

The impact of climate change is an external factor that also needs to be considered with mine closure. It is forecasted that weather conditions will be more extreme and shorter intervals. This will not only influence the scope of the rehabilitation process but also the type of vegetation that will thrive in such conditions as the participant describes extensively.

*"So ja think we do need to look at adaptations in terms of climate change. Because the current predictions and modelling is that we are going to have less rain but more intense. More floods more storms you know like that hail storm which we had already and it is going to be higher temperatures. If you take that into consideration is the current rehab, vegetation that we implement would they be (...) would they survive that changed because we are in the change phase. And we do pick up that currently because you should have had the rain already our moisture content in the ground is very low. Which means more dust and what do you create when you rehab? Dust. So that is one example. I think the biggest factor that might influence us are climate change only because it is such a new animal. Climate change, Eskom situation because we don't know about electricity, which will influence us if we get to a point of closure. There was a drone attack on one of the oil fields that is influenced that is external things that will influence us so. The diesel price might go up significantly because of something happening out there. And that is now in terms of closure. The political climate might change. So there really is a lot of things that can influence us."* – P2

#### 3.3.2.4 Developing a project

There are many resemblances between the lifecycle of a project and the lifecycle of a mine (Fourie & Brent, 2006:1085). The principles for project management can be applied to the mine lifecycle. The different phases will have various milestones that will improve the closure management throughout the life of the mine.

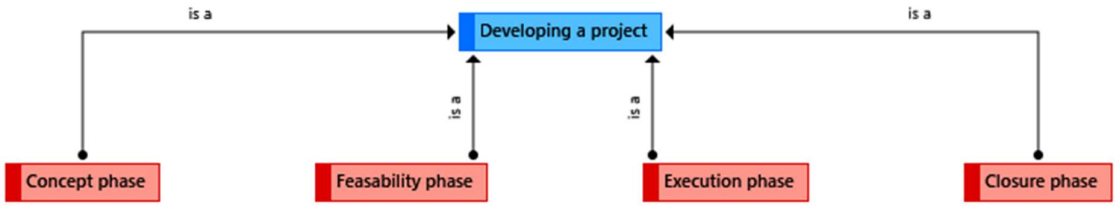


**Figure 3.6: Developing a project sub-theme of closure planning**

**Source: Researcher compiled**

The theme was shaped from the different phases of a project, similar to that of the life of the mine. The concept and feasibility do not apply to this specific mine, but with the exploration of the entire mine lifecycle, value initiatives were identified from the data for these phases before production.

Mine design with closure in mind will have a significant benefit for the mine plan. It will lower the cost of production and the closure provision. The different scenarios must be evaluated before the mine start with production to see what is the best solution.

**Concept phase**

This phase is not that applicable to this specific open cast mine since it has been in production for almost 70 years. Nevertheless, what is found is that this phase is critical when starting a new open cast mine.

*"So in my experience you're better off if you are on you are a new mine, if you are an old mine."* – P2

This phase explores the efficient mining methods, volumes and qualities of the ore with the development of a new mine. The milestone of these phases is an executable conceptual design. This designs should already include a closure plan to ensure progressive rehabilitation is achievable as defined by the participants.

*"Just start a new mine and plan properly how you design it with the least rehab required."*- P2

*"So you need to make sure you got a proper plan. That is why we actually making sure we got a proper plan. A proper plan to execute the plan that brings down that cost a lot.And if you do that correctly and should do a good design from the start. That helps you to do interim rehabilitation on that."* – P8

**Feasibility**

The milestone of this phase is to have final designs that are going to be implemented. These designs should already include an integrated closure plan to ensure progressive rehabilitation is achievable and beneficial.

*"…you know when developing a project in front end loading and continue that level of rigour and that level of planning and execution all the way through to ultimately relinquish the waste back to the regulator or sell around to the next land user. I think that is by far the most value the most value and biggest opportunity.* – P1

**Execution phases**

This phase will focus on moving the waste around and extracting the ore.

*"So, Through operations phase there will focus on getting ore out of the ground and moving dirt but there equally needs to be the focus what will be the implications of what we will doing today on the ultimate closure cost and where can we do the smart things that, you know handle material once dump to final design, do concurrent rehabilitation that helps us better manage the asset in the closure phase"* – P1

This is the phase of which the impact is most severe. This impact can be managed by concurrent rehabilitation as mentioned by the participant. Mining operations should be conducted by keeping the closure in mind. There is a clear benefit as described by the participant.

*"And that can be used secondarily after that so there is a clear benefit to operating with closure in mind in the type of material that you use, the type of construction that you use, the kind of activities that you engage in, to make sure that you're not actually creating liability every day. It is always better to reduce the liability everyday then creating a liability every day" – P6*

It is of the utmost importance that inpit dumping occurs according to the mine plan. If not it will have to be rehabilitated which means double handling of waste material. This which could have been considered a benefit is now part of the restoration process.

*"That is why we actually making sure we got a proper plan. A proper plan to execute the plan that brings down that cost a lot."* – P8

*"But it is part of the mine planning currently. Just another example of using your operational base to make it cheaper. Here for example this dump here. It is 120 m high it is over tipped it is not straight cut to fill."* – P7

**Closure phase**

This is the last phase of the lifecycle and before the environment is restored to as far practically possible to its original condition. The milestone of this phase is to successfully obtain the closure certificate. It is the process of the physical closure and rehabilitation of the mine and monitoring the environment after closure for any deviations. These phases should be managed throughout the lifecycle to have the minimum rehabilitation left.

*"Ja, I think the one thing you must remember is that we make a certain call off what is the strategy with land use on mine closure. So if it is grazing rehab, then I have to do rehabilitative I need to lift roads and I need to break down structures and I need to turn it all into grazing land. And Slope the waste dumps and revegetate it and that was set up certain number of hectares of grazing land. The problem is what if you change the strategy and it is not grazing."* – P4

With mine closure there is the probability of residual that cannot be excluded. This must be managed after mine closure to address the matter. In the case of the mine, a river was impacted. This was the result of dewatering but is addressed as described by the participant

*"A residual impact or impact that will continue you cannot eliminate and those impacts you cannot eliminate. And you need to provide a mechanism to address it. So in this case we cannot repair that river we filled up the holes from a safety perspective but we are not able to solve the problem on a permanent basis. The river cannot be restored technically as I said. So you are going to have to put in your closure plan okay. But if you don't address it because you have we have acknowledged that we impact on those farmers. So if you cannot fix that problem you need to say how you are going to continue addressing that need."* – P7

### 3.3.2.5 Rolling horizon

The rolling horizon theme emerged from the subthemes long-term and short-term planning. That is also what the intention is with a rolling horizon, is to give a view on the short and long-term planning (Blom et al., 2019:318).

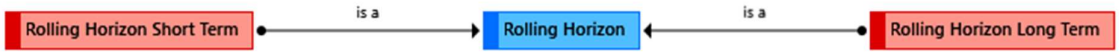


**Figure 3.7: Rolling horizon sub-theme of closure planning**
**Source: Researcher compiled**

#### Short term horizon

The short-term horizon has to do with the day-to-day actions of the closure plan. It is a short-term view not longer than two years. This horizon will focus on the activities that need to do with regards to mine closure By focusing on the deviation as established by the mine closure plan baseline. This plan to set daily targets for concurrent rehabilitation was possible but also to allow for waste dumping according to final designs.

*"Of course what we do carry in the current expenditure on an annually budgeting"* – P1

*"So I would actually at this point in time that is where we are looking how we can do it more efficiently rather than what we are doing saying we can do it better more of*" – P8

#### Long-term horizon

The long-term horizon is for a period more than two years and more related to the remaining life of the mine. This is more long-term targets that need to be achieved to ensure a successful mine closure. It depends on the effective execution of the short-term planning.

*"It depends on what time is left in your mine. The closer you get to your end of life. The amount of detail that you will have will increase so when you start the provision*

*for mine closure you have a very vague estimate that you must provide. The closer you get to the end of life you will increase your detail that is required."* – P3,

Since this mine has been in production before the environmental conservation, a legacy has built up that needs to be rehabilitated with closure. This increased the liability in the balance statement.

*"Historic operations like with the mine that haven't done enough concurrent rehabilitation we see an ever-increasing closure provision on the balance sheet and whistle that is not manifest in the short term in cash you have to pay it in some point in time."* - P7

#### 3.3.2.6 Rehabilitation

The theme rehabilitation emerged from the sub-themes' rehabilitation impact and concurrent rehabilitation. Restoration of the environment has an impact on the profitability of a mine and the long-term provision. With the proper integration into the day-to-day production activities, it can be beneficial by curing the level of disturbance to the environment.


**Figure 3.8: Rehabilitation sub-theme of closure planning**
**Source: Researcher compiled**

**Rehabilitation impact**

Before the implementation of environmental regulations, it was a requirement to rehabilitate the environment. This created legacy issues for many mines, including this open cast mine. Rehabilitation needs to be incorporated into long and short-term planning. The impact of rehabilitation increase of production or deferring the rehabilitation and increases the liability as mentioned by the participants.

*"So because it is something new for the mine. It wasn't done in the past I mean you in terms of the last 10 or 15 years. The guys are not used to costing for it. It increases the production cost if you do concurrently rehab."* – P2

*"But your concurrent rehabilitation will have an influence on your production cost."* – P4

Due to the significance of the legacy, it will take time to rehabilitate the back-log. Rehabilitation needs to be integrated into the mining plan as far as practically executable.

The mine only really started with rehabilitation ten years ago. It began with a small portion and progressively increasing the rehabilitation target as described by the participant.

*"And I was involved in starting that rehabilitation programming 2011. So in 2011 effectively our rehab started. We started small just trying to achieve a few hectares. We gradually increased it last year was the first time we had a target of 50 hectares. This year again a 50 hectares target. And you are ramping up that target."* - P7

**Concurrent rehabilitation**

Concurrent rehabilitation is the process of doing rehabilitation while in production. It has a benefit to the mine if it is done according to final designs, but it increases the production cost if it is not integrated into the operational plan. It is critical to do concurrent rehabilitation and nor deferring it until closure. It will result in significant areas to restore, as explained by the participant.

*"If you do not do concurrent rehabilitation and you do not work smartly you are going to be left with a lot of area to rehabilitate in those later years when the cash flow will decreased."* – P7

*"So if you leave all your rehabilitation cost to the closure. All of the liability will also increase"* – P8

The four categories of concurrent rehabilitation that came out strong are, catching up on the back-log, backfilling of waste, in-pit dumping, sterilising of ore zones.

This is an old mine and commenced with production long before the promulgation of the environmental laws and regulations. It means that the mine has a challenging task to do catch up on legacies. The integrated planning of this plays an important role in successful concurrent rehabilitation and to keep the different stakeholders satisfied.

Backfilling and in-pit dumping of waste is the two methods utilised to do concurrent rehabilitation. This type of progressive restoration can only be done in the areas where the ore product is depleted as described by the participant.

*"So if you started with backfilling you actually sterilise a big portion of the iron ore body. So you need to be very certain at what phase you can do that.* – P8

What makes this difficult is the legacy constraints and that this open cast mine uses blending so mining happens from different pits to ensure the product is the correct specification. So these methods can't be used in production active sites.

*"Because ideally remember we do blend. So you do have different big pits but ideally, you would mine one pit move over to another pit and backfill that pit. So that would have been the ideal and that would have been a great benefit for the company."* – P2

If the plan is implemented correctly there is a significant two folded benefit by in-pit dumping. That is the pit is already rehabilitated which decrease the liability, and it reduced production cost by shorter hauling distances of which diesel is a significant cost driver.

*"First of all, you don't have a rehabilitation cost until you get to the point where it goes above the natural surface. Because then you still going to have to slope and revegetate. But the biggest single impact and it is massive at the open cast mine is shorter haul distances and it is not just the distance it is to lift involved so."* – P4

Currently, the mine is performing well on the front of concurrent rehabilitation as described by the participant.

*"What we are currently doing is better than what DMRE is is providing as a guideline"*- P2

### 3.3.3 Provision

This theme emerged from four different sub-themes. This sub-themes provides a guideline with regards to a surety, compliance to international accounting standards, and the various cost drivers used to calculate the closure estimate as indicated in figure 3.9.

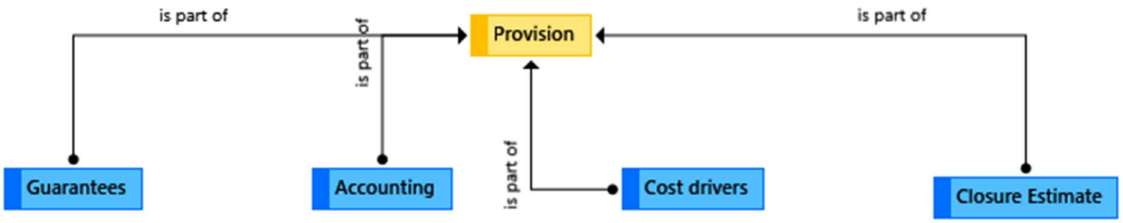


**Figure 3.9: Provision theme**

**Source: Researcher compiled**

Mine closure provision is the quantifiable obligation caused by mining operations to restore the environment to an acceptable, sustainable condition. It represents the amount of future cash flows if the mine should close today. This is the liability on the balance sheet that regulators and conservationists are monitoring.

The first sub-theme is the different instruments and the governing and control of the funds as accepted by the regulatory body.

### 3.3.3.1 Guarantees

The guarantee is a type of surety that is equal to the amount of provision for rehabilitation on the balance sheet. The guarantee can be in the form of a trust, bonds, cash deposits or bank guarantee. The participant describes the concept behind the requisite of a guarantee.

*"I know the financial side you need to provide for that your trust account has got enough money to match your provision or you have got bank guarantees. So that when the time comes for you to perform or to do that rehabilitation you got resources."* – P9

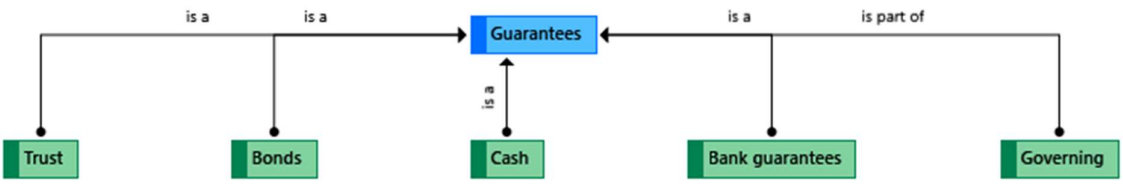


**Figure 3.10: Guarantees sub-theme of provision**

**Source: Researcher compiled**

There are four different financial instruments prescribed by the government and acceptable as a guarantee for the provision. This is aligned with the literature that refers to Section 89 (South Africa, 2002:78) and Regulation 53 (South Africa, 2011:38-39) as acceptable methods of financial guarantees.

*"So there's many vehicles you use for mine closure provisions. So you have provisions, you have a balance sheet"* – P5

**Trust**

Trusts are one of the financial instruments that is accepted as a warranty for the provision. For the trust to be accepted by the regulatory authority, it must comply with managing framework of section 41 of the MPRDA.

The trust is one of the financial instrument used as a surety as described by the participant.

*"So it's now going to be the owner, and the legislation also said now you will have a certain provision that you going to have to put into some sort of a trust fund to make sure that you putting away enough money to rehabilitate the site to an acceptable level as determined by the DMR."* – P4

*"So the big thing is the current set-up of the mine closure now is to have a separate trust account. So that you can keep the money on the side. To avoid so that when the time comes to close you got the money. And on an annual basis or a regular basis that is submitted to DMR"* – P9

There are regular engagement with the regulatory body to prove that the trust has sufficient funds for mine closure.

*"I know there's a process whereby to continuously engage to DMR. I know the financial side you need to provide for that your trust account has got enough money to match your provision…"* – P9

**Bonds**

Bonds are the second method as a warranty that is accepted by the regulatory body. The is currently not uses by the mine but is within the compliance of the regulatory authority as described by the participant.

*"There are also government requirements to for bank guarantees or bonds, so again that's a legal compliance perspective." – P1*

**Cash**

Another financial instrument acceptable by the DMR is in the form of cash deposits. This is not the most recommendable option because it makes the working capital less. Fortunately, the mine also has a healthy bank balance in supporting the case of the ability to sustainably close the mine as described by the participants.

*"Currently our what do you call it (...) bank balance, if you can put it in that way, is (…) more than enough to cater for that as well." – P3*

*"Again this open cast mine group is in a very good financial position with no debt" – P8*

**Bank guarantees**

Bank guarantees are the more expensive type of warranty that the mine uses. The reason that it is more costly is that it has to be renewed on an annual basis and the cost based on the percentage fee of the warranty amount. Both trust and bank guarantees are used in support of the provision as described by the participant.

*"I believe we have enough money currently in the trust as well as the bank guarantees. And the bank guarantees is provided in terms of this. A bank guarantee is only the guarantee that they will stand in for payment of that, but the money has to come from somewhere." –P3*

**Governing**

Upon the exploration of the different forms of guarantees available and utilised by the mine, it was founded that the governing and control of the financial instrument might not be that good. The management of the provision funds remains within the power of the management.

*"Currently it's still the management, so up to board of directors. They will still do it, but I'm saying there needs to be better control over it"* – P5

The participants elaborate on a recent example were some of the funds designated for the provision for closure was withdrawn. This poses a severe risk, abandoning the mine with a shortfall on the restoration cost.

*"So the new registration does govern the way you can do it, however if you look at something like the Gupta mines. Where the guys actually drew money from their closure provisions, so they removed funds from it. You need to have ways of preventing that from happening. So what companies need to stress that they shouldn't be able to access the funds they have for rehabilitation. And they need to find a way to govern it so that happens because in that specific case if you look at the gold mines around Jo'burg area once the mines closed there was no rehabilitation done and has a knock-on effect. So if companies create the provisions they and have the money or the funds available they mustn't be able to access those funds until closure and must be a way to govern it or strictly controls around it so they not able to access it until such times as its really required for it was meant to do. …"* – P4

This open cast mine, however, aims to be a responsible corporate citizen by managing the provision on a regular base and reviewed by independent auditors.

*"but (…) managing on a regular basis is obviously very important your predictability of whether you're going to make profit or not next month is not always very accurate so you got to make sure that you are putting at regular intervals money away into the trust funds."* – P4

### 3.3.3.2 Accounting

Accounting entails exploring the transparency of reporting and the financial management of the mine closure.

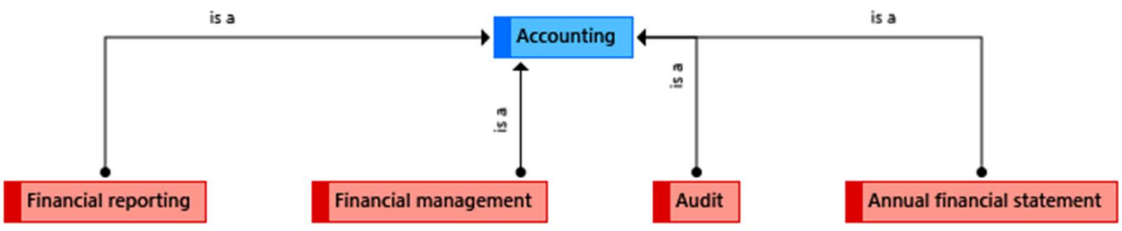


**Figure 3.11: Accounting sub-theme of provision**

**Source: Researcher compiled**

The accounting sub-theme emerged from the four different categories, comprises financial reporting, financial management, audit, and the annual financial statements.

**Financial reporting**

Financial reporting has many facets related to it, but the most important is the IAS 17. This accounting standard is the international guideline which stipulates the recognition and measurement requirements for provisions.

*"So that is the first thing we need to understand the state of the site which gives us disturbance to date which is what is required under IAS 37 to calculate the closure provision"* – P1

This provision is in the balance statement as one of the liabilities. The most significant portion of the liability is the rehabilitation of waste dumps as described by the participant.

*"In our case the liability is probably 70% made up of rehabilitation of the waste dumps. Big volumes that needs to be moved. Large cost and then the vegetation side followed on the reshaping side. So that is a big part of the cost."* – P7

This liability must be managed so it does not seem to be spinning out of control due to different stakeholders analysing the commitment of the company towards the environment as described by the participant.

*"There needs to be proof that you are trying to address your liability. It shouldn't look like it's running out of control. The ideal is that it stays as close as possible to its maximum levels so that you address those things as you mine."* – P7

The liability can be curbed by doing concurrent rehabilitation. This must be integrated with the operational planning as explained by the participant.

*"Another key component of managing closure liability is to ensure that a concurrent rehabilitation opportunities are optimised throughout the life of the operation to decrease liability."* – P7

This liability of the mine does not include a social component. It rather forms part of the social labour plan that is executed throughout the lifecycle of the mine as described by the participant.

*"We don't make provision for social closure. Social impacts are currently addressed on the SLP."* – P7

**Financial management**

Financial management is to determine the effect of rehabilitation on the critical business indicators, such as the unit cost, profitability, cost-benefit and the cost of production.

Concurrent rehabilitation does increase the cost but it also reduces the liability on the balance sheet. Any abnormal deviations from the rehabilitation plan are however excluded from the unit cost to ensure comparability.

*"So it increases your cost. Although it's not a cash flow cost it is an indication of cost that will flow at the end of life. In terms of your per-unit cost any unforeseen or abnormal increases or changes will be excluded from the unit cost. So if there is an abnormal increase in terms of your life-of-mine or something that's not foreseen in the past you can exclude it in the interim but mainly the (...) values are included in the per-unit cost as well."* – P3

The current price for the ore is good, and this provides the opportunity to do more concurrent rehabilitation as prescribed by the participants.

*"Currently our unit cost is (...) Cost for our ore is looking good it is stable. Actually increasing again but it is always market-related. I don't foresee now based on the current moving of the ore price that our life-of-mine will"* – P3

Although concurrent rehabilitation will increase the cost, there will be a benefit of saving money at the end of the lifecycle explained by the participants.

*"There's always a benefit in terms of (...) rehabilitating before the end of life because your cost in terms of rehabilitating now is a more certain cost than in the end of life. Can be done on the areas that we not mining anymore. So you can do a rehabilitation there. It will save your cost at the end of life."* – P3

*"I think there can be a significant benefit because we just look at material movement costs. We have to pay the contractor to come afterwards to move material if it is just a pure waste of money. So I think there can be a significant benefit."* – P7

There is an operational cost saving with in-pit dumping that the haulage distance will decrease and also less diesel consumption because the haul truck doesn't need to drive uphill out of the pit to dump outside the pit.

*"In-pit dumping is just (...) Is a shorter driving distance in terms of saving cost there but in terms of rehabilitation, concurrent rehabilitation while the mine is still running."* – P3

Furthermore, simply saving with concurrent rehabilitation by the time value for money as described by the participant.

*"If you look if you have the reasoning of time value of money the same thing happens. So if you leave all your rehabilitation cost to the closure. All of the liability will also increase with inflation over that time. So there is a financial gain as well to say listen it makes sense to do this in (...) annually. So in my stay in business it's part of my stay in business strategy"* – P8

Nevertheless, there is a balance of concurrent rehabilitation to keep all the different stakeholders satisfied. Investors will surely expect a dividend on their investment. Some of the profits will then be declared as dividends, and some will be converted to a form of guarantee of closure provision.

*"Also the cost of (...) putting money aside to ensure your rehabilitation also has a cost impact it is better to do as little as possible to put away issue it out to your shareholders than to keep it for possible rehabilitation. So that benefit is also there."* – P3

*"That has huge benefit for the mining operation. First of all you don't have a rehabilitation cost until you get to the point where it goes above the natural surface. Because then you still going to have to slope and revegetate. But the biggest single impact and it is massive at the open cast mine is shorter haul distances and it is not just the distance it is to lift involved so."* – P4

**Audit**

This mining company appointed an external consultant to verify the amount of the provision to ensure it is sufficient.

*"We don't just use in-house capability and we get audited regularly. So within certain cycles, there is different consultants different in-house experts come and check our provision that we are making for final closure."* – P4

*"But every three years there is a detailed process whereby consultants and our local mining people or our experts in the company are involved in this process. I'm quite confident with the amount of work that they doing, that it will provide."* – P9

It was however found that significant discrepancies exist between the value which may oppose an understatement of the provisions.

*"And I do understand that sometimes there are very big discrepancies in values but. I have to make the assumption that they know what they are doing. They are the experts I'm not."* – P4

*"We get a specialist consultant whose job it is to close mines and work out rehabilitation provisions, so they can come in and check and ensure that we are complying with what we need to."* – P5

**Annual financial statement**

The financial statement is the reflection of the commitment and the assumptions made by management with regards to mine closure provision. This is one of the instruments that can be utilised by different stakeholders to analyse.

The value in the balance sheet of the mine represents the NPV of the environmental restoration cost as described by the participant.

*"the mining house uses the NPV calculation and caries it as a provision on the balance sheet."* – P1

According to the annual financial statement, the amount of provision provided in total for the two years follows:

**Table 3.3: Change of provision amount**

| Cost category | 2017 R'bn | 2018 R'bn | Difference R'bn |
|---|---|---|---|
| Enviromental rehabilitation | 1,502 | 1,968 | 0,466 |
| Decommissioning | 0,449 | 0,271 | 0,178 |

**Source: (KIO, 2018a:55)**

The environmental rehabilitation increased by R0,466bn and the decommissioning increased by R0,178bn. The increase of the environmental cost was due to the waste dump footprint increase of the open cast mine. These values are extremely sensitive for the assumptions made with estimates considering the discounted rate and the remaining life of the mine. An adjustment of 1% upwards or downwards to the discounted rate, has an impact of approximately R200m, upwards or downwards. The difference in the adjustment is recognised in the income statement.

*"In terms of the closure provision, there are 6 monthly readjustment to a closure provision and the movement and the provision will go to your income statement. At the open cast mine because we have so many legacy dumps and such an old mine we generally have movements of increased cost rather than any profit realised like, stock when the movement comes in the provision."* – P5

If the amount of provision keeps increasing, that implies that not enough progressive rehabilitation was done like the participant describes.

*"…haven't done enough concurrent rehabilitation we see an ever-increasing closure provision on the balance sheet…"* – P1

#### 3.3.3.3 Cost divers

Upon exploration of the data, it was found that the primary cost drivers of the closure of open cast mine consist of rehabilitation of the environment and the demolishing of infrastructure. This is illustrated in Figure 3.12 and described by the participant.

*"So it's mainly volumes of material they product to be rehabilitate. It looks at the area that needs to be rehabilitated, infrastructure that needs to be reused or demolished"* – P5

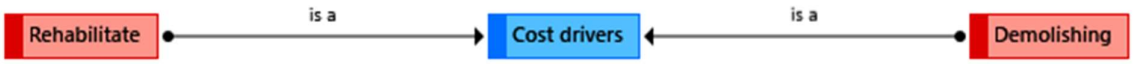


**Figure 3.12: Cost drivers sub-theme of provision**
**Source: Researcher compiled**

With open cast mining, the most significant cost driver of closure cost will be the rehabilitation cost disruption of the environment.

**Rehabilitation**

The fist cost driver is rehabilitation. Rehabilitation is the single most significant cost driver of restoring the environment due to the sheer volumes related to open cast mining. It includes the restoration and revegetation of the environment to be sustainable pre- and post-closure.

This mine has been in operation prior- and post- promulgation of the mine closure provision regulations and litigations. The participant describes closure provision challenge considering the level of disruption over the period.

*"So financial provisioning the ecology side if you want to rehab an area that is really disturbed like this mine, since 1956 where rehab and environmental legislation were not important" – P2*

This means that previous mining methods were conducted without ample consideration to closure fo the mine. This created a backlog of rehabilitation that needs to be done. To catch up on this backlog is not as simple as just to start doing it. It is a complex process that requires careful, integrated planning because the mine is still fully operational. There are only selected areas of legacy dumps that can be rehabilitated concurrently. The participant defines the approach used to address the back-log.

*"We recently done an exercise to look at the backlog rehabilitation. Some of the old stuff. So we need to define backlog. Backlog is regarded as those areas that are accessible for rehabilitation over the life of mine. So it is no longer going to be used for mining. So one could go there to rehabilitate but one needs to look at the further part of the definition. In addition to its being accessible it must also not be unnecessarily costly."* – P7

During the data analysis, it was discovered that topsoil that is required for the revegetation of the area was also dumped in a manner that is not retrievable as alluded to by the participant.

*"So we do not have any topsoil."* – P2

This means that with revegetation at closure, some topsoil will have to be acquired. The mine is currently showing good commitment towards the revegetation process.

Experimenting with what type of flora is adaptable to the area and the methods used to plant against the slopes of the waste dumped when the mine closes. The sloping process and moonscaping with regards to the vegetation are described by the participant.

*"Because those measures that you put in the closure plans. So the measures for example being ok we will reshape the waste dumps to 24 degrees and then we will do moonscapes then we will plant these grass"* – P7

In the process of estimating provisions for mine closure, there is a degree of uncertainty attached to some cost drivers. Management then makes assumptions based on the information currently available on progressive rehabilitation. These assumptions have a significant impact on the magnitude of the closure provision as described by the participant.

*"…another example would be very optimistic assumptions the cost for rehabilitation because we don't do enough concurrent rehabilitation therefore we haven't tested the techniques and proven that they are sustainable we find, when we get into closure that we have been optimistic or we haven't done sufficient concurrent rehabilitation to say that at the prescription to be sustainable for further investigation we actually have to spend a lot more money to get to the required level to meet the success criteria."* – P1

Another assumption that was made was that the water resource would not need any rehabilitation and met the prescribed standards which means that no provision is provided for water sustainability after mine closure. There are so many people dependant on the water resource that this is a risk not to be underestimated. An example was discussed, where an assumption was also made, for a mine very much similar to this mine did not to include a provision for water rehabilitation. Then when the mine closed down and rehabilitation commenced, a minimal margin of solvent was found above the compliance level, which means that management had to resolve it, at a cost.

*"A mine which was in the mining house's portfolio as know all that waste regarded as very earth friendly went down the closure pathway we found solutes that were only marginally over recommended values, but they were over recommended values so you know that is another example were we made an assumption we will not have to*

*do any treatment. We had to introduce additional mitigation measures to deal with those water quality issues."*- P1

**Demolish**

The second cost driver demolishing of infrastructure and determining what can still be salvaged to be used or sold when the mine closes as explained by the participant.

*"And then the second big component is then your infrastructure that needs to be removed at the end of the day. You need to understand, what is it infrastructure? You need to understand how you are going to remove it and what it is going to cost."* – P7

This cost driver is much less complex to quantify and the smaller cost driver in comparison to rehabilitation. It is also much easier to control and quantify as described by the participant.

*"We tend reasonable job on demolishing and decommissioning but that tends to be a relatively small component of the total cost generally only in the order of 10% – 20%"* – P1

#### 3.3.3.4 Closure estimate

The closure estimate comprises seven sub-themes, as indicated in Figure 3.13. The basis of quantifying the cost associated with mine closure and restoration provision. The basis is defined by making a particular assumption based on the information available. These assumptions will have a significant impact on the total provision as described by the participant.

*"And whether our assumptions are, have kept at all the necessary provisions. Because mine closure is based on assumption. And how good is our assumptions at the end of the day. With any other estimates you can go either way. It can be as close as possible to what you gonna spend"* – P9

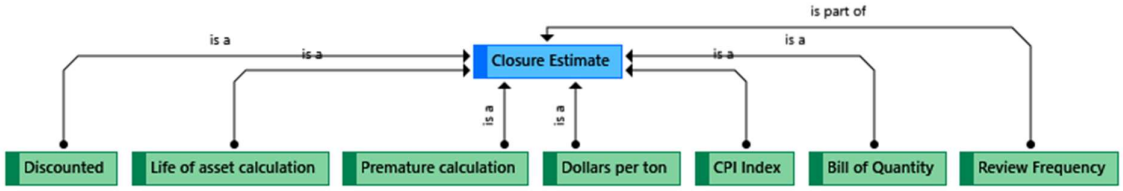


**Figure 3.13: Closure estimate sub-theme of provision**

**Source: Researcher compiled**

Due to different amounts for the provision, used for various purposes, it is essential to clarify the method of estimation. This is to ensure that the stakeholders have confidence in the values of provision and conformance to transparent reporting, as explained by the participant.

*"It is important for people to realize that, that yes there are a range of different numbers and often we'll have different standards by our internal calculations required by the regulator so that introduces another set of numbers. So, yeh it's important that differences between this numbers relating to closure are made clear."*

- P1

### Discounted

The first estimate is the discounted value. This discounted value is one of the methods used by the mine for closure provision as indicated by the participant.

*"…even for the provision discounted, there is undiscounted, there is 100%"* – P1

### Life of asset calculation

The life of asset calculation is different from the life of mine calculation. The life of mine calculation includes the future increase of the environmental footprint as described by the participant.

*"The difference in life asset calculation or life of mine calculation is that you allowed for future disturbance so grow of pit, growth of waste truck dumps perhaps new tailings storage facilities, but you also build in concurrent rehabilitation activities so on one hand the disturbance profile generally increases but you can somewhat offset that by doing concurrent rehabilitation."* – P1

**Premature calculation**

The premature calculation use by the open cast mine to determine what the cost would be if the mine closes today. It excludes any future disturbances to the environment and represents the value equal to existing disturbances to date, as explained by the participant.

*"So the are two numbers that are calculated yes there are differences so premature only considers existing disturbance today so effectively you seen that the mine closes today and all we have to fix-up is the disturbances that occurred to date."* – P1

**Dollars per ton**

The dollars per ton is one of the alternative methods for provision for closure that can be used according to IAS 17.

*"The way that so under IAS 37 there are effectively two ways that you can provide for closure and rehabilitation. One is dollars per ton"* – P1

**CPI Index**

The CPI is the normal inflation increase linked to particular cost drivers. It is not sufficient to only adjust the provision with CPI. There must a due diligence process, based on the footprint as described by the participant.

*"So you will have a better idea of the increase of your mine dumps and your mine slopes rather than just increasing it by CPI."* – P3

**Bill of Quantity**

The Bill of quantity is the detailed cost sheet that includes all the different cost drivers at a specific rate and volumes. This must be as accurate as possible since this forms the basis of the quantification of all the different estimates as described by the participant.

*"Okay so from a first principle the first thing we need is an accurate bill of quantities"* – P1

### Review frequency

To ensure that the provision of the mine's estimate is accurate, it is reviewed at least on an annual basis as described by the participant.

*"…we have a process in place that we review it on an annual basis rather than every three years."* – P3

## 3.3.4 Stakeholder engagement

Stakeholder engagement emerged from two sub-themes, stakeholder analysis and collaboration, as illustrated in Figure 3.14.

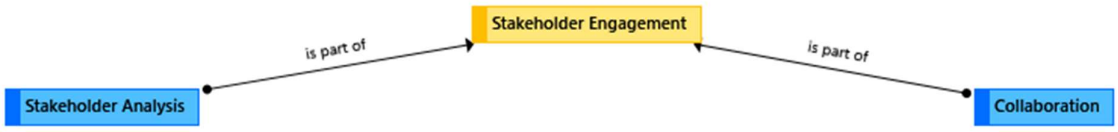


**Figure 3.14: Stakeholder engagement theme**
**Source: Researcher compiled**

Stakeholder analysis is the identification and prioritisation of the different stakeholders, while collaboration is the process of working together to achieve success.

### 3.3.4.1 Stakeholder analysis

There are a wide variety of stakeholders that has interest in mine closure. A stakeholder analysis was used to distinguish between the different expectations based on power and interest of the stakeholder, illustrated in Figure 3.15

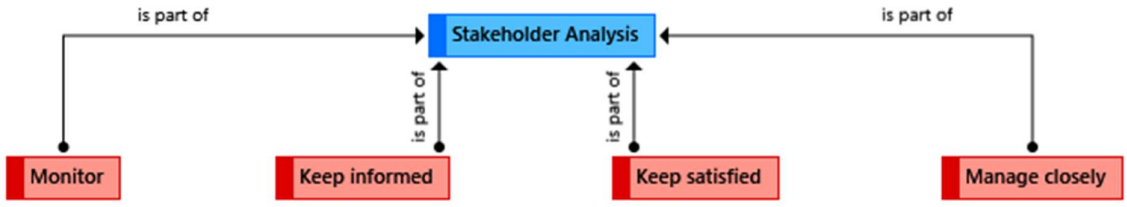


**Figure 3.15: Stakeholder analysis sub-theme of stakeholder engagement**
**Source: Researcher compiled**

This allows a better understanding of the expectation of the various stakeholders with regards to mine closure.

The stakeholders identified during the analysis of the data was allocated according to the different dimensions improve the management. The prioritisation was based on the stakeholders' power and interest with mine closure. This has the possibility of change over time.

**Monitor**

Due to the dewatering process of mining, many farmers don't have water anymore. The mine currently supply water to these farmers as described by the participant.

*"So related to water it is challenge of that water supply to farmers, which we are currently supplying with water."* – P7

**Keep informed**

Shareholders want to know what the company's commitment is towards sustainable mine closure and if their investment grows. The change of the amount of the provision will be a reflection on what the company's commitment is as explained by the participant.

*"I think from a company perspective and a shareholder perspective also. There needs to be proof that you are trying to address your liability. It shouldn't look like it's running out of control. The ideal is that it stays as close as possible to its maximum levels so that you address those things as you mine. So that is part of the reason."* – P7

**Keep satisfied**

This group of stakeholders consisted of regulator, communities and services such as the municipalities and the water regulator. The participant elaborates on and emphaszes on the importance of the group of stakeholders with regards to mine closure.

*Then the other big one is the regulators. Regulators being DMR water affairs environmental affairs conservation guys. Those are, then also municipality and then for example the water the water-board around which is distributed So that we had*

*some starting engagements with the DMR. Because those measures that you put in the closure plans.* – P7

**Manage closely**

The most influential and powerful group of stakeholders that need to be managed closely are the employees. These groups contribute towards the sustainability and a large population of which the impact of closure will change there lives dramatically as explained by the participant.

*"So if you look for instance the open cast mine probably more than half of the people that are employed in this area are employed by the mine. Now how do you calculate the impact that it will have for each and every artisan, foreman, and boilermaker that will otherwise have to be employed somewhere or find a way to sustain themselves."* – P6

### 3.3.4.2 Collaboration

The sub-theme collaboration emerged from four categories illustrated in Figure 3.16. Cooperation with internal colleagues and external stakeholder is crucial. It is to ensure that everyone works together to a common goal of sustainable mine closure.

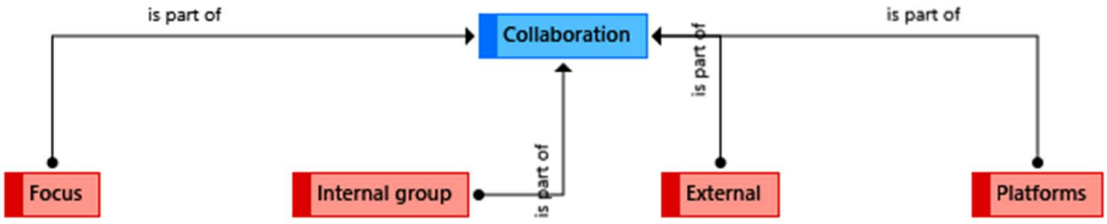


**Figure 3.16: Collaboration sub-theme of stakeholder engagement**
**Source: Researcher compiled**

The collaboration between the different stakeholders is essential to align the focus and working towards a common goal.

**Focus**

There is an agreement between the neighbouring mines to share information about the underground water and the quality of air. The focus here is to collaboratively working together and sharing information to manage the impact on the environment.

*"So the closest mine is obviously the neighboring mine and we do actually have agreement with the neighboring mine to share information on both the boreholes so water and on dust. So there is agreements in terms of that it also includes blasting and those things."* – P2

The other category that aligns the focus for collaboration is to leverage from lessons learned with regards to mine closure as described by the participant.

*"I guess Witbank in North of Joburg is a good example where we have four or five mines in close proximity and we certainly try leverage of."* – P1

To not making the same mistake twice could save money and not let the provision escalate out of control as described by the participant.

*"I think that is now an area where we are joining up the group' coal division. We started to work with them they have some successful projects running there. So we will go and benchmark with them. And see how they approach the offset of the land. Obviously in our area we are much more remote. In the coal fields there are many small towns and urban villages that are within their operating area. So he wanted to see how and what we can learn from them. To bring to this open cast mine."* – P8

**Internal group**

Internal collaboration between the different departments is essential to ensure that internal operations progress with closure in mind. This will bring significant cooperation between the department and accomplish synergies.

**External**

Not much attention was previously given to collaboration between neighbouring mines focusing on mine closure. This mainly is due to the mines producing the same product so is in effect in a competition which makes cooperation more of a challenge as described by the participant.

*"I think it is a huge area of opportunity, I don't think we have done a good job, but certainly other haven't done a good job equally of that co-operative approach I think as I said huge opportunity huge value in getting that right and you know the mine with the other mine is a great example where we have identified some merely significant potential cost savings from a closure and rehab perspective through*

*increase collaboration, but we don't do a good job of it today and it's a challenge that causes breaking through the mentality well we are in competition in iron relation to selling iron ore whatever the commodity is, but if there is a win-win scenario's for both companies."* – P1

Collaboration between the different mines is however not impossible because the mines already work together in some of the production at the Bruce pillar activities as explained by the participant.

*"…so we have got the Bruce pillar as well. So in terms of the neighbouring mine I think we are fairly ok."* – P2

There is a substantial opportunity for closure synergies between neighbouring mines that can decrease the amount of liability significantly, as described by the participants.

*"Mines in close proximity we haven't been talking to yet. We have identified some opportunities with the neighbour mine. Where we might want to join dumps to decrease closure liability but those discussion still need to take place."* – P7

**Platforms**

There are many platforms available that provide the opportunity to instigate mine closure initiatives and working together by sharing information to ensure sustainable mine closure. With the appropriate information, management can make more informed decision surrounding mine closure. This environmental information is accessible to all the stakeholders as described by the participant.

*"Then there is another platform as well. So on the (...) underchair what is it not the chair anymore it was the chair. The under chair of the chipping water use Association. Which also is a kind of a small child of the department of water and sanitation with certain rights. So on that platform there is actually water Information Management System, where we have to send our reports so all the mines do have access to that information system, all the land owners have access." – P2*

The mining group also has a mine closure toolbox that supports the process of internal and external collaboration, as described by the participant.

*"So in terms of I think the groups' closure toolkit from the group is actually helping us. Because we have got a one guideline that tell us how things need to be done.*

*And the fact that we have got all the. It is an international rollout plan if I can put it that way so there's a lot of learnings there is not just South Africa."* – P2

### 3.3.5 Sustainability

The theme sustainability emerged from four sub-themes, including the triple bottom line and corporate social responsibility, as illustrated in Figure 3.17.

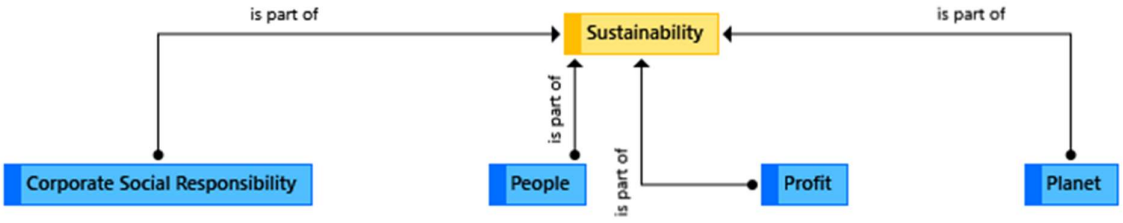


**Figure 3.17: Sustainability theme**

**Source: Researcher compiled**

Sustainability is an integrated process throughout the lifecycle of the mine. To achieve sustainable mine closure is to manage the balance between the people, planet and profits.

#### 3.3.5.1 Corporate social responsibility

The subtheme corporate social responsibility emerged from a comprehensive subcategory which is the reputation of the mining company as illustrated in Figure 3.18. The focus is specifically on how management conveys the mine closure message to the different stakeholders.

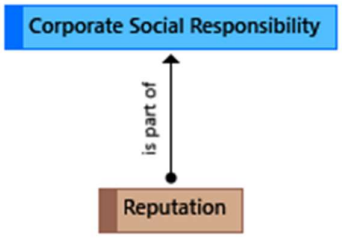


**Figure 3.18: Corporate social responsibility sub-theme of sustainability**

**Source: Researcher compiled**

**Reputation**

The reputation of a company is built on the sustainable management of the company. The legacy left behind with mine closure could ruin the reputation of the group mining

company and will make future investments a challenge. Although not explicitly related to the specific mine is the scenario very similar with regards to this mine what the negative effect is of an ineffective mine closure. The participant elaborates on another open cast mine.

*"So it's important because I think in the past what used to happen these guys would start mining and then when things get tough they will run away, which at the end of the day makes it the government's responsibility or the land owner's responsibility to rehab the area. So most of the mines that our dealt with like diamond alluvial mining is large vast properties on other (...) with other land owners. And when a mining company just went away. That is why along the west coast you have all these trenches that are still open and nobody is looking after it. So that is the big risk and then to be a responsible person you have to ensure that you leave a legacy a positive legacy behind for. Because people talk and you do not want to be associated with a company that just leaves."* - P2

### 3.3.5.2 People

The people aspect of the triple bottom line principle emerged from three subcategories, as illustrated in Figure 3.19. The focus is on how the social element is managed with regards to mine closure.

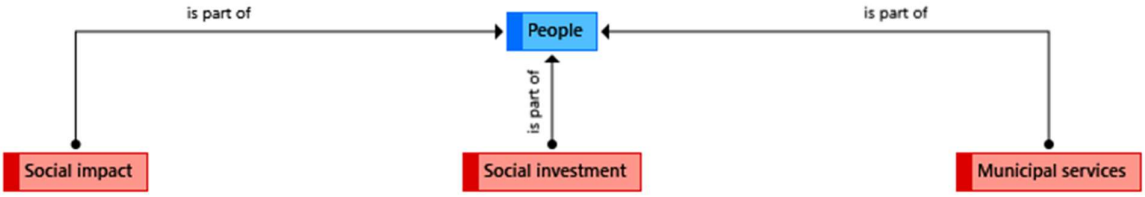


**Figure 3.19: People sub-theme of sustainability**
**Source: Researcher compiled**

This dimension of the triple bottom line principle is often neglected by mine houses, especially post-closure as alluded to by the participant.

*"But the important one that people use to usually forget is the social side of it. So you need to think of what happens…"* – P2

This will have a severe impact on the sustainability of the community.

**Social impact**

The social impact on when a mine closes is a significant change that will influence the entire surrounding community. People were privileged when the mine was still in production, but when the mine closes, it becomes a different scenario. The majority of people will lose their jobs, subsequently their income and benefits as indicated by the participant from previous experience.

*"But you tend to forget that Namakwaland and does not have a lot of jobs. And we were spoilt as big company employees because the guys most of the guys built their houses, build it we called it The Red cards so you could buy from supply chain at cost price. So it was cheaper even to change a tire because they had contracts in town. It was cheaper for you as an employee to build a house. And those are some of the benefits that they lost."* – P2

As in the example discussed with the participant, is that people will become desperate to get an income and turn to illegal mining and damaging heritage sites that should be conserved for future generations to come.

*"So that they would take over and start small scale mining, but now you get that we done all that rehab specifically around the town and now you have people that are in a Heritage site where we were not allowed to mine, as mining diamonds illegally. So that is the other spin that you get."* – P2

**Social investment**

The open cast mine is currently investing on a larger scale to train and upskill its employees and the surrounding community to be more marketable as explained by the participant.

*"… for community engagement and on either opportunities or social impact or social projects that are either aimed at empowering communities to be able to work for us but now with the latest the mining group sustainability strategy it is more focused on empowering communities to be able to find more jobs outside mining."* – P6

Social investment also does not form part of the closure provision. It is instead a continuous process through the lifecycle of the mine as described by the participant.

*"The continuity with the people in the area is more a focus of the social development and there they look into creating businesses that will be able to go on after the mine has closed so there is drive from the SD side and specific SLA to ensure that after the mine have closed that those guys can go on with the businesses as well."* – P3

**Municipal services**

The municipality is very much dependant on the mine for financial support and technical trade capabilities. Sooner rather than later before the mine closes the municipality will have to be able to function on their own, as explained by the participant.

*And we need to get to a point where we are on spoon-feeding anymore we need to let the child go. To put it simply and I'm just scared that because all our appointments on the government is politically appointed. It is to our detriment as well if we cut the cord too soon then the umbilical cord.* – P2

Currently, the financial management is defective and the municipality struggles to pay their debtors as alluded to by the participant.

*"Because they are not paying Sedibeng."* – P2

Even though a significant amount is paid by the mine as described by the participant.

*"I mean the Gamagara local municipality is the third biggest municipality in terms of taxable revenue production in the country. And I think that's mind-boggling. Now we know that is mostly more than 50% certainly due to the fact that the mine pays rates and mine employees actually don't default on their rates and taxes with the municipality. So, once this closure you can imagine what happens to that type of revenue collection from the municipality side."* – P6

#### 3.3.5.3 Profit

The sub-theme profits emerged from two categories as the second dimension of the triple bottom line principle, illustrated in Figure 3.20.


**Figure 3.20: Profit sub-theme of sustainability**

**Source: Researcher compiled**

### Assumptions

Assumptions form part of managing the element of future uncertainty. These assumptions made by management has a significant impact on the provision for closure. The tendency is that management is over-optimistic about mine closure assumptions and prove to be incorrect, as explained by the participant.

*"But I would say across the industry and certainly include the mining house in this we tend to make quite ambitious assumption throughout the life of mine. That when we challenge them largely in the last 5 to 10 years often even as the latest couple of years we tend to find that they were over ambitious assumptions and that the cost tend to be higher when those assumptions don't proof to be correct."* – P1

Obtaining and analysing the data is a very time consuming and complicated process to allow management to make more informed decisions as the participant explained.

*"That is 5-10 years of collecting data and modelling and so on you won't know whether you have a problem with particular solvent until you have done all of that modelling."* – P1

### Cost increase

To accomplish sustainability before and after mine closure will let cost increase, either concurrent operational cost or aggregation of the liability. To ensure that the people don't fall into poverty and that the environment the mine is doing what it can to support sustainability.

Without sufficient liquidity, the mine would not be able to be a sustainable business. The management of the mine is a complicated balancing process of how much to invest in the community and how much to restoring the planet with regards to mine closure — this all by taking into considering the diverse interest of the stakeholders.

### 3.3.5.4 Planet

The sub-theme planet emerged from three categories as the third dimension of the triple bottom line principle, illustrated in Figure 3.21.

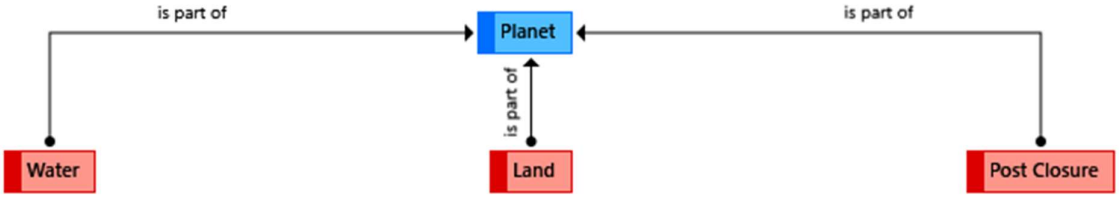


**Figure 3.21: Planet sub-theme of sustainability**
**Source: Researcher compiled**

#### Water

Currently, the mine is one of the largest water suppliers in the Northern Cape. The responsibility lays on the mine to ensure the water is managed responsibly as explained by the participant.

*"Between us and the other group mine we have got the biggest single source of groundwater in the Northern Cape so the responsibility lies very heavily on us to protect it and to look after it."* – P4

The mine is doing what it can to protect the underground water resource by investing a large amount of capital in protecting it.

*"So between 2015 and now in just SIB capital alone we are actually spending and an excess of a billion. A billion Rands on water management and Compliance projects."* – P6

The concern is what will happen with the water supply after mine closure as described by the participant.

*""Because we can't physically cannot it would be extremely irresponsible to switch off all the dewatering pumps. Essentially it means the communities North of us and even in town, Kathu will run out of water"* – P4

**Land**

Mines are often established in an ecologically sensitive area were the perseverance of the environment is essential as described by the participant.

*"So we operate mostly in, for other reasons, some or other reason always insensitive ecological sensitive area where you have mining operations."* – P2

**Post closure**

To ensure sustainability post-closure and determining the value of the closure provisions planning, the land use must be determined that would not benefit a few, but the aim should be to create a sustainable environment generating as many jobs as possible. There will with mining always be a residual impact; in this case, it is the water supply to surrounding farmers as described by the participant.

*"There will be what do they call it? A residual impact or impact that will continue you cannot eliminate and those impacts you cannot eliminate. And you need to provide a mechanism to address it. So in this case we cannot repair that river we filled up the holes from a safety perspective but we are not able to solve the problem on a permanent basis"* – P7

The once-flourishing economy will diminish and people who see skills are not improved will fall into poverty.

*"There is going to be some tough economic times if we are unable to do some extensions"* –P4

The value of land will diminish since the primary source of contribution to the economy of the area will be absent after closure as described by the participant.

*"…after mine closes we gonna try and stable land use but is highly likely to be a lower value land use"* – P1

The small miner that might be members of the community will see if they can still find something that is saleable to the market.

*"But you are going to have these small miners doing erratic odd jobs and things."* – P4

### 3.3.6 Toolbox

The Mine Closure Toolbox (MCT) is an international guideline used by the mining group to conduct sustainable mine closure on the same principles. It consists of the aim and the six tools, as illustrated in Figure 3.22.

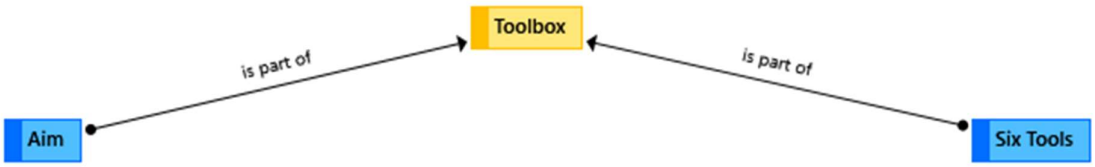


**Figure 3.22: Toolbox theme**

**Source: Researcher compiled**

This six tools MCT version is a recent upgrade of the previous three tool version. The different tools were supported and explained by the participants.

#### 3.3.6.1 Aim

The aim of this tool emerged from six sub-categories, as outlined in Figure 3.23.

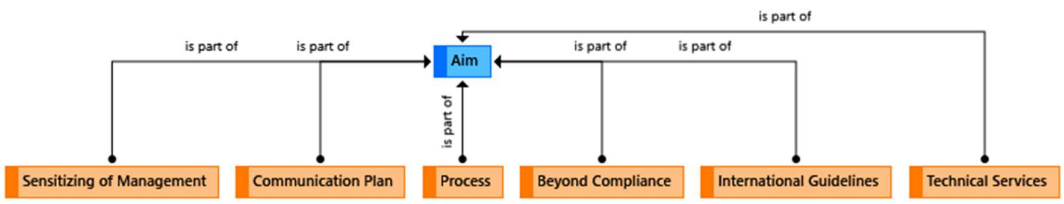


**Figure 3.23: Aim sub-theme of the toolbox**

**Source: Researcher compiled**

#### Sensitising management

The first aim of the MCT is to sensitise management. This is to explain to management that does not have a background on sustainable mine closure, what is it about. Like the participant advised based on experience.

*"…must be sensitising of management. So that is something that I might not have done well enough." – P7*

#### Communication plan

The communication plan is essential to ensure alignment and to achieve sustainable mine closure. This mine has a division called the social way that is used as a

communication medium between the different stakeholders as described by the participant.

*"Then it's also guided by the Social way because there is an engagement plant that is in there and what needs to be engaged and how much, what information is communicated with which department or which land-users all communities and the time frames and then thirdly it is also governed by legislation."* – P2

**Process**

Since this is a group MCT, all the mines will be aligned and following the same process. The MCT key performance indicators might be unique for each mine, but the process remains the same. There are lessons learned that could be shared amongst the group with mines that struggled with the same closure challenges as described by the participant.

*"Because we have got a one guideline that tell us how things need to be done. And the fact that we have got all the. It is an international rollout plan if I can put it that way so there's a lot of learnings there is not just South Africa."* – P2

**Beyond compliance**

The aim of the MCT is not just to adhere to the prescribed mine closure compliance, but to exceed expectations beyond compliance as described by the participant.

*"the mining group's social ways and the closure toolkit it is to ensure that we are best practice so we go beyond compliance."* – P2

It provides the opportunity to plan better for mine closure with the most relevant information available as described by the participant.

*"So you are actually in a better position if you are and you mine only because of all the information available and legislation and toolkits you can plan better towards closure."* – P2

**International guideline**

MCT aims to serve as an international guideline, that can be used for any type of mining methods. The MCT is regular benchmark against best international mine closure planning practices.

*"…the toolbox have taken into account a lot of international guidelines already..."* – P7

The process remains, unique for the particular mine and due to the jurisdiction of the country that the mine is located.

**Technical services**

The MCT was developed and supported by a global technical team for all types of mining methodologies as described by the participant.

*"for example and mine house's technical service team have worked on closure plans across many countries. And they have used that knowledge to build a toolbox."* – P7

### 3.3.6.2 Six tools

The tool and guideline used in the mining group is the closure toolbox illustrated in Figure 3.24. This is a handy tool bringing all the different disciplines together. It follows a systematical, logical process. The toolbox that is discussed here is the updated version, that consists of six tools instead of the three tools as was discussed in the literature.

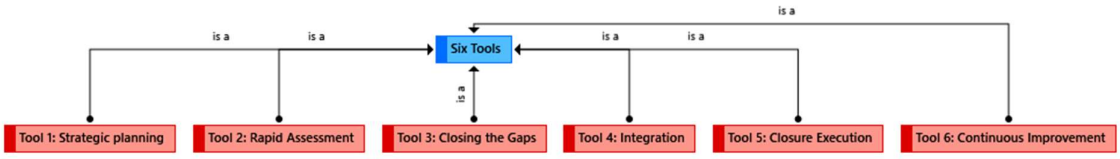


**Figure 3.24: Six tools sub-theme of the toolbox**
**Source: Researcher compiled**

**Strategic planning**

This is the first step of the Toolbox is to compile a strategic plan for mine closure. It identifies mine pre- and post-closure factors applicable to the specific mine as explained by the participant.

*"It is establish the biophysical and physical context The Social and economic contexts. Looks at the internal and external requirements. External being legislation for example, internal being for example the mining house, mine closure standard. And the risk assessments. All of that fits into the strategic planning part of the*

*toolbox and they say what are the components you need to look at. And what level of detail you should include."* – P7

**Rapid assessment**

The second step is to determine if there are any between the existing plan and defines the level of detail required based on the remaining life of the mine. The participant explains the rapid assessment process.

*"Consist of six components there is 1, 2, 3,4,5,6 that each one you ask a question to establish physical and biophysical context."* – P7

**Closing the gaps**

Step three describes the execution plan to address the gaps in step two, as explained by the participant.

*"Then it says ok if you if you are a one this is what you have if you are two this is your challenge if you are five you doing good"* – P7

Upon discussion of integrated planning the participant mentions that they are currently working on an updated version. It includes three additional toolsthat will be discussed in the following sections.

*"So the mine closure toolbox version 2 that is the current guidance we are developing version 3 as we speak that will released it in next couple of months"* – P1

**Integration**

This process focuses on integrating the closure plan into the operational plan as explained by the participant.

*"So there is still opportunity for integration and that tool describes to you. What are the things you need to do when you consider integration planning?"* – P7

**Closure execution**

This tool describes the process of execution that is going to be utilised to mine closure, as explained by the participant.

*"And then tool 5 is closure execution and that is there is part of the closure plan where you talk about the closure programs. So should you close what is your closure*

*programme looks like are you going to have a 5 years with 100 people are you going to have it over 10 years with 50 people."* – P7

**Continuous improvement**

This step is to ensure that the tool remains best practice through continuous benchmarking as explained by the participant.

*"And tool 6 is just the review and continuous improvement on what you are doing. It gives some guidance and that aspect"* – P7

## 3.4 SUMMARY

Chapter 3 discussed the results obtained from the empirical research, which was addressed in the research questions. The researcher interviewed a total number of nine different specialisst that influence the management of the closure provision of open cast operations. The researcher asked these participants to discuss why is it essential to manage the provision for mine closure and rehabilitation, the benefits of progressive rehabilitation, the impact on sustainability and the sufficiency of the provision.

During this discussion, the importance of the influence of management on the closure provision became apparent. The five themes that emerged from the discussions were closure planning, provision, stakeholder engagement, sustainability, and mine closure toolbox.

It became clear that closure planning is a multidisciplinary process that needs active collaboration among managers to ensure success. It emerged that planning is not only the last phase of the lifecycle but an integrated process through the lifecycle of the mine.

The empirical study reveals further that the provision for mine closure can be actively managed and controlled. The provision reflects the obligation created by mining operation that needs to be rehabilitated at mine closure. This liability can be kept under control by progressive rehabilitation.

Stakeholder engagement for early phases is very crucial to ensure alignment and establishing a sustainable environment. There are proper and effective processes in place to manage this dimension. What became evident is that the alignment with

governmental institutions is the most significant challenge. Little progress is made on this front.

It revealed that sustainability management is an essential factor pre- and post mine closure. It is to be a responsible corporate citizen, balancing the three spheres namely people, planet and profit.

The guideline used for mine closure is the toolbox. It was found that this tool is in the process to be revised adding three additional tools. The three tools are integration, execution and continuous improvement. This was founded to be shortcomings during the literature review.

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# 4 CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

## 4.1 INTRODUCTION

In 2008, there were almost 6000 South African abandoned mines already with many nearing the end of life in the foreseeable future as described in the problem statement, section 1.3. It represents the enormous challenge and responsibility that mine management has to conduct mining operations with closure in mind.

The purpose of this chapter is to conclude the empirical study by summarising the findings of how the management of closure provision for an open cast mining operation is perceived. Factors under review include closure planning, provision, stakeholder engagement, sustainability and the mine closure toolbox.

The chapter further reverts to the research objectives and provides a critical evaluation of the primary and secondary objectives, then consecutively concluding with recommendations to improve the management of closure provision for an open cast mining operation.

## 4.2 CONCLUSIONS ON THE EMPIRICAL STUDY

### 4.2.1 Conclusion on qualitative data analysis

A total of nine different specialists that are involved either directly or indirectly in the management of closure provision participated in the qualitative research analysis. Three of these nine were from the finance department, three from the safety and environmental department, one from mining, one from projects and one from the global group.

The results revealed the importance of the influence that managers have on the closure provisions, either direct or indirect. Closure planning is a multidisciplinary process consisting of a variety of managers that each have a different goal to accomplish, such as controlling cost, increasing efficiencies, increase of production and rehabilitating the disturbed area. The results further revealed that some of these key performance indicators work against each other, which makes integrated planning so much more essential to find alignment between the influential stakeholders.

It also became apparent that this mine has some legacy challenges since it has been in production before the promulgation of environmental legislation and regulations.

The rehabilitation team in the collaboration of other teams is doing what it possibly can to do concurrent rehabilitation with current operational activities such as dumping according to design and in-pit dumping. It is, however, a difficult task because the mine utilises a blending strategy to recuperate ore from different pits and sections to ensure the high-quality ore provided to the niche market.

After the empirical research, data was analysed by utilisation of CAQDAS, Atlas TI. The interviews were verbatim transcribed, and the text was coded. The codes were compared among the various participants to identify several emerging themes related to the management of mine closure provision. The following sections elaborate more on the themes closure planning, provision, stakeholder engagement, sustainability and the toolbox.

### 4.2.2 Closure planning

Planning such mega-mining operations is a challenge in itself, planning for closure that is considered to be a future event is, even more, a challenge. All the participants agreed that the aim of closure planning should be an integral part of the operational and capital investment throughout the life-cycle of an open cast mine. Mine closure planning commences the same time as the start of production.

It was found that the open cast mine does have some legacy challenges, but management is well aware of it and does have a catch-up plan to rehabilitate the backlog. Unfortunately an opportunity was missed by many mines and this open cast mine with the amendment of the legislation in 1997 to negotiate alternative methods of restoring the environment.

The participants revealed that the benefit of integrated planning decreases the liability and the operational cost. To commence and progressively increase with concurrent rehabilitation to a level that its minimum rehabilitation must be done with mine closure.

According to the literature in section 2.4.4, the idea behind concurrent rehabilitation is to incorporate it into the closure plan and the operational plan. This will promote the alignment between the different stakeholder and work toward the common goal. The challenge, however, is not to sterilise ore bodies that can be retrieved from the different pits.

The participants also alluded to a technology project currently in the feasibility phase that will have an impact on the remaining life of the mine. Operational planning preparing for this by stockpiling the tailings separately that will be easily accessible to beneficiate with new technology.

The literature in section 2.6.7 indicated the dedication of the mine and the group to implement technology on a sustainable and breakthrough front. There is a technology division. FutureSmart drives these technology initiatives to reduce the environmental footprint.

### 4.2.3 Provision

Financial provisions are required to cover environmental liabilities whenever they might occur during the lifecycle of any mining project and at closure. It reflects on the balance statement as a long-term obligation.

The participants revealed that the most significant cost driver of an open cast mine is haulage cost and that rehabilitation of the waste dumps will be the most significant cost driver when the mine closes. The demolition of buildings and infrastructure is a small portion compared to rehabilitation and revegetation.

It was indicated that this amount should be guaranteed through a trust, bonds cash or bank guarantee. This is supported by the literature MDPRD discussed in section 2.5.3.7.

There was, however, a concern raised by a participant about the transparency of increases of the provisions. The participant could not understand why the increase was so significant. In the literature, section 2.7, the different types of estimates are discussed. Each of the estimates has a specific purpose of evaluating mine closure scenarios.

It was found that there were concerns about the sufficiency of the mine closure provision. Some of the participants were of the opinion that the provision would be sufficient, and others were sceptical about it.

Participants also elaborated on the assumption that there is no provision provided for ensuring the groundwater will no be contaminated and remain potable for human

consumption. The argument was that earth-friendly mining methods are utilised and that the quality of groundwater is monitored on a continuous basis.

The participants mentioned that social sustainability is not included in the provision for mine closure which might pose a future risk to the amount of provision. This is managed through the operational cost by investing in the local communities employing a social labour plan and other community investment projects.

Two of the participants were concerned about the governing and controlling of the provisions guarantee. They refer to an example of a Gupta mine, Optimum, that was discussed. The mine was abandoned with no funds to restore the environment loading government with the liability.

It is essential, therefore, that financial provision must be secure, sufficient and available when required (EPA, 2015:3).

### 4.2.4 Stakeholder engagement

The participants mentioned that the most challenging stakeholder is government institutions, specifically the DMR. There were almost forty attempts to arrange sessions but with no success. On occasion, the DMR did visit the mine. It was, however fruitless visits due to the low interest of the progress made with rehabilitation. It was only mentioned that the mine would be held liable for any restoration cost. Currently an external consultant is appointed to assist with the process to get the buy-in from the DMR.

A participant mentioned that it was difficult to obtain funds approval for doing the rehabilitation. Management does not always fully comprehend the impact deferring rehabilitation has on the magnitude of the liability. Therefore to ensure that funds get approved management must be sensitised of any changes provided with context.

It was mentioned that there is good collaboration between neighbouring mines on some aspects such as information sharing on borehole information. There is, however, an opportunity to work together on the restoration of the environment. Mega dumping will be an option due to the increased area. The benefit of this is less sloping of mine dumps and revegetation that will introduce a significant cost saving for all the open cast mines.

### 4.2.5 Sustainability

Sustainability management is a difficult challenge to find a balance between different stakeholders. On the one side, one expects a return on investment, and on the other side it is the conservation of the environment that causes the outflow of funds.

The commodity cycle and expansion of the footprint, cost pressures, contracted business models and other factors shift the focus towards short-term planning and less to the endowment of sustainability (McCullough et al., 2018:396).

Early engagement with stakeholders is essential to manage these expectations. Firstly to identify the stakeholders involved with the closure and rehabilitation. Then to prioritise these different stakeholders based on the influence they have on the mine closure.

The participants mentioned that the community is very dependant on income from the mine. What will impact the community, even more, is that most of the mines almost have the same remaining life, which implies that all will close more or less the same time.

An alternative approach was suggested by one of the participants to negotiate with the regulatory body to instead invest the provision on initiatives that will create more jobs. To restore it to farmland will only sustainably support fifty people maximum.

### 4.2.6 Toolbox

The toolbox was referred to on numerous occasions as the accepted tool to guide the process of mine closure. This is a clear guideline that was developed for longer than five years by benchmarking its other mines.

There are some shortcomings in version two but are addressed in the new version 3. This toolbox is in the process to be updated with three additional tools that include integration, closure execution and continuous improvement.

## 4.3 RECOMMENDATIONS

The following recommendations are proposed according to the themes that emerged. It is based on the challenges described by the participants and the insights obtained during the exploration of the data.

### 4.3.1 Closure planning

The planning of mine closure is a complex and comprehensive process that includes many stakeholders and regulation and litigation requirements. It is, therefore, essential to do proper planning and change management to achieve sustainable closure.

The majority of participants agreed that the integration of the mine closure plan is where the benefit is. It will control the amount of disruption on the environment, subsequently reducing the liability and if executed according to final designs, reduce the operational cost.

The biggest constraint that emerged is the legacy dumping of the old mine. This can be concurrent rehabilitation by a collaborative process of sequential mining and in-pit dumping. This will be a less complicated process with a new open cast mine, dumping according to final designs.

Table 4.1 is a proposed action plan for a comprehensive, integrated mine closure plan.

**Table 4.1: Actions for closure planning**

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 1 | Develop an integrated mine closure plan | Head of the environment department | Prior to the start of the next programme |
| 2 | Develop rehabilitation aligned with the NEMA | Environmental manager | Prior to the start of the next programme |
| 3 | Integrate rehabilitation into the operational plan of the mine | Head of the environment department | Prior to the start of the next programme and ongoing |
| 4 | Appoint external consultants to assess closure plan | Environmental manager | Six months before the final update and again with the final update |

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 5 | Conduct an additional gap analysis and include and improve the closure plan | Environmental manager | Six months before the final update and again with the final update |
| 6 | Remove unnecessary programmes from the plan | Environmental manager | Prior to the start of the next programme |
| 7 | Assess landform evolution modelling waste characterisation report | Environmental manager | Prior to the start of the next programme |

**Source: Researcher compiled**

### 4.3.2 Provision

The provision is a monetary representation of the level of disruption to the environment. It is the obligation created throughout the lifecycle of the mine. The biggest driver of the open pit rehabilitation is the hauling of waste. The challenge is to keep the amount of provision stable, but within boundaries, that is fit for purpose.

Changes to the provision amount is mainly as a result of the increase of the estimates' level of detail and alterations of assumptions. The majority of participants described that changes to the provision amount are a challenge and not always well received by managers. This is mainly due to the effect such adjustments have on different key performance indicators of the managers. Therefore transparency reporting and is essential to ensure that all the different stakeholders are aligned and understand the reasons behind the changes.

Table 4.2 is the recommendations to manage the provision in the balance statement.

**Table 4.2: Actions for provision**

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 1 | Assess and update rates | Land manager | Prior to the closure provision update |
| 2 | Sensitising and change management of | Land manager | Prior to the closure provision update |

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| | adjustments of mine closure liability | | |
| 3 | Assess social closure cost | Land manager | Prior to the closure provision update |
| 4 | Review the substance of the updated closure liability obtained from contractors | Environmental manager | Six months before the final update and again with the final update |
| 5 | Ensure the NPV is calculated correctly by investigating the sequencing of premature closure cost over the remaining life of mine | Senior financial specialist | Prior to the closure provision update |
| 6 | Quantify and included the social requirements post closure | Senior quantity surveyor | Prior to the closure provision update |
| 7 | Actively reduce liability by rehabilitating legacy dumps | Mine manager | Ongoing, measured and monthly |

**Source: Researcher compiled**

### 4.3.3 Stakeholder engagement

There are many stakeholders that will be impacted with before and after mine closure. It is therefore essential to commence with engagement as early as possible. This is to manage and mitigate the element of surprise. The process of engagement should have a clear focus on the intentions and requirements of all the stakeholders. This should be appropriately managed and mitigated continually.

The most difficult stakeholders, according to participants, are governmental institutions. Reinforcing an alternative approach is recommended mitigating this challenge.

Table 4.3 recommends action steps for stakeholder engagement.

**Table 4.3: Action steps for stakeholder engagement**

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 1 | Compile a stakeholder engagement strategy based on the level of influence and power | Environmental manager | Prior to the start of the next programme and ongoing |
| 2 | Engage with the DMR according to the engagement strategy plan to ultimately agree on the revised closure plan | Environmental manager | Prior to the start of the next programme and ongoing |
| 3 | Engage with the community in close proximity with the focus on identification of social closure requirement and incorporate in the provision | Public affairs manager | Prior to the start of the next programme and ongoing |
| 4 | Engage with Sedibeng with the focus of water management after mine closure | Principal water engineer | Prior to the start of the next programme and ongoing |
| 5 | Engage with municipalities, focus on handing over and maintenance of infrastructure | Public affairs manager | Prior to the start of the next programme and ongoing |
| 6 | Engage with farmers to achieve a sustainable water supply post mine closure | Public affairs manager | Prior to the start of the next programme and ongoing |
| 7 | Report to shareholders on the progress and impact of | Executive management | Prior to the start of the next programme and ongoing |

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| | the integrated mine closure plan | | |
| 8 | Sensitise mine management of changes in the provision | Environmental manager | Prior to the start of the next programme and ongoing |
| 9 | Collaborate with neighbouring mine to establish synergies | Environmental manager | Prior to the start of the next programme and ongoing |

**Source: Researcher compiled**

### 4.3.4 Sustainability

Sustainable closure is the strive but also the most challenging for the mine, as mentioned by the majority of participants. It comprises the management of the three spheres people, planet and profit. The aim is to leave the environment in the same or better state as far as practically possible.

Table 4.4 recommends action steps to improve sustainability before and after closure.

**Table 4.4: Action steps for sustainability**

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 1. | Appoint consultant to evaluate the sustainability strategy pre- and post-closure | Public affairs manager | Prior to the start of the next programme |
| 2. | Develop a conceptual model for post-closure pit water balance quality | Land manager | Prior to the closure provision update |
| 3. | Assess and clarify the groundwater risk | Land manager | Prior to the start of the next programme and ongoing assessments |

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 4 | Conduct study for most appropriate and sustainable land use after mine closure | Land manager | Prior to the start of the next programme and ongoing assessments |
| 5 | Introduce new technology that will lower the impact on the environment and improve sustainability | Principal technology engineer | Prior to the start of the next programme and ongoing research |

**Source: Researcher compiled**

### 4.3.5 Toolbox

The mine closure toolbox is the current closure guideline used by the group and by this open cast mine. This is a tool that has been developed for longer than five years and continue to evolve. It contains most of the critical items, but the researcher recommended two additional tools, as described in Table 4.5.

**Table 4.5: Additional action tools to MCT**

| | Action step | Responsibility | Time frame |
|---|---|---|---|
| 1. | Include changing as an additional tool | Head of mine closure | Prior to the start of the next programme |
| 2. | Include communication strategy as an additional tool | Head of mine closure | Prior to the start of the next programme |
| 3. | Update the closure toolbox for the specific mine | Head of mine closure | Prior to the start of the next programme and ongoing |

**Source: Researcher compiled**

## 4.4 CONCLUSION

In conclusion, there are many things that the mine has at its disposal to conserve the environment. The mine has been in operation before the promulgation of the

conservation and restoring the environmental legislations and regulations and still is in operation. This left the mine with a legacy that also needs to be rehabilitated.

There is however room for improved integration of the mine closure into the operational plan. With the successful integration of the closure plan into the operational plan concurrent rehabilitation is now possible. The result is a reduction of the disruption on the environment, subsequently reducing the liability and reduce in operational cost.

The mining group is currently in progress to upgrade the mine closure toolbox with integration and continuous improvement.

## 4.5 ACHIEVEMENT OF THE STUDY OBJECTIVES

Realising the primary and secondary objectives, defined in section 1.4 in Chapter 1, ultimately determines the success of this research.

The primary objective of this study was to assess the management of mine closure procedures throughout the lifecycle of the mine and identify gaps. It would further assess underlying risks or opportunities related to the gaps that will influence the closure liability. The researcher aimed to gain practical theory through in-depth interviews with various specialists involved with the management of mine closure provision.

In order to deal with the primary objectives, the following secondary objectives must be addressed and included in the following:

In the literature study:

- Explain the lifecycle of an open cast mine.
- Contextualise the closing phase of an open cast mine
- Investigate the management of the closure plan of an open cast mine
- Investigate the legislation that drives closure of an open cast mine.
- Investigate mine closure sustainable closure for an open cast mine
- Investigate different closure cost estimates and reporting for an open cast mine

In the empirical study:

- Describe the research method study
- Identify the population and the sample
- Identify the data collection technique
- Collect data, analyse the data
- After the analysis, a discussion of the results will follow

The study met the following objectives:

- To explain the lifecycle of an open cast mine through the literature review
- To contextualise the closing phase of an open cast mine through the literature review
- To investigate the management of the closure plan of an open cast mine through the literature review
- To investigate the legislation that drives closure of an open cast mine through the literature review
- To investigate mine closure sustainable closure for an open cast mine through the literature review
- To investigate different closure cost estimates and reporting for an open cast through the literature review

The literature review provided information to ensure that secondary research objectives were met.

- Describe the research method study
- Identify the population and the sample
- Identify the data collection technique
- Collect data, analyse the data
- After the analysis, a discussion of the results will follow

The findings in the extensive phenomenological empirical study assisted the researcher in providing valuable information regarding the management of mine

closure provision for an open cast mining operation. The discussions of the results in Chapter 3 and the recommendations in Chapter 4 support these research objectives.

The researcher depended on both the literature and the phenomenological empirical study. This was to ensure primary and secondary research objectives were met with the purpose of exploring and in-depth understanding of the management of mine closure provision for the open cast mining operation.

## 4.6 SUGGESTIONS FOR FUTURE RESEARCH

This research interviewed a total of nine different specialists involved in the management of a specific open cast mine closure provision. Even though the researcher suspected saturation, it could not be proven. The ideal would be a similar study with a larger sample at a different open cast mine to gain even more accurate and saturated insight into the management of closure provision for an open cast mining operation. The broadening of the sample and over an extended period could provide more qualitative insights into benefits and challenges integrated closure planning and the sustainability management pre- and post mine closure.

By considering the average age and the remaining life of mines in South Africa, more and more mines will approach the closure phase within the next 20 years. This makes the topic relevant for the next 20 years.

The following topics concerning the management of closure provision for an open cast mine operation merits investigation:

- Assessing the management of closure provision for underground mine operation
- Assessing the closure synergies between neighbouring mines
- Assessing the control and governance of mine closure guarantees
- Investigating sustainable opportunities for land use after mine closure

Similar research can be conducted in a few years from now with the same participants to determine any alterations to the management process of a sustainable mine closure provision. This opportunity could provide indispensable insight into managing mine closure provision, enabling a sustainable environment after the mine closes.

## 4.7 SUMMARY

This chapter comprises the conclusions and recommendations based on the literature and the valuable practical data obtained through the in-depth interviews of nine different specialists that are involved with the management of mine closure provision. The construct was identified in the problem statement, followed by research through a literature study in Chapter 2 and consecutively then scrutinised through the empirical study in Chapter 3. The empirical study was conducted through a qualitative interview guideline.

From the empirical research, it is evident that there are challenges concerning the management of mine closure provision. From the phenomenological empirical study, a set of recommendations was developed that provide ideas to improve the integration of the mine closure plan into the operational plan. These ideas were generated on the five themes closure planning, provision, stakeholder engagement, sustainability and the mine closure toolbox.

The research meets all objectives stated in Chapter 1 through the combination of the literature review and phenomenological, explorative empirical research.

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# APPENDIX A: LETTER FROM LANGUAGE EDITOR

Dynamic Language & Translation Specialists

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*CC No: 1995/017794/23*

Thursday, 21 November 2019

To whom it may concern

**Re: Confirmation of language edit, typography and technical precision**

The MBA dissertation "*Assessing the management of closure provision for an open cast mining operation*" *by SJ Erasmus* (12257532) was edited for language, typography and technical precision. The referencing and sources were checked as per NWU guidelines.

Final, last minute corrections remain the responsibility of the author.

**Antoinette Bisschoff**

**BA Languages (UPE – now NMU); MBA (PU for CHE – now NWU); Translation and Linguistic Studies (NWU)**

Officially approved language editor of the NWU since 1998
Member of SA Translators Institute (no. 100181)

# APPENDIX B: ETHICAL CONSENT

NORTH-WEST UNIVERSITY
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Economic and Management Sciences Research
Ethics Committee (EMS-REC)
Tel: 018 299-1427
Email: Bernie.Linde@nwu.ac.za

24 June 2019

Prof A Smit
*Per e-mail*

Dear Prof Smit,

**FEEDBACK – ETHICS APPLICATION 21062019 – S J Erasmus (12257532)(NWU-00375-19-A4) MBA – Prof A Smit**

Your ethics application on, *Developing a management framework for an open cast mine closure provision*, that served on the EMS-REC meeting of 21 June 2019 refers.

**Outcome:**

Approved as a minimal risk study. A number, NWU-00375-19-A4, is given for three years of ethics clearance.

Kind regards,

A. Bevan-Dye

Prof Ayesha Bevan-Dye
Deputy Chairperson: Economic and Management Sciences Research Ethics Committee (EMS-REC) Vaal Campus

# APPENDIX C: INTERVIEW SCHEDULE

NWU | BUSINESS SCHOOL BESIGHEIDSKOOL SEKOLO SA KGWEBO | ASSOCIATION OF MBAS ACCREDITED

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**Department**
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01 March 2019

## Interview Schedule

### Topic: Developing a management framework for an open cast mine closure provision

*The interviews that will be conducted concerning mine closure provision will be recorded and transcribed. It seeks to explore the factors which contribute to the sustainable closure and management of mine closure provision for an open cast mine in South Africa.*
*Data will be analyzed by establishing new themes; these themes will then be subcategorized. The usefulness of the codes will be determined by breaking it down into tertiary codes. Similar codes and concepts will then be incorporated. Any contradictions and exemptions that may exist will be defined, and additional information will be gathered on deviations. New emerging patterns will be defined. Explore for surprises or something out of the ordinary.*
*The demographical information is only generated to determine the participant profile and will not be used to make any comparisons.*

**Demographical question**

1. What is or was your involvement regarding mine closure and rehabilitation?

**Business information**

2. Why is it important to manage the provision for mine closure and rehabilitation?
3. What are the essential factors that need to be considered when calculating the provision for mine closure and rehabilitation, and why?
4. What influence does closure cost applied during operation have on the production cost?
5. Does the company have a process in place that they follow to engage with stakeholders that will influence by mine closure, such as the Department of Minerals and the surrounding community, mines in close proximity please elaborate on this process?
6. Do you think the provision will be sufficient to ensure sustainable mine closure of the mine in the future, why?
7. Do you foresee any risks for mine closure that should be considered and addressed in the provision calculations?

**Conclusion**

8. What do you think the mining company can do differently to better prepare for future mine closure?
9. Any general comments regarding mine closure provision?

# APPENDIX D: LETTER OF CONSENT FROM THE MINE

IRON ORE
KUMBA IRON ORE
Sishen Iron Ore Company (Pty) Ltd
SISHEN MINE

**LETTER OF PREMISSION FOR SJ ERASMUS TO CONDUCT THE RESEARCH IN SISHEN MINE.**

**03 June 2019**

This letter serves to confirm that Mr SJ Erasmus I.D No. 8111075124088 is granted the permission to conduct the research study with the title **"DEVELOPING A FRAMEWORK FOR AN OPEN CAST MINE CLOSURE PROVISION"** at Sishen mine.

Hoping you shall find the above in order and should you have any queries you are welcome to contact the undersigned.

Kind regards

**Prajay Maharaj**
**Manager Finance and Supply Chain**

03/06/2019
**Date**

# APPENDIX E: ONE OF THE VERBATIM TRANSCRIBED INTERVIEWS

**Interview with P7**

**I: Question1: Is demographic related and that is. What is or was your involvement regarding mine closure and rehabilitation for opencast mining? Specifically this open cast mine?**

P7: Okay I have joint this open cast mine in 2006 in 2007 I became involved in the first update of the mine closure plan. Up to that stage to plan was very basic. In 2007 we appointed a consultant they assisted us with the bill of quantities detailed update and the first level of modelling for the waste dumps. But, so in 2008 we had to first real jump in the provision and the 2008 mine closure plan was our first plan that was significantly detailed. Since then we have done a few updates of the plan. I've been involved right through the process. So about 3 or 4 years ago we got involved the mining house' s technical services the mine closure team also became involved. We started doing some more work on the rehab and closure plans. So all along involved in that. Then the rehabilitation history for this open cast mine is. There was some trials in 1980s but then there was some proper trials that started in 2003 by Potch University. Then between 2003 for about 8 9 years there was no rehabilitation. And I was involved in starting that rehabilitation programming 2011. So in 2011 effectively our rehab started. We started small just trying to achieve a few hectares. We gradually increased it last year was the first time we had a target of 50 hectares. This year again a 50 hectares target. And you are ramping up that target. So in short I've been involved in demand closure plan for many years as well as the rehab plan.

**I: Okay since this open cast mine is a quite old mine about 70 years. Is that amount of hectares is that sufficient to catch up?**

P7: We recently done an exercise to look at the backlog rehabilitation. Some of the old stuff. So we need to define backlog. Backlog is regarded as those areas that are accessible for rehabilitation over the life of mine. So it is no longer going to be used

for mining. So one could go there to rehabilitate but one needs to look at the further part of the definition. In addition to its being accessible it must also not be unnecessarily costly. I'll take an example the slopes that are facing towards the pit. Yes we can in theory go and doze them down. But it wouldn't make sense now. You can't take out the footprint because of the restrictions. There's a channel there's a road. So it's our active area you can toe of the dump if you want to. To rehab it now you must cut hit back which will be hugely costly. So looking at the backlog then there is areas that is no longer used but also accessible at a reasonable cost. So that backlog needs to be principled at the mine house is trying to establish. Is that your backlog as far as possible you will work it away during your life of mine period but then (...) So to make sure that we work away the backlog we need to increase the target but, when you talk about target you also need to consider how much you are going to be adding over the life of mine, how much disturbance. Which you also need to work away. So if you look at the backlog and new disturbance combined that is where you going to settle on your target. Our current target is not sufficient 50 hectares we need to ramp it up. But in our current five-year plan or the proposed five-year plan we want to gradually increase the amount of rehab that we are doing.

Even so if we do rehabilitate that backlog. Then at mine closure there will still be a lot of areas that required to be rehabilitated but can only be done after mining stops and I'll take an example the dump here by the plant. No way that you can doze it down. It must wait until the mine closes. So there is our challenge. There is some areas that are accessible where you can go into work at a reasonable cost and then there is those new things for example on the Western dump. As it develops we will rehabilitate it. That is a principle we started that wasn't in place before so we now actually doing concurrent rehabilitation. And the aim is to continue doing that on all the new disturbed areas or new waste dumps being built from today forward.

**I: Okay**

**Question 2: Why is it important to manage the provision for mine closure and rehabilitation?**

P7: The provision must be managed in my view to take into account what is going to happen as the mine nears closure in the later years. If you do not do concurrent rehabilitation and you do not work smartly you are going to be left with a lot of area to rehabilitate in those later years when the cash flow will decreased. But therefore you need to manage that liability.

I think from a company perspective and a shareholder perspective also. There needs to be proof that you are trying to address your liability. It shouldn't look like it's running out of control. The ideal is that it stays as close as possible to its maximum levels so that you address those things as you mine. So that is part of the reason.

Then from a regulatory perspective as well you need to look at the liability and demonstrate that we are trying to manage responsibility. Legislation is increasingly tougher. The new financial provision regulations also requires or have a lot of requirements that we need to comply with and a lot of that relate to the provision.
Ja I think that is it. In financial terms you will be able to answer or help me build on that. Why do we need to manage that provision? A lot of unhappiness at the end of each year if the provision increases.

**I: Why is that? What causes the unhappiness?**

P7: I think that is and that is where you must help me there is liability if I understand correctly lays on a balance sheet after company and it reflects as a liability. And I believe shareholders are looking at that and if it increases the question is asked but what is the mine and the business unit doing to make sure that that doesn't increase so significantly. That is part of the answer but how to express it nicely in financial terms I am not sure.

**I: Ja, that is in essence what is happening. Okay**

**Question 3: What are the essential factors that need to be considered when calculating provision for mine closure and rehabilitation? So from your site what inputs do you need to provide to give a give guidance to calculate the provision?**

P7: Okay I'll tell you first what is it that is the cost drivers of the liability. Ok let me start at the beginning when you are doing a liability assessment. You need to understand why are you doing it? Yes part of it is legislation but the first process or one of the steps used to do a proper risk assessment to determine that when you close what would be your risks. And your closure program and your liability is aimed at addressing those risks.

So you are going to identify in your closure plan the measures that you must implement to address the risks. And those measures are then translated into the financial or into a cost.

So looking at an (...) One can use the mine closure toolbox as an example on how to determine what all the factors. You need to understand what is the environment in which you are operating. Because when you do rehabilitation you will aim to achieve similar conditions that you have in the area. So the physical environment is one component then there is social environment.

Social environment a lot of people are depending on the mine. When the mine close you going to remove that source of income. You're never going to be able to replace it. But you need to consider what can you leave behind that can support at least a part of the community. The environmental perspective and the social perspective that you need to consider.

And then you need to go look at what is the liability made up of. In our case the liability is probably 70% made up of rehabilitation of the waste dumps. Big volumes that needs to be moved. Large cost and then the vegetation side followed on the reshaping side. So that is a big part of the cost. What do we do with the waste dumps?

And then the second big component is then your infrastructure that needs to be removed at the end of the day. You need to understand, what is it infrastructure? You need to understand how you are going to remove it and what it is going to cost.

Then you need to look at post-closure management measures. So once you have done the rehab and closure you need to start monitoring because she want to achieve

a certain level of success. You need to tag that for a minimum number of years. And I think we have made assumption in our mine closure plan that we would have a proposed closure monitoring period of at least 10 years. You can track to success of the program and work towards closure certificate.

But there are various factors that come in there on that post closure side. Then except for the rehabilitation and the removal of infrastructure there are other costs that you need to consider. What is that maintenance going to cost you for the 10-year period?

There is for example dewatering. Currently dewatering what are we going to do with the water infrastructure. Because this is a source of water for the community. And preferably it should be handed over to an authority that distribute water. So those are some of the things. But it is a very long list. But to be components is there waste dump rehabilitation and then the infrastructure and thirdly then the social component.

And getting to that point on the rehabilitation that is challenging in our case you got various challenges like topsoil. So you also need to try and figure out as quickly as possible how are you going to rehabilitate so that you get a method that can work but that is a big learning experience.

I:Okay.

**I: Question 4: What influences does closer cast applied during operations have on production cost I think we touched on that it's basically about the balance sheet and maybe a bit more finance-related then we'll go to the next questions that will be more relevant then maybe a few things to it I want to come back to.**

**Question 5. Does the company have a process in place that I follow to engage with stakeholders that is going to be influenced by the mine closure such as to DMR and the surrounding community and also mines and close proximity?**

P7: Okay so that is one of our challenges I would say this stage. The closure toolbox addresses engagement with your stakeholders. In terms of stakeholder consultation I think we have initiated it and the one example is through the corporate affairs

department sitting. They did the update of the SEAT which year was it last year or the year before and in that SEAT they included one of the issues with discussion with the stakeholders was mine closure. So if you are going to look at the seat you will find that there was at least already some discussion. But it is something that one needs to plan out over the coming years and say what level, who will you engage with what level of Engagement do you desire. That would be with surrounding stakeholders.

Then the other big one is the regulators. Regulators being DMR water affairs environmental affairs conservation guys. Those are, then also municipality and then for example the water the water-board around which is distributed So that we had some starting engagements with the DMR. Because those measures that you put in the closure plans. So the measures for example being ok we will reshape the waste dumps to 24 degrees and then we will do moonscapes then we will plant these grass those measures there needs to be buy-in. But preferably you don't want to get to the point where you have done now half of your rehabilitation and they come and say no we don't like this.

But I must admit to engage with the DMR in a province like this it is challenging. They have got a lot of demands on their time. And to get that engagement is sometimes difficult. But we are planning it in our updated closure plan as one of the gaps that we identified is improvement on the stakeholder engagement. We need to plan it out how are we going to achieve it.

**I: And mines in close proximity**

P7: Mines in close proximity we haven't been talking to yet. We have identified some opportunities with the neighbour mine. Where we might want to join dumps to decrease closure liability but those discussion still need to take place. We have talked about maybe using the Northern Cape mine managers Association or what do they call it as a platform for engaging on this topic as well. So it has not happened yet but part of the planning.

**I: Okay ja, you mentioned specifically about this post closure management. so their engagement with mines nearby for example your water management how**

**are that going to be managed because how are they going to determine It is this open cast mine that got the water or is there a responsibility also for the dust.**

P7: For the water currently that we use is in terms of a water use license. Water and mineral is the same principle. Water belongs to the government you can apply to use it. So we are for water use license currently that allows us to dewater and to use some of those water in the plant and to distribute the rest of it. Mostly to the Sedibeng water pipe but also some of it goes to the Gamagara municipality.

To get to a situation where the mine closes. There needs to be consultation with department of water affairs as to what is your plan with water. And whatever that plan is needs to be endorsed by them. It wouldn't be for this open cast mine to make the decision who is getting the infrastructure and the water.

So related to water it is challenge of that water supply to farmers, which we are currently supplying with water. There needs to be a discussion how are we going to continue that supply into the future. We are starting the process now we have started its through consultant EXM they engaging they all came to help us to engage with the stakeholders. Sedibeng water affairs municipality farmers regarding that repair off to sinkhole. The repair is not technically a viable option. So if we don't repair the river we will have to provide those farmers forever and a day. You need to find a mechanism to do it. And that will have an impact on your closure liability. Because remember we work out the closure liability prematurely if we close now what is it going to take to continue that it is a shortcoming currently. But it will have to happen. Consultation with authorities for example on water is already starting to happen. Alright so what was the question again?

**I: Ja it was basically that just the stakeholders that is using the water and how is that managed. So just something else that I picked up. You mentioned now if we don't repair that pockets then we have to provide that liability still eternity or before we can. Because you can only obtain the closure certificate once to liability is finished**

P7: There will be what do they call it? A residual impact or impact that will continue you cannot eliminate and those impacts you cannot eliminate. And you need to provide a mechanism to address it. So in this case we cannot repair that river we filled up the holes from a safety perspective but we are not able to solve the problem on a permanent basis. The river cannot be restored technically as I said.

So you are going to have to put in your closure plan okay. But if you don't address it because you have we have acknowledged that we impact on those farmers. So if you cannot fix that problem you need to say how you are going to continue addressing that need. What I'm thinking now for example is maybe you have a trust fund managed by a body which generates annual income which will be used to supply those farmers. That is what I'm currently thinking so it's quite a challenge.

**I: But is there a time duration on that or**

P7: I cannot think that there is time duration on that (...) I do not know to me once to closure certificate is issued The Liability goes away. It might be that the trust fund or the trust values is eventually transferred to… for example Sedibeng water and they take over the provision. But I'm not sure how it is going too managed. I don't have that answer.

**I: Will that jeopardize or stretch out the closure certificate the issuing of it?**

P7: I don't think so. If you have got the sensible or workable agreement and proposal it can be transferred. It wouldn't make sense to delay the closure certificate. I rather think there is many other things that could also delay the closure certificate. So that one doesn't stand out for me particularly. I think you can manage that one.

**I: Ja, it is brought to the table so it is visible. Okay**

**Question 6: Do you think to provision will be sufficient to ensure sustainable mine closure in the future.**

P7: I think the provision we have much higher confidence in that we had in previously because of the more detail planning we have done over the last two years, but there are still gaps and this water provision is one of them. And then there is further work to be done in terms of the waste dumps to confirm the reshape volumes. That are the big things that stand out for me. And then the social closure provision.

We don't make provision for social closure. Social impacts are currently addressed on the SLP. But in some stage for that one of the maintenance phase for example you also have to determine. But if the mind should close what would that social liability be or what are we going to contribute. For example 10 years after closure. So those three things are examples I think that there will be more (...) there will probably be an increase in the liability once you understand those better.

So it may be that it is not fully sufficient at this stage but that is based on the understanding of what we have now. We can't over provide right now but I think there will be some additions to it. As the level of confidence increase. On the this closure plan update that we did now part of the closure toolbox is you review where are you with the closure plan against the guidance set by the mining house. But then if you say okay on this component we are at this level of detail but we want to be on that level of detail. Then we say ok that's a gap and then we identify that gap and all the other gaps. And then we say ok over the next three years. Year one we will focus on that one year two on that one etc. So that all the time you do go on to increase confidence in your closure plan.

**I: And the sufficiency of the liability**

P7: Yes that is right

**Questions 7: We also touched a few on that and that is do you foresee any risks for mine closure that should be considered and addressed in the provision calculation that is not included. I think we did discuss that now.**

P7: Ja, I think the big one I think is the water which is not currently included. As I said we are now already having that consultation process. The aim of the consultation

process is to get to a memorandum of understanding between water affairs, Sedibeng municipality, farmers on this end stage issue. So that's probably a risk.

The other risk that I can refer you to is that let me have a look at our risk assessment that we have done because we also identified in the (...) if you look at the risk before closure you say ok I'm going to do xyz then you relook at it and say ok our first closure risk you believe is going to be this level because you did those things. Then you say ok there is a residual risk on some items then there's also what they call maybe latent risks. Things that we are not aware of now which could come out.

But other than for the water right now. And then I think probably also figuring out how best to rehabilitate the slopes because of the topsoil shortage and getting the material mixed for the growth mediums sorting that out. That is the challenge and then on the social side I think that we can get more (...) to a higher level of detail as well to understand what do we want to do at closure.

**I: Another thing is there any harmful substances like asbestos and radioactive isotopes that we needs to be specially handled.**

P7: Three things I think we can look at. We can look at asbestos but most of it is being removed as part of the Dingleton relocation plan. To the railway line clean up. That is where most of the asbestos is so that is in hand. Most of it is almost gone.

Second thing is we need to look at our waste dumps. When water goes through them do they pick up chemicals that leach out? Answer is no we have sampled the waste dumps we have done the lab tests and there is not an expectation that there will be contamination.

And then thirdly we can look at hydrocarbons. We have localised areas is on the mine such as Filling stations**,** diesel workshop the life of mine workshop the load-out station the hef plant, the ammonia nitrate store. There is that localised positions that we know there is currently contamination. There are projects to address it over time. But when we close we know we are going to have to for a number of years continue to manage those facilities.

**I: So that is the water management Project**

P7: What water management Project.

**I: I had an interview yesterday with the GM of SIB and he mentioned about the water projects.**

P7: The water projects are aimed to address the contaminated runoff. So on the mine we are supposed to separate dirty areas and clean areas. So normal rainwater or rain water coming from the plant. We classify it as affected. Because it was already in contact with sludge with the dust then there's other areas on the mine that would be clean areas for example natural veldt.

But according to law we need to separate clean and dirty water. So we need to have systems in place. So this new dam that they built near Sisheng at the SIB offices. That is part of the project to separate clean and dirty water. So the principal with that dam for example, all the water comes in the sludge settles out and dirty water or clean water then close out if (...) once the dam is full because that dam only catch the first 20% of the rain and then it will spillover so. The idea is that it's still clean water. But the storm water project is aimed to address to separation of clean and dirty areas. So that is a project but it is not addressing post closure management of risk areas.

**I: Allright**

**Question 8. What do you think the mining company can do differently to better prepare for future mine closure.**

P7: Well we need to increase the level of rehabilitation. We you to make sure about the rehabilitation methods we are applying. Make sure that we achieve a certain level of success there. The other thing we basically need to improve is the confidence in your closure plan. To say that ok we have identified those risks. You have identified those management measures. But what is it that we don't understand yet. And I think the social closure is an example.

So for me all of it is linked to improving the level of confidence in terms of your items in your closure plan over time. And if you just consistently address as is required by the tool box then you will be making sure that your (...) end outcome will have more confidence that it will be achieved as you desiring it to be. So yes I will just refer back to the (...) all the items all the gaps, closing those gaps understanding what you are going to do when you get closure.

**I: Okay, so that is basically the methods that we going to use. Okay**

**Question 9. Any general comments regarding mine closure provision that you think might be important to include in the study.**

P7: So just say again what is it that you are trying to achieve

**I: So the topic is developing a management framework for opencast mine closure provision. That is the main topic.**

P7: So what would typically and management framework be. Is it the (...) what do you mean if you say management framework.

**I: It is identifying the areas or let me go to the main objective. The main objective of the study is to develop a management framework for mine closure and decommissioning procedures. This framework could then be used to consider provision for sustainable mine closure and decommissioning. The study will also further assess the current management of mine closure plan while still introduction. So that is in essence.**

P7: So if you say framework is it to put it in a formal guideline.

**I: It will be a form of a guideline trying to be used to be determining if your closure will be sufficient and also to identify gaps like you say. That you think about that.**

P7: I think the best that you can do is to look at for example the closure toolbox. Because I think. The important components that must be in that framework is included in the toolbox. Now I think the toolbox have taken into account a lot of international guidelines already because for example and mine house's technical service team have worked on closure plans across many countries. And they have used that knowledge to build a toolbox.

So I think if you look at the framework that guidance document the toolbox plus there's a few others like is it the ICMM council for metals and minerals something like that. Australian guideline document. So I would use that and say okay look at the framework from that perspective.

Part of your framework must be sensitizing of management. So that is something that I might not have done well enough. Marinus for example we discussed that draft. Management understand that implication of delayed rehabilitation for example.

**I: Ja, deferring the cost to later stages and the other risk is that there will be no operations the will be no income basically scarcity of funds.**

P7: That is part an important part of the framework how you do that engagement. But otherwise as I say I would look at the toolbox.

**I: The toolbox in essence if you can explain just quickly how it works or what topics does it exists out of**

P7: I presented this at this strategy session now. So the mine closure toolbox has got six tools in it. Here is a diagram explaining. The strategic planning part. Is looking at where are you situated. So it looks like your physical environment, biophysically so your biological environment. It looks out the surrounding land uses. It look at the communities. It looks at (...) basically assesses where you at. You can link back to the ICPS, to the ICPS process which the mining house uses as a rating tool.

It is establish the biophysical and physical context The Social and economic contexts. Looks at the internal and external requirements. External being legislation for example, internal being for example the mining house, mine closure standard. And the risk assessments. All of that fits into the strategic planning part of the toolbox and they say what are the components you need to look at. And what level of detail you should include.

The second part of the rapid assessment. Basically the rapid assessment helps you to determine at which level of maturity is your closure plan currently at. So tells you ok for this component social closure or for ecological or for surface water or groundwater. What is it that you should know when you are 20 years from closure. What should you know when you are 10 years from closure five years the level of detail increases so it helps you to do that assessment of where are you at.

Tool three closing those gaps. So this is where we at that is where we want to be. What are the actions you need to take to get to the next level and then it proposes incremental steps to say ok. We know this you have to do this in the following manner to get to closure. So it helps you to plan to address the gaps that you have identified.

Integration is a new tool that they added. It is basically giving you some guidance on how the rehab and closure team should integrate with mine planning team. Because we have been increasing our efforts in that arena and make sure that the mine plan takes into account the rehabilitation and closure requirement. For example the Western built that we are building we are following that approach where we are making sure that every area are completed every year so that you can do the concurrent rehab.

To take an example this time in the early years it was always constructed like this, they tip here, they tip here. They tip here they go back start tipping again go back start tipping again that's never completed area so now that area is done It go for concurrent rehab. So they didn't create the, now we are telling the guys listen you need to do it step-by-step because we want to rehab. So that is one part of integration.

The other part is what we show is that financial dip towards the end how does the liability grow. How can we include in mine planning that we addressed at. Where the waste dumps have been tipped incorrectly. We are going to be trucking out waste in any case from the pit. We may as well go and dump it against the slope which can help you to achieve that desired slope angle easier so you move less material. So reducing operational cost to address to rehab cost. So there is still opportunity for integration and that tool describes to you. What are the things you need to do when you consider integration planning?

**I: On the integration will there be benefit to do it as production or how significant do you think the benefit will be?**

P7: I think there can be a significant benefit because we just look at material movement costs. We have to pay the contractor to come afterwards to move material if it is just a pure waste of money. So I think there can be a significant benefit.

In pit dumping is another example it is an operational saving but it's also closure saving because you are chucking that stuff back in the pit you are saving money with travelling distance but also you don't have to go reshape and rehab it so there is significant.

**I: So that is just physical dumping of waste in the pit that is what it's all about.**

P7: Yeah that is what we called the in-pit dumping. I will show you an example here. The is the Vliegveld dump pits they are right towards Dingleton. This is to dump part this was pit. This pit I think was 300m deep. So the waste that is coming out of the Dingleton push back goes straight into the pit. So they fill up the pit. You can see the levels every bench is 20 m high. So starting there you can still see it is pit. Backfill backfill backfill... so it is 100 200 300m space hole filled up.

And our current assumption is that we will only rehabilitate. We will not rehabilitate because that is in the pit from ground level up you will rehabilitate. But you can see the cost saving that is realised here. So there might be opportunities to, to mine out somewhere where there is a bit quicker so that you can get that waste back in. But it

is part of the mine planning currently. Just another example of using your operational base to make it cheaper.

Here for example this dump here. It is 120 m high it is over tipped it is not straight cut to fill. So what are we going to do there? So we are saying we are going to be building a waste dump here a new waste dump here. So that waste can go there on the waste dump but there's also an opportunity to go and tip waste here. Tip it out there tip it in there and you sort out the slope, during operations. You facilitate rehabilitation. Those are the opportunities that the tool talks about.

And then tool 5 is closure execution and that is there is part of the closure plan where you talk about the closure programs. So should you close what is your closure programme looks like are you going to have a 5 years with 100 people are you going to have it over 10 years with 50 people. What are the things that you need to consider. For the actual closure execution part. So that is the tool 6 and then ag 5.

And tool 6 is just the review and continuous improvement on what you are doing. It gives some guidance and that aspect. That is the six tools. There is a separate document that that sets examples. So in the toolbox says you must have a zone of influence document so it gives you an example. You must have a SWOT analysis it gives you an example. A closure risk assessment it gives you an example. So for the different things that you need to have it gives you some nice examples. Execution plan and scheduling that I haven't even looked at yet. but at least that I know it will be a next step for us in the closure plan but when we do it I can go look at that example and build it around that.

Post closure management plan for that 10 year post-closure. An example of a management so this is actually good.

**I: Ja, that is a very good guideline**

P7: Just in terms of the guidelines that rapid assessment level of details 10 to 5 years from closure 15 years 25 years and there is more than 25 years. When you are 10

years from closure your level of detail should be much higher done it is there. And in for example it says that when you 10 to 5 years you want a detailed closure plan.

But for you to have a detailed closure you need to kind of evaluate where you are at different components it will ask you on infrastructure which level of detail are you are you at that level you can read that wording or are you at this level. If you for example year but we want to be as 15 to 10 years because you draught closure plans. If we are here currently then that closing the gaps would explain what you need to do to get to this level of detail. And this is part of your maturity rating you can see this is the rating for example it will say I what is on track... but on this item four maybe it's social you got a gap so you need you need to move from there to there. On some items you might be ahead of level of detail.

And that is the gap assessment that we do. We talked about integration now. You can read here the key benefit of integrated closure lies in the elimination of future closure activities and liabilities by changing the current operational activities for example waste drop placement Tailings can be (...) one of our criteria at this time as we want to put half, this is clay in the middle there is competent material there that outer wall but all of this is playing you cannot rehabilitate on clay. So the closure provision says that we will over that area put half a meter of calcrete. You can imagine to pour in that concrete as a closure cast are going to be high but if we can do it by operations come in and tips that area so we cut that costing..

**I: Sjoe ja this is going to be quite significant.**

P7: Another key component of managing closure liability is to ensure that a concurrent rehabilitation opportunities are optimised throughout the life of the operation to decrease liability. That's where I said to test your rehabilitation methods and to build stakeholder confidence.

And then at the same time when you do concurrent rehab you also manage your other impacts water dust visual. if you look at the Sisheng side from the North. Okay but we haven't had we had almost no rain that's why everything is brown but if we had good rains what are doing impression we are going to create. It is going to be quite good.

**I: yes**

P7: So we got two rating systems the one rating system is that table with the gap analysis. We got a rating system on Call It the integrated closure planning system. Consist of six components there is 1, 2, 3,4,5,6 that each one you ask a question to establish physical and biophysical context. Then it says ok if you if you are a one this is what you have if you are two this is your challenge if you are five you doing good you should be here. So then it rate item 1.1 to this one you said a 4 it rates item 1.2 has a four. It rates item 1.3 was a four. 1.4 was a... then if you look at item 2.1 it is rated as one item 2.3 is rated as a one. And it draws you this diagram where you at with an average. We did this a few years ago when we started with the ICPS. We were at level 2.7 we are going to redo that now the end of this year and then look at the updated closure plan and where we are at with level of maturity. But this is the second rating system that they use. Our target is for 4 aren't we trying to get there at 2021

**I: okay**

P7: Rehab strategy so I have explained to you the toolbox and the examples. It is a good document.

**I: ok thank you**

P7: is that it

**I: that is it**

P7: ok I hope I helped you
**I: you did definitely**