INVESTIGATING CLIMATE CHANGE INTERVENTION STRATEGIES IN OPENCAST MINING CONTRACTING AND PLANT HIRE COMPANIES: A CASE OF MUTUAL CONSTRUCTION COMPANY GROUP OF COMPANIES, SOUTH AFRICA

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Declaration

I, the undersigned, Peace Aaron Matangira, student number 48370754 hereby declare that this thesis is my own original work, with the exception of quotations and references which are attributed to the original source. This thesis has not been submitted to any other university and will not be presented to any other university for a similar or other degree award.

Signature ……………………………………………………………………………

Date…………………………………………………………………………………

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List of Acronyms and Abbreviations

EIA	- Environmental Impact Assessment
EMPr	- Environmental Management Programme
HOD	- Head of Department
AMPLATS	- Anglo-American Platinum Mine
APPA	- Atmospheric Pollution Prevention Act
B. Ed	- Bachelor of Education Degree
B. Acc	- Bachelor of Accounting Degree
BAU	- Business as Usual
Bsc. Eng. {Undergrad}	- Bachelor of Science (Engineering) Degree
CAT	- Caterpillar Mining Equipment
CDP	- Carbon Disclosure Project
CEO	- Chief Executive Officer
CFO	- Chief Financial Officer
COP	- Code of Practice
COP	- Conference of the Parties
DEA	- Department of Environmental Affairs
DME	- Department of Mineral and Energy Resources
DRC	- Democratic Republic of the Congo
DWAF	- Department of Water Affairs
EHS	- Environment Health and Safety
EMPs	- Environmental Management Plans
EQSTRA	- EQSTRA Holdings Private Limited Company
GDP	- Gross Domestic Product
GHG(s)	- Greenhouse Gas (es)
GNR	- Gazetted National Regulation
GPS	- Global Positioning System
GRSA	- Government of the Republic of South Africa
HEF	- High Energy Fuel
ICMM	- International Council on Mining and Metals
IPCC	- Intergovernmental Panel on Climate Change

ISO	- International Organisation for Standardisation
IT	- Information Technology
JSE	- Johannesburg Stock Exchange
M. BA	- Master's Degree in Business Administration.
M. D	- Managing Director
MCCGC	- Mutual Construction Company Group of Companies
MHSA	- Mine Health and Safety Act
MPRDA	- Minerals and Petroleum Resources Development Act
MT	- MegaTerrex 3300 Dump Truck Series
NCCRS	- National Climate Change Response White Paper
NEMA	- National Environmental Management Act
NME	- Norwegian Ministry of Environment
NT	- National Treasury
OECD	- Organisation for Economic Cooperation and Development
OEM	- Original Equipment Manufacturer
OHSAS	- Occupational Health and Safety Assessment Series
PPM	- Pilanesberg Platinum Mine
PWC	- PriceWaterhouseCoopers
QDNRM	- Queensland Department of Natural Resources and Minerals
REDISA	- Recycling and Economic Development Initiative of South Africa
RNMET	- Republic of Namibia Ministry of Environment and Tourism
ROM Pad	- Run of Mine Pad
SA	- South Africa
SAWSIS	- South African Weather Services Information Systems
SHEMP	- Safety Health and Environment Management Plan
THA	- Tharisa Minerals
TIA	- Technology Innovation Agency
UG2	- Upper Group 2 Chromite
UN	- United Nations
UNFCCC	- United Nations Framework Convention on Climate Change
UNISA	- University of South Africa
WIMS	-Weigh In Motion Information Systems

Abstract

Climate change has come to be understood as a deleterious phenomenon, which threatens business, society and ecological systems, thus making it imperative to understand its impact on human, social and economic activities as well as the impact of these activities on climate change. Against this background, this research sought to determine climate change intervention strategies in the mining supply chain in general, specifically focussing on opencast mining contracting and plant hire companies' practices. This focus on the mining industry was driven by its importance in South Africa and globally, despite its significant direct and indirect contribution to climatic changes.

The mixed-methods multiple case study focused on the climate change management of the Mutual Construction Company Group of Companies (MCCGC), an open cast toll mining firm and equipment supplier. Limited to two sites, Pilanesberg Platinum Mines (PPM) and Tharisa Minerals (Tharisa) Mines, the researcher gathered data through interviews, questionnaires, observations and document review. Data was analysed through deductive content analysis.

The research made three major findings: (i) the MCCGC, like its principals PPM and Tharisa, does not have an explicit climate change management strategy. Instead, climate change is managed indirectly through implicit strategies seeking to manage environment, health and safety concerns of the mines, (ii) as a contractor, the MCCGC has had to adopt PPM and Tharisa's implicit approach to climate change management strategies to meet contractual obligations, instead of an explicit approach and, (iii) the MCCGC and its principals' commitment to environment, health and safety management, and implicitly climate change management, is not mere rhetoric but is being put into practice.

The research concluded that MCCGC's lack of expressed climate change management intentions and practices exposed the firm to climate change risks, most notably financial risks and reputation risks. Financial risks arise from possible *ex post* climate change liability. In addition, MCCGC is risking its contract tenures, particularly if the two mines change ownership and the new owners insist on an explicit rather than implied climate change strategy with all its suppliers. Reputational risks arise from the possible failure to attract new clientele and investors who may perceive MCCGC as a risky partner, due to an inept climate change intervention strategy.

Key words:

Climate change, strategy, mining, supply chain, opencast, opencast contracting and plant hire, risk, contractor, implicit, explicit, practice.

CHAPTER 1: INTRODUCTION

1.1 Background

As one reflects on current global and national environmental discourses, the one topic that quickly comes to mind for scholars as an issue of concern for both business and society is climate change. It is a concern that cuts across every sector of the economy, including the mining sector. Climate change is described as a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (Henson, 2008). This change is caused by factors that are both natural and human induced. Examples of natural processes are oceanic circulation, variations in solar radiation received by earth, plate tectonics movements and volcanic eruptions (Henson, 2008). Human activities that accelerate climate change through the emission of greenhouse gases (GHGs) largely relate to the burning of fossil fuels as energy sources driving the various human and social activities (Henson, 2008: United Nations Framework Convention on Climate Change [UNFCCC], 2013).

Despite early disputes on climate change, there is now a consensus that the phenomenon is real. This consensus is evident in world events from the First World Climate Conference of 1979, to the more recent post 2012-Doha amendment of the Kyoto Protocol, as well as the Paris Agreements (UNFCCC, 2013). The realisation that this unnerving menace threatens the sustainability of the earth's ecological systems, including the survival of humanity, has elicited humanity to act against the real and anticipated adverse effects of climate change. Human actions to this end can be divided into two broad categories: mitigation and adaptation.

Climate change mitigation relates to human measures that can either reduce (abate) or increase absorption through sinks (sequestration), of Greenhouse Gases (GHGs) (UNFCCC, 2001). Examples of such activities include emission elimination, emission reduction, and enhancing carbon sinks by encouraging reforestation. On the other hand, climate change adaptation relates to changes in ecological, social, or economic systems in response to evident or projected climate causes and impacts (Queensland Department of Natural Resources and Minerals [QDNRM], 2005). These changes can be in processes, practices and structures to minimise potential damages or to benefit from opportunities associated with climate change (UNFCCC, 2001).

In the context of a differently endowed world with differing vulnerability to the adverse impacts of climate change, human reaction to climate change raises a number of interesting questions that include; how is the world mitigating and adapting to climate change? Are current mitigation and adaptation efforts significant and adequate? Most important, are the mitigation and adaptation efforts applicable to all sectors of the economy? These questions are very important to the economic development of many underdeveloped countries and economic growth in the developed world.

The mining sector remains one of the leading commercial sectors in South Africa's economy and development. It contributed 8.3 percent of total Gross Domestic Product (GDP) in 2013 (Chamber of Mines (2013). This, from mining's 25 percent input to the economy through direct and indirect investments (Chamber of Mines, 2013). The mining industry also contributed 50 percent of South Africa's foreign exchange revenue in 2013 (KPMG, 2013).

Having conceptualized the significance of this industry to South Africa, this research focuses on climate change mitigation and adaptation practices in South Africa's mining sector with particular focus on the Mutual Construction Company Group of Companies (MCCGC). The firm is a wholly owned subsidiary of EQSTRA Holdings. MCCGC is a contractor integrated into the mineral extraction and beneficiation sub-chains of the mining value chain. The firm holds contracts with notable mining houses that include BHP Billiton, Amplats, and Rio Tinto, both inside and outside South Africa (MCCGC, 2013; EQSTRA, 2013). The MCCGC services encompass all open cast mining operations namely drilling, blasting, loading, hauling, rehabilitation and plant hire (EQSTRA, 2013).

In its operation, the firm uses a variety of machinery that includes; drill rigs, excavators, dump trucks, loaders, graders, dozers and other related machinery. The majority of this machinery is powered by fossil fuels, which release GHGs into the atmosphere. GHGs give rise to global warming which in turn leads to climate change. Given the rising levels of awareness on environmental stewardship and the increasing frequency of climate change linked extreme weather events in South Africa and across the globe, there is considerable pressure on the mining industry to play a role in reducing or eliminating GHG emissions. Third-party service provider firms like the MCCGC are also expected to play a part in minimising GHG emissions. Nelson and Schuchard (2013) are explicit in recommending that mining companies need to adapt their corporate strategies, design and engineering practices, supply and distribution to the physical changes associated with climate change. The MCCGC is one of the South African companies involved in mining and thus has a role in contributing to the management of the climate change phenomenon.

The dichotomy of the positive economic benefit of mining versus the negative results of its activities has resulted in a call for environmental stewardship. The diverse requirements of mining houses and their supply chains, to act in a manner that addresses climate change has led to the line of enquiry rooted in the problem statement that is outlined below.

1.2 Problem Statement

Not all of the mining industry's contributions are positive to human economic, social and environmental welfare. Two of the most notable negative contributions of the sector are environmental degradation in general, and climate change in particular, through direct and indirect means. The most prominent current discourse on the negative contribution of the mining industry is centred on the industry's contribution and vulnerability to climate change (PriceWaterhouseCoopers [PWC], 2012). Total GHG gas emissions by the South African mining industry are currently undetermined. This is because of a less than full disclosure and management of GHG pollution levels by companies (Mzenda and de Jongh, 2011). This poses a problem in climate change mitigation. Mining firms are increasingly being called to account for their direct and indirect GHG emissions. Since the MCCGC is one of the largest contractors in opencast mining in South Africa, it is worthwhile investigating if and how the company is responding to climate change in the course of fulfilling its contractual obligations.

Nelson and Schuchard (2013), note the insufficiency of a detailed understanding of climate change risks and opportunities throughout the mining value chain. Despite this, mining, firms are expected to mitigate and adapt to climate change. This expectation is explicitly and implicitly transmitted to suppliers integrated into the mining value chain. For the supplier companies, the biggest risk is the threat of exclusion as the mining houses seek to meet international and national climate change regulatory regimes. It is therefore imperative to determine how a mining service supply firm, like the MCCGC, operates and how it intends to mitigate and adapt to climate change in its operations.

1.3 Research Rationale

Climate change has emerged as a factor that is likely to pose one of the greatest threats to company profitability, as well as to humanity (Mzenda and de Jongh, 2011; PwC, 2013). The inability to mitigate and/or adapt a business to the dynamics of climate change has the potential to adversely impact its profitability and thus its sustenance. The International Council of Mining and Metals, [ICMM] (2013), cites three critical climate change risks that confront almost all mining operations. These are: (1) financial, (2) physical and (3) legislative risk. To this list, one can add reputational risk. Managing all these risks requires the formulation and implementation of a climate change management initiative throughout the length of the mining value chain. This means that a mining firm has to manage issues that are internal to its operations as well as those that are inherent from interactions with its goods and services suppliers. This is important because a firm's contributions to the climate change phenomenon and its management, is not only determined from its internal operations but also includes how it manages the actions of its suppliers in seeking the same.

Jira and Toffel (2013) show that there are a growing number of companies that are engaging in climate change management along the supply chain. Despite this, Nelson and Schuchard (2013) show that most companies reporting climate risk in the Carbon Disclosure Project in the mining industry are large corporations such as Anglo American, Goldfields and Exxaro. Notably, there is a paucity of research and disclosure of how firms that supply goods and services to the mining sector are performing with regard to climate change management. This research addresses this gap by analysing the climate change mitigation and adaptation strategies of the MCCGC as toll mining services provider in the platinum mining industry of South Africa. The research is premised on the assertion that the climate change management practices of the MCCGC and other mining goods and services providers ultimately contribute to the increase or decrease of the industry's carbon emission. MCCGC, as a contractor of note, provides a suitable case study of climate change management along the mining supply chain. The research findings have the potential to inform policy, legislation and practices in the sustainable development, climate change mitigation and climate change adaptation space.

1.4 Aim and Objectives

The aim of this study was to apply scientific research in order to investigate the climate change mitigation and adaptation strategy and practices by the MCCGC. Noting that climate change response falls into two broad categories, climate change mitigation and climate change adaptation, the research set to achieve three specific objectives as follows:

(i) To conduct a distilled review of policy and legislative frameworks that drive MCCGC's climate change mitigation and adaptation strategies and practices.
(ii) To determine and document the strategy and practices by the MCCGC in mitigating climate change.
(iii) To determine and document the strategy and practices by the MCCGC in adapting to climate change.
(iv) To identify the factors that drive the MCCGC's response to climate change in its operations as a toll mining service provider.

1.5 Research Questions

Following on from these three objectives, the research posed the overarching question: What strategies and practices does the MCCGC have in place to respond to the challenges posed by climate change? To achieve the research objectives, and answer the over-arching question, the following three research sub-questions were formulated for the study:

(i) What internal and external policy and legislative frameworks guide MCCGC's climate change response?
(ii) What strategies has the MCCGC adopted to mitigate climate change as both an internal initiative and to meet its contractual obligations?
(iii) What strategies has the MCCGC adopted to adapt to climate change as both an internal initiative and to meet its contractual obligations?
(iv) What factors drive MCCGC's responses to climate change management in its operations as a toll mining service provider?

1.6 Location of the Study Area

The study was carried out in two MCCGC operations, which are: (i) Pilanesberg Platinum Mines (PPM) and (ii) Tharisa Minerals (THA). PPM is located on the western limb of the

Bushveld Complex, 60 kilometres from the town of Rustenburg in the North West Province of South Africa (PPM, 2013). PPM is an open cast mine. The ore is mined out after exposure, through sequential stripping of the overburdened earth and rocks. The processes leading to the reef removal are: drilling the ore-bearing rock using a drill rig, blasting with explosives, loading blasted matter into dump trucks using excavators, and finally hauling the blasted rock to the mine dumps or processing plant (Ibid).

The second site, Tharisa Minerals, South Africa Chrome Mines, is situated between Mooinooi and Marikana in the North West Province of South Africa. The chrome is mined by means of an opencast mining method as is the case with PPM. After the ore is removed, the land area is then rehabilitated. With the location of the study having been established, the following, Section 1.7 provides a forecast of how the thesis will be structured and written, proceeding this Chapter 1.

1.7 Thesis Outline

Chapter 2 which follows has a dual function. First, it provides the theoretical underpinnings that informed the study, discussing climate change management (mitigation and adaptation). Second, it contextualises the theoretical discussion by presenting cases that outline the climate change response strategies and practices of opencast mining principal companies as well as opencast contracting and plant hire companies.

Chapter 3 presents the methodology. This incorporates the presentation of the research design and the methods used to gather the data which addressed the research questions. The chapter also details how the data was analysed, how issues relating to reflexivity, validity, trustworthiness, limitations and ethics pertinent to the research were dealt with.

Chapter 4 provides an analysis, presentation and discussion of the findings. The chapter identifies MCCGC’s climate change responses and the drivers of these responses. Chapter 5 draws the research conclusions. The chapter also provides suggestions for future research in this field

.

1.8 Conclusion

This introductory chapter provides the building blocks and main concepts of the study through a brief theoretical background of climate change, its origins, characteristics and inherent risks. An emergent problem statement follows from this background, indicating that the development trajectory of industry in general and the mining in particular has led to the current climate related problems of society and industry. The problem is aggravated by the inadequacy in policy, legislature, knowledge and the proliferation of mitigation and adaption responsive to the demise. Based on this a logical rationale ensues, this being to study how industry in general and more specifically the mining supply chain's opencast mining contracting and plant hire address climate change. To focus the study four objectives were set. The essence of these was to investigate and explore the legal and policy terrains, strategies and practices related to climate change mitigation and adaptation, and outline drivers/ factors guiding climate change responses in the afore-mentioned supply chain. These objectives were transformed into research questions which will then be answered as the dissertation progresses.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The opencast mining contracting and plant hire business can no longer continue with a Business As Usual Approach (BAU) in virtually all its operations. The business faces a number of challenges that need urgent attention. Key challenges in this space include the current (2016) global economic crisis, fuel price volatility and supply security, human health, and poverty alleviation. These challenges are compounded by environmental concerns, most notably climate change. Climate change is perhaps the biggest single challenge of the 21st century because its adverse impacts threaten virtually all aspects of all of earth flora and fauna, both directly and indirectly. This chapter examines the climate change threat in the context of mining in general and from the views of mining contracting and plant hire firms in particular. It also reviews the strategies and practices which the opencast mining contracting and plant hire sector are utilising or can adopt in response to the climate change challenges.

2.2 Climate Change

As stated in Chapter 1 climate change is the significant and lasting, scientifically provable alteration in the earth's average weather variables, state and properties over periods ranging from decades to millennia (Henson, 2008; Metz *et al.*, 2007). This alteration results from global warming which is induced by the accumulation of GHGs in the atmosphere. The GHGs absorb energy, slowing or preventing the loss of heat to space. In this way, GHGs act like a blanket, making the earth warmer than it would otherwise be. This process is commonly known as the "greenhouse effect" (Klein et al., 2011; Bernstein et al., 2007). The increase of GHGs in the atmosphere is induced by both natural and human activities. Natural activities contributing to the phenomenon include volcanic eruptions, changes in earth's orbit and changes in solar activity (Miller, 2006). Human contributions largely relate to the human activities which burn fossil fuels that emit GHGs such as carbon dioxide, methane and nitrous oxide (Bernstein *et al.*, 2007; Goklany, 2005). Such fuels are burnt to generate electricity, to propel motor vehicles and aeroplanes, and to power some industrial operations.

A notable and acknowledged result of climate change is the increase in the frequency and severity of extreme weather events like flooding, droughts, extreme snow, hailstorms and heat waves, among other related abnormal weather phenomena (Nhamo, 2013; Bolin *et al.*, 2007). There have been notable increases in decadal temperature, with global temperature increasing by between 0.2^{o}C and 0.6^{o}C compared to the pre-industrial levels (Winkler, 2005). This phenomenon has been termed global warming. Some regions, such as Queensland in Australia, have already experienced above 3^{o}C increases in temperature (Marais, 2010). In South Africa the temperatures have increased by an average 0.13^{o}C – 0.3^{o}C per decade since 1960 (Boko et al., 2007; Kruger and Shongwe, 2004). Similarly, there have been notable increases in the frequency and severity of extreme weather events. In South Africa, there have been noticeable increases in cases of floods, storms and droughts (Benhin, 2007).

The temperature increase and extreme weather events are jointly reshaping the social and business activities and environments in which both operate. Policymakers at all levels of government, private sector players and private citizens are acting to limit the current and future adverse risk and impacts of climate change. The ICMM (2013) and Knobloch & Leurig (2010) distinguish seven climate change risks that have a bearing on businesses such as MCCGC. These are: (1) physical risks, (2) reputation risks, (3) social risks, (4) regulatory risks, (5) legal risks, (6) political risks and, (7) competitive risks.

Physical risks largely relate to the physical impacts of climate change on the flora and fauna and the related natural and man-made infrastructure. For example, the mining industry confirms increased heat from climate change is related to increased health concerns which are causing lowered productivity and financial losses (Palazchuck and Doyle, 2005). Nelson and Schuchard, (2009) note that this increased heat causes illness and accidents which in turn result in increased sick leave, property damage, lower production and related loss in revenue for companies. In addition, temperature increases are having an impact on human, animal and plant health, through incremental and redistributive impacts of disease vectors in areas where they were absent or relatively lower in number (Wilkinson et al., 2011; Wu et al., 2015).

An example of such vector related disease re-distributive patterns is malaria, caused by mosquitoes (Gross, 2005). Climate-change-induced increased precipitation may lead to floods that in turn may damage transport routes, limiting access to and from commercial activity centres such as the opencast mining sites (Bolin et al., 1995). An example of an opencast mine which flooded, from what is believed to be climate change induced heavy rains, is Exxaro, South Africa's Grootegeluck Pit flood in 2015 (Exxaro, 2017). The flood led to millions of Rands worth of revenue and property damage-related losses.

An important point to note is that these risks carry a financial risk aspect in the form of damage to infrastructure that needs to be repaired, lost productivity when inputs cannot be moved to sites of commercial activity, and products cannot be moved to the markets or other destinations where they are further processed. Such financial risks have transcended into the insurance arena, with insurers adjusting insurance premiums to cater for the heightened likelihood of climate change induced loss events thus increasing corporate overhead costs and reducing profit margins (Knobloch and Leurig, 2010). Climate change risks also come in the form of reputational risks.

Reputational risks relate to the hazards that a brand is exposed to when it is associated with actions which communities, investors and other stakeholders perceive to be negative. In this case, a mining firm associated with climate-related damages or perceived mismanagement of the climate change risk environment may lose, or have its social operating licence eroded (International Council on Mining and Metals, 2013). Mining companies are often perceived as a source of climate and environmental degradation by the public and the communities they operate in, both in South Africa and globally (Shaw, 2012). This has led to conflict with communities (Nyirenda, Ngwake and Ambe, 2013). Reputational risk for a contracting and plant hire companies could relate to equipment that is old and results in excessive carbon emissions that increase the overall carbon footprint of the parent mine operations. The reputational risks are associated, to some extent with social risks.

Social risks and reputation risks have certain levels of interlinkages, but reputational risk is not exclusive to societal interactions with the mining house. Specific social risks arise from negative risks and opportunities within the context of a company's interactions with the society within which it works. A classic example provided by the ICMM (2010) is how mining companies in Chile's Quillagua and Coppiapo regions are in conflict with urbanites and agriculturalists due to climate related riverine water shortages. Such conflicts have led to local government imposing stricter water licence regulations.

This point brings into perspective regulatory risks that are linked to climate change. The ICMM (2010) and Smith (n.d.) highlight how regulations linked to climate change mitigation or adaptation can become a source of operational or financial business risks. Nhamo and Chavalala (2014) also allude to how increased regulations can cause added financial obligations when companies implement compliance mechanisms. An example of this regulatory risk is how electricity and water consumption restrictions have been implemented in South Africa and Chile during times of water scarcity (ICMM, 2010).

The risk of litigation has increased with the proliferation of regulations and laws affecting climate change, aimed at protecting the private and public sectors of society from third-party negligence or injuries related to climate change. This legal risk can be illustrated in the case of BHP Billiton's litigation for large-scale environmental damage when its Ok Tedi tailings dam collapsed in 2009.

Another risk that arises due to climate change is political risk. Baleen and Molojork (2016) discuss political risk from the perspective of what triggers it, when it will be triggered and what form it may take. According to their paper, power-struggles between influential groups can occur over scarce resources such as water, pasture, flora and fauna, inter alia. Violent political clashes over these, which can be linked to increased scarcity of resources due to climate change, are already occurring in West African countries such as Sudan, Kenya and Rwanda (Ibid). Competitive risks are another aspect that can be added to this plethora of risks related to climate change.

Larsh and Wellington (2007) state that companies which react faster and better to climate change by being innovative reap rewards from the opportunities presented by this phenomenon and will thrive, relative to their competitors. Notable competitive advantages include increased investor confidence, increased share pricing, brand strengthening, cost saving and enhanced liquidity. Companies such as Global Electric (GE), Toyota and Honda are already yielding dividends from both new or improved product lines that are aligned to energy efficiency, reduced fuel consumption and innovative technologies that reduce carbon emissions. In 2005, GE generated US$8.5 billion from clean energy products.

Acknowledging the human contribution to climate change, its impact on current and future generations, and the risks associated with the failure to manage it, responding to the climate change phenomenon is becoming a significant preoccupation of many private and public sector firms and departments. Managing climate change falls into two broad groups: climate change mitigation and climate change adaptation.

2.3 Climate Change Mitigation and Adaptation

Climate change mitigation is the human intervention towards stabilising GHG concentrations that are within the atmosphere through the elimination and/or minimisation of the amount of anthropogenic GHG emissions into the atmosphere (Hansen *et al.,* 2013; Enger and Smith, 2013; International Panel on Climate Change [IPCC], 2001). Energy generation, especially coal and petroleum fuel-fired electricity generating plants and the transport sector (goods and human transports) are the major anthropogenic sources of GHG emissions. As a result, climate change mitigation efforts are primarily focused on reducing or efficiently using, and/or abandoning fossil fuels as major energy sources in these operations.

Mining industries are showing practices aligned to the global drive to mitigate climate change. These practices are realised in projects aimed at energy efficiency, renewable energy and clean technology advancements. Technological breakthroughs in this space include mining machinery such as electric hybrid vehicles, light portable drill rigs, and the hydrogen cell dump truck, used by Rio Tinto (Vella, 2013; McIvor, 2010). Renewable energy projects include the use of energy from wind, solar, co-generation plants, biomass, methane, natural coal-bed methane and biogas uses, among others (Votteler and Brent, 2016). Anglo American is already utilising 14 percent of renewable energies from this mix (Ryan, 2014).

Behaviour modelling, public awareness, environmentally-friendly building designs, afforestation and reforestation add to this mix aimed at climate change mitigation. Large corporates such as Exxaro, BHP Billiton and Vale operating in South Africa, amongst others, are also engaging and financing climate change mitigation practices. In 2010, BHP Billiton injected over US$ 300 Million per annum into mitigation options (McIvor, 2010). The opportunities presented by the mitigation actions are co-beneficiary, aiding the business through increased energy security and lowered energy costs. This, because renewable energy is cheaper and more reliable in the long run; and hence aids the sustainability as well as profitability of the mining enterprises (Ibid).

Current mitigation efforts are aimed at preventing global temperature increase from reaching a 2^{o}C threshold, which is regarded as the tipping point at which most human and natural systems can adapt within reasonable costs (Hansen *et al.,* 2013; Winkler, 2005). Laukkomen et al., (2009) posit that mitigation is a way of avoiding climate change from becoming unmanageable. The current challenge is that climate change is a present phenomenon and some of its adverse impacts have been felt and seen, and some are yet to be experienced but are expected with a great degree of certainty (Eggleton, 2012; Pearce *et al.,* 2010). This realisation has led to the need to deal with current and projected adverse climate change impact through climate change adaptation response (Smit *et al.,* 1996).

Climate change adaptation is the change in human and natural systems that are aimed at implementing interventions which aid these systems to live with evident or perceived climate change impacts (IPCC, 2001). The aim of these adjustments is to moderate the adverse effects of climate change and to exploit any arising opportunities. Climate change adaptation activities can be planned or unplanned and operate in both the public and private sector spaces.

Planned adaptation relates to deliberate or conscious response to climate change based on knowledge or experience of the impacts (Nitkin and Medalye, 2009; Tompkins *et al.,* 2009). An example is the building of defences to manage climate change induced storms and rises in sea, river or dam levels (Asberghaus and Baccianti, 2013). Unplanned adaptation on the other hand, relates to unintentional adaptation actions to climate change impacts (de Coninck, 2011). An example of such actions is building better drainage systems after unanticipated flooding. Planned adaptation within the mining industry is increasingly becoming the norm. Mining houses such as Vale, Anglo American, Total Coal and BHP Billiton have routinely mainstreamed climate change adaptation into their management matrices (Nelson and Schuchard, 2009). This consideration has improved the level and quality of climate change adaptation in many businesses and case studies will be presented towards the end of this chapter.

However, not all planned and unplanned adaptation bears positive results. At times businesses are also maladaptive. This occurs when the measures aimed at adaptation either result in an unintended negative effect on mitigation efforts or have unintended negative effects elsewhere (Burton, 1999). In reference to maladaptation McDowell, Moe and Hess., (2010:11), state that, "This can occur when adaptation strategies increase greenhouse emissions, burden the most vulnerable, have high opportunity costs, reduce incentive for adaptation, and limit choices available for future generations". An example of this is when a business embarks on coastal mining, thereby becoming more vulnerable to coastal flooding and severe climatic events that occur along the coastline (IPCC, 2015).

Climate change adaptation aims at either value protection or value creation. Value protection is done to protect the current capital base, markets, infrastructure, employees and communities from evident and imminent climate risks and losses (Nelson and Schuchard, 2009). Value creation occurs when the company creates and enjoys benefits from the opportunities created by climate change (Ibid). The benefits include expansion of business opportunities, the creation of business partnerships, enhanced profits, new markets, increased political influence, better corporate image, increased share price as well as created synergies with the communities. Anglo American Global provides a case of value protection. It developed and implemented adaptation action plans for its operations based on the global climate change vulnerability study it carried out through the Imperial College of London (Ibid). Value protection is also achieved through innovative engineering designs. Norsk Hydro, in Qatar, has built its facilities two metres higher to prevent flooding. Kinross mining is also building redundant water-capturing facilities to capture rainfall and increase storage capacity for processed water in lieu of climate change related water shortages and increased evaporation rates.

A critical point to note is that some value creation opportunities also have implications for mitigation efforts. For example, Shell Global's diversification into alternative energy and fuel supply by investing into research projects that produce biofuels as well utilising the biofuels, has implications for climate change mitigation and adaptation (Shell, 2015). Other opportunities, value creation opportunities, which have mitigation implications, include waste management practices such as re-use, recycling and the selling carbon credits (Harmony, 2014). Having, noted the above, it is imperative to assess the theoretical frameworks, which serve as lenses to understanding roots of the various approaches to climate change mitigation and adaptation.

2.4 Theoretical Frameworks: the lenses applicable to understanding responses to climate change by mining companies.

The theoretical frameworks to climate change response whether mitigation or adaptation is clustered into two main categories. These categories are: the market based and non-market based approaches.

2.4.1 Market based approaches, theories and principles

Moarif, (2012) defines market based approaches as those that aim to influence the behaviour of firms and individuals through the financial incentives and disincentives they are exposed to, or even creating new markets. A list of some economic theories guiding the development of these mitigation and adaptation approaches include: the Rational Theory, Pareto Theory, Free Market Theory, Neoclassical Economic Theory, Fiscal Federation Theories and the Prospect Theory (Asberghaus & Baccanti, 2013). The theories also work within the context of a number of economic and legal principles such as: cost benefit analysis, Samuelson's marginal benefit rule, property rights, equity principles and the procedural and distributive justice principles (Asberghaus & Baccanti 2013).

Attempts to define and understand these theories, principles as well as pin-point their application in climate change mitigation and adaptation lead to the realisation they are best assessed as an integrated system. An ideal illustration is that: free market theories work in allowing private industry to accumulate the capital. This capital enables then to make rational decisions that benefit them, as per the rationale theory which theorizes that a company or individual behaves in a manner based on a rationale of maximum returns to themselves. These companies however work in a neo-classical theory based environment, a public world where the government has to regulate market failures and regulate property right laws. As the company functions on a day to day basis various trade-offs are made in order to balance and enable trade-off for mutual beneficiation, this is the application of the Pareto Theory principles. In summary based on behaviour theories a company is in a constant cycle of decision making which in turn shapes its behaviour. These behaviour needs to be informed as per the education theories so as to be shaped in a particular manner through shaped perceptions , norms and belief patterns. These theories and principles however, will not be discussed into further depths as that transcends the context of this paper.

At a global policy level these economic theories have shaped the development of the creation of greenhouse gas markets, within the ambits of the Kyoto Protocol. The Kyoto Protocol provides a platform for beneficiation when countries do not produce carbon units. This is achieved through systems such as: (i) emissions trading, (ii) the clean development mechanism (CDM) and (iii) joint implementation (JI). Countries such as South Africa, Zimbabwe and India have translated these theoretical approaches into fiscal policies such as (i) taxes on greenhouse gas emissions or energy use, (ii) tradable permits (iii) tradable deposit refund systems and (iv) subsidies like the solar water geyser projects and renewable energy use at corporate or house-hold level (IPCC, 2013). These work in isolation or are supported by the non-market based approaches.

2.4.2 Non-market based approaches and theories

Non market based mitigation and adaptation approaches are those approaches that are not linked to economic incentives, disincentives or the Kyoto Protocol mechanisms for carbon credit trading. Various theories under-pin and provide methodologies on the application of non-market based mechanisms of climate change mitigation and adaptation. These include amongst others (i) education theory (Sessa, 2013) (ii) behaviour based theory (Sessa, 2013), (iii) holistic integrated approaches/ joint management approach (UNFCC, 2011), (iv) Population Growth Theory (Sustainable Population Growth Australia [SPGA], 2013) (v) ecosystem based approaches (Subsidiary Body for Scientific and Technical Advice [SBSTA], 2011).

The education and behaviour based theories are inherently linked (UNFCCC, 2013; Sessa, 2013). These theories focus on increasing education and awareness levels. The argument is that through increased education and awareness levels mitigation and adaptation practices can ultimately be translated into individual and social environmentally sustainable norms. Key components of this model are local level involvement, the tying of these principles into young people’s activities and school curricula.

Joint management advocates action based on an integrated systematic approach. This approach includes policy setting, observation and planning. In addition to these it focuses on participatory involvement starting at local levels. It also includes financial, technological and technical support systems and management by key performance indicators (Bolivia, n. d; UNFCCC, 2013).

The population growth theory argues that mitigation and adaptation strategies cannot succeed unless they are linked to population regulation (UNFCCC, 2013: SPGA, 2013). It states that the inclusion of population reduction mitigation and adaptation strategies will not succeed (UNFCCC, 2013: SPGA, 2013).

Ecosystem based approaches focus on community and multi sector involvement to adapt to climate change by fostering the health of ecosystem for example by forestation, wetland management etcetera. (SBSTA, 2011) Key elements to this approach are: expertise, awareness, capacity building, research, toolkit development, multi-sector collaboration and co-operation (SBSTA, 2011).

The above having been stated one realizes that there is a rational and strategic background against which mitigation and adaptation strategies can be evaluated. But, what are the key the key differences and synergies between these two concepts: (i) climate change mitigation and (ii) climate change adaptation.

2.5 Mitigation and Adaptation: Differences and Synergies

The analysis of approaches between mitigation and adaptation shows the differences in the approaches. These differences are largely resident in the source, practices, policies and action levels. Klein *et al.*, (2005) identify three important differences between the two approaches. These differences relate to: (1) the spatial and temporal scale of their effectiveness and practice, (2) the cost and benefits of each approach; and (3) the actors and type of policies around the two approaches.

The spatial and temporal scale differences relate to the fact that mitigation measures are implemented in varied spaces that include the local, regional and international levels. This is because GHG emissions are not localised but are global. As a result, McKibbin and Wilcoxen (2004) argue that mitigation is best suited for international and national level emphasis. Adaptation on the other hand relates to a local system which, at best, extends to a regional level (Klein *et al.,* 2007). This is because adaptation practices have to suit specific local (and regional) realities relating to varied geographic, institutional, and infrastructural resource issues among others (Ibid). Hence in mining contracting and plant hire work, service providers must be acquainted with every specific mine site climate change so as to sufficiently adapt.

The implementation of climate change mitigation and adaptation actions also carries different costs and benefits. Mitigation practices are characterised by technology and infrastructure- related investments that are focused on using renewable energy sources and/or improving energy efficiencies (Klein *et al.,* 2007; McKibbin and Wilcoxen, 2004)). As a result, the monetary cost of implementing mitigation strategies can be determined and evaluated and, where possible, compared with alternative options. The cost of adaptation on the other hand, is rather difficult to assess, because adaptation costs relate to avoided losses to human, cultural and natural systems, to which it is difficult to assign a pecuniary value (Ibid).

In addition, the cost differences pertain to the benefits of adaptation measures and practices that are immediately effective as is witnessed by reducing vulnerability to the adverse impacts of climate change in comparison to mitigation benefits which are realized after longer periods (Klein et al., 2007). For example, the impact of reducing GHG emissions on the climate (mitigation) are not likely to be as immediate compared to adaptation measures such as building a dam to adapt to the climate change induced seasonal dry spells.

The players, and policy types and levels active in the two spaces also differ. Mitigation actions typically relate to the energy and transportation (Klein, Schipper and Dessai, 2005). This focus on energy and transport limits the number of players in the mitigation practices implementation space (ibid). In contrast, adaptation work includes a wider range of players in both the private and public sectors. The players are in diverse sectors that include agriculture, natural resource management, urban planning and coastal management, among others (Agyepong, 2014). Most notable is that although players in the adaptation space are affected by climate change, they are typically not key decision-makers on the adoption of adaptation measures.

Despite the differences, Klein et al., (2007) posit that the perceived differences arise because stakeholders in the climate change space often emphasise different aspects of mitigation and adaptation in their work. Consequently they assert that despite the differences, mitigation and adaptation do not only work in tandem but are in fact synergistic. They define four types of interrelationship between the two as follows:

1. *Adaptation actions that have consequences for mitigation*. For example, a typical response to flooding would be to increase the size and number of water pumps. The

majority of these pumping devices are powered by diesel or electricity which translates into an increased demand for diesel or electricity. This power is generated by burning fossil fuels causing GHG emissions to increase, especially when there are no carbon sequestration provisions. An increase in GHG emission could be subverted by the use of alternative cleaner energy sources that produce less, or no GHGs (Klein *et. al.*, 2007).

2. *Mitigation actions that have consequences for adaptation*. For instance, where water is in abundance, hydro-electricity is ideal to reduce GHG emission from fossil-fuelled electricity generation plants. However, when water supply becomes constrained due to climate change induced droughts, this raises a potential area of conflict when irrigating food crops and it becomes necessary to mitigate the impacts of climate change on precipitation patterns alteration.

3. *Trade-offs or synergies between adaptation and mitigation.* The argument is that, in principle, it would be beneficial to simultaneously adopt and implement both climate change mitigation and adaptation practices. The challenge in this regard is resource (finance, human and technology) scarcity to adopt and implement both practices.

4. *Processes that have consequences for both mitigation and adaptation.* Notwithstanding the above, there are cases when it is inevitable to consider the simultaneous implementation of both mitigation and adaptation. For example, where there is a need to mitigate GHG emissions through a dam with hydro-power generating equipment, the same dam may also be a source of water for irrigation, adapting to climate change water scarcity (Klein *et al.*, 2007). A key consideration in such a case would be to avoid singling out one function (hydropower or irrigation) as the dam's main purpose.

In summary, climate change mitigation and adaptation practices are complex and dynamic concepts individually, and in their interaction. The complexity and dynamism have not halted the attempt to manage the climate change challenge. Instead, there is a litany of current, proposed, and envisaged public and private sector policies seeking to manage the phenomenon. The next section examines the architecture and type of these policies.

2.6 Mitigation and Adaptation Policy and legislation

The theoretical underpinnings of climate change management strategies cannot come into effect without their translation into the active public and economic realms of society through policy (Miller and Spoolman, 2011). The Australian Concise Oxford Dictionary states that policy is a course or principle of action, adopted or proposed by a government, party, business or individual. These policies can be perceived as risks or opportunities. A plausible approach to examine the climate change management policy terrain would be the identification of the relevant policies at international, national, provincial/ state, local governance and site level (Hoffman, 2014).

The architecture of climate change mitigation and adaptation policy indicates organisation on two broad levels: the international level and the national level, the permeation and translation of these broad level policies into site-level policies, standards, procedures, and work instructions mark their transformation into strategies and practice for companies such as MCCGC. This section traces the translation and adoption of international policy through national and sub-national levels to site-level strategies and practices in a private enterprise.

The international level is the broadest policy level. The 1992 United Nations Framework Convention on Climate Change - UNFCCC (UN, 1992) and the Kyoto Protocol (UN, 1996) can be argued to be international level policies that guide regional and country level climate change management policies and practices. The UNFCCC is one of the earliest institutions that enabled the global climate change policy trajectory. Through it, the majority of countries in the world reached an international treaty to cooperatively consider the management of climate change. The aim of the treaty was to consider how the different countries could limit average global temperature increases, the resulting climate change, as well as cope with whatever impacts were, by then, inevitable. The UNFCCC was ratified by 195 countries, with South Africa ratifying the convention in 1997 (Nhamo and Phopiwa, 2014).

However, the convention did not succeed due to poor commitment by signatories, inadequate monitoring and enforcement, and a lack of clear targets (Ibrahim and Uke, 2013). This led to the development of a complimentary Kyoto Protocol, making the global policy framework to climate change a two-tier system (Nhamo, 2011). The Kyoto Protocol was ratified by 192 countries (UNFCCC, 2013). South Africa ratified the protocol in 2004 (ibid). The Kyoto Protocol presents mitigation and adaptation as the two key strategies to climate change response. The protocol outlines the key components of mitigation and adaptation frameworks as technology development and transfer, research, financing, behavioural change, capacity building, carbon and methane sequestration technology development and use, as well as carbon offsetting via economic instruments and carbon trade mechanisms (UN, 1997).

Subject to two yearly reviews, by the Conference of the Parties (COP) which is the conference of the parties in the supreme policy-making body of the UNFCCC; the Protocol has brought in a number of key policy developments such as the Bali Roadmap of 2007 (Carpenter, 2008). This roadmap outlined adaptation, mitigation, capacity building, technology transfer and financing as the five pillars that industry needs to focus on in response to climate change (Nhamo and Pophiwa, 2014; Nhamo, 2013). Mining companies such as Exxaro have also found direction in these international commitments. Exxaro (2015) recognises and streamlines its “Climate Change Strategy” guided by COP 15’s Copenhagen targets of 34 percent and 42 percent carbon reduction in South Africa by the year 2020 and 2025 respectively.

These and other international level policies have been translated into national climate change response policies in a number of countries. Examples of this can be drawn from the developed, medium developed and developing countries. With reference to the Kyoto Protocol’s adoption by the first world countries, the Norwegian Government developed the Norwegian Climate Policy (Norwegian Ministry of Environment (NME), 2011). Norway’s primary policy drive is domestic carbon neutrality, through carbon pricing, carbon trade systems, as well as funding research and technology development through its Enova funding schemes. It also seeks to benefit from trading its own technologies such as carbon capture systems. The policy posits a multi-sector approach, which targets various high emitting and individual industries in actions to reduce carbon emissions. Climate-considerate housing and construction, enhanced public transport and fuel efficient vehicle importation are some of the options that Norway intends to pursue.

Norway’s climate policy also focuses on industrial climate response. This is stimulated through carbon tax, funding for technology development and purchase, technical advice and support as well existing pollution prevention and environmental protection legislature. The country also asserts that in order to achieve the domestic and global goals in climate change management it has to lead the international community in policy formulation, and also aid developing and medium-developed countries in climate change response. Norway’s approach to the policy signifies a country which accepts its responsibility in creating the current global crisis, as well as the financial advantages developed countries have to procure and implement resources, skills and technology for climate change response. The document is, however, vague on adaptation.

Namibia is a medium developing country that has also adopted climate change through the National Policy on Climate Change for Namibia (Republic of Namibia Ministry of Environment and Tourism [RNMET], 2010). A prominent aspect of the policy is that it presents climate change as an extra burden to a resource deficient country that is financially challenged and has vulnerable industries and citizens. Two key focus points immediately emerge as the need to mitigate and the need to adapt. The focus for Namibia's policy is to adapt by protecting key development pillars and livelihood providers within the communities and industry. The focus areas are agriculture, fisheries, electricity, human health, infrastructure, and disaster management. To enable this, the policy focuses on education and training, public awareness, stakeholder involvement research and information needs, as well as legislation development. In the policy, Namibia also presents itself as a victim of the developed countries and other countries' pollution, and as being in need of financial, information, and technical assistance.

The South African Department of Environmental Affairs (DEA) (2011) updates South Africa's response to climate change through the National Climate Change Response White Paper. The foundation of this response can be traced back to South Africa's focus on sustainable development. The sustainable development vision was articulated in the National Framework for Sustainable Development in South Africa (DEA, 2008). The framework's objective was to ensure a sustainable, economically prosperous and self-reliant nation, with the means to safeguard its democracy by meeting the fundamental human needs of its people as well as managing its limited ecological resources responsibly, for current and future generations (ibid.). In other words, the vision was a developmental trajectory, although the term 'climate change' was not key in this framework and only featured once in the document. However, this changed when the term became prominent within the sustainable development discourse arena resulting in climate change management being the sole purpose of the National Climate Change Response Strategy White Paper (NCCRS), (DEA, 2011).

National level policy objectives are often supported by a plethora of policies that directly and indirectly refer to climate change management. South Africa has seen the promulgation of over 25 climate change related legislative instruments (Nhamo *et al.*, 2014). These new era policies for climate change mitigation and adaptation are complimented by pre-mitigation and adaptation era laws, which were aimed at regulating civil and business risk in the areas of commerce, safety, environment, social welfare as well as mineral extraction and beneficiation. These precedent legislations include; The Mines and Minerals Resources Act, The Mine Health and Safety Act, The Occupational Health and Safety Act, The Atmospheric Air Pollution Prevention Act, and The National Environmental Management Act, among others (Uys and Steyn, 2014). These tier (1) policies still impact on mitigation and adaptation efforts and are still of relevance.

These national policies have permeated into lower government levels that include provincial/state[1] level, local government level and public policies for the public sector. For example, in South Africa, each of the provinces either has or is developing its climate change response policies and strategies as guided by the national interest articulated in the national policy. For instance, the response of the country's commercial hub province, Gauteng, is articulated in the Gauteng Climate Change Response Strategy and Action Plan (Gauteng Province, 2012). Provincial/state level policies are, in turn, also translated to local government level policies. At this level, South Africa has 278 municipalities in South Africa, comprising eight metropolitans, 44 district and 226 local municipalities. Cape Town, the city that hosts the country's parliament, articulates its climate change response through the Cape Town Energy and Climate Change Strategy (City of Cape Town, 2005).

One of the most notable actions by the city, together with other cities like Durban and Johannesburg, is an attempt to address the GHG emissions' challenge from motor vehicles through developing expansive and reliable public transport projects such as the Bus Rapid Transport System and the Gautrain project to minimise the use of private vehicles (Nhamo, Pophiwa and Tshagela, 2014). The private sector is also actively engaged in attempts to manage the climate change phenomenon. Private sector responses to this end are driven by the need to manage the earlier-discussed risks (Mduli and Barve, 2011).

The urgent need to address climate change challenges and the scarcity of human, technological and financial resources to manage them, dictates the need for an organised and efficient implementation of the climate change management policies and strategies. A number of guiding framework models have been developed to this end.

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[1] Some countries use the term province, for example, South Africa and others use the term state, for example, Nigeria and the USA.

2.7 Mitigation and Adaptation Strategy Frameworks

There are various guidelines informing practices in the implementation of climate change mitigation and adaptation strategies across economic sectors, including mining. These have been developed by international, national, private and academic agencies. The United Nations Convention on Climate Change (UNFCCC), United Nations Environmental Programme (UNEP) and the Intergovernmental Panel on Climate Change (IPCC) play a significant role on the international stage. Examples of guidelines published at an international level include: The UNFCCC Resource Guide for Implementing National Communications for Non Annexure (I) Countries: Module (4) which focuses on the measure to mitigate climate change (UNFCCC, 2008). The IPCC produces climate change assessment reports. At the time of writing this chapter, five such reports had been produced between 1990 and 2014 (www.ipcc.ch).

State level guidelines come in various forms and are published on a variety of platforms that include web-based resources and repositories of publications. One such resource is the Environmental Protection Agency (EPA) of the USA's "Local Climate Action Framework: A Step-by-Step Implementation Guide" (www.epa.gov). Such national guidelines are often translated into appropriate lower government level guidelines such as the USA General Services Administration Action Plan and Alaska's Climate Adaptation Planning Manual (USA General Services Administration (GSA), 2013; Johnson, 2011). Local governmental bodies such as South Africa's Cape Town also exhibit such framework, through publications like the Framework to Adapt to Climate Change (Nhamo, Phopiwa and Tshagela, 2014).

The various guidelines are aimed at integrating the emerging paradigms of mitigation and adaptation into already existing and active environmental management systems. Despite the availability of these various tools, the undertone is that there are three basic frameworks which can be adopted to implement climate change mitigation and adaptation. Figure 2.1 is a simplified framework model for mitigation. It is adapted from the United Nations Framework Convention on Climate Change Guidelines (1 and 4) for climate change mitigation and is applicable to a number of situations and operations including the mining sector and its input goods and services linkages.

Figure 2. 1: UNFCCC Climate Change Mitigation Framework (***Source: UNFCCC, 2013)***

Figure 2.1 is a cyclical model which can be streamlined for climate change mitigation actions at a company level. The genesis of the process involves an identification of the GHGs that are produced by an entity. This is followed by a compilation of a list of GHG emitting and absorbing (technically known as sources and sinks) aspects of the business which in turn is followed by a measurement and the creation of an inventory of the entire scope of GHGs. The GHG emissions quantity established in this step is considered as the baseline from which emissions reduction targets are set.

To effectively and efficiently stabilise and reduce the emission, the mitigation options are then identified and ranked from best to worst. The assessments are based on various criteria that include cost, effectiveness, resource availability, future discount rates, perceived social behaviours and preferences, amongst other factors. After the options are ranked, policy statements and regulations are formulated to enable their implementation. In turn the policies are translated into action plans, which are then resourced financially, institutionally and in terms of human competencies for implementation. Implementation progress is measured and reported through formal reports that feed into national communications. Key components to the strategy include the identification and active movement to break barriers to climate change mitigation. In conjunction with mitigation is adaptation, illustrated in Figure 2. 2.

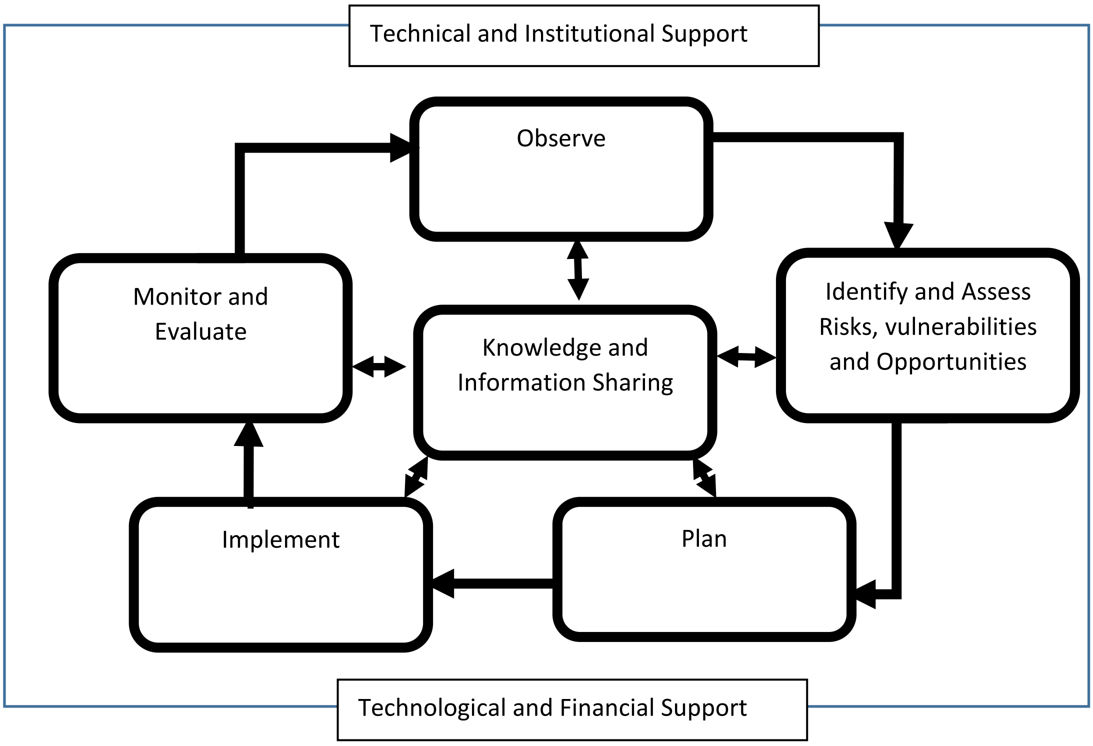

Figure 2. 2: UNFCCC Climate Change Adaptation Model **(Source: UNFCCC, (2013)**

The adaptation framework illustrated in Figure 2.2 occurs in five key stages within an iterative process. These stages are: (i) observation, which includes the use of personal and scientific observations to identify how and to what extent the climate is changing so as to make a decision of whether the change is relevant or not. (ii) Risk and vulnerability assessment which involves a two-step assessment of legal, financial, operational, customer based, supply process based on current and future risks that emanate from climate change. The first step serves as a screening process which enables the sieving of risks to enable focus only on the significant ones. The significant risks are then ranked using exposure, probability and severity matrices to enable appropriate prioritisation of actions based on the organisations' vulnerability to the risk(s). (iii) The third stage is the planning step. During this stage, adaptation options are identified and ranked with regard to cost-benefit analysis, technological availability, ease of implementation, social impact assessment as well as environmental impact assessment. (iv) Once the options are ranked, they are implemented, as the fourth stage. Implementation involves the active use of: infrastructure, finances, available human and technological resources to ensure that the organisation prevents or minimises not only the effect of adverse impacts but also maximises opportunities provided by climate change. (v) The fifth stage involves monitoring and evaluation as well adjustment of the strategy to ensure effectiveness and efficiency.

Hoffman (2014) identifies an alternative step-by-step process for developing and implementing climate change responses. The model is important on two fronts. The first is that it integrates mitigation and adaptation strategy development and application. The second is that the model is specifically formulated for industrial applications. This model presents climate change management as a three-stage model with a feedback loop. The three stages are: (i) Strategy development (ii) Organisational Inward Focus, and (iii) Organisational External Focus.

Strategy development comprises four steps, namely: observation, risk assessment, identification of options and the setting of objectives and targets. Organisational Inward Focus involves resourcing the set options and obtaining internal stakeholder buy-in. Organisational External Focus involves the development of mandatory and voluntary external policies which address climate change concerns and risks at international and local levels. These processes are periodically monitored, evaluated and reviewed through feedback loops to check if there is new information as well as alignment to set goals and targets. This information is used to recalibrate the system towards evolving needs. The use of feedback loops draws from the traditional continuous improvement model of the International Standards Organisation (ISO) series.

While the models may appear sound, their efficacy is tested during practical implementation. However, their application in mining requires one to infer on what the mining supply chain consists of, so as to master the scope of climate change response within this industry.

2.8 Supply chains: an overview with cases of climate change response

The supply chain involves the network of organisations that are involved in the upstream and downstream linkages in different processes and activities that create values value in the form of products and services for the consumers (Christophel, 1998). Supply chain management can be viewed as a business process that seeks to ensure the efficient and productive flow of products, materials, services and information from the supplier through to the customer (Chopra and Meindle, 2007). Supply chains are within all facets of industry be it, tourism, agriculture, manufacturing, retail, mining which includes the opencast mining contracting and plant hire sector represented by MCCGC, the focus case of this study.

The mining supply chain's intricate network of and linkages is profiled by (Owusu-Bio, Donkor and Muntaka, 2016) into four key categories (tiers) and these are: (i) direct suppliers (engineering service providers, original equipment suppliers, consumable input suppliers, agents and distributors. (ii) Indirect suppliers (specialised engineering and services, component manufacturers, input providers). (iii) Direct mining services (geological, survey, landscaping, laboratory services, drilling services and (iv) Indirect service providers (finance, insurance, real estate, legal services, transport and logistics, civil engineering, environmental services, construction, landscaping, catering, cleaning and security). Opencast mining Companies such as MCCGC have an affiliated supply chain interlinked to them for equipment, machinery, material, human resources, information technology, travel, accommodation and management consultancy amongst others. These are necessary to meet the toll contractual requirements of their customers such as PPM and Tharisa Minerals. Companies such as MCCGC provide the required logistical support as well as have internal logistical requirements such as the movement and handling of inventory, resources, materials and information.

Backward (input), forward (output) and fiscal (governance) linkages exist within these tiers. Studies worldwide and in particular Australia, India and China indicate that the mining industry supply chain linkages are extremely energy intensive hence have a significant carbon footprint from emissions (Ruttinger and Sharma, 2016). These carbon emissions are also derived from logistical services of the mining supply chain such as such as prospecting, mine establishment, drilling, blasting, loading and hauling of mineral resources as well as products such as coal. At times however activities within the supply chain such as mine decommissioning and rehabilitation have both negative and beneficial aspects to climate change mitigation and adaption for example the Anglo-American mining water development projects in Mpumalanga provide carbon sinks from the dam construction as well as water supply resilience for climate change induced droughts, hence are an adaptation mechanism.

International mining companies such as Rio Tinto, BHP Billiton, Vale and Anglo American; regional ones such as Newpont Mining in Ghana and national South African companies such as Exxaro have realised that managing the supply chain and optimising its efficiency has an economic, legal reputation, competitive, financial, community, environmental and physical risk aversion benefit. All of which fit within the nexus of climate change related risks as was discussed in Chapter 1. To this end, they have implemented supply chain management technologies software such as Triple Point Technology's Commodity XL™ and QMASTOR mining solution suites (Isherwood, n.d). These technologies are able to integrate and manage production efficiency, optimise fleet movement, manage costing, vessel movement optimisation, domestic and local supply chain management, load management as well as project on supply chain risk. In this, they provide both a mitigation and adaption strategic tool. The ability to be integrate and meet the requirements for fleet service and management reliant companies such as MCCGC, and its applications at international, regional and national levels makes this a relevant and significant case for this study.

Additionally, recent success in climate change negotiations, public awareness and the ever increasingly evident impacts of climate change have spearheaded mining companies to explore the renewable energy option. The Chilean mining sector has systematically cut down on carbon emissions by transitioning to renewable energy such as concentrated solar and wind power (Mathews, 2014). This has had an added advantage of creating an industry, employment, energy supply security and environmental protection since it reduces the need for foreign energy imports, which Chile traditionally relied on.

Despite the these cases, Ruttinger and Sharma (2016), concur that "very little", has been done to bring in a systematic climate focus and investigate the role climate change can play in destabilising the mining and metals supply chain as well as the availability and perhaps even the pricing of these commodities. One hence can conclude saying that even as recently as 2013 - 2016, scholars and industrialists are concerned on the mining supply chain's mitigation and adaptation regulation and operational resilience (Mason and Guico, 2013; Ibid).

The next section examines cases of practical climate change management within the mining supply chain by a number of mining companies selected from an international, regional and South African, national scale.

2.9 Climate Change Mitigation and Adaptation in Mining

The basic model of mining presents the industry as a project cycle which is implemented in phases. These phases begin with business strategy development, exploration, infrastructure development and site establishment, operations, decommissioning, mine closure and rehabilitation phases (Chavalala and Nhamo, 2014). These phases are inherently supported by service departments such as, human resources management, environmental management, engineering services and health and safety management (Technology Intervention Agency (TIA), 2012). The entire process is serviced by various contracting and supplying companies, whilst the end product is consumed by a variety of markets. It is within this context that mitigation and adaption are applied.

Ore extraction mining operations are executed through a number of optional mining methods which include, shaft/underground mining, quarrying, and opencast mining. Open-cast or open-cut mining is a surface mining technique for extracting rock or minerals from the earth by their removal from an open pit or borrow pit. This form of mining differs from extractive methods that require tunnelling into the earth (Sahoo et al., 2013). Mining firms can either use internal resources to extract the mineral bearing rock from the pits or may contract service providers to do this. The opencast mining contracting and plant hire business sector focuses on the provision of mining services to mine owners by providing specialised services and equipment for ore extraction, and at times its transport to a processing site (Leighton, 2008). The degree to which mining firms outsource this function differs with some mines choosing to only outsource the provision, operation and maintenance of equipment, while retaining in-house mining geological, survey and mining-right, legally-mandated management functions.

Climate change mitigation and adaption have become embedded into the various mining models. The case studies presented here provide empirical evidence of how the macro-scale international and national framework models for implementing mitigation and/or adaptation have been micro-scaled for adoption at the corporate and site level. The cases are drawn from international, regional and the South African national contexts.

2.9.1 Thiess Holdings

Thiess Australian Mining Company is a subsidiary of Leighton Holdings, one of the largest opencast mining contracting and services companies in Australia. The company acknowledges its corporate, social, environmental and sustainable development responsibilities. It is on record that Thiess Holdings has been actively implementing a climate change mitigation strategy that focuses on energy efficiency since 2008. This intervention lowered fuel consumption and ultimately reduced GHG emissions through reduced diesel usage by heavy mining equipment such as haulers, loaders and ancillary equipment which consume approximately 16 percent of the energy demand in opencast mines (Wilkinson, Lionel and McDonald, 2010). Relative to the entire mine's 16 percent energy consumption demands, fuel consumption constitutes 90 percent of the energy demand of the opencast mining contracting and plant hire companies. Thus, it contributes the bulk of their carbon emissions profile. Thiess Holdings' energy efficiency strategy was catapulted into action through its pro-active participation in a trial energy efficiency improvement case study project in association with the Australian Government Resources, Energy and Tourism Department (Saxelby, 2009). The results of the case study are described in this section of the chapter and provide a benchmarking case of how climate change mitigation frameworks are applied to industrial settings.

Strategy formulation was driven by corporate vision and legislation leading to an energy and emissions audit, which was verified by external auditors as per government standards. The emissions audit provided the benchmark for future energy and emissions reductions. Employees from one site were then used in a screening exercise to identify the opportunities for energy efficiency. Out of these, 206 actions emanated. These were then rationalised into 46 streams of similar actions. Out of these 46, the following four were implemented immediately:

1. Reduce machine idling time through stakeholder involvement and monitoring. The machine operators were given daily data on idle time, as well as the costs and emissions related to these. The drive was centred on behaviour change.
2. The second option for immediate implementation was the reduction of turbo idle times through engaging external stakeholders; the original equipment manufacturers (OEM). Thiess Holdings had realised that the stipulated five-minute rule for idling vehicles at start-up and shut-down was too generalised and could be reduced, hence decreasing fuel consumption and GHG emissions. The negotiations with the supplier successfully resulted in a warranty-backed agreement to reduce this idling time from five minutes to three minutes. This resulted in savings on energy, money and machine lifespans.

3. Engineering modifications for energy consumptions reduction was achieved through automatic switching on and off of mobile lighting equipment by applying day-night switches. This reduced diesel wastage by the lighting equipment plants which had been high previously, due to either people forgetting or delaying to switch them off. The initiative also eliminated the need to burn diesel when supervisors drove to the lighting plants to switch them off. The net result of this initiative was reduced diesel consumption by the lighting plants and vehicles used to drive to them, and a penultimate GHG and cost reduction.

4. Payload management was another option that was implemented immediately. Optimising the payload improved fuel efficiency with immediate pecuniary value and GHG emissions' reduction. The process involved buy-in from all echelons of the organisation. It involved a regular collection and sharing of data from payload, savings, losses and profits during the entire exercise. This then led to improved attitudes and behaviour towards energy efficiency.

The case of Thiess Holding shows a largely internal focus in climate change management initiative implementation. The initiative was largely self-financed and estimated to have a payback period of less than two years.

However, the organisation also focussed outwards, by jointly implementing the process with the government department for mineral, resources, energy and tourism. In the process, Thiess was also active in the formulation and roll-out of the energy efficiency policy and had an insider advantage by being a part of the trial run. Further external engagements included public publications of the case study findings. The energy efficiency and carbon emission reductions are measured and reported annually, in order to review and modify processes for greater progress.

2.9.2 Vale

Vale Mining Company provides a regional perspective of regional climate change responses in opencast operations and mining houses. Although it is based in Brazil, it has its operations in Latin America, and African countries like Mozambique and the Democratic Republic of Congo (DRC) (Vale, 2017). Vale Mining Company is adapting to climate change through incorporating climate change into its business management strategies (Nelson and Schuchard, 2009). The strategy includes identifying legislative, physical risks and business opportunities related to climate change.

The climate change response strategy is spearheaded by Vale's New Economy and Climate Change team, which utilises scientific modelling to identify local, regional and international risks and opportunities related to climate change. In Brazil, Vale used the National Institute of Space Research Institute to identify the weather variations in North and South Brazil to determine the vulnerability and opportunities of its operations there (Nelson and Schuchard, 2011). In response to the physical risk to infrastructure and operations, emergency preparedness planning and practice were identified by the company as critical issues for managing the associated risks. The firm is acting in various ways to adapt to the present and projected changes. For instance, the company participates in the fire-fighting practices of local municipalities in anticipation of climate change related cases of fire. The firm's participation also seeks to build community relations as well as develop the appropriate and adequate fire response skills (Ibid).

Market diversification and expansion in renewable energy as well as clean technology development and marketing have been recognised as an opportunity by Vale. This is a synergistic approach that facilitates both mitigation and adaptation. To this end, Vale has collaborated with technology development institutions and the Brazilian National Bank to form the Vale Research and Technology Development Institute (McIvor, 2010). This collaboration is seeking to create equipment that has a lower carbon footprint, is more energy-efficient, and is aligned to sustainable business practices. Examples of technological innovations that Vale has developed and is using include pneumatic-driven air pumps and compressors that have replaced their GHG producing predecessors. Vale is also exploring climate change related opportunities by diversifying its markets. This, through the development, selling and internal purchase of solar-powered generators, lighting plants, compressors and pumping systems from its own clean energy equipment distribution company. Vale does not want to be subjected to the whims of policy developers; instead it pro-actively participates in the climate change policy development.

The company is participating in the development of international and national legislation in forums such as the World Council on Sustainable Development, the Copenhagen Communiqué and Greenhouse Gas Protocol Brazil (Bristow, 2010; NewEconomy, 2012). The company further participates in the voluntary Carbon Disclosure Projects (CDP), as a way of improving investor and public image, whilst also improving business operations. Within the South African context, Exxaro is also responding to climate change.

2.9.3 Exxaro Resources Limited

A third example of a company engaged in climate change response via systematic management tools and practices is Exxaro of South Africa. The firm is a black-owned conglomerate with operations in the mining industry covering coal and precious minerals (Exxaro, 2014). Since 2007, Exxaro has established climate change, energy efficiency, and carbon reduction strategies which cover its entire operations (Togo, 2014). The implementation of these strategies exhibits the stages of strategy formulation, internal focus, external focus as well as the monitoring and evaluation loops.

The company has established steering committees focussing on energy efficiency, electricity consumption and carbon emissions reduction (Togo, 2014). Such pro-active inference into operations made Exxaro realise that energy efficiency, supply and demand security, as well as cost, were a major risk to its operations and sustainability. Exxaro hence further assessed from where these risks would emanate (ibid; Exxaro, 2009). The company's actions and outcome in the climate change management arena are facilitated by its carbon emissions data base, as well as informed research conducted by the three chairs it sponsors at the Universities of South Africa, Pretoria and Witwatersrand (Exxaro, 2013; Nhamo, 2014). This informed approach has led Exxaro to identify key policy shifts in the climate change arena and hence respond to them.

At a policy level, legislative and regulatory risks were pinpointed as emerging from international policy such as the Kyoto Protocol, South African legislation such as the National Climate Change White Paper, the eminent carbon tax, and the investor-driven Johannesburg Stock Exchange Sustainability Reporting Index (JSE SRI) (Exxaro, 2009). These policies were also an indicator of growing political and public impetus towards reducing coal-based electricity, due to its association with GHG emissions, global warming and ultimately climate change. Exxaro realised that such sentiment could potentially drive it out of business, since 88 percent of its revenue is from coal supply to

South Africa’s electricity generating and supply utility, Eskom’s thermal power stations and municipal power stations (Togo, 2014). The sentiments could also lower the company’s shareholder value, due to lowered investor confidence (Ibid). The carbon tax could increase operating costs to unprofitable margins for some ore seams as well as reduce profit margins (Exxaro, 2014; Harmony, 2013).

In response to these risks the company is pursuing a business adaptation strategy aimed at both value creation and value protection, by diversifying into the opportunities presented by the growing renewable energy production sector (Exxaro, 2014). Exxaro also acknowledges the opportunities presented by renewable energy development, production and use legislation, such as the Renewable Energy Feed-in Tariff System, as well as the Energy Efficiency Accord (Togo, 2014). These have created markets and rewards for energy efficiency as well as production. In response to these drivers, the various stakeholder forums such as the Clean Energy Forum (CEF) and Energy Efficiency Forum (EFF) have aligned their actions to lean towards Exxaro’s Climate Change Response Policy (Ibid). This move towards cleaner energy provision also has co-benefits for mitigation. In order to benefit from the renewable and clean energy production sector, Exxaro has partnered with Tata India, a technology development company to form Cennergi, a renewable energy and technology development marketing company (Ibid).

Exxaro also has an outward focus in its climate change management works. The company participates in both national and international policy formulation forums. These include: Climate Change Initiative, National Business Initiative, Chamber of Mines and the United Nations Global Compact among others (Exxaro, 2015).

Exxaro has already experienced decreased energy dependency, improved efficiency and reduced energy costs through its housing project in Lephalale, South Africa (Sinkhakane, 2011). This is because the houses under the project been built according to the climate smart United Nations specifications. These specifications enhance energy efficiency, reduce power-grid electric energy needs and utilise solar-water heating and internal cooling systems (Veti and Morris, 2014). The use of natural shedding for heat regulation as well heat retention polymers also reduces the houses’ energy needs during winter (Togo, 2014).

2.10 Conclusion

Climate change management theories, practices and technologies are still the subject of intensive research and will continue to be in the medium- to long-term future. The discoveries and developments in the field will determine the economic, social and environmental viability of companies within the mining industry in general as well as the mining industry in its entirety. Contract mining and equipment supplying (hire) companies in this sector are also affected and interested stakeholders. Two issues are critical in these developments. The first is that development will be guided by a combination of private and public policies at various levels. The second is the need to ensure the efficient use of scarce human, technological and financial resources through simultaneously focusing on interventions that combine mitigation and adaptation issues. This is particularly important for companies in developing countries like South Africa.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research approach used to address the research questions to meet their objectives. As stated in Chapter 1, the main objectives of the research were to investigate and document the climate change mitigation and adaptation strategies, and the practices that are employed by MCCGC. Chapter 2 reviewed the theoretical concepts and practices that underpin these research objectives. The present chapter provides the details of the data collection and analysis methods that were used in the research. The chapter also discusses issues related to validity, trustworthiness, limitations and ethics which were encountered, considered and addressed during the research process. Given that the principal researcher is an employee of the MCCGC, the chapter also examines the issue of reflexivity as a means of managing relationship dynamics and responses to questions and analysis of the responses. The research for this study is discussed in Section 3. 2 below.

3.2 Research Design: Case Study Research

This research was designed and conducted as a case study. Case study research typically involves an in-depth observation of a bounded system which forms the unit of analysis (Creswell, 2013; Liamputtong, 2013). This approach enables the investigation of a bounded contemporary phenomenon or object within its real-life context (Gilham, 2000; Yin, 2009). Case study research can be applied to a single case where it is referred to as a single case study (Creswell, 2013). Alternatively, it can be applied to more than one case where it is referred to as a multiple case study or a collective case study (Creswell, 2013; Gilham, 2000). This research adopted the latter approach, focusing on two mines; Pilanesberg Platinum Mines (PPM) and Tharisa Minerals Mine. The multiple case study approach offers the advantages of generating results that are considered to be more compelling and therefore is regarded as being more robust in comparison to the single case study approach (Yin, 2012).

The case study was conducted as a means to explore, as well as to describe, the climate change management strategies and practices of MCCGC. This made it both an exploratory and a descriptive case study. Babbie (2010) describes an exploratory case study as one that aids the researcher in familiarising with a topic of interest or a relatively new subject matter; in this case, how climate change is managed within the opencast mining sector's contracting and plant hire portion of the supply chain. A descriptive case study involves the researcher observing and describing the observations that pertain to the issues under investigation (Ibid). This research sought to examine and document how the MCCGC group is engaging with the climate change management discourse as it offers services to its clients. A qualitative research approach was implemented within the case study.

3.3 Research Approach: Qualitative

Against a background of the complexity of factors around climate change management, the research sought data that could effectively and adequately interrogate these factors. Qualitative data is primarily concerned with experiences of research subjects and how such experiences shape the meaning of information collected about a specific research topic (Rubin and Barbie, 2008). Denzin and Lincoln (2013) also argue that quantification procedures can be employed to extend and reinforce qualitative data and interpretations. Resultantly two types of data; qualitative and quantitative data were collected to help interrogate the complex factors surrounding climate change response strategy development and their translation into practices at the selected case study units.

Although the study was predominantly a qualitative case study it had a mixed methods approach. A mixed methods approach employs more than one type of research method. The methods may be a mix of qualitative and quantitative methods, a mix of quantitative methods or a mix of qualitative methods (Bryman 2001). This research employed the mixed methods approach that used a mix of qualitative and quantitative methods.

The mixed method approach also extended to the use of a diverse array of data collection and analysis methods. Data was gathered through questionnaires, observations, interviews and document analysis as a means of triangulation. Data analysis was through content analysis as well as document analysis.

The qualitative research approach was practiced on the data which was collected using the sampling design and methods that are discussed in the following Section 3.4.

3.4 Sampling Design and Methods

The sample design for this research involved the selection of two case units or study sites using the site selection criterion discussed in section 3.4.1, hence the research design being a multiple case study. Within these case units a sampling methodology was implemented as described and discussed section 3.4.2.

3.4.1 Site Selection Criterion

The MCCGC has 11 mining-related operations in Africa (MCCGC, 2013). In South Africa, the firm provides opencast mining and plant hire services to the following mines: PPM, Tharisa Minerals, Nkomati, Dorstfontein, Steelkeenspruit, Coal of Africa in Vele, Muhanga, Eland, Khutala and Wolvemaanskraans. Its Plant Hire Section and head office are coordinated from Midrand, South Africa. Figure 3.1 is a map showing how MCCGC's operations are spread into Africa. South African operations are in the Mpumalanga, Northwest, Limpopo and Gauteng Provinces. The firm also has two sites outside South Africa. These are the Benga project in Mozambique and the Areva project in Namibia. In addition to mining contracts, the company also has a plant hire division which hires out heavy mining and construction machinery to various companies and individuals within Southern Africa.

Key to List of current projects
1. Boschmanskraans
2. Steenkoolspruit
3. Khutala
4. Nkomati
5. Dorstfontein
6. PPM
7. Tharisa
8. Benga (Mozambique)
9. Trekkopje (Namibia)
10. B2 Gold (Namibia)

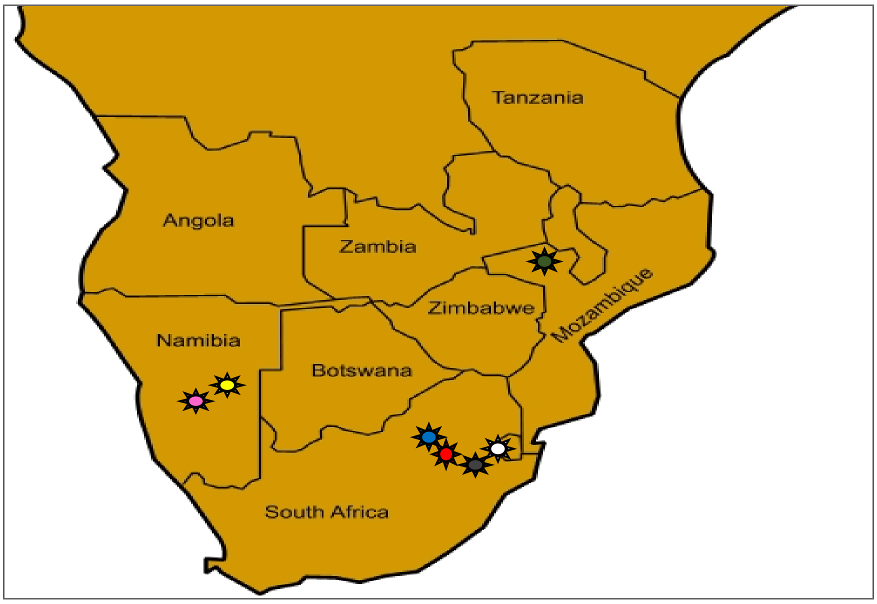

Figure 3. 1: MCC Group Mining Contract Projects, 2013.
Source: Adopted from, www.mccgroup.co.za,

Examining the climate change management practices at the 11 operations was not going to be possible within the time and finance limits of this research. As a result, two sites, PPM and Tharisa Minerals Mine were chosen as case units.

The two mines were selected based on two considerations. First, the two sites can be considered to be representative of MCCGC operations because they are the largest of MCCGC's operations sites. More importantly, the two sites host the entire range of machinery and technologies that the MCCGC group employs in its other contracts. The two mines also have the same fundamental mining processes as the other nine sites.

Second, the two sites were also convenient for the researcher, offering both time and cost effectiveness against the background of the time and financial related constraints of the research. The two mines are within a 120 km driving distance from the residence of the researcher who resides in Rustenburg, a town situated in the Northwest Province of South Africa. The town is located between the two mines; 100km from PPM and 30 km from Tharisa Minerals. Furthermore, the researcher works at PPM and also worked at Tharisa Minerals within the time frame of the study. All these considerations jointly strengthened the issue of convenience and familiarity with the cases being studied (Welman et al, 2008; Gillham, 2000). Study units were then selected from these two selected sites.

3.4.2 Study Units Selection

Data informing the research was generated from both human and non-human sources. The human sources comprised various employees at different levels within each mine's hierarchy and departments.

Employees were stratified according to hierarchy per department. Stratification allowed the targeting of respondents at the various hierarchical levels. This gave the appropriate triangulation. The targeted employees at each level informed the research by either responding to a questionnaire or an interview. Table 3.1 shows the population and sample of employees who responded to the questionnaire, per department.

Table 3. 1: Questionnaire Administration at PPM and Tharisa

		PPM				Tharisa		
Item	Department	Shift	N	n	%	N	n	%
1	Executive Management	Straight	1	1	100	1	1	100
2	Management	Straight	7	7	100	9	5	55
3	Administration Staff	Straight	2	2	100	5	4	80
4	Survey	Straight	3	1	33	9	4	44
5	Safety Health and Environment	Straight	9	1	11	4	2	50
6	Human Resources and Training	Straight	7	4	57	5	2	40
7	Production	A	70	62	88	85	38	44
		B	67	33	49	93	77	83
		C	64	47	73	93	0	0
		D	60	18	30	N/A	N/A	N/A
8	Engineering	A	22	12	54	15	10	66
		B	22	N/A	0	20	N/A	N/A
		C	25	20	80	20	18	90
		D	21	N/A	N/A	N/A	N/A	N/A
		Straight	120	20	17	60	33	55
9	Blasting	Straight	49	33	67	38	26	68
10	Sub-contractors	Straight	16	11	68	N/A	N/A	N/A
Total			**565**	**272**	**58 (Avg)***	**457**	**216**	**60 (Avg)**

Key: N – Strata Population Size; n – Respondents accessed; N/A – Questionnaires not administered.

Source: Fieldwork, (2015)

Table 3.1 shows that the average response rate at PPM was 58 percent and 60 percent at Tharisa Mine. An interesting occurrence was that Shift C at Tharisa Mine did not respond to the questionnaire. This was due to a general reluctance by the Shift Manager to allow people to participate. No clear reasons were given as to why this occurred, although the researcher deduced that this was due to increased production pressure due to rainfall delays in the preceding days, as well as a negative perception with regards to the researcher's intentions. There was a 100 percent response rate from executive management at both sites. The response from middle management at Tharisa was 55 percent participation compared to 100 percent at PPM. This was partly because the researcher was resident in PPM and had time to engage with the targeted respondents compared to periodic visits to the Tharisa Mine.

Interview respondents were chosen from the executive management team at the top, cascading down to the foreman level at the lowest level of the inquiry. This selection was based on Rubin and Rubin, (2014) who advise that interviewees do not have to be numerous but can be a set of few knowledgeable individuals who can provide high quality responses. Eighteen respondents were eventually interviewed as shown in Table 3.2.

Table 3. 2: Interviews Conducted (√ - means done: x – means not done)

Title of Interviewee	PPM	Tharisa
Executive Manager	√	√
Senior Production Manager	√	√
Engineer/ Engineering Manager	√	√
Human Resources and Training Manager	√	√
Health Safety and Environmental Manager	√	√
Administration Manager	√	√
Financial and Procurement Manager	√	√
Blasting Manager	√	√
Survey Manager	√	√

Source: Fieldwork

The researcher's familiarity with the variety of equipment used by MCGCC was used to classify the machinery under investigation. Table 3.3 lists the categories of machinery used in both sites.

Table 3. 3: Machinery categories per site

	Number of Units	
Machine Category	**PPM**	**Tharisa**
Excavators	7	20
Dozers	10	14
Graders	2	3
Light Vehicles	65	69
Dump Trucks	38	51
Lighting plants	18	20

Source: Nel and Du Preez, (2015)

The machinery was classified into six categories namely; (i) excavators, (ii) dozers, (iii) graders, (iv) light vehicles, (v) dump trucks and, (vi) lighting plants. The analysis of machinery traits pertained to fuel consumption records, fuel efficiencies, oil consumption, service history and the existence of any technological advancement that influences climate change mitigation or adaptation. However, it was not possible to examine all the machine records because of access restrictions, large volumes of data in these records and time limit constraints. Consequently, the records that informed this research were compiled from a sample of all the machinery records. The samples were selected through stratified random sampling in each category when the possible units of analysis exceeded three. Where the number was three or less, all the records were analysed. Stratified random sampling is applied when study units are heterogeneous and the population is too large for non-random sampling, hence samples are drawn from homogenous groups that are classified along the lines of a mutual trait (de Vos et al., 2005; Kothari, 2004). With the sampling methods having been defined the researcher collected data as per the following data collection methods.

3.5 Data Collection Methods

Four methods namely; questionnaires, observation, interviews and document analysis were used to gather the data. The methods were applied as follows:

3.5.1 Questionnaire

The researcher personally administered the questionnaires at both PPM and Tharisa Minerals mines. The questions were largely aimed at obtaining narrative data on climate change mitigation and adaptation strategies at the both the PPM and Tharisa Mines. Mathews and Ross (2010) and Delport (2005) describe questionnaires as a list of standardised questions, which are presented to respondents seeking responses that are either structured or subjective. The use of questionnaires allowed for the gathering of relatively structured data about climate change management.

The questionnaires were administered to three employment tiers at each mine. The three broad tiers were (1) executive management, (2) middle management and (3) operational level employees. All the questionnaires were divided into six sections comprising both close-ended questions, which required direct answers, and open-ended questions that allowed respondents to respond without restrictions (Appendix D). Section A of the questionnaire focussed on MCCGC's policy and planning. The section was aimed at identifying the policies and planning that informed MCCGC's strategy and practices pertaining to climate change management. Section B focussed on finding out the nature of legal considerations that informed climate management practices at the two mines. Section C sought to determine if the mines included climate change risk and vulnerability assessments in managing their operations.

Section D sought to assess whether there were administrative controls to guide the field practices. It also sought to assess issues such as the availability of documented mitigation and adaptation procedures and the extent and source of employee's knowledge about climate change and its management. Section E investigated the presence or absence of internal and external monitoring and evaluation of the climate change management strategies and practices. Section F was focussed on finding out if there was a systematic review process of the set strategies and policies. For triangulation purposes, observations were also used to collect data.

3.5.2 **Observation**

Participant observation involved looking, feeling, listening and sensing events or phenomena that were related to climate change management as they occurred within PPM and Tharisa Minerals (Babbie, 1994; Chadwick et al, 1984). The observation process involved, (i) recording what was seen and heard whilst in the field, (ii) analysing field notes through deductive and intuitive reasoning and (iii) converting the field sketch notes into filed notes for further analysis (Merriam, 2009). Some observations were captured through photographs. The observations were based on the two categories of climate change management: mitigation and adaptation. Observations were conducted and recorded under three broad coded areas at each locale. These were; (i) administration, engineering, blasting, and production areas. A checklist provided a consistent approach to data gathering using this approach.

Observations informing what mitigation strategies and practices were evident at MCCGC within the administration site pertained to postings of policies, awareness campaigns, and previous audit finding. The researcher also sought to see how information that affects diesel consumption and emissions output was captured, distributed, analysed and utilised within the work engineering and production sites. Within the production section observations were related to the conditions and processes within the drilling, blasting, loading and hauling aspects of the mining operation. The major focus of observation pertained to the design and conditions of roads, ramps, loading areas, tipping areas, pits and drilling blocks. This is because these factors impact upon fuel consumption, a significant issue in climate change mitigation.

In the engineering section of the operation, observations related to the kind of machines in use in the field, the facilities used to service and upgrade this machinery as well as the availability and management of waste management facilities. The researcher also observed what management practices were evident with regard to hydro-carbon resource consumption and regulation, since this has a direct impact on emissions production, and hence mitigation. Such issues were targeted due to their impact on the company's carbon footprint. Within the blasting section, the research assessed the blast fragmentations, as these have a direct impact on fuel efficiency, hence air emissions output.

With regard to adaptation, observations related to how and what people used to react to the adverse impacts of climate change in the pit. Issues for observation pertained to the availability of potable water, sheds, and air conditioners. Interviews augmented the observations.

3.5.3 Interviews

Formal semi-structured and informal unstructured responsive interviews were applied to gather data from various managers at both PPM and Tharisa Minerals between September 2014 and January 2015. Responsive interviews are those where questions are asked in a flexible manner which allows the interviewer to adopt the flow and type of questions to the answers flowing from the conversation on a specified topic (Rubin and Rubin, 2012). This responsive nature allows a focused, qualitative, insightful approach in questioning respondents compared to sticking to set questions in a rigid unresponsive technique (Ibid). The semi-structured responsive interviews posed pre-formulated, open-ended and close-ended questions. These were re-enforced by probes as was done similarly with the unstructured interviews (Welman et al., 2013; de Vos et al., 2005). The interview responses were recorded as hand-written notes and captured through a digital voice recorder where permission was granted (Welman et al, 2013; Rubin and Rubin, 2012). Informal interviews were intuitive conversations that related to climate change management either at individual or corporate level (Rubin and Rubin, 2012; Welman et al., 2005). These were held with individuals who at times were not on the respondents' list, but could provide additional and insightful information.

The executive management interview guide was the shortest, comprising five questions (Appendix F). The questions were aimed at finding out if climate change was viewed as a risk, determining the presence or absence of climate change management strategies and policies and the availability of financial resources to drive the strategies and policies. The middle management interview guide had eight questions aimed at: i) identifying and assessing climate change related operational risks and (ii) determining how these risks were administratively and practically managed in a systematic manner (Appendix F).

The interview process also used the power of observation. During interviews, the researcher observed and noted the respondents' body language which included facial expressions, hand gestures and attitude signals as they appeared before, during and after the interviews. They were used for later inferences during data analysis. As part of the interview process, an email containing the interview guide was sent to the respondents 12 to 48 hours before the interviews were conducted. The target respondents were asked to confirm the interview appointments in writing. Complementing the interviews was document analysis.

3.5.4 Document Analysis

This research also used document analysis to gather relevant data. Document analysis is a systematic procedure for reviewing or evaluating printed and/or electronic documents (Merriam, 2009). The research accessed, reviewed and analysed documents that included MCCGC's safety, health and environmental reports, meeting presentations, budgets, risk assessments and inspection reports. Also assessed were audit documents, annual financial reports, corporate policies, standards, procedures and managerial instructions documents were analysed. Journal publications, magazines, videos, films, newspapers and television programmes were also included as information sources. An advantage to this approach was that some of this data was readily available without cost. A disadvantage was that documents containing information perceived as confidential were difficult to access or at times withheld. Table 3.5 lists the documents that informed this research.

Table 3. 4: Summary of analysed documents

Issue	Document Requested	Source
1.	Policies and procedures related to climate change mitigation and adaptation.	SHE Department
2.	Financial records related to climate change mitigation and adaptation.	Finance Department
3.	Strategies related to climate change mitigation and adaptation.	SHE Department
4.	Organograms and documents with employee duties and responsibilities.	HR Department
5.	Risk analysis documents	SHE Department
6.	Legal and other requirements specifications and compliance records	SHE Department
7.	Resource consumption and waste generation records	Engineering/ SHE Departments
8.	Asset registers	Engineering Department
9.	Republic of South Africa Bill of Rights	Internet

10.	Republic of South Africa Constitution	SHE Department
11.	Mine Health and Safety Act, 29 of 1999	SHE Department
12.	RSA public policy documents on climate change and the green economy	SHE Department and Internet

Source: Author

The data that had been collected using these four methods was analysed, to address the research questions. The approach of using various methods to collect and analyse data is referred to as triangulation.

3.6 Triangulation

Triangulation was applied in the course of the study. Creswell, (2013) describes triangulation as the use of multiple and different sources, methods, investigators and theories to provide corroborating evidence. According to Denim, (1978) and Patton, (1999) the four types of triangulation are: (i) methodological (using more than one data collection technique), (ii) source (obtaining data from more than one source), (iii) investigator (use more than one observer) and (iv) theory triangulation (use more than one theoretical position/ professional opinion to interpret the data). Guion, (2002) and Walsh, (2013) also add environmental, time and space triangulation. Environmental triangulation involves the collection of data at differing times, locales and environmental conditions so as to compare the data, relative to these parameters (Guion, (2002). Triangulation in this research was done to increase the validity, certainty and depth of understanding provided by the data (Walsh, 2013; Yeasmin and Rahman, 2012; Guion, 2002).

This research applied methodological triangulation by using questionnaires, observations, interviews and document analysis as multiple data collection methods. This served to either corroborate or identify differences in the data generated by the different data collection methods. For example, sometimes the respondents mentioned documented practices that differed from the research observations. In some cases, the respondents could not recall certain details, or could not clearly articulate their response in writing, yet they were able to clearly narrate their views in interviews.

Table 3. 4 summarises the data collection methods that were used, rating them in terms of their ‘usefulness’ to the study.

Table 3. 5: Data collection methods rating

Issues	Questionnaires	Interviews	Document Analysis	Observation
Environmental management strategy	*	**	***	*
Mitigation strategy	*	***	**	*
Adaptation strategy	*	**	***	*
Mitigation practice	*	**	*	***
Adaptation practice	*	*	*	***

Legend: *** Most useful method ** Useful method * Least useful method

Source: Author

The research also employed source triangulation. Source triangulation was achieved by obtaining data from different respondents within different hierarchies of the organisation (Yeasmin and Rahman, 2012).

Data collection using the selected research instruments could not be conducted with inappropriate and inadequate research instruments nor could it be done in an unplanned manner. To ensure the appropriateness and adequacy of the research instruments and plan, a pilot study was conducted.

3.7 Pilot Study

Maxwell (2013) and Yin (2012) refer to a pilot study as a prelude to a research study. It is used to clarify and test the appropriateness and adequacy of research instruments. This serves to assess the feasibility of a full-scale study, identify logistical problems which might occur using proposed methods, and a greater research approach (Ibid). This research conducted a pilot study that had three phases. The first phase of piloting which was done at Rasimone Platinum Mines involved orally administering a set of open-ended and close-ended questions to mining specialists (managers, surveyors, planners and safety officials) during a conference break. The pilot phase took advantage of the rare congregation of these varied sets of skills to develop and refine the questionnaires and interview guides.

This piloting phase revealed a number of issues that are important in addressing climate change mitigation issues. These issues include; fuel efficiency, pit optimisation, road (re)design, gradient control, ramp design, energy use reduction, emissions reduction and technology innovation in mining, among others. Those that address adaptation include fatigue management and mine design to cater for rainfall excesses and inadequacies. From these discussions it was also evident that climate management was an inter-disciplinary exercise that was done through different strata within the organisation. This finding rendered it necessary to employ a stratified approach in administering questionnaires and conducting interviews. Consequently, the main research questionnaires were drafted as: (i) a relatively complex and technical questionnaire set designed for executive level responses, (ii) a relatively less complex questionnaire drawing answers from strategy, finance and practice, targeting the middle management tier and, (iii) an extremely simple, practically oriented questionnaire for operational level employees.

The exercise also revealed that the technical terms such as “mitigating” and “adapting” to climate change were not easily understood by the miners. More important is that such technical terms often invoked feelings of confusion, discouraged responses and led to a loss of interest in the subject. This realisation led to adjustments to the questionnaires and interview guides to avoid and minimise such technical terms. The researcher also decided on personally administering the questionnaires to enable clarification and motivation of respondents, after observing the miners’ struggle with the technical terms related to climate change. After amendments, the research instruments were re-tested.

The follow-up pilot phase involved testing the refined instruments from the first phase, on the safety department and peers. This phase identified concerns that include precision, appropriateness and ambiguities in certain questions. For example, the questionnaire targeting the middle management tier was identified as being rather long and thus tiresome, a feature that could lead to incomplete or inadequate responses. Some interview schedules were also considered to be rather long. These observations led to the drafting of questionnaires that could been addressed within 15 to 30 minutes and interviews that would not exceed one hour unless the interviewee was available for longer periods.

The third phase of the pilot study was a logistic preamble visit to Tharisa Mine. The visit served to introduce the study to the management team. It also afforded the researcher a guided tour of the site. This was important for familiarisation with the site, and travel routes within the mine for easy access to the research subjects as well points of interest for the main data gathering phase. The shift roster and department structures were also ascertained during this visit. The visit identified the shift-change periods as the appropriate time to administer the questionnaires to operational level employees. This was because all employees within that work group would be in one location. Management and clerical staff were accessible after all the other staff had settled into their shift work. The pilot study was immediately followed by the main data collection phase.

3.8 Data Analysis

De Vos et al., (2005) and Patton (2002) describe data analysis as a process of bringing order to data so that it yields useful information. Qualitative content analysis was utilised as the data analysis method in this research. The analysed content derived from questionnaires, observations, interviews and documents as outlined in the data collection methods section.

Qualitative content analysis is a research method that involves a subjective interpretation of various modes of communication through a systematic classification process of coding and identifying themes or patterns (Hsieh and Shannon, 2005: 1278). It includes the checking of: behaviours (gestures and daily routines); the appearance of particular words, sentences, writing patterns and trends in documents; and then establishing a narrative based on their frequency and established relationships (Liamputtong, 2013: 246).

Critics of this approach argue that it is subjective, cast doubt on its efficacy in scientific research, and question the scientific validity of content analysis in research. Mayring (2002: 2) opposes these assertions, defining content analysis as, "An approach of empirical, methodological, controlled analysis of text, within their context of communication, following analytic rules and systematic models, without a rash quantification."

Noting Mayring (2002)'s assertions, a within-case and cross-case content analyses were done for PPM and Tharisa Minerals. Within-case content analysis involves examining the intra relations in a specific site, while cross-case content analysis infers inter-relationships and divergences in the thematic patterns presented between two or more sites (Liamputtong, 2013: 246). The latent projective data that was gathered from PPM and Tharisa via questionnaires, observations, interviews and document analysis provided insightful meaning after being processed through the reflective process of content analysis. The basis of the conclusions was a broad coding and theming schema that did not follow a predictable pattern (Potter and Levine-Donnerstein, 1999). Content can be; (i) manifest – superficial and surface evident, (ii) latent pattern – meaning is derived from evident patterns and latent projective as described above (Ibid).

Hsieh and Shannon (2005) present three approaches to content analysis. These are conventional, directed and summative content analysis. Firstly, conventional content analysis entails the derivation of codes and themes, which emanate directly from the data (Hsieh and Shannon, 2005). Secondly, directed content analysis bases its analysis on pre-determined guiding codes and themes that come from a pre-set theory or theories, relevant studies, empirical evidence, pre-defined concepts or definitions (Ibid). Thirdly, summative content analysis involves an enumerative counting process of key words, themes or other elements of interest that can be enumerated within the gathered data and the deriving meanings thereof (Ibid). This research adopted a directed content analysis approach.

Within the directed content analysis, Zhang and Widemuth (2005) and Patton (2002) argue that inductive and deductive reasoning may be applied symbiotically because; the two reasoning approaches are not mutually exclusive. Both inductive and deductive reasoning were utilised within this research. Inductive reasoning is a valid inference and interpretation of available data using careful examination and comparison. In inductive inference, we go from the specific to the general, condensing the raw data is into categories or themes for further analysis. Deductive reasoning entailed the utilization of previously defined definitions, concepts, gathered theory and studies to enrich and guide the coding, theming as well as the drawing of findings and conclusions through systematic inference that drew interlinkages and reasonable findings. Drawing from the inductive and deductive reasoning, the study presented the findings in the form of debated conclusions, after deliberating on the collected data's cohesion and divergence as eminent from the varied triangulated data yield. The resultant findings and conclusion were at times cohesive and sometimes divergent from the theoretical and conceptual underpinnings of the research.

An eight-step methodological process was followed in conducting the content analysis. The steps adopted from Zhang and Wildemuth (2005) were: (1) data preparation, (2) defining units of analysis, (3) developing categories of coding schema, (4) testing the coding schema on sample text, (5) coding all the text, (6) assessing coding consistency, (7) drawing conclusions from coded data and, (8) reporting of the methods and findings. These stages were executed as follows:

Step (1): data preparation involved converting the collected data into a data repository. The 46 questionnaires were transferred to a Microsoft Excel spreadsheet. The 11 interviews were transcribed verbatim into Microsoft Word transcripts. Pictures were downloaded into computer-stored folders and notes from observations and document analysis were typed into Microsoft Word recordings.

Step (2): involved the researcher developing codes for all the data that he had gathered from both PPM and Tharisa to provide a template for in-putting and analyzing the data in a logical and insightful manner. This process can best be described as scheming or developing data codes. Merriam (2010) coins it as, coding of schema. The available data yielded 46 schema codes. These were further refined into broader data streams in a third stage of data analysis.

Step (3) involved applying deeper thought and inductive reasoning on the 46 data streams, to yield a richer, broader more generalized thematic categories from the data. This process is known as theming. From this, the following eight themes were derived: (1) Policy adoption and strategic administration, (2) Hazards/ Aspects and Risk/ vulnerability Assessments, (3) Policies, standards and procedures formulation and application, (4) Competence building *vis-a-vis* training, awareness and behavior modeling, (5) operational control, (6) energy efficiency and conservation, (7) resource conservation and waste management and (8) system's review - monitoring, evaluation and reporting. This led to step (4).

Step (4) involved testing the themes by assessing if the data collected from the two sites could be systematically categorized within the defined thematic streams without losing content and relevance. The themes that had been chosen for the relevant data fit the research needs. The researcher then proceeded to the fifth step.

In Step (5), the researcher took data from PPM and Tharisa and assigned it to a relevant code within the schema developed in step (2). Coding of all the text was done by ascribing content from data into the relevant codes/ thematic categories. This was done concurrently with step (6) whereby continuous checks were run to see if data fell into the set schema or additional schema had to be developed.

Step (7) involved drawing conclusions from the categorized data by making inferences from inductive reasoning and supporting deductive discussions. Relationships, patterns and cross-linkages between the data were explored at this stage. This then led to Step 8, a report presentation step. This was done through a descriptive process anchored within the coded data. Narratives and discussions revolving around the collected data supported these descriptions. Tables and pictures were used as visual presentations within the data analysis.

The research continually sought to ensure the credibility and trustworthiness of the data, its analysis as well as the research study.

3.9 Reflexivity

Lambert et al, (2010:322) define reflexivity as,

> "…an integral part of research whereby the researcher reflects continuously on how their own actions, values, and perceptions impact upon the research setting and can affect data collection and analysis".

The researcher had to continuously, consciously refrain from having a biased view when collecting, analyzing, or presenting data. This was particularly important because the researcher is an employee of the company, which informed the research. This aspect meant there was a continuous need to consciously, distinguish between the roles of being an employee as well as that of researcher. Mauthner and Daucet (2003) advise that a researcher has to operate on the two levels; that of being an outsider, as well as an insider. Adopting this approach, both objective and subjective styles of data gathering and analysis were utilised as a means to eliminate or minimise the researcher's biases during the course of the study. Peer reviews as well as supervisory oversight were also used as a means to guard against researcher bias (Bryman, 2012).

3.10 Credibility and Trustworthiness

Sandelowski (1993) argued that issues of validity in qualitative studies should not be linked to truth or value, but rather to "trustworthiness". Trustworthiness according to Sandelowski (1993) is a matter of persuasion, wherein the researcher makes the methods used in research visible, available and auditable, thus empowering the readers to assess the acceptability and replication potential of the study as was done in the research methodology section and appendices of this thesis. Rolfe (2004) and Guba and Lincoln (2002) have postulated that trustworthiness can be attained by achieving credibility (participant ability to confirm), dependability (justifiability of research context or circumstances), transferability (ability to be done elsewhere and at other times) and confirmability (auditability of results or ability to be corroborated) in one’s research methodology.

The above focal points of trustworthiness were achieved in this research by conducting it as a case study in two real study units (PPM and Tharisa). The very nature of it being a multiple case study increases it trustworthiness. The confirmability of the findings and credibility is rooted in that the study had real participants whose data was stored in a repository and includes confirmable audio recordings, pictures, various documents and signed questionnaires, which are kept in a controlled environment. The credibility of the researcher is that he has a confirmed competency in under-graduate research, this being a basic requirement for conducting this study. The credibility is enhanced by external checks, supervision and peer review by an established researcher from UNISA. Various methods of triangulation in data gathering, including supporting research into the empirical and theoretical underpinnings of the research also add to the rigor used to make this research and its findings trustworthy.

3.11 Limitations of The Study

The research confronted a number of challenges, of which four were noteworthy. The first major challenge was managerial reluctance to release respondents to inform some aspects of the research. As a result of this reluctance, some questionnaires and interviews were administered in the field and not in offices and classrooms as initially anticipated.

Second, the inability to work in a controlled, comfortable, office space for questionnaire administration and interviewing presented unique challenges at Tharisa. The researcher had assumed that the employees who are operators of machinery had pens to complete their duty checklists. However, this assumption proved to be false. At times the targeted respondents did not have pens and were reluctant to go back and collect them. This added to the time spent collecting data and led to semi-completed and totally incomplete questionnaires.

Third, some key respondents, and documents, were no longer available or were missing due to structural changes within the company. The re-structuring led to the reassigning, relocation and resignation of some targeted respondents. Fourth and last, while the research sought to study MCCGC, on reflection the research could have benefited from studying other similar companies for comparison. However, limited finance, and time did not allow for an expansive study.

3.12 Ethics

Ethics define what is proper and improper in scientific research. They indicate what is right and what is wrong (de Vos *et al.*, 2005). To ensure compliance to the ethics of the UNISA College of Agriculture and Environmental Sciences (UNISA, 2013), this research followed the established department's research ethics guidelines. Appendices E and F, show the ethics clearance application and approval documents that applied to this study. Inherent to the ethics approval process are the permits to conduct study within the PPM and Tharisa Minerals sites, which were granted by MCCGC senior management officials.

All the respondents that participated in interviews and questionnaires surveys had to grant written consent as shown in Appendix E. The form was designed according to the UNISA and the related College of Environmental and Agricultural Sciences (CAES) regulations (UNISA, 2013). Accordingly, the form included the right of participants to withdraw from the study and the procedures to do so. A moment of anxiety occurred during the data gathering period, when Tharisa's Human Resources Manager expressed concerns about the ethical clearance and wanted a note from the Human Capital Director confirming that the study was company sanctioned and had relevance to the business. He also wanted to know whether the company had policies to guide such research. This was resolved by providing the afore-mentioned manager with the UNISA ethics clearance certificate and other supporting documents.

All the raw data was only accessible to the principal researcher and was kept in a lockable cupboard in an inaccessible area off-site. All the findings were presented in a manner that could not link a particular response to an identifiable individual to preserve anonymity.

3.13 Conclusion

This chapter justified using MCCGC's PPM and Tharisa Minerals sites in a multiple case study, which explores and describes the mining contracting and plant hire companies' response to climate change. The data collection from these sites was done following a prescribed scientific mixed methods research methodology. The methodological approach outlined in this chapter opens a window into the mechanisations, attitudes, knowledge and technical management response to climate change in the mining industry. The “responsive interview” led to deeper conversations during the interviews. This was aimed at yielding more data, as well imprinting an inquisitive mind-set, which may enhance paradigm shifts towards climate change responses in the organisational culture, where this was evident.

The research approach allowed the respondents to openly convey the information they had in relation to the subject, which permitted the researcher to engage with them and gather data from within the real life contexts. Content analysis was the chosen data analysis with the aim of obtaining thick, in-depth descriptions of how climate change is mitigated and adapted to, at PPM and Tharisa. Such an analysis has academic relevance that enables drawing of robust conclusions and recommendations. This approach helped to build on the stock of literature in the industrial climate change management arena. The role of ethical considerations assisted in ensuring the study continued and preserved its integrity. Considerations such as reflexivity considered both before and during the study ensured the realisation of acceptable levels of reliability, credibility and trustworthiness of the study. Leading from these issues, the next chapter presents, describes and analyses the research findings.

CHAPTER 4: PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Introduction

Chapter 1 set the aims and objectives of this research. Chapter 2 presented the theoretical underpinnings and Chapter 3 described the research methodology. The current chapter presents, analyses and discusses the findings pertaining to climate change management by the Mutual Construction Group of Companies (MCCGC) at the Pilanesberg Platinum Mines (PPM) and Tharisa Minerals (Tharisa) Mines. The climate change management findings, at the two mines will be benchmarked against local and international technology, standards, policy and legislation.

4.2 Summary of key Findings

The research made three key findings. The first finding is that the two mining houses, Platmin and Tharisa Minerals (plc.) are operating their opencast mining sites, PPM and Tharisa without explicit climate change response and management strategies. Despite the absence of explicit climate change, response strategies the two organizations do engage in climate change, management activities. Their approach to climate change management is guided by established policies and strategies whose broader framing is explicit environment management and implicit climate change management.

The second finding is that MCCGC, as the contractor, is obliged to adopt climate change, management policies and strategies of PPM and Tharisa to meet its contractual obligations. One would expect MCCGC to have its own policy explicitly addressing climate change as a matter of corporate sustainable governance and maybe as a competitive and reputational advantage (Mzenda and de Jongh, 2012). However, this is not the case, as just like its principals, MCCGC does not have an explicit climate change response policy either. The subject is addressed implicitly in MCCGC's health, safety and environment management policies. This arises (perhaps) from the fact that its principals currently do not insist on an unequivocal climate change management policy as a condition to secure and maintain the mining contract.

The third finding is that at the two mines, the implicit climate change management strategies are not mere rhetoric but are actually put into practice. Details of these findings are outlined in the following five sections.

4.3 Findings at PPM

Findings at PPM, which relate to legislative policy and frameworks, mitigation strategy and practices, adaption strategies and practices as well as the drivers for these strategies and practices are discussed in this section 4.3. The Figure 4.1 below, a satellite map picture Pilanesberg Platinum Mine relates the findings to the geographical location they were derived from.

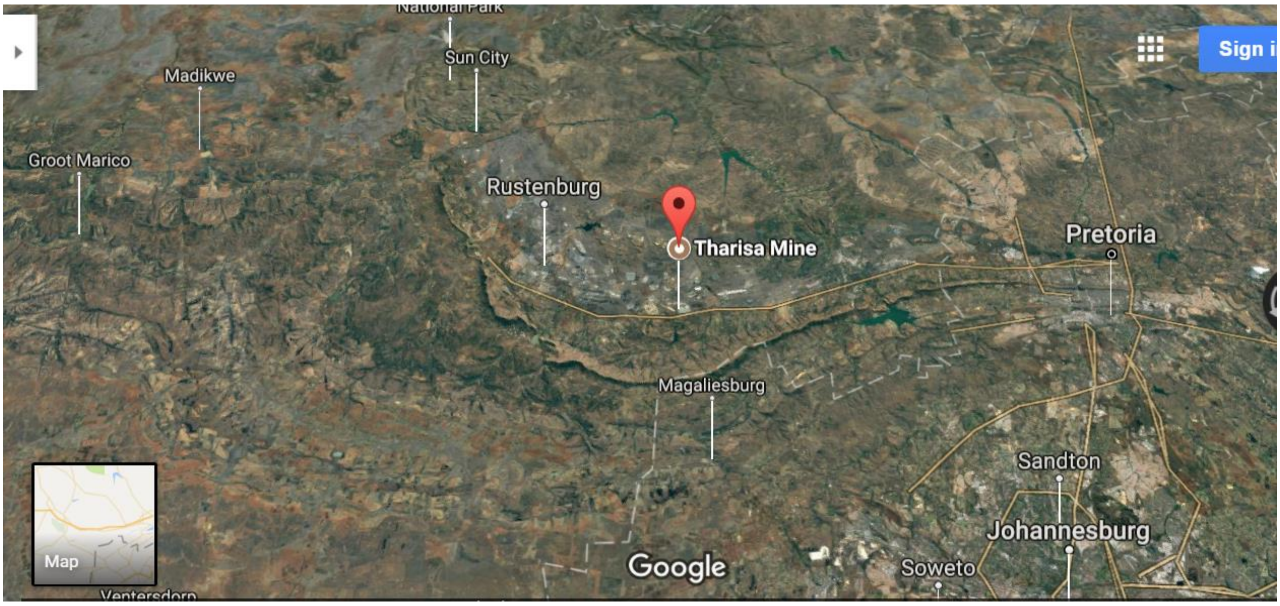

Figure 4. 1: Satellite map image of PPM, 31 August 2017. Source: Google Maps

Section 4.3.1 discusses findings related to legislation and policy frameworks at PPM.

4.3.1 Legislation and policy frameworks

As stated earlier PPM, as the principal and MCCGC as the contractor have established implicit climate change management strategies whose implementation is visible in practices at the mine. The climate change management narrative and practice is covered under the three broad umbrellas of Environment, Health and Safety (EHS) management collectively, referred to as an "integrated EHS strategy" (Coetzee and Badenhorst, 2013). The process is that when contractors like the MCCGC tender for contracts, they present their own integrated EHS systems as an assurance to the principal that they can meet the principal's legislative and best practice EHS management requirements. The principal has three choices: (1) to adapt the presented system, (2) reject it and impose its own system, and (3) allow the contractors to selectively apply best practice elements from either system. The latter option applies at PPM. The mine's integrated EHS system is informed by national laws and voluntary international environmental management codes.

The Health, Safety, Environment and Quality Agreement that MCCGC signed with PPM legally binds the former to identify and comply with the latter's identified legal and voluntary statutes which govern mining practices in South Africa. Section 24a of the Constitution of the Republic of South Africa No. 108 of 1996, states the right of citizens and residents to live in and be exposed to an environment that is not harmful to their wellbeing (Government of the Republic of South Africa, (GRSA), 1996). Supporting this, Section 24b gives the state rights to enact laws for environmental protection, pollution prevention, mandate re-accrual of renewable resources as well as promote sustainable development to ensure that future generations are not prejudiced by the present generation's developments (Ibid).

The constitution is translated into a number of sector-specific policies and laws with sections that are relevant to environmental management and general laws that have a broader environmental management objective. The MCCGC has to comply with these laws to responsibly meet its contractual toll-mining obligations. Nhamo and Chavalala (2014) posit that such responsible mining practice retains share value, increases investor confidence, strengthens the social operating license, lessens the risk of litigation, prevents negative media attention and retains the statutory mining licenses.

Practices in South Africa's mining sector in general, and MCCGC's action at PPM in particular, are governed by the provisions of the Minerals and Petroleum Resources Development Act (MPRDA) 28 of 2002 (Department of Minerals and Energy Resources (DME), 2002). Of relevance to this research, the preamble and Section (2) of the Act give effect to Section 24 of the Constitution, which seeks to ensure that South Africa's mineral, and petroleum resources are developed and exploited in an orderly and ecologically sustainable manner while promoting justifiable social and economic development (Ibid).

To realise this objective, Section 22 – 25 of the Act calls for environmental management plans and programmes covering the exploration, construction, operation, closure and post-closure periods of mining projects (DME, 2002). These management programmes pertain to air, water and the general environment in and around the mining sites. These plans and programmes have to unambiguously show the technical and financial provisions for implementation as stated in Section 41 of the MPRDA (Ibid). Section 41 of the MPRDA specifically requires any mining right or permit holder, such as PPM, to have a registered fund with the DMR, which caters for environmental management and the rehabilitation of any aspects of the environment that are damaged by the company. This responsibility, legal liability and financial risk are transferred along the supply chain to the contractor through the Principal (PPM) mandating environmental stewardship on the contractor. This is because as outlined in Section 100 of the MPRDA, MCCGC as a contractor is not the legally accountable party to comply with the statutes; instead, it is the responsibility of PPM as the mining license holder.

However, PPM can only comply through MCCGC's actions. The MCCGC does not idly react to the statutes of PPM but also plays a pro-active part in this compliance, advising its principal, PPM, on how to effectively and cost efficiently comply with legal requirements pertaining to the management of the environment, air quality and related matters. This ensures MCCGC protects the contract and ultimately its revenue streams.

Management and employee knowledge, execution of the Environmental Impact Assessment (EIA), and Environmental Management Programmes (EMPr) is measured by MCCGC via on site-internal and semi-external audits as a key performance indicator used in contract fulfilment appraisals. An examination of PMM's amended EIA and 2015 – 2025 EHS objective and targets show that MCCGC and PPM have EIAs, EMPr and EMPs that comply with the MPRDA's climate mitigation related laws (PPM, 2016; PPM 2012; PPM, 2008). The inclusion of climate change management as a focus point in these policy documents was confirmed by the PPM environmental specialist who stated that:

> *"Policy documents such as the annual objectives and targets and environmental management programmes aim at climate change mitigation through vehicle emissions reductions* (to cater for scope 1 emissions reduction) *and electricity related emissions reduction* (targeting scope 2 emissions). *This is achieved through fuel use reduction and electricity management so as to reduce carbon dioxide emissions equivalent emissions into the atmosphere, therefore mitigating against climate change."* (Interview excerpt, June, 2016).

As stated in Section (4.2) these policy statements are not mere rhetoric but were observed in practice. In the fulfilment of its contractual obligations, MCCGC executes PPM's Environmental Management Plans (EMPs). MCCGC's activities in this space include topsoil preservation in topsoil dumps, mine rehabilitation through backfilling and re-vegetation, as well as vegetation conservation through minimal bush clearing. Reforestation is also undertaken through rehabilitation projects such as dozing walls of waste rock dumps and tailings dams to natural angles of repose (battering) and covering them with topsoil to allow re-vegetation. These activities help in creating and sustaining the carbon sinks required for climate change mitigation. The plan to convert the open-pit into a water reservoir at a mine closure is an interesting rehabilitation project which MCCGC and PPM have blue-printed. The reservoir project has a dual impact, serving as a sink as well as an adaptation strategy towards sustainable water harvesting and supply in this dry region of the country.

While Section (2) of the MPRDA and various sections and sub-sections of this Act call for environmental management, it is not very specific regarding the standards and targets related to climate change mitigation. Specific standards are defined in other laws that have an effect on mining operations. A relevant and important law identified and applied by MCCGC in this regard is the National Environmental Management Act (NEMA) 107 of 2004 (Department of Environmental Affairs (DEA), 2004). NEMA specifies clear targets with regard to national environment management in general and climate change in particular. NEMA has provisions that relate to air quality, water quality and soil quality in economic activities such as mining and other industrial operations.

Air quality management under NEMA aims at identifying, monitoring, mitigating, adapting to and reporting the levels and types of air pollutants that affect human wellbeing, deplete the ozone layer and cause global warming. These objectives are addressed through five key NEMA statutes and related regulations. These are: (1) National Environmental Management Air Quality Act 39 of 2004, (2) National Ambient Air Quality Standards – Gazette National Regulation (GNR) 1210 of 2009, (3) National Air Quality Standards for Particulate Matter less than 2.5 micron metres (PM2.5) - GNR 486 of 2012,(4) Regulations regarding the Phasing out and Management of Ozone Depleting Substances – GNR 351 of 2014 (PPM, 2016) and (5) Atmospheric Pollution Prevention Act (APPA) 65 of 1965 which governs air emissions from industry (DEA, 1998), (www.environment.za). It is not clear how both MCCGC and PPM are complying with these laws. This does not necessarily mean MCCGC or even PPM are in breach of legislation. The firms are actively seeking to monitor and control their contribution to air pollution. For example, at the time of this research, PPM was erecting air quality monitoring stations. Bond (2004) argues that these laws inadequately address the reduction of greenhouse gases from fuel combusting vehicles in opencast mining activities because opencast mining is not listed as an activity that needs monitoring and reporting against the set standards.

Despite this gap, a plant manager working for MCCGC argued that the company addresses climate change by abiding with Government regulation, GNR 486 and APPA when purchasing equipment. In his words,

> *"Obviously MCCGC complies with the Atmospheric Pollution Prevention Act (APPA) 65 of 1965, by ensuring that we buy machines that do not have excessive emissions and comply to certain legal thresholds for air emissions. Currently we are moving from tier 1 to tier 2 and 3 engines which have less emissions.* (Interview excerpt, September 2015).

However, Bond (2004) again discredits such assertions, stating that the concerned regulations are inadequate, due to their limited focus on particulate matter which is insignificant to global warming.

As discussed in Chapter 2, (Sections 2.2, 2.4 and 2.5), the ecological, industrial, temporal, spatial and role player interactions that determine atmospheric air quality and adaptation are complex. Consequently, the various interlinking laws that govern MCCGC's response to air quality, and inherently climate change, are equally complex. The MCCGC environmental policy, corporate objectives and targets require sites to identify and comply with the legislations that cover the international, national, local government, client and group standards space.

This legislation relates to soil, water and waste management within mining, agriculture, transport, forestry, energy and housing sectors. MCCGC's employees pledge commitment to abide by these laws in signed contractual documents such as job descriptions, work contracts, key performance indicators and legal appointment letters. These contractual documents mandate and stipulate the employees' legal duty to comply with laws such as the Conservation of Agricultural Resources Act 43 of 1983, Section 28 of NEMA, NEM: Water Act 36 of 2009 and the MPRDA. These and other laws seek to safeguard the mitigation role of trees, top soil, and water either as carbon sinks, agents for sink regeneration or agents for clean renewable wind and hydro-energy generation.

The laws drive mitigation by mandating soil, water and air conservation, soil erosion prevention and veldt protection (DEA, 2009; DEA, 2008; DWAF, 1983). Mitigation is also advanced by Section 17 of the NEM: Waste Act 59 of 2009, which requires waste reduction, re-use, recycling and resource efficiency. The MCCGC has put these laws into practice through implementing and adhering to internal MCCGC and PPM site specific standards and procedures on targeting biodiversity, vegetation, waste management, air quality and veldt management. While this approach ensures compliance with all legislation and ensures the covering of different concerns there is, however, an inadequate identification of the laws and by-laws relating to climate change.

For example, the research found that the legal register which MCCGC used at PPM at the time of this research did not refer to the local government (Moses Kotane District) by-laws governing climate change and neither did it refer to the key driving legislation towards a green economy and climate change management at the national and global level. International climate change management driving laws and voluntary codes that the legal register appears to exclude include the UNFCCC, Kyoto Protocol, Green House Protocol, ISO-14,064 on Carbon Dioxide Accounting, Copenhagen Accord, Carbon Disclosure Project and the Green Stimulus Package amongst others (Nhamo and Pophiwa, 2014). National climate change laws and voluntary codes of practice that appear to have been excluded from the legal register used by MCCGC include the National Climate Change Response Strategy, the White Paper on the Promotion of Renewable Energy, the Sustainable Development Criteria for Clean Development Mechanism, the Long-Term Mitigation Strategy, the National Energy Efficiency strategy and the Draft Carbon Tax Policy (Ibid). This places the company at risk of non-compliance, as well as possibly missing out on opportunities that are resident within the incentives of these policies and legislation.

Despite these omissions, the response shows that whether through its own strategies or those of PPM, MCCGC believes it strives to comply with both national legislation and international standards. This compliance translates into mitigation and adaptation strategies and practices.

4.3.2 Mitigation strategy and practice

The mine has translated these standards to suit local conditions resulting in the formulation of a guiding strategy enshrined in the "PPM EHS standard No. PPM-SOP-GEN-41", whose objective is,

"…..to ensure that all legal and other requirements related to health, safety and environmental issues applicable to PPM are identified, kept up to date and communicated to all personnel". (Sherrard and Humphries, 2013: 2).

This means that through MCCGC, PPM operates under an integrated EHS strategy. This strategy is ISO accredited and certified by TUV SUD, a Germany-based accreditation body. The application of an accredited integrated EHS strategy to comply with international and national legislation as well as best practice for sustainable mining is not a new concept. International cities such as Denver in the United States of America (USA) and mining companies such as BHP Billiton have similar systems (Shmiechen, 2012; Nzimande and Chauke 2012). More important and relevant to this work is that the link with the ISO-14,000 series serves to ensure the implementation of climate change mitigation practices, which in this case relates to targeting air pollution prevention and resource conservation (ISO, 2017;Francis and Steele, 2010), as discussed in Chapter 2. A working advantage to this arrangement is that both the MCCGC and PPM follow the IS0-14, 000 series stipulations on environmental management, which in turn addresses climate change management. It is within this context that MCCGC tacitly engages with the climate change management agenda and the related practices toward climate change mitigation that were observed during the study are discussed below.

The research revealed that MCCGC's climate change mitigation intervention practices can be analyzed under two categories; the pit-based and out-of-pit based interventions. Pit-based interventions pertain to the bush clearing, rock blasting, loading and hauling operations. Out- of-pit interventions include tax beneficiation by restricting off-site fuel usage, fleet management using information technology, resource conservation by applying IT intervention in offices, waste management, fleet reduction, and employee capacitation and stakeholder involvement.

MCCGC's opencast mining operation at PPM follows the operational cycle of bush-clearing, drilling, blasting, loading, hauling and dumping (Sahoo et al., 2014). As stated in Chapters 1 and 2, these operations are heavily dependent on diesel fuel powered machinery (Wilkinson, Lionel and McDonald, 2010; Saxelby, 2008). Examining each stage of the operations provides insights into how mitigation is occurring at MCCGC.

As a contractor, MCCGC is not involved in drilling operations at PPM. MCCGC's work at the mine commences at the blasting stage. Here MCCGC has redesigned the blasting burden spacing by widening it to reduce usage of explosives and high energy fuel (HEF). The HEF is an oil-based energy source which is used together with nitrogen based explosives. These two burn to emit GHGs, contributing to global warming, which gives rise to climate change and its adverse environmental impacts. The redesigning of the blasting burden spaces has other benefits, too. One such benefit is the control of blast fragment size ensuring that the resultant fragments enable a high loading efficiency during the loading and hauling stage. This reduces excavator loading times and consequently diesel usage.

Loading operations have also benefited from a number of Blasting Department initiatives seeking to reduce the diesel consumption of associated machinery. These include having smoother floors by controlling hole-depths to a standard level. This reduces moon-scaping or undulations on roads and ramps, which if untreated cause higher fuel consumptions and premature component failures.

Loading platforms, where excavators perch and load (benches) have been standardised to a required 1.5 metres or the height of the dove tail of the dump truck so as to increase loading efficiency and reduce fuel consumption by reducing idling and optimising the upswing of the loading bucket during loading. Commensurate with proper loading methods, attention has been given to the hauling process so as to create conditions that are conducive to fuel conservation.

These conditions include, but are not restricted to road and traffic management. The length of the hauling distance, road gradients, road camber, road smoothness, number of intersections and number of stops all affect the ease of using the road (Kocojevic and Komljenovic, 2010). The managers of MCCGC at corporate level have implemented a standard procedure, "Mining Procedure No. 15: Construction and Maintenance of Haul Roads and Ramps" (Bullock, 2011), so as to ensure consistent fuel efficient construction of the roads and ramps. Regular site surveys to measure the quality of road surfaces has also assisted in reducing tyre damage and the cost of replacing the tyres. This reduces the contractor’s carbon footprint by reducing rubber usage. Tyre manufacture, transport and locked-in carbon are a significant contributor to GHG emissions.

In addition to these changes, MCCGC has constructed viewpoints for a real-time observation of operation at the pit, seeking to increase efficiency. A pit controller in the viewpoints ensures the assigning of dump trucks to the appropriate loading machinery and sites. The controllers also monitor issues such as effective truck to loader ratio, and that trucks are filled to optimum levels. This assists in optimising operations through reducing unproductive truck idling times which translate to reduce fuel consumption which in turn means reduced GHG emissions.

The use of pit optimising software, (ModelMaker™, GEOVIA Whittle™ (Whittle) and DataMine™) has resulted in pit optimisation which in turn has led to fuel conservation and carbon footprint reduction at MCCGC’s PPM operations. This software ensures that MCCGC complies with the Section (51) of the MPRDA which advocates optimised and efficient operations for economic, resource conservation and increased profitability (DME, 2002). Dagdelen (2001) describes optimisation in mining as the designing of the pit and mineral extraction process to obtain the maximum financial benefit through reduced project cycle and process costs. The MCCGC executive manager explained that, MCCGC’s technical planning department conducts six-monthly pit optimisation “shell” simulations as part of an advisory and support service to customers and site management. Case studies from Etruscan in Africa and Centera Gold’s American and Canadian mines demonstrate how pit optimisation increases fuel efficiency and reduces greenhouse gas emissions by optimising top soil to ore strip ratios, geological body selection, drilling patterns and sequences, blast designs, reducing hauling distance and informs selective mining techniques to reduce fuel use per tonne of mineral produced (Dassault Sytems, 2017).

While pit and operations optimisation all help to reduce emissions from the related operation machinery, the nature and state of the diesel-powered heavy mining equipment determines the quantity of deleterious emissions. A number of initiatives have been introduced on this front. The Engineering department’s mitigation interventions include purchasing and use of fuel-efficient mining equipment. MCCGC uses Terex MT3300 Electrical hybrid, 150 Tonne Dump Trucks in its PPM contract. The vehicles generate their own electricity through an on-board power generator, which converts the kinetic energy from the wheels into electric energy which powers the truck. The disadvantages with this technology are that it needs highly specialised mechanics that are currently rare and expensive in the South African market and to an extent, globally. It also has spare parts availability problems as most of the spare parts have to be imported from the United States of America. This poses the risk of work stoppages when there are delays in the freighting of spares. As a result of these and other challenges, MCCGC is planning to decommission these trucks.

While the experience with hybrid vehicles has been disappointing, this has not stopped work on seeking to improve the fuel efficiency of petroleum fuelled power vehicles. One such endeavour has seen the conversion of one of the five excavators, from being a back hoe loading tool into a face shovel configuration to increase its loading efficiencies. According to MCCGC management this conversion produced a 302 tonne loading tool, which is the first of its kind in South Africa (www.specguideonline.com). The conversion has had various benefits that include an increased loading efficiency, higher productivity; reduced fuel consumption per weight of ore moved, and consequently reduced carbon emissions also per weight of ore moved (Liebher, 2013).

Work to improve fuel efficiency has also seen the introduction of speed control on the dump trucks, limiting them to 40 km/hr. This has three-benefits namely; (i) it lowers fuel consumption which in turn reduces carbon emissions, (ii) it lowers the frequency of tyre damages which in turn lowers tyre costs, and (iii) increased safety records. The introduction of all these and other measures has also meant the tracking of mining machinery fuel consumption performance and its management within specified limits (Van Breda, 2013; Mhuruyengwe, 2010). The area manager mentioned that fuel usage by vehicles is benchmarked, stating:

"*For* [every] *truck there is a benchmark, for example a CAT 777 Horse Power Dump Truck with a full load uses an average of 65 litres in an hour. You can be efficient in terms of amounts issued (when you lower the machines operating speed).* [this] *also reduces diesel fumes in the air"* (Interview excerpt, September 2015*).*_

He further stated that differences in consumption were investigated so as to maintain benchmarked consumption patterns per machine.

Information Technology (IT) has also been used to reduce liquid fuel, electricity, paper and printer cartridge use at PMM. Reducing electricity consumption has led to a reduction in PPM's scope 2 GHG emissions. The use of printing paper and related equipment has been outsourced to a third party, Kyocera, a company which pools and manages printing in a manner that is economically and environmentally sustainable. Kyocera assigns individual identification codes for printing and keeps the relevant records. This is meant to limit services abuse. This not only translates into reduced costs but also has the co-benefit of reducing PPM and MCCGC's carbon footprint.

Liquid-fuel usage management is one of MCCGC's emissions and cost cutting focus points. This focus has been extended to non-mining fuel consumption. In November 2013, MCCGC reduced this aspect of fuel consumption by preventing personal use of company vehicles. The firm ceased to issue company vehicles to individual employees and replaced this benefit by paying a related monetary allowance. This move led to a change in the behaviour of employees that led to indirect carbon emissions reduction when employees began to join transport 'lift clubs' in order to curtail their personal fuel and maintenance costs of driving to and from work. While some individuals still retain the use of company vehicles, there are limits on their use and those who abuse the vehicles are reprimanded accordingly.

Waste management practices have an impact on GHG emissions reduction. At PPM, MCCGC separates waste for recycling (Figure 4. 1). Bins are colour-coded following the national standards, with green bins for clean paper, black bins for recyclable waste, red bins for oil contaminated waste and hazardous waste.

Figure 4. 3: Waste separation for recycling at PPM (Photograph taken by Peace Matangira 28.12.2016)

Used tyres are managed as per the Integrated Industry Waste Tyre Management Plan, which is part of the Recycling and Economic Development Initiative of South Africa (REDISA). The plan and initiative are legislated by NEM: Waste Act Number 59 of 2008: Waste Tyre Regulation 11 (4) of 2009 (DEA, 2009). The used tyres are collected (Figure 4. 2) and sent to a government tyre recycling facility. This in turn reduces scope (2) carbon emissions directly through reduced tyre production as well as indirectly reducing waste tyre-based carbon stores.

Figure 4. 1: PPM Waste tyre collection and dispatch point for REDISA (Photograph taken by Peace Matangira 28.12.2016).

Further waste stream based emissions reduction management practices at PPM include oil conservation practices that include the re-use and re-cycling of oil where possible. The oil that cannot be re-used is sold to an oil reclamation agent for re-use as a fuel for furnaces or for blast inputs such as HEF. This waste-to-fuel process assists in reducing virgin hydro-carbon resource extraction. Scrap metal is also sold for recycling with the same co-benefits of reduced GHG emissions associated with the extraction and process of virgin metal ores.

While all these efforts are important it is imperative to reiterate that an effective climate change management plan should balance mitigation and adaptation. These should be structured according to the relevant vulnerability and advantages of the mine.

4.3.3 Adaptation strategy and practice

The ISO-14, 000 series is supported by other related standards such as the Occupational, Health and Safety Management 18001 Series (OHSAS 18001) which informs adaptation strategies and practices at PPM, in the manner discussed in Chapter 2. The intricacies of this strategy were discussed in chapter 2 and the subscription and certification of the strategy by TUV SUD is discussed within section 4.3.2.

At PPM, the MCCGC indirectly addresses adaptation in the integrated EHS management strategy. As is the case with the mitigation strategy, adaptation is informed by national law and voluntary international codes. The Mine Health and Safety Act 29 (MHSA) (GRSA, 1996), and its related regulations, govern MCCGC's adaptation practice at PPM. Sections 2A, 4.1a, 3.1a, 7 (4) and 11 of the MHSA place climate change adaptation responsibility on MCCGC and PPM as employers, requiring them to mine in a manner that protects the health and safety of the employees and property from the associated hazards (DMR, 1996).

The integrated EHS system's elements that address adaptation are informed by the Occupational, Health and Safety Management 18001 Series (OHSAS 18001) standards. PPM `has adapted this international voluntary standard into a site specific, PPM-SOP-GEN-048: HSEQ Management Roadmap, which requires MCCGC as a contractor to continuously assess the sources of risks and initiate participatory measures to eliminate or reduce the risk levels to reasonable, practicable and acceptable levels as required by policy and law (Humphries and Coetzee, 2015). Following the policy and legal requirements, adaptation measures involving infrastructure development and design, road maintenance, sun screening, financial hedging, emergency detection, water management and temperature regulation have been implemented.

The biggest adaptation work has been aimed at combating the adverse effects of climate change induced heavy and incessant rains**.** Outside the pit, Infrastructure development has been used as a method to combat flooding of roads cause by incessant rains. Adaptation work to this end has involved the building of a water drainage system that conveys water away from the road to counteract the water pooling on the roads. In 2015, MCCGC and Trollope Mining Services funded the resurfacing of roads leading to the mine with rain absorbing, self-draining soils. This was an effort to counteract the effects of incessant rains which sometimes made the road un-usable, resulting in delayed production, increased absenteeism and late- coming. In 2010, water catchment dams were built to harness surface water runoffs from low rainfall. However, these had to be decommissioned due to water license problems and legal non-compliance sanctions imposed by the Department of Water Affairs and Forests.

To combat slippery road conditions during and after the rains, "all-weather" roads are being built within the pit, by applying crushed rock aggregate onto the surfaces of roads and ramps to ensure operations continue under different weather conditions The crushed aggregate rock creates a permeable layer allowing the water to drain away into the "sponge" created by these rocks. The use of crushed aggregate rocks on roads is documented in the management minutes of MCCGC's weekly heads of departments (HOD) meetings since 2014 (M. de Jager, personal communication, 2015).

In retrospect, lessons were learnt from inadequate drainage systems in the opencast mine from pit floods in the 2011/12 rainfall season. Consequently, in 2016, PPM's General Manager requested that the MCCGC-led infrastructure department begin an all-weather road construction project, and they instituted a drainage management plan in anticipation of possible flooding during the rainy season. The expedition of such plans is also a reaction to increasing rainfall intensities and longer rainfall seasons in the area. The increased rains sometimes hamper production due to water logging and slippery road surfaces. The MCCGC area manager stated a need for bigger and stronger water pumps to pump water out of the pit, thus avoiding work stoppages. Also, realising the business risk associated with pit flooding, MCCGC has maintained a stand-by crew and stand-by water pumps to support the client's pumping capacity. Despite these periodic excesses of water, the dry season also presents challenges.

The dry seasons bring about the challenge of dust, which is exacerbated by increased evapotranspiration rates, and at times lower than expected rains. The MCCGC sub-contracts two companies, Flowcentric and Dithakadu who are evapotranspiration and dust-allaying specialists to drive an adaptation response for the excessive dust caused by drier soils which emanate from excessive evapotranspiration, and inadequate rains to sustain adequate water levels for dust suppression. These evapotranspiration specialists provide and apply dust-allaying chemical compounds that reduce dust rises and lessen the need for high amounts of water to control dust (Bothma, 2016).

The MCCGC employees who work in the pit and the field are exposed to the adverse effects of climate change hazards which include excessively high temperatures and ultra-violet radiation, causing skin cancer, fatigue, fatigue-related accidents, sunburn and dehydration, among other temperature-related physical ailments. Adaptation policies have been applied to counter these hazards by mandating employees who are exposed to these hazards to wear sun visors, take periodic fatigue breaks in designated shaded rest areas, and wear coverall type clothing (A.Broekhuizen, personal communication, 2011). In addition, MCCGC provides cold water, water coolers and cooler boxes to employees to combat thirst and fatigue from excessively high temperatures (H. Botha, personal communication, 2016). The company was obliged to install additional water taps at the training centre and administration blocks to quell unionised complaints from employees citing the need for extra oral rehydration due to climatic shifts (MCCGC, 2015). MCCGC is also investigating purchasing water fountains and industrial water coolers to ensure that all employees have access to cold water.

Retrofitting air conditioners in buildings and vehicles has become an adaptation necessity to combat the hot conditions that have been created by climatic shifts. In 2015, the tyre bay, service bay and service truck operators raised complaints against MCCGC accusing the firm of failing to provide comfortable ventilated waiting areas, as well as inadequately cooled vehicles. These concerns have since been addressed at a cost of over R200, 000.00 (Botha, 2015; Coetzer, 2015).

Adaptation practices have also moved to finance management. The company's budget for its PPM contract carries a provision for costs that may be incurred through rainfall related work stoppages and the need to pay for adaptation measures (MCCGC, 2015). These provisions had not been included in years preceding 2011 and led to losses in projected revenues whenever climate change related work stoppages occurred (EQSTRA, 2013). This inadequacy in planning had a negative impact on the image, investor return on equity, investor confidence and the bottom line of MCCGC. The losses triggered MCCGC to consider adaptation that acknowledges the difference in the locations of its contract sites that include drier countries such as Namibia and Botswana (Ibid). Climate risks have now become integrated into MCCGC, PPM's business risk registers, with rainfall and lightning being amongst the top 10 business and financial risks (D. Sisiya, personal communication, 2016; K. Jordaan, personal communication, 2015).

An important element of adaptation is planning based on accurate data and information. To this end, MCCGC subscribes to the South African Weather Service Information Systems (SAWSIS) to provide real time and forecast weather related information. This has resulted in the development of early warnings systems for heat waves, thunderstorms, storms, incessant rainfall, assisting in taking precautions to combat the adverse impacts of forecasted weather events. For example, the early warning systems is used when temperatures exceed 42°C, a level at which employees have to be evacuated from the pit as well as when thunderstorms with lightning are six kilometres away from the mine (W. Stander, personal communication, 2016). MCCGC, also uses hand held and mounted lightning detectors to predict lightning in the field and prevent harm to its employees by evacuating the pit if lightning is less than six kilometres away. MCCGC also runs awareness campaigns to educate employees on the presence of various adverse weather conditions as well as how to minimise and control the risks thereof.

Summing up, MCCGC is working to adapt to climate change. Its adaptation shows both reactive and anticipatory adaptation.

4.3.4 Factors/ drivers of climate change response

Drivers for climate change mitigation by MCCGC at PPM as described in section 4.3.1 are mostly based on legislation, client policy, corporate policy, knowledge, financial savings, environmental stewardship (moral imperative) and a need to maintain community relations.

Drivers for adaptation are risk aversion from the risks outlined and discussed in Chapter 1. These are: (i) financial risk resultant from climate change related production losses, property damage, (ii) physical risks such as excessive droughts that can lead to food supply shortage or an inability to conduct critical mine activities such as dust suppression. (iii) (iv) Reputational risk exposures also drive MCCGC to adapt to climate change, The company risks reputation loss from being unable to manage risk that affect productivity and service delivery, for example if the pit floods or the roads are unusable leading to production delays. (v) Legislative/ regulatory risk emanate from facets such as the need to defend the TUV SUD accreditation by the client. Such voluntary regulations have significant impact on markets and stock pricing. Export markets may refuse to trade with uncertified companies. (vi) Health risk such as heat stress and fatigue that have resulted in work stoppage and illness also drive MCCGC at PPM to adapt to climate change. The proliferation of knowledge on climate risks has also led to a response toward climate change adaptation. Opportunities in terms of cost reductions have led to adaption practice such as using the open pit as dam rather than back filling it. This also has co-benefits of a positive social impact. Noting the above the study findings at Tharisa were also classified under similar themes. The findings at Tharisa's are discussed in section 4.4.

4.4 Findings at Tharisa

The study findings at Tharisa were are discussed under similar themes as those at PPM. These were related to legislative policy and frameworks, mitigation strategy and practices, adaption strategies and practices as well as the drivers for these strategies and practices. These are discussed within this Section 4.4 of the research. The Figure 4. 2 is a satellite map picture of Tharisa Minerals and provides a contextual picture of where the findings were derived from.

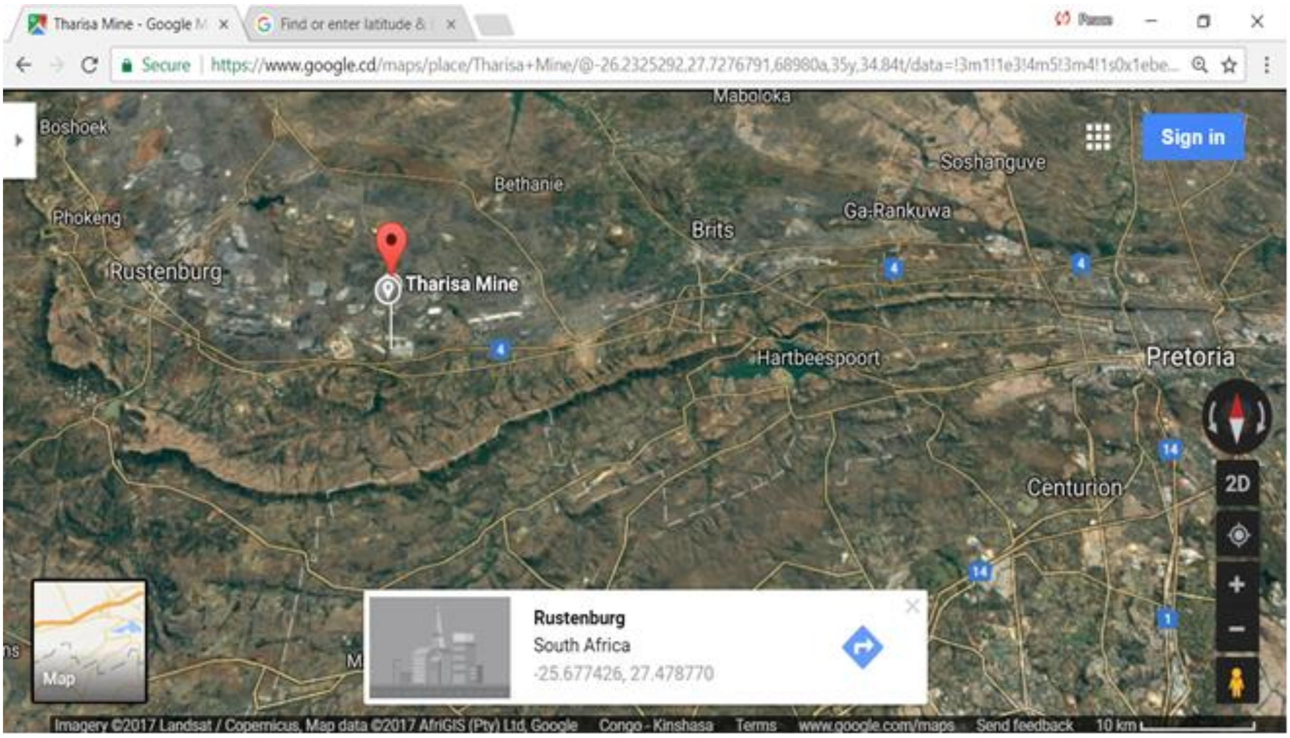

Figure 4. 4: Satellite map image of Tharisa, 31 August 2017. Source: Google Maps

The following findings emanated from the defined area of Tharisa Minerals.

4.4.1 Legislation and policy frameworks

Similar to operations at PPM, MCCGC's climate change mitigation and adaptation strategies and practices at Tharisa are implicitly addressed within an integrated environment, health and safety management system (EHS). This approach is articulated in Tharisa's policy documents namely; Tharisa Mineral's Safety Health and Environmental Management Plan (SHEM Plan) and Tharisa Mineral's Safety Health and Environmental Management (SHE) Policy (Smith and Malunga, 2015). MCCGC Tharisa does not conduct energy use audits and carbon foot printing because, as stated in Section (4.2), their climate change management strategy is not explicit and does not follow published frameworks such as those described in Chapter 2 (Section 2. 6). An explicit strategy towards mitigation, such as those presented in Chapter 2 (Section 2. 6), would most likely ameliorate such rudimentary omissions in mitigation efforts.

Complimenting Tharisa's principal policy documents are MCCGC's SHE Plan, objectives and targets and the SHE Policy which mandate the opencast mining contracting company and plant hire company to comply with the principal's (Tharisa) policies as a minimum requirement to meet its contractual obligations of the toll-mining contract. The MCCGC's policy documents are fundamentally similar to those of the principal, with both policies citing international and national laws as well as a similar scale and voluntary codes of practice, as the drivers for EHS management in general and implicitly climate change management (Tharisa, 2015; Mhuruyengwe and Matangira, 2010).

As at PPM, the voluntary international environmental management code of practice, ISO-14,001 which implicitly addresses mitigation, and a similar code OHSAS-18,001 which implicitly addresses adaptation, are the EHS system's drivers towards mitigation. Their fundamental elements, relative to climate change management were discussed in Sections 4.3, 4.4 and 4.5. These included a precautionary approach to sustainable ecological management (mitigation) and adapting to ecological shifts (adaptation). Mitigation is achieved by conserving resources, legal compliance to sustainability laws, continuously improving technologies, behavior and operational practices, preventing pollution, preventing biodiversity resource and energy wastage, and training employees.

Adaption is achieved through a similar approach, which focuses on protecting and creating corporate, social and employee value through conserving resources, legal compliance, and preventing harm, improving continuously on technologies and practices, pursuing opportunities and training employees. These strategic focal points are translated into practice through the plan, do, check and act management framework, derived from the Deming's cycle of continuous improvement. However, unlike at PPM, the integrated EHS system at Tharisa is uncertified by a recognized assurer such as TUV SUD. This does not disqualify the system's relevance in climate change management but may reduce its credibility to stakeholders and reduce the system's efficacy in addressing EHS issues such as climate change (Dereinda and Greenwood, 2015; ISO 2015).

Despite the various policy commitments by MCCGC's Tharisa operations to subscribe to international climate change laws, policies and voluntary codes, the research could not find evidence of climate change management practices referring to relevant international agreements and protocols. Examples of apparent omissions were the citation of the Kyoto Protocol, Copenhagen Agreements, Cancun Agreements and World Summit on Sustainable Development, among others. One would expect that as the cornerstones of drivers of climate change mitigation and adaptation, such protocols and agreements would be integrated into MCCGC or Tharisa's policy documents and translated into mitigation, adaptive value addition or adaptive value protection practices as discussed in Chapter 2.

In spite of this apparent failure to explicitly incorporate these international protocols and agreements in documents dealing with the climate change phenomenon, MCCGC's management at Tharisa's is conversant with their company's constitutional duty to comply with the national environmental management laws. The managers who were interviewed were aware that these laws are drafted to protect the environment in general and climate change management in particular. However, and in contrast with the case at PPM, there was an apparent lack of deep and adequate knowledge of the legislation which determines climate change mitigation in Tharisa's operations. This presents a business risk, which translates into operational, health, legal and financial risks because knowledge is a key driver of mitigation practices (Muduli and Barve, 2012). For example, MCCGC's management team at Tharisa was unaware of the impending carbon tax. On further discussion and explanation by the researcher on what this tax entails, MCCGC's financial expert at Tharisa showed concern, and argued that such a tax could have a disastrous financial impact on the site and the opencast mining contracting and plant hire industry.

The apparent lack of awareness on the legal requirements driving environmental management and climate change mitigation by MCCGC's managers and employees at

Tharisa did not result in a total neglect of national environmental management legal requirements. Operations at Tharisa acknowledge climate change and its management. The legal register systematically identifies laws such as the Constitution of the Republic of South Africa, MPRDA, NEMA, MHSA, APPA, Biodiversity Conservation Act, NWA, and NHA, which implicitly address mitigation and adaptation. Section 4.3, 4.4 and 4.5 already provided an in-depth discussion on the relevant mandates of these laws and their relevance to mitigation and adaptation practices at mines. As was the case at PPM, these legal requirements have been translated into corporate compliance standards, employee contracts, job descriptions, key performance indicators, procedures and training programmes thus making it the responsibility of all employees to mitigate and adapt to climate change. Cummings et al, (2010) documents similar practices by Fortune 100 companies such as Kingfisher. The MCCGC's climate change management practices at Tharisa Mine will be discussed in Sections 4.7 (mitigation) and 4.8 (adaptation).

4.4.2 Mitigation strategy and practice

A notable difference between MCCGC's operations at Tharisa compared to PPM is that at the former, MCCGC was involved in drilling operations. Tharisa operations follows the mining sequence of bush clearing, drilling, blasting, loading, hauling and dumping as well as mine growth stages, namely; mine development, operation, closure and rehabilitation. Similar to the discussion of PPM's operations, Tharisa's mitigation interventions are classified and discussed as in-pit and out of pit interventions.

Mitigation interventions in opencast mines focus on diesel fuel conservation because up to 90 percent of energy demands and greenhouse gas emissions (scope 1 emissions) produced by opencast mines relate to diesel powered heavy-duty mining equipment use (Wilkinson, Lionel and McDonald, 2010). The remaining emissions are related to electricity consumption (scope 2 emissions) and external consumption by service providers and consumers (scope 3 emissions) (Iyar et al., 2010). An MCCGC engineer at Tharisa concurred with this assertion, stating that the opencast mine does not use much electricity, hence a general lack of focus in reducing its electricity consumption with alternative energies such as solar energy. Unfortunately, MCCGC's energy use, energy savings and related greenhouse gas emission ratios for scope 1, 2, and 3 emissions are not documented; thus, there is no baseline for greenhouse gas mitigation efforts. This fundamental inadequacy in the mitigation strategy and practices could be avoided by adopting published mitigation frameworks similar to those presented in Chapter 2, Section 2.6. These include the UNFCCC (2013) Mitigation Framework (Figure 2. 1) and Hoffman's (2010) mitigation framework. Such frameworks guide a company to evaluate the carbon emissions quantities, profile their sources, evaluate risks and opportunities that are aligned to them, and then enact a prioritized set of interventions to alleviate and benefit from the risks. The system is implemented in a pro-active, participatory manner, which checks and balances itself based on internal and external information systems and statutes.

Irrespective of the apparent broad scale inadequacies of both MCCGC's approach to climate change mitigation at the Tharisa site, the practice of fuel capping stood out as a significant mitigation intervention. Fuel-capping is a contractual agreement between Tharisa Minerals and MCCGC, which sets a benchmark limit on the amount of diesel to be consumed per cubic meter of ore (blasted rock) or earth material moved (Jordaan, 2015). Fuel consumption below the fuel cap carries financial rewards for MCCGC and its employees, whilst exceeding the cap leads to financial penalties such as payments for a portion of costs above the upper cost limits. The practice of fuel capping motivates the formulation and implementation of the in-pit and out-of-pit fuel use reduction practices, which influence climate change mitigation.

In-pit mitigation practices aimed at enabling MCCGC to meet the fuel cap limits, as well as the EHS system pollution and conservation requirements are presented sequentially, following the production cycle. The production cycle begins with bush clearing and topsoil stripping to open space for drilling operations. This process is done as per the EMPr and MCCGC corporate procedures so as meet the legal and EHS system requirements for sustainable mining. The requirements include air quality management and water, soil and forestry resources protection (Gerber and Putter, 2013; METAGO, 2010). Bush clearing is done as marginally as possible and topsoil is banked in topsoil dumps for subsequent return to its original area at mine closure, enabling forest rejuvenation. Nzimande and Chauke, (2010) acknowledge the positive ecological influence of such practices citing them in BHP's Mpumalanga mines. However, scholars such as Mudd (2008) argue that referring to mining as "sustainable", is an oxymoron especially considering that to produce one kilogram (kg) of gold results in the emission of 11.5 tonnes of GHGs into the atmosphere.

After the bush clearing process, the drilling process begins. Production drilling needs to follow specific patterns so as to attain an appropriate blast fragments for optimum mining and processing energy efficiencies. Poor fragmentation leads to higher energy demands in downstream processes such as ore crushing and milling. Drilling operations at Tharisa actively seek to avoid inappropriate fragment sizes. A significant practice to avoid this is the accurate tagging of holes to be drilled, indicating the accurate hole-depth and geological hole- positioning using GPS technology. Drilling at the correct angles, depth and burden spacing optimises mining operations leading to a reduction in scope 1 and 2 greenhouse gases because such optimisation leads to efficient explosives uses, loading and hauling operations and also eliminates the need for re-drilling (GEOVIAWhittle™, 2016). Re-drills are also avoided by “collaring of holes”. “Collaring of holes”, involves inserting polythene plastic tubes into the head of the holes and leaving a protrusion to prevent water ingress and hole- collapse.

The application of efficient blasting technologies such as electronic detonation devices rather than using less efficient shock tubes has led to MCCGC Tharisa’s blasting operations contributing to the reduction of greenhouse gas emissions mitigation discourse because it uses less HEF and produces a better blast fragmentation. Finer fragmentation has also reduced fuel consumption requirements by reducing the amount of secondary drilling and blasting which involves using additional heavy duty diesel consuming machines like Panthera Drill Rigs, compressed-air driven Jack Hammers and compressed-air driven truck mounted drill rigs.

MCCGC at Tharisa also employs vehicle fleet management techniques as a means of reducing diesel consumption. Fleet productivity in the control room is actively managed through a televised global positioning system which is linked to the machine’s on-board engine monitoring units and computer systems. This enables the supervisory staff to monitor fleet movement and monitor and stop fuel wasting practices such as excessive idling. Practices that prevent excessive idling facilitate mitigation efforts because such actions reduce the amount of GHGs emitted into the atmosphere (Pearce et al, 2009).

In addition to using fleet management to control fuel consumption, a MCCGC Production Foreman at Tharisa, explained that fuel consumption is also reduced by technically preparing and maintaining the loading areas in a manner that reduces the effort needed by dump trucks to move over the surface. This also reduces the expenses incurred from tyre and machine damage from rough and undulating surfaces. As explained by Wilkinson, Lionel and McDonald, (2015) unprepared surfaces increase fuel consumption of mining equipment which in turn increases the equipment's GHG emissions. The use of ancillary equipment such as dozers and graders to prepare the mining surfaces and loading platforms as opposed to using the heavier and less energy efficient excavators also saves fuel use and reduces greenhouse gas emissions.

Another practical technique used to save on fuel and carbon emissions at Tharisa is the optimised truck loading technique dubbed the “t” formation. This technique has been standardised in MCCGC's technical mining procedure number 16, and mandates that trucks should enter the loading zone in a manner that ensures production and energy optimisation.

The translation of this procedure into practice is a clockwise or anti-clockwise drive-in style which also incorporates technical aspects such as the correct truck-to-excavator ratios and optimal pairing of a loading tool such as an excavator, face-shovel or front-end loader to the right model or size of dump truck (material hauler). The combination of these technical mining aspects optimises production rates and efficiency. The Production Foreman's words articulate this loading technique concisely. He said:

> *“We ensure that we have enough trucks on the machine. We don't put more than enough on the machine. We just put average trucks that we need for the machine, so the truck doesn't wait for a long time for the machine to fill up the other truck. It can be 2 minutes then the other truck that is filling goes away and then the other comes in* [immediately]. *We know we have got the right numbers of the trucks when there is always one truck waiting to load, other than the one that is loading and* [one that is pulling away]. [There must] *always be one truck that is standing, waiting to be loaded* (so as to prevent delays, idling and diesel wastage).*”* (Interview excerpt, September 2015*).*

During the site visit it was illustrated why this technique is called the “t” formation. As observed, the trucks tend to draw a footprint on the loading area which looks like a hand written “t”.

As mentioned in Section 4. 4, which described mitigation practices at PPM, road maintenance and traffic management is critical in fuel-use management. The maintenance and management of the road conditions and quality at MCCGC's Tharisa site is also managed as per the corporate "Mining Procedure No. 15: Construction and Maintenance of Haul Roads and Ramps" (Bullock, 2011), so as to ensure a consistent fuel-efficient construction of the roads and ramps. However, unlike at PPM, at Tharisa, MCCGC has a dedicated road construction and maintenance manager. As a result, the roads at Tharisa were observed as being in a better condition, had fewer stop signs, and more yield signs and traffic circles, compared to those at PPM. Such initiatives work to reduce fuel consumption and GHG emissions in open pit operations.

Similar to PPM, in-pit viewpoints have been erected at Tharisa. Management meetings and over-inspections are done there so as to control pit operations and reduce fuel-wasting practices. The Roads Construction and Maintenance Manager has established this as his permanent workstation and the vantage point ensures that he maintains operational control and direction, yielding the co-benefits of maximised energy efficiency, reduced fuel consumption, cost savings, increased profit margins and a lower carbon foot print.

Additional road construction and maintenance practice that were observed within the MCCGC operations at Tharisa included (1) monthly road-condition surveys termed "site severity studies". Similar to those at PPM, these are done by tyre specialists who have in-depth knowledge on tyre management and how it optimises costs, tyre-life and productivity. (2) Periodic surveys and reporting on the pit conditions using drones (this was not done at PPM). (3) Pit condition mapping and correlation to fuel consumption, machine abuse and productivity using truck-mounted, electronic road condition sensors (this was not done at PPM). The cumulative information from these various systems is used by MCCGC's management at Tharisa to provide the technical information which is used to optimise fleet usage, costs, production and profits.

The co-benefits of the above-mentioned practices include reduced tyre and diesel consumption, as well as supply chain savings for these inputs to the production process. The net result includes a reduction in the carbon footprint of MCCGC's operations at Tharisa, either directly by reducing scope one emissions, or indirectly by reducing scope two emissions which would have been emitted during production and transport of the spare parts tyres necessary to repair prematurely failing machinery and tyre induced by poor pit floor and road conditions.

A number of mitigation practices that are similar to those at PPM were observed and documented at Tharisa. The researcher has already discussed the legal basis of these similar practices in Sections 4.3 and 4. 4 and will now only briefly describe and document these similar practices as observed at Tharisa so at to contextualise them. The MCCGC operations at Tharisa also focus on pit optimisation using the ModelMaker™ mine optimisation software. As is the case at PPM, this software ensures that MCCGC complies with Section (51) of the MPRDA which stipulates that mining should be optimised for efficiency and conservation purposes as well as mining economically and profitably (DME, 2002).

The out-of-pit interventions observed at MCCGC's Tharisa operations are similar to those at PPM, perhaps because they are implemented uniformly as corporate rather than being site specific practices. These were discussed in Section 4.4. The interventions include the integration of IT systems in fleet efficiency and abuse prevention management systems. Engineering controls such as maintenance and services at the recommended intervals are typical fuel-conservation and emission-prevention techniques practiced at both sites. Tharisa operations also outsourced printing services to Kyocera, reduced the light duty vehicles fleet in 2013, and imposed a restriction on off-site use of light duty vehicles. There are also various forms of waste-sorting and recycling promotion, tyre management through the Recycling and Economic Development Initiative of South Africa (REDISA), used oil recycling and re-use and scrap metal recycling.

As discussed in Chapter 2 (Section 2.3), climate change has already triggered shifts in rainfall patterns, temperatures, and wind to an extent, which pose adverse impacts. The MCCGC and Tharisa employees acknowledge some of these impacts. Consequently both firms have had to adapt to these climate changes related impacts. This adaptation is discussed in the following section.

4.4.3 Adaptation strategy and practice

The guidelines of MCCGC's climate change adaptation strategy at Tharisa are articulated in the policy documents of both the principal (Tharisa) and the contractor (MCCGC). Both strategies address climate change within the ambit of the health and safety management arm, of their integrated Environment Health and Safety management system (EHS). The firms' adaptation plans are applied concurrently because the companies have a corporate responsibility to manage the health and safety of their employees, to advance stakeholders' interests, as well as enhance or protect corporate value (Nitkin et al., 2010; Nelson and Schuchard, 2010; Mzenda and de Jongh, 2007). However, because of the requirements of Section (100), of the MPRDA and Sections 2A, 4.1a, 3.1a, 7 (4) and 11 of the MHSA which state that the principal remains accountable for the legal obligations on health and safety in general and adaptation in particular, Tharisa's policies take precedence. The MCCGC's policies only apply in the absence of an explicit or implicit Tharisa policy statement. Policy documents capturing these commitments were the Tharisa SHE Plan, Tharisa Safety Health and Environment Policy, MCCGC SHE Policy, MCCGC Objectives and Targets and the MCCGC Objectives and Targets between 2011 and 2016.

The research found climate change adaptation practice related to water management, infrastructure development and design, road maintenance, financial hedging, sun screening, fatigue and thermal stress management as well as awareness and competence building. As at PPM, rainfall and the related water management issues are two critical aspects of climate change to which MCCGC operations at Tharisa have had to adapt.

Observations indicate an inadequately developed water drainage management system within the entire MCCGC opencast mining operation at Tharisa. This includes the surprise finding where it was observed that MCCGC management at Tharisa has not implemented the practice of integrating DMS (crushed rock aggregates) into their roads and ramps so as to make them all-weather roads, or at least accelerate their drying period after rains, for increased production. As stated in Section 4. 4, the MCCGC Production team at PPM is already doing this.

Despite these findings, the Drilling and Blasting manager indicated that the mine routinely prepares the relevant infrastructure every rainfall season, albeit inadequately and at times too late into the rainfall season. The afore-mentioned manager also added that management was conducting drainage improvement studies so as to deal with cases of future rainfall excesses and floods. A Production Manager also indicated that the site had been inadequately prepared for a recent storm of over 54 mm of rainfall. At the time of the study, remnants of the storm evidenced by water-logged sections of the road and slippery roads in some areas were hampering production and adding safety risks such as truck damage, tyre damage and possible collisions. Some of the roads were temporarily abandoned pending their drying off naturally.

The mine was actively ensuring that such cases of floods do not halt operations. Actions to this end involved ensuring the availability of functional water pumps and water pumping into built reservoirs. The Production Manager and Drilling Managers indicated that MCCGC was continuously running stage pumps to pump water from the bottom of the pit to the plant and surface dams.

An opportunity created by the high water volumes is that the water can be harvested and used as a dust suppressant. This is unlike at PPM where water scarcity has necessitated the need to use dust-suppressant chemicals in dust-suppression activities. Tharisa's operations pump unadulterated water from water reservoirs directly into water bowsers for spraying onto roads and loading areas. The availability of natural water saves on water costs because the company does not have to purchase road dust-suppression chemicals. However, the counter argument is that costs related to maintaining the water bowsers and associated equipment translate to a higher cost compared to the use of chemical dust suppressors (C. Bothma, personal communication, 2016).

Despite the abundance of water at times, Tharisa operations are at risk of suffering water shortages in the drier periods and during droughts. Drought interventions, such as water harvesting in reservoirs and utilising underground water that is abundant at the mine, have been employed. Sumps have been created within the pit as a way of channelling these underground water streams into in-pit catchments. A Production Foreman stated that the mine has no shortage of water because one of the pits had reached the underground water table. Utilising this water source circumvents the debilitating legal limits on the amount of water that a mine can store in its reservoirs.

Tharisa also suffers the same plight as PPM, with regard to dry soils created by hot temperatures and excessive evapotranspiration causing dust, which in turn affects visibility in mining operations and increases the risk of vehicle collisions. To adapt, the mining operations conduct frequent dust-suppression activities of spraying water onto haul roads. However, at times this is inadequate or slow and operators have to adapt by increasing following distances between haulage vehicles. While this improves safe operation it, however, slows down production.

The MCCGC Human Resources Manager at Tharisa indicated that there has been community action against dust created by the operations during loading and dumping operations. The conflict between mines and communities, due to the deleterious impact of mining activities on communities, is well documented. At Tharisa MCCGC faces a unique challenge because as the human resources manager said,

"*Last year April we suspended operations as a results of community unhappiness. We suspended the West Mine which is on the other side of the road, after it only started for two to three weeks.* [The problem] is that the *houses and schools are within a 500 metre radius of the mine so when you blast* [or operate the mine], *they are affected by the dust fallout, amongst various other nuisances generated by the mine*". [Interview excerpt, September 2015].

According to Benhin (2006), climate change is likely to exacerbate dust conditions due to excessive drying of soils linked to climate change induced droughts and heat induced excessive evapotranspiration. Although Tharisa currently uses water cannons to spray loading material and reduce the dust, it is likely that it will be done at a higher cost due to the increased evapotranspiration. To counter such cases, MCCGC's management at Tharisa is currently investigating the use of dust atomisers and dust blowers which are supplied by the evapotranspiration specialists and the dust management specialist company, Flowcentric (Bothma, 2016).

The MCCGC employees who work in the Tharisa pit are exposed to adverse weather conditions which include excessively high temperatures and ultra-violet radiation, which in turn cause skin cancer, fatigue, fatigue-related accidents, sunburn and dehydration amongst other temperature-related physical ailments. Adaptation policies have been applied to counter these hazards. The policies mandate employees who are exposed to these hazards to take periodic fatigue breaks in designated shaded rest areas as well as providing clean and cold drinking water. However, unlike at PPM, operations at Tharisa do not mandate employees to wear coverall-type clothes like long pants, and long-sleeved shirts to cater for the extreme exposure to the sun's ultra-violet radiation.

Financial adaptation practices were also noted. These include forecasting for rains within the annual budget so as to maintain share-holder confidence through financial disclosures of the impending losses in revenue and production. These projections also allow for expenditure budgets by non-productive departments such as engineering to be lowered and aligned to the weather-induced reduction in revenue.

The financial experts also indicated that in future, the financial risks and added costs from financial policies such as the impending carbon tax would have to be incorporated into the tendering prices. The financial expert also warned that introduction of the impending carbon tax had the potential to put opencast mining contracting companies such as MCCGC out of business because their marginal profit margins may not be able to sustain the extra overhead costs. His words echoed his sentiments when he said:

> "[The carbon tax] *will definitely affect us [opencast mining contracting and plan s in general and MCCGC in particular]. That tax can take away up to 15 million for MCCGC (at 2013 rates). If we as MCCGC at Tharisa make R15 million a year in profits that will be a good year for us. The tax can take away the whole year's profit of a whole MCCGC site. That's how big the impact is*." [Interview excerpt, September 2015].

At the time of the interview the accounting specialist was not sure if there were financial provisions for carbon tax and could not locate any such provisions in the accounting statements. He went on to state that for the company to adapt, it would have to start incorporating carbon tax into its tender price as well as put in hedging clauses that allow for review of tender prices in line with changes in climate change regulations. The expert was also sceptical as to whether current contractual arrangements allowed for renegotiating contractual payment rates so as to cover the added costs of climate change regulations, adding that if this was not the case then MCCGC was, "in serious trouble" in light of such a tax being enacted.

An important element of adaptation is planning based on accurate data and information. Tharisa does not subscribe to the South African Weather Service Information Systems (SAWSIS) to provide real time and forecast weather-related information as PPM does. Instead of broad spectrum strategic information on weather, Tharisa's operation only focuses on lightning detection and evacuation procedures when the risk is high. Lightning detection is done by means of hand-held and vehicle-mounted lightning detectors with the use of the control room for pre-warning and emergency evacuation. MCCGC also runs awareness campaigns to educate employees on the presence of various adverse weather conditions as well as how to minimise and control the weather-related risks.

4.4.4 Factors/ drivers of climate change response

The drivers for climate change mitigation by MCCGC at Tharisa are similar to those described for PPM in section 4.3.4 and are derived mostly from legislation, client policy, corporate policy described in section 4.3.1 and 4.4.1. The training of management on legal requirements and these policy and regulatory frameworks also drives climate change mitigation. In addition the desire to derive financial savings and environmental stewardship (moral imperative) also drive MCCGC's climate change strategy and practices at Tharisa.

Similar MCCGC at PPM the Drivers for adaptation by MCCGC at Tharisa are risk aversion from the risks outlined and discussed in Chapter 1. These are: (i) financial risk resultant from climate change related production losses, property damage, (ii) physical risks such as excessive droughts that can lead to food supply shortage or an inability to conduct critical mine activities such as dust suppression. (iii) (iv) Reputational risk exposures also drive MCCGC to adapt to climate change, The company risks reputation loss from being unable to manage risk that affect productivity and service delivery, for example if the pit floods or the roads are unusable leading to production delays. (v) Legislative/ regulatory risk emanate from facets such as the need to defend the TUV SUD accreditation by the client. Such voluntary regulations have significant impact on markets and stock pricing. Export markets may refuse to trade with uncertified companies. (vi) Health risk such as heat stress and fatigue that have resulted in work stoppage and illness also drive MCCGC at PPM to adapt to climate change. The proliferation of knowledge on climate risks has also led to a response toward climate change adaptation.

Opportunities in terms of cost reductions have led to adaption practice such as using the open pit as dam rather than back filling it. This also has co-benefits of a positive social impact. Noting the above the study findings at Tharisa were also classified under similar themes. Noting the various similarities and disparities in findings from the two sites section 4.4.5 gives a comparative summary of the findings at the two sites.

4.4.5 Comparison of the two cases – summary

The research findings on climate change mitigation and adaptation strategies and practices that were observed at both MCCGC PPM and Tharisa sites and documented in this chapter (Chapter 4) are summarised in Tables 4.1 (Mitigation strategies and practice) and 4.2

(Adaptation strategies and practices). From these, comparisons of climate change mitigation and adaptation response can be drawn along the same themes, which address the research questions and objectives. These are legal and policy frameworks, mitigation strategy and practice, adaptation strategy and practice and the driver/ factors for the response. It was apparent within the findings the same legal and regulatory frameworks governing climate change mitigation at PPM were recognised at Tharisa. Although, Tharisa management had less knowledge of these compared to PPM management. The applicable laws are identified in Chapter 2 and Sections 4.3.1 and 4.4.1 of this chapter.

Both MCCGC Tharisa and MCCGC PPM subscribe to the constitution and laws of the Republic of South Africa. The laws have been translated into strategy. This was evident within the environmental management programmes documents such as EIAS, EMPs, EMPr d Tharisa). Such legal requirements were supported by the subscription of both sites to ISO-14, 001 which addresses climate change mitigation as discussed in chapter 2 and preceding sections of this Chapter. However PPM's mitigation system provides more assurance in terms of effectiveness because it has been audited and certified by an external auditing firm, TUV SUD.

The strategies are not mere rhetoric but have been translated into the culture of both sites through value entrenchment systems such as norming through rules and commitment through contracts, job descriptions, contractor's packs and pledges. Support systems such as training and disciplinary procedure that re-enforce the norms and culture further support climate change mitigation strategy implementation at both MCCGC sites that were studied.

The implementation of climate change mitigation strategies was evident in observed practices at both MCCGC sites at: PPM and Tharisa. The observed practices included technological interventions such as use of pit optimisation software, and enhanced operational efficiency through systematic operational analysis, data management, planning, supervision and monitoring. Efficiency was also achieved through process efficiency within the production cycle, that is: drill, blast, load and haul. These efficiency reduce inputs such as machine components, oil and diesel and thus the carbon foot print of MCCGC at the two sites thus mitigating climate change. Both sites also focus on waste management and topsoil management which contribute to climate change mitigation by conserving sink and sink regeneration. Innovative application of information technology such as control rooms, visual GPS, WIMS, Vision Link are engineering based information system based climate change mitigating practices that were noticed at both sites of study. Printing reduction through printing solution companies such as Kyocera also assisted mitigation efforts at both site.

The depth of focus on identifying legal frameworks around environmental management and the related information dissemination was better at PPM rather than at Tharisa. There were however differences at the two sites regarding mitigation strategies. These were mostly observed in some practices that were evident in one site but not in the other. These included: (i) the retrofitting of back-hoe excavators into face shovels at MCCGC, PPM site was not done at the Tharisa site. (ii)The rehabilitation method of using the pit at PPM as a dam which then creates a sink and reduces emission from backfilling was not part of the Tharisa plans. (iii) The use of less carbon emitting MT3300 electric hybrid Dump truck was only at PPM. The MCCGC site at Tharisa was advanced in the aspect using drones for surveys as well as on-board weight-o-meters to survey road conditions and improve load efficiencies, practices which were not present at the PPM site.

Climate change adaptation strategy and practice was also apparent in the actions of MCCGC at Tharisa towards compliance with proliferate legal and policy frameworks that were identified at: international, national, client and internal levels. The main legal reference for adaptation being the Constitution of the Republic of South Africa, MHSA, Mines and Mineral Act, and the OHSA. The mechanisms of compliance to this legislation were found within the content of internal voluntary regulations. These included: road construction, water pumping, bogged down (water logged), HIRA procedures, inclement weather, electrical storms, emergency evacuation, fatigue management, slope stability procedures and codes of practice. Inference into their names indicates their purpose, which is to target the adaptation towards specific climate change related risk

Similar to observations at PPM, adaptation practices ensued from these legislative and that emanate from these reports were observed at both sites and these include water pumping and addition of extra pumps to cater for increased rains, extra human resources for pumping including development of pumping specialists as well as consultancy on water management. Both sites provide for financial hedging by having a budget for rainfall and climate related loss of production and maintain investor confidence through budget disclosures regarding expected losses and how to manage them. Weather information systems were implemented at both sites so as to provide real time and fore-cast data on expected climate related disturbances or opportunities for operations. A minor difference between MCCGC at PPM and that at Tharisa was that at PPM they utilised SAWIS whilst at Tharisa they utilised AWS, however the function was the same. Also it was only at PPM that they used hand held lightning detectors as a tertiary lightning detection system, whereas both sites used the digital electronic and wall mounted lightning detectors as primary and secondary systems. Both sites also used dams and sumps to capture rainwater as well as adapt to prevent pit flooding. Both sites used shed nets and provided water to protect people from excessive heat and fatigue.

Further differences included that only PPM had practiced river diversions, but this may have been due to a geography specific problem of a perennial river cutting across a supply and access route to the mine. Two adaptation practices that had operational, financial, reputation, competitive and community relations advantages or co-benefits which were practiced at PPM but not at Tharisa were (i) the application of road dust suppression chemicals, which led to less fuel consumption for dust suppression, less competition for water with the community and enhanced service delivery by eliminating stoppages by client or community for nuisance dust, and; (ii) The construction of the dam instead of back filling the pit. The PPE use regulations at PPM were strict, by demanding use of coverall to prevent cancer from UV radiation. However this could be maladaptation because employees became excessively hot in summer months and could lead to fatigue and accidents. At PPM there was a deliberate move to purchase water coolers for operators a move which was not evident at Tharisa site.

Fundamentally the strategies are similar both for mitigation and adaptation. However there seems to be a difference in the culture and level of implantation. The MCCGC site at PPM seems at a more mature and assuring level of strategy development as well as practice towards climate change mitigation. Perhaps due to a higher presence, drive and information support system from the client.

Table 4. 1: Summary of mitigation strategies and practices at PPM and Tharisa

Department	**Risk/ Opportunity**	**Unwanted Consequence**	**Mitigation examples**
Broad based Environmental Management (Mitigation) Strategy. Affects all mining related departments. (Production, Engineering, Human Resources, Administration).	Scope 1, 2 and 3 GHG emissions and sink destruction mine development and mining operations.	Climate change and weather variability related risks and opportunities to the business, flora, fauna and society.	1. Law - Constitution, MPRDA, NEM:AQA, NEM: Waste Act, Resource Conservation Act; REDISA (PPM and Tharisa) 2. External voluntary regulations: ISO14001 (PPM and Tharisa) 3. Environmental impact assessment and management programmes: EIA, EMPs, EMPr, annual objectives and targets, baseline risk assessments, continuous risk assessments (daily task evaluations, checklists).[PPM and Tharisa] 4. Internal voluntary regulations: SHE Policy, Standard operating procedures, SHE rules, contracts, job descriptions, contractors packs; SHE pledges (PPM and Tharisa).
Production (Survey, Bush clear, drill, blast, load, haul)	Inefficient diesel and hydrocarbon (HC) [oil, grease, etcetera, etcetera] usage in production operations	Scope 1 air emissions leading to global warming and climate change	1. Computerised pit optimisation: GEOVIAWhittle, ModelMaker (PPM and Tharisa) 2. Operational management and control: Viewpoints, analytical spread sheets, operational control meetings and plans, training, disciplinary codes, audits, system reviews (PPM and Tharisa). 3. Waste reduction, reduction, re-use and recycling. Waste to energy (PPM and Tharisa). 4. Production process optimisation and efficiency: optimised drilling patterns, innovative drill practices, optimised blast design, efficient blast technology loading practice, optimised truck cycles, optimised road construction, optimised ramp construction, optimised loading and tipping area conditions, optimised truck to excavator ratios and matching, selective mining (PPM and Tharisa). 5. Drone surveys versus continuous daily surveys (Tharisa).
Production	Destruction/disruption of carbon sinks (trees, soil and water reservoir) destruction	Greenhouse gases accumulation, global warming, climate change risks and impacts.	1. Mine closure plans: Dams (PPM), rehabilitation (PPM and Tharisa). 2. Topsoil stripping and banking (PPM and Tharisa). 3. Land rehabilitation (PPM and Tharisa). 4. Fleet optimisation and reduction leading to lift clubs (PPM and Tharisa). 5. Future reclamation pit to dam during mine decommission (PPM).
Engineering	Inefficient diesel fuel combustion by machines	Scope 1 air emissions leading to global warming and climate change	1. Innovative application of information technology: Control rooms, visual GPS, WIMS, Vision Link (PPM and Tharisa). 2. Purchase and application of electric hybrid machines [MT Terrex 3300] (PPM).
Engineering	Diesel consumption by machines	Scope 1 air emissions: global warming and climate change.	1. Planned maintenance and services of machinery (PPM and Tharisa).
Engineering	Waste management: Paper, steel, iron, HC.	Scope 2 GHG emissions: global warming and climate change.	1. Waste recycling, re-use, re-sale to Jar Oil and Reclam (PPM and Tharisa).
Engineering	Premature tyre and property damages.	Scope 3 air emissions: global warming and climate change.	1. Road construction and maintenance standards (PPM and Tharisa). 2. Site severity surveys using specialists or electronic sensors (PPM and Tharisa). 3. Safety management systems (PPM and Tharisa).
Human resources	Non-productive diesel usage employee travel.	Scope 3 air emissions from employee work related transit.	1. Non-productive fleet reduction. Replaced vehicles with allowances (PPM and Tharisa). 2. Lift club due to point 1 (PPM and Tharisa).
Administration	Energy and paper usage from printing.	Tree sink destruction: GHG accumulation, global warming and climate change related impacts.	1. Innovative information technology: smart Kyocera “green” pool printers (PPM and Tharisa).
Administration	Electrical resource wastage	Scope 2 GHG air emissions: global warming and climate change	1. Mostly awareness (inadequate). (PPM and Tharisa).

Table 4. 2: Summary of climate change adaptation at PPM and Tharisa

Department	Vulnerability/ Opportunity	Unwanted Consequence	Adaptation examples
Project	Excess rain	Mine access road disruptions and closures leading to delayed production, supply route cut-off, poor machine maintenance, failure to sell produce, accidents, litigation, investor confidence loss and conflict with communities.	1. River diversion (PPM) 2. Road reconstruction and re-surfacing (PPM and Tharisa)
Mining operations	Excess rains	Mine haul roads disruptions and closure leading to loss of production, delayed revenue, mine accidents, insurance costs, high insurance costs, litigation, loss of investor confidence	
Mining operations	Excess rain	Mining block inundation and flooding leading to loss of revenue, property damage, high insurance costs.	
Mining operations	Excess rains	Excess ground water and ground overflow leading to slope instability, erosion, mud slides.	1. Slope stability code of practice and management program (PPM and Tharisa) 2. Geological inspections and report (PPM and Tharisa) 3. Slope treatment and stabilisation (PPM)
Project	Incessant rains	Loss of production	1. Training 2. Financial hedging and budget disclosures (PPM and Tharisa)
Project	Lightning storms	Electrical power failures leading to loss of revenue and higher power supply costs.	
Project	Lightning storms	Lightning strikes on equipment, electrocution of employees, loss of production, revenue losses, insurance costs, litigation.	
Project	Lightning storms	Electrical power failures	
Mining operations	Droughts	Inadequate water for dust suppression	1. Road dust suppression chemicals (PPM) 2. Dams and sumps (PPM and Tharisa)
Project	Hot weather and high UV exposure	Employee health complications: Fatigue, high blood pressure, loss of consciousness, related accidents.	1. Law and voluntary external (PPM and Tharisa) 2. Internal voluntary regulations: Evacuation rules, fatigue management procedures (PPM and Tharisa) 3. PPE regulations (PPM more than Tharisa) 4. Shedding (PPM and Tharisa) 5. Cool water supply (PPM and Tharisa and water coolers (PPM).

Tying up these findings, an emerging issue is that at both sites, MCCGC complies with first- tier legal statutes, voluntary regulations, and client strategies that implicitly address climate change by developing internal policies, programmes, plans and procedures. However, and in contrast, both PPM and Tharisa do not appear to disregard the second tier legislation and voluntary regulations that are explicit on managing climate change. This omission by the principal tacitly exposes MCCGC to a number of climate change related risks.

4.5 Conclusion

The research found that at both PPM and Tharisa sites, MCCGC implemented an integrated environment, health and safety management system as a broad strategic approach to managing environmental, health and safety-related aspects of the business. This strategy implicitly addressed the climate change mitigation and adaptation practices of MCCGC's activities in the two mining contracts at the two sites. These strategies and practices are driven by the (i) South African Constitution, (ii) ISO-14,001 (iii) OHSAS-18,001 and (iv), the toll mining contract obligations. This implicit reference to climate change management is surprising given the prominence of the climate change issue in almost all business and social forums. This implicit reference could be the reason for a largely reactive climate change management approach at both mines particularly with reference to adaptation. The reactive approach potentially leaves MCCGC and its Principals vulnerable to the risks that are associated with climate change.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents conclusions and further research suggestions, based on the research findings. The aim of this study was to evaluate climate change mitigation and adaptation strategies and practices of MCCGC, a mining supply chain's mining contracts and plant hire company. The research specified two objectives. The first was to investigate and document the strategies and practices used by MCCGC in mitigating climate change. The second was to identify and profile the strategy and practices used by MCCGC in adapting to climate change. In order to meet these objectives, it posed the overarching question: What strategies and practices does MCCGC have in place to respond to the escalating climate change phenomenon?

The nature of this study dictated the use of a multiple case study approach in order to gain in-depth understanding of MCCGC (SA)'s specific climate change exposures and responses at contract sites. To this end, PPM and Tharisa Minerals were the research sites. A multiple case study approach offers the advantages of generating results that can be considered more robust in comparison to the single case study approach. The site selection criteria was determined by convenience, purpose, accessibility, representation, research time limits and cost effectiveness considerations.

The research gathered evidence through, questionnaires, interview schedules, observations and a document review for triangulation. The data was analysed through the qualitative content analysis approach simultaneously applying inductive and deductive reasoning. They followed the ethical guidelines of the UNISA College of Agriculture and Environmental Science (CAES). As an employee of MCCGC, the principal researcher had to continuously, consciously refrain from having a biased view when collecting, analysing the data and reporting the research findings.

5.2 Summary of conclusions

The research had three major findings. Firstly, both Pilanesberg Platinum Mines and Tharisa Minerals (plc) have developed implicit rather than explicit climate change management strategies. Secondly, MCCGC as a contractor and registered corporate has developed an intrinsic climate change management strategy. Thirdly, these strategies have been transformed from rhetoric into practice by MCCGC at both PPM and Tharisa opencast mining sites as it services its toll contracts. The practices address climate change mitigation (preventing climate change by abating, sinking or sequestrating GHGs) and climate change adaptation (living with climate change). The following summary subsections provide a summary of the key findings as per research question.

5.2.1 Legislative and policy frameworks

At both MCCGC sites (PPM and Tharisa) international legislative and policy frameworks have permeated into the mining industry and drive climate change mitigation through first tier laws such as the Constitution, MPRDA, NEM:AQA, NEM: Waste Act, Resource Conservation Act; REDISA (PPM and Tharisa). Similarly adaptation is governed by a set of first tier laws. These include the Constitution of the republic of South Africa, MHSA, MPRDA, NEM: WQA, OHSAS. Noticeable is that both sites do not identify new generation laws related to climate change which address climate change adaptation.

5.2.2 Mitigation strategies and practices

The climate change mitigation strategies of both PPM and Tharisa are enshrined in an integrated environmental health and safety management system that is aligned to ISO-14,000 and OHSAS-18,001 series of management systems. The resultant climate change mitigation response practices from these strategies were classified by the researcher as: (i) in-pit and (ii) out-of-pit interventions.

In-pit mitigation practices, aimed at Scope 1 emissions-reduction, focussed on energy efficiency. Energy-efficient practices in drill and blast operations include collaring of drilled holes, increasing the burden spacing in drilling and use of efficient electronic blasting devices among others. Energy-efficient practices in load and haul operations included optimising operational conditions and practices to reduce fuel burn. Examples of this, *inter alia*, included grading roads, reducing stop signs and using efficient loading techniques. Pit optimisation which results in energy conservation and reduced GHG emissions was being addressed by employing a variety of mining software to improve operations. In-pit mitigation measures also included topsoil conservation, land rehabilitation, land re-vegetation and plans to convert some of the disused opencast pits into a dam. Despite all these initiatives a major issue was that MCCGC and its principals have not paid attention to measuring their energy savings. This omission foregoes initiatives towards carbon emissions trading.

Innovative information technology is applied at both MCCGC operations to optimise mining equipment application and maintenance. Real-time information from these systems is routinely captured and used to manage energy inefficient behaviours or operational practices. However, there are inconsistences in the application of the technologies between the sites. For example, Tharisa uses television monitors to visualise machine locations and PPM operations do not.

Examples of out-of-pit interventions that reduce fuel consumption, increase energy efficiency and penultimate reduce scope 1 GHG emissions that were observed at MCCGC's PPM operations included the retrofitting of a back hoe excavator to a face shovel. Energy efficiency was also attained through green purchasing and use of energy efficient Terex MT3300 electric hybrid vehicles. However, the high maintenance costs, maintenance skills gap and parts availability this fleet has been an impediment. Despite this, these interventions have a co-benefit of reducing scope 1 GHG emissions.

Both MCCGC operations at PPM and Tharisa conduct fleet machine maintenance and servicing to ensure efficient fuel consumption. There is a challenge of high capital and maintenance costs in regard to purchasing and maintaining energy efficient technologies. Scope 2 emissions mitigation at both sites occurred through waste management practices such as colour-coding of bins to promote recycling of paper, steel, used oil, oil filters, dust filters and tyres. More waste streams could potentially be segregated and recycled. Revenue generation can also be an opportunity from recycling. Scope 3 emissions are implicitly managed through a robust safety management system that reduces tyre and property damages thus limiting supplier energy uses. MCCGC introduced a car allowance to halt the use of corporate vehicles for private use, this culminated in lift clubs hence reducing fuel use and carbon emissions. These mitigation strategies and practices are supported by adaptation strategies and practices.

5.2.3 Adaptation strategies and practices

Personnel at PPM and Tharisa verified that they too were experiencing the deleterious consequences of current scientifically proven climate change. Both PPM and Tharisa's adaptation strategies are informed and formulated to meet the OHSAS-18,001, health and safety management standard as stated earlier as well as to meet legal requirements of the Constitution of South Africa, the MHSA, MPRDA, National Health Act and the OHSA amongst others. Both MCCGC at PPM, and MCCGC at Tharisa, comply with client and internal voluntary regulations such as codes of practices on health and emergency preparedness, and procedures on mine de-watering, among others. Continuous risk assessments were carried out as per legal requirements, and these identified vulnerabilities to climate change risks such as excessive rains (floods and incessant rains), lightning (electric storms), droughts, heat and ultra-violet radiation.

Practices observed concerning climate change adaptation were mostly similar at both sites. Road management was observed at both sites so as to prevent disruption of mining activities due to inaccessible in-pit and out-of-pit mine rods. PPM has various interventions linked to this such as river diversions to divert watershed areas from inundating roads, road resurfacing using competent soils and material on access roads to the mine and using DMS (quarry stones) on pit roads and ramps so as to make them weather proof. Excessive rains and flash floods that could potentially inundate mining areas, flood the pit, and cause property damage were also being adapted to in a similar manner at both sites. An observed practice to this was water pumping. MCCGC at PPM has, however, provided extra pumps to the client to guarantee effective pumping whereas MCCGC at Tharisa does the entire pumping operation. Mine drainage plans and drainage engineering were observed at both sites, although they were noted as inadequate. PPM as a principal has hired a consulting mining engineering company to bolster these plans and MCCGC at PPM executes the plan. More research and mine design may be necessary to ensure the adequacy of this plans and reduce the operational risks.

Both PPM and Tharisa use weather information systems to ensure the safety of employees as well as plan their mining, taking climate and weather related hazards and variables into perspective. This is done using the South African Weather Services Information System at PPM and the African Weather Systems portal at Tharisa. Lightning detectors are also used to highlight lighting danger, and evacuation procedures are in place. PPM adds dust suppression chemicals into water used for dust suppression thus reducing the effects of excessive evapotranspiration and water shortages associated with climate change related droughts. Tharisa has not adopted this practice. Both sites built water harvesting dams and sumps to ameliorate climate related water shortages. PPM also had a managerial instruction to evacuate heat exposed employees from the pit once temperatures reach $42^{o}C$

so as to ameliorate health concerns. The code of practice for thermal stress at PPM also mandated the use of coveralls, shade nets and provision of adequate hydration of heat exposed employees. The code of practice was complied with. Tharisa did not have a similar approach on evacuating personnel when it is too hot. However they also provided coveralls, sheds, sun visors, water coolers and cold water to employees. Both sites had air conditioning facilities in offices and machines, whilst at PPM some machines and buildings had to be retrofitted with air-conditioning units.

There is financial provision for climate change through budgets and financial disclosure but this seems inadequate and is a tolerance to an otherwise ameliorable situation. There is a potential to reap financial benefits from climate change for example carbon trading that is not exploited.

5.2.4 Factors/ drivers

The factor driving climate change mitigation and adaptation are entrenched in risk aversion principles. However during the course of the study one could realise that the theories shaping the drivers of climate change mitigation and adaptation are reflected as the driving force within the two study units. In brief, with training on legislation, client and MCCGC requirements towards environmental stewardship MCCGC as a company is effecting (driving) climate change mitigation and adaptation along the framework of theories on climate change mitigation and adaptation discussed in Chapter 1. From the finding the following conclusions were bourne.

5.3 Conclusions

The conclusions are aligned to the objectives of the research as well as the research questions. They focus on legislative and policy frameworks, mitigation strategy and practice, adaptation strategy and practice and the drivers or factor for these strategies and practices.

5.3.1 Legislative and policy frameworks

Conclusions regarding legislative and policy include that there is a seeming lack of knowledge and filtration of the policy that directly affects climate change mitigation and adaptation. Although high level policy exists at a national level, these have not been filtered into the legislation that the mining industry is adept to - first tier legislation. With this inadequacy there is an evident absence of regulatory authority guidance and enforcement, of the relevant climate change drivers and related risks. The absence of clear legislative and policy frameworks is mirrored by the absence of these at a local municipality level as well as corporate and site level. It is worrying that no follow-up by regulators as to the magnitude of climate change response by the mining supply chain. This can pose a national and economic security risk.

5.3.2 Mitigation strategies and practices

MCCGC is also foregoing financial opportunities related to climate change. Most notable in this space is the foregone revenue generation from carbon trade schemes and financial aid from government green economy support systems such as the clean development mechanism. This, because both sites that were studied only identified first-tier generic laws that address climate change implicitly and did not identify second-tier laws. The second-tier laws do not only regulate climate change but also provide lucrative incentives for the desired actions.

5.3.3 Adaptation strategies and practices

By not having an explicit climate change policy, MCCGC exposes itself to a number of climate change risks. If this is not addressed these risk may ultimately impact on the financial and technical viability of MCCGC. Most prominent in the risk arena are reputational and financial risks. With regard to reputation, mining firms that rate explicit climate change management as part of contracting adjudication measure will score firms like MCCGC low which may reduce their chances of securing a contract. If the MCCGC seeks to expand its operation to cover a variety of firms, then investing in developing an explicit, detailed and up-to-date climate change management response is imperative.

Financial risks arise from costs that may arise when climate damage is linked to firms particularly *ex post* and these firms are obliged to pay for particular damages and remedial actions. More worrying is that mine firms are traded between mining houses, and should both PPM and Tharisa be sold to mining houses that prioritise explicit climate change management, then MCCGC is exposed to losing the contract or alternatively speedily drafting and implementing such a policy. The hazard of urgently drafting such a policy to meet contractual obligations is that this may strain the company’s financial resources.

Comparisons of the two site’s strategies and practices indicate that the mitigation and adaptation responses are not standardised leading to inconsistences and possibly to varied effectiveness. This indicates a lack of centralised control and MCCGC's lack of shared learning between the two sites. This is not only inefficient but exposes MCCGC in many ways. Reputational risks are particularly high if one of the principals learns that the contract could have avoided some issues that may arise later, had it applied practices and knowledge that it has and actually applies in some of its contracts elsewhere. Such a discovery may lead to a principal concluding that the contractor could be acting in bad faith. Such a conclusion may have an adverse effect on possible future contracts.

5.3.4 Drivers/ Factors

Summing up, while MCCGC is engaged in climate change mitigation and adaptation work as part of fulfilling its contractual obligation, its lack of an explicit climate change policy and related strategies exposes the firm to many risks. In a rapidly transforming world, which in 12 months has seen the world appear to converge on climate change management as evidenced by the Paris Agreement, which is under threat from the climate change sceptical new United States of America administration of Donald Trump, it may be prudent for MCCGC to protect itself again future liabilities of all forms. An explicit climate change management policy may cushion the firm against some of these liabilities.

Having come to the conclusions, informed by the findings. The chapter proceeds to provide suggestions in the following section.

5.4 Suggestions

The following suggestions are postulated in order to address noted gaps either in the legal and policy frameworks, mitigation strategy and practice, adaptation strategy and practice and drivers or factors that propel these facets of climate change response. They may also suggest the re-enforcement of positive observations or expose opportunities noted during the research.

5.4.1 Legislative and policy frameworks

The research has revealed that strategic approaches and practices towards climate change mitigation and adaptation are evident in some parts of the opencast mining supply chain but are inadequately developed and mostly reactive or a co-benefit of core mining practices. Prominent within the research is that there is little government co-ordination and practical field support in some of these responses. One way of addressing this gap is government-led or initiated design and introduction of frameworks and toolkits for climate change mitigation and adaptation covering public and private enterprises.

5.4.2 Mitigation strategies and practices

At a national level there is a need to develop industry specific legal and frameworks that address climate change mitigation and practice in companies such as MCCGC, and the mining supply chain. It is advisable to revise first tier legislation to which the industries subscribe and disseminate these as it would probably be easier for the industry to relate to "their" legislation.

It is also advisable for the learnings and practices between sites to be disseminated between sites, so as to exchange learnings. Both sites had some valuable strategic elements and practices that were done in isolation yet had potential revenues, reputation and even competitive advantage over the other.

It is also suggested that the government does a thorough impact assessment before implementing carbon tax regiments and other punitive economic instruments that may further endanger the economic viability of the supply chain actors in the mining sector. There seems to be alarm, and caution within the industrialist that tax regimes may sink the stressed companies or marginalise their profits to unsustainable levels.

5.4.3 Adaptation strategies and practices

As with mitigation strategy there seems to be a lack of an explicit approach and guideline to adaptation by MCCGC, mining contracting and plant hire companies and the mining supply chain in general. A suggestion would be that policy makers and industrialists from this sector firm an industry specific forum to strategise towards this socio-economic risk.

There is also a need for forums of education, information sharing and behaviour modelling at the various echelons of society so as to guide and promote climate change adaptation. Related to this is a need to have industry specific technology research and innovation platforms so as to explore the opportunities climate change offers to the opencast mining industry supply chain.

5.4.4 Factor/ drivers

The drivers for climate change response seem very high level and scholarly but have not proliferated into the pragmatic real of industry. The steering wheels of commerce need to be turned by a climate change focussed captaincy and labour force. It suggestible that more research, advice, material and technological support be provided by private and public sector actors towards developing: economic, behaviour, ecosystem, technological, population, and education based drivers for climate change response.

5.5 Areas of further research

Also, the study was limited to only two sites in the mining sector and to a toll mining and equipment supplying firm. Research could expand to industries. With regard to the mining sector, further research could focus on the following three issues:

(i) Quantifying the amounts of GHG emissions in the South African value chains.

(ii) Determining the feasibility of establishing clean energy options for the mining value chains.

(iii) Determining the nature and determinants of climate change risk assessments along the mining value chain.

Again, while these recommendations pertain to the mining industry, they are extendable to other sectors as well.

5.6 Conclusion

This chapter has provided a summary, conclusions and suggestions on the study of how MCCGC in general, the opencast contracting and plant hire business sector and the mining supply has responded to climate change. In conclusion there is legal and policy frameworks governing climate change. However it is the earlier generation legislation that is implicitly and coincidentally driving climate change despite the presence of later generation laws and policies. There is inadequate knowledge and enforcement of the third tier legislation that is current on mitigation and adaptation. There is also evidence of implicit climate response strategies either for mitigation or adaptation at both MCCGC sites (PPM and Tharisa). These are mostly similar and are based on ISO – 14, 001 for mitigation and OHSAS-18, 001 for adaptation. The evident practices emanating from the strategies indicate that MCCGC is practically vesting efforts towards climate change mitigation and adaptation but there are various suggestions that are available on how to improve, explore opportunities or sustain good practices on climate change mitigation and adaptation.

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Appendix A: Permission letter to conduct at study at Tharisa Minerals.

tharisa Minerals

MEMO

MCC

To : Morris Mhuruyengwe
Tharisa Minerals General Manager alias MCC Project Manager

From : **Peace Matangira**
MCC – Tharisa, Safety, Health and Environmental Manager

Date : **03 December 2010**

Ref : Request to conduct an environmental study on: Environmental Issue (s) and Management solutions for, MCC Group – Tharisa, and include it as a case study, science paper for a Master of Science: - Environmental Management Degree Programme, with U. N. I. S. A.

Sir,

I intend to register with the University of South Africa for a Master of Science Degree study in [illegible]vironmental Management. Registration is for the 2011. I have identified MCC Group of Companies as a stakeholder who can benefit from this study. The study will:

1. Identify key issues in environmental management for the group/ selected site(s) within the group.
2. Establish the current level of compliance to regulatory statutes and voluntary codes.
3. Identify cost efficient and cost saving environmental management methodologies and systems that can be implemented for the group, with the intention of benefiting the bottom line.
4. Evaluate, and propose rationalized, practical management solutions and systems to issues of conflict in environmental management within the group.
5. Forecast on future trends in governmental and clientele views on environmental management and strategize MCC's response to these.

It is my sincere hope that you accept this proposal as I think it will be of great benefit for the group. With the sterner legislative, investor, client and corporate governance norms and increased public sensitivity that is [illegible]ing I, believe such a project is a necessity for the site and the group. Recent evidence of this is the Vele Project, whereby environmental issues have become a spanner in the works.

I humbly await your response.

Regards,

Peace Matangira
Tharisa Minerals, - MCC Safety Health and Environmental Manager

Approved: [signature], Morris Mhuruyengwe *(Tharisa Minerals General Manager)*. Date, 2010/12/06.

Appendix B: UNISA ethics committee approval of the study

UNISA university of south africa

2014-04-14

Ref. Nr.: 2014/CAES/072

To:
Student: PA Matangira **Student nr: 48370754**
Supervisor: Prof G Nhamo
Department of Environmental Sciences
College of Agriculture and Environmental Sciences

Dear Prof Nhamo and Mr Matangira

Request for Ethical approval for the following research project:

Investigating mining supply chain's response to climate change: Case study of South Africa's MCCGC

The application for ethical clearance in respect of the above mentioned research has been reviewed by the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. Ethics clearance for the above mentioned project (Ref. Nr.: 2014/CAES/072) **is given** for the duration of the study.

Please be advised that should any part of the research methodology change in any way as outlined in the Ethics application (Ref. Nr.: 2014/CAES/072), it is the responsibility of the researcher to inform the CAES Ethics committee. In this instance a memo should be submitted to the Ethics Committee in which the changes are identified and fully explained.

The Ethics Committee wishes you all the best with this research undertaking.

Kind regards,

Prof E Kempen,
CAES Ethics Review Committee Chair

ALL THE BEST

Prof MJ Linington
Executive Dean: College of Agriculture and Environmental Sciences

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

Appendix C: MCCGC Directors Consent Form for research PPM and Tharisa

UNISA university of south africa

CONSENT FORM

AUTHORISATION OF A MASTER OF SCIENCE RESEARCH PROJECT

Protocol Title: Investigating Mining Supply Chain's Response to Climate Change: Case Study of South Africa's MCCGC.

(Please read this consent document carefully before you decide to participate in this study)

Research Aim: The aim of this case study is to apply scientific research in order to evaluate the climate change mitigation and adaptation strategy and practices by the Mutual Construction Company Group of Companies (MCCGC).

Location of the Study: This Master of Science research project is being done within the South African borders on a South African company, namely MCCGC. It focuses on two selected sites within the group. These sites are MCCGC Tharisa and MCCGC Pilanesberg.

Objectives:

(i) To investigate and document the strategy and practices by the MCCGC in mitigating climate change.

(ii) To identify and profile the strategy and practices by the MCCGC in adapting to climate change.

Methodology: Questionnaires, recorded observations as well as air emissions sampling will be used to to collect data.The data will then be scientifically anaysed. Conclusion and recommendations will then be submitted to the company and UNISA. All participations and data collection will be on an informed consent basis.

Who is conducting and funding the study:

The study is being primarily self funded by Peace A. Matangira. Nominally the MCCGC can provide funding on approval. The project however is not dependant on the nominal funding.

What you will be asked to do in the study:

You will be asked to answer a questionnaire when the time approaches for this. The questionnaire will only be administered on a voluntary basis.

You will also be asked to allow the administration of a questionnaire (s) to employees within your care. None of them will be coerced into answering them and all questionnaires will be held in confidentiality.

Also it will be asked of you to grant permission for sampling to be done on machine emission levels.

Further contributions as may not have been envisaged in this note may be requested but only voluntary participation/ authorization will be asked of you.

Time required:

The duration of the study will measure 1 - 2 years, of which the researcher will ask for the above mentioned. Only agreed times and appointment dates will be utilized.

Access to Existing Records*:* where necessary the researcher will request for existing records that fall within the scope of the study.

Longitudinal Study: For further academic purposed it may be necessary for you and the company you represent to participate in further studies to this one, on this subject matter.

Risks and Benefits:

There is no envisaged risk taking into account that confidentiality is guaranteed unless where you will have given written consent for disclosure of identity.

Beneficiation:-

1. Academic contribution to the South African academic society so as to aid development.
2. Academic contribution to the M.C.C Group of companies so aid to aid better climate change based risk management.
3. Access to research material by the researcher and thus information on adaptation and mitigation strategies to the climate change phenomenon, hence you can better direct your area of responsibility in this regards.
4. Building partnerships in industry and academia.

Compensation: There will be no compensation for your participation. This is a voluntary exercise.

Confidentiality: Your/ company identity will be kept confidential to the extent provided by law and yourself. Your/ company information will be assigned a code number that is unique to this study if required. The list connecting your/ company name to this number will be kept in a secure place should you require confidentiality. The Study Supervisor, academic assessors at UNISA and other researchers will be able to see the list or the interview you participated in. No one in the M. C. C. Group of Companies will be able to see your interview or even know whether you participated in this study. When the study is completed and the data have been analyzed, the list will be destroyed. Study findings will be presented only in summary form and your name/ company name will not be used in any report, without your written consent. Any details linking M.C.C Group of Companies or their clients to the study findings will not be published without the written consent of yourself or any affected party.

Limits to confidentiality: Confidentiality will not be broken in reference to any information obtained unless you give written consent.

Anonymity: Your identity in this study would be anonymous. It will not be possible to know who chooses to participate in this study and who did not. It will also not be possible to know who completed which questionnaires.

Voluntary participation: Your participation in this study is completely voluntary. If you choose not to participate in this study, this will have no effect on the services or benefits you are currently receiving. You may refuse to answer or grant permission to any of the questions or requests we ask you and you may stop or end the interview or participation of your site in this study at any time.

Right to withdraw from the study: You may choose to stop participating in the study at any time.

Recording: written, pictorial, audio- or video-recording during scientific sampling or interview of focus group will be used in this study. You may choose to allow or dis-allow these recordings. You can request that the recording can be stopped at any time during the interview of yourself or focus groups, either permanently or temporarily, as appropriate to your needs. Only the researcher, his UNISA research supervisors and academic assessor will have access to the recording. Any records will not be used for any other end except for this and other subsequent research projects. Research records will be kept in a safe in the researcher office at Pilanesberg Platinum Mine. Transcription of the records may be done but anonymity will be maintained.

Who to contact if you have questions about the study: In case of having any questions about this study please contact:

Research Supervisor (s):

Doctor Vuyo Mjimba

UNISA Institute for Corporate Citizenship

0733540590

Professor Godwell Nhamo

UNISA Institute for Corporate Citizenship

0731631114

The Principal Researcher: Peace Matangira

PPM - M. C. C. Safety Manager

0724417153

(YOU WILL BE GIVEN A COPY OF THIS FORM WHETHER OR NOT YOU AGREE TO PARTICIPATE)

If you agree to participate in this study please sign on the next page. Thank you.

Agreement:

I have read the procedure described above. I voluntarily agree to allow the principal researcher to conduct studies at the mentioned sites of MCCGC.

I have received a copy of this description.

I understand that this (interview/focus group/ research process) will be (pictured/audio-/video-) recorded).

WITNESS: Jo Johansen

Signature: ____________________ (MCCGC Official).

Date: 31/01/14 Title: OPERATIONS DIRECTOR

Principal Investigator: ____________________ Date: 31/1/14

I agree to allow this project to continue on this site as proposed and for interviews and scientific sampling methods to be applied. I understand that I can request the project proceedings to be stopped at any time.

Your completion and return of the consent form indicates your consent for this study to be conducted at your site/ person.

Consent Form, College of Agriculture and Environmental Sciences, Unisa Page 4

Appendix D: Project Manager's consent form for research to be conducted at Tharisa

Informed Consent Form

Protocol Title: Opencast Mining Industries Response to Climate Change: ***A Case of the M. C. C Group of Companies, South Africa.***

Please read this consent document carefully before you decide to participate in this study:

Purpose of the research study: This Master of Science research project is being done within the South African borders on a South African company namely MCC Group of companies. It focuses on a few selected sites within the group in this instance M.C.C Group of Companies at Tharisa Minerals. In the research an assessment is to be done on the contribution of this elective; so as to get a sample baseline data catch which enables insight into the significance and impact of such companies to the climate change phenomenon. Focus is also on evaluating whether this company is adopting or mitigating towards the phenomena and to advice or enhance on improvement opportunities to current systems. Questionnaires will be done on willing participants as well as air emissions sampling on machinery.

Who is conducting and funding the study:

The study is being self funded by Peace Matangira.

What you will be asked to do in the study:

You will be asked to answer a questionnaire when the time approaches for this. The questionnaire will only be administered on a voluntary basis.

You will also be asked to allow the administration of a questionnaire (s) to employees within your care. None of them will be coerced into answering them and all questionnaires will be held in confidentiality.

Also it will be asked of you to grant permission for sampling to be done on machine emission levels on your site.

Further contributions as may not have been envisaged in this note may be requested but only voluntary participation will be asked of you.

Time required:

The duration of the study will measure 2 – 3 years, of which the researcher will ask for the above mentioned. Only agreed times and appointment dates will be utilized.

Access to Existing Records*:* where necessary the researcher will request for existing records that fall within the scope of the study.

Longitudinal Study: For further academic purposed it may be necessary for you and the company you represent to participate in further studies to this one, on this subject matter.

PIETER J. NIEMAN
Project Manager

1

Risks and Benefits:

There is no envisaged risk taking into account that confidentiality is guaranteed unless where you will have given written consent for disclosure of identity.

Beneficiation:-

1. Academic contribution to the South African academic society so as to aid development.
2. Academic contribution to the M.C.C Group of companies so aid to aid better management.
3. Access to research material by the researcher and thus information on adaptation and mitigation strategies to the climate change phenomenon, hence better direct your area of responsibility in this regards.
4. Building partnerships in industry and academia.

Compensation: There will be no compensation for your participation. This is a voluntary exercise.

Confidentiality: Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number that is unique to this study. The list connecting your name to this number will be kept in a secure place. The Study Supervisor, academic assessors at UNISA and other researchers will be able to see the list or the interview you participated in. No one in the M. C. C. Group of Companies will be able to see your interview or even know whether you participated in this study. When the study is completed and the data have been analyzed, the list will be destroyed. Study findings will be presented only in summary form and your name will not be used in any report, without your written consent. Any details linking M.C.C Group of Companies or their clients to the study findings will not be published without the written consent of yourself or any affected party.

Limits to confidentiality: Confidentiality will not be broken in reference to any information obtained unless you give written consent.

Anonymity: Your identity in this study would be anonymous. It will not be possible to know who chooses to participate in this study and who did not. It will also not be possible to know who completed which questionnaire.

Voluntary participation: Your participation in this study is completely voluntary. If you choose not to participate in this study, this will have no effect on the services or benefits you are currently receiving. You may refuse to answer or grant permission to any of the questions or requests we ask you and you may stop or end the interview or participation of your site in this study at any time.

Right to withdraw from the study: You may choose to stop participating in the study at any time.

Recording: written, pictorial, audio- or video-recording during scientific sampling or interview of focus group will be used in this study. You may choose to allow or dis-allow these recordings. You can request that the recording can be stopped at any time during the interview of yourself or focus groups, either permanently or temporarily, as appropriate to your needs. Only the researcher, his UNISA research supervisor and academic assessor will have access to the recording. Any records will not be used for any other end except for this and other subsequent research projects. Research records will be kept in a safe in the researcher office at Pilanesberg Platinum Mine. Transcription of the records may be done but anonymity will be maintained.

Who to contact if you have questions about the study: In case of having any questions about this study please contact:

Research Supervisor: Professor Godwell Nhamo

UNISA Institute for Corporate Citizenship

0731631114

The Principal Researcher: Peace Matangira

PPM - M. C. C. Safety Manager

0724417153

YOU WILL BE GIVEN A COPY OF THIS FORM WHETHER OR NOT YOU AGREE TO PARTICIPATE.

If you agree to participate in this study please sign on the next page. Thank you.

Agreement:

I have read the procedure described above. I voluntarily agree to allow the principal researcher to conduct studies at the M.C.C Group of Companies that is at Tharisa Minerals

I have received a copy of this description.

I understand that this (interview/focus group/ research process) will be (pictured/audio-/video-) recorded).

Signature: PIETER J. NIEMAN Project Manager

Date: 2013-06-11

Principal Investigator: PEACE MATANGIRA Date: 11 June 2013.

I agree to allow this project to continue on this site as proposed and for interviews and scientific sampling methods to be applied. I understand that I can request the project proceedings to be stopped at any time.

Your completion and return of the consent form indicates your consent for this study to be conducted at your site.

3

Appendix E: Project Manager Consent for study to be conducted at PPM

UNISA university of south africa

CONSENT FORM

Protocol Title: INVESTIGATING MINING SUPPLY CHAIN'S RESPONSE TO CLIMATE CHANGE: CASE STUDY OF SOUTH AFRICA'S MCCGC.

Please read this consent document carefully before you decide to participate in this study:

Purpose of the research study: This Master of Science research project is being done within the South African borders on a South African company namely MCC Group of companies (MCCGC). It focuses on a few selected sites within the group in this instance M.C.C Group of Companies at Pilanesberg Platinum Mine. In the research an assessment is to be done on the contribution of this elective; so as to get a sample baseline data catch which enables insight into the significance and impact of such companies to the climate change phenomenon. Focus is also on evaluating whether this company is adapting or mitigating towards the phenomena and to advice or enhance on improvement opportunities to current systems. Questionnaires will be done on willing participants as well as air emissions sampling on machinery.

Who is conducting and funding the study:

The study is being primarily self funded by Peace A. Matangira, but has nominal funding by the company MCCGC on certain aspects of the project. The project however is not dependant on the nominal funding.

What you will be asked to do in the study:

You will be asked to answer a questionnaire when the time approaches for this. The questionnaire will only be administered on a voluntary basis.

You will also be asked to allow the administration of a questionnaire (s) to employees within your care. None of them will be coerced into answering them and all questionnaires will be held in confidentiality.

Also it will be asked of you to grant permission for sampling to be done on machine emission levels on your site.

Further contributions as may not have been envisaged in this note may be requested but only voluntary participation will be asked of you.

Time required:

The duration of the study will measure 2 – 3 years, of which the researcher will ask for the above mentioned. Only agreed times and appointment dates will be utilized.

Access to Existing Records: where necessary the researcher will request for existing records that fall within the scope of the study.

Longitudinal Study: For further academic purposed it may be necessary for you and the company you represent to participate in further studies to this one, on this subject matter.

Risks and Benefits:

There is no envisaged risk taking into account that confidentiality is guaranteed unless where you will have given written consent for disclosure of identity.

Beneficiation:-

1. Academic contribution to the South African academic society so as to aid development.
2. Academic contribution to the M.C.C Group of companies so aid to aid better management.
3. Access to research material by the researcher and thus information on adaptation and mitigation strategies to the climate change phenomenon, hence better direct your area of responsibility in this regards.
4. Building partnerships in industry and academia.

Compensation: There will be no compensation for your participation. This is a voluntary exercise.

Confidentiality: Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number that is unique to this study. The list connecting your name to this number will be kept in a secure place. The Study Supervisor, academic assessors at UNISA and other researchers will be able to see the list or the interview you participated in. No one in the M. C. C. Group of Companies will be able to see your interview or even know whether you participated in this study. When the study is completed and the data have been analyzed, the list will be destroyed. Study findings will be presented only in summary form and your name will not be used in any report, without your written consent. Any details linking M.C.C Group of Companies or their clients to the study findings will not be published without the written consent of yourself or any affected party.

Limits to confidentiality: Confidentiality will not be broken in reference to any information obtained unless you give written consent.

Anonymity: Your identity in this study would be anonymous. It will not be possible to know who chooses to participate in this study and who did not. It will also not be possible to know who completed which questionnaire.

Voluntary participation: Your participation in this study is completely voluntary. If you choose not to participate in this study, this will have no effect on the services or benefits you are currently receiving. You may refuse to answer or grant permission to any of the questions or requests we ask you and you may stop or end the interview or participation of your site in this study at any time.

Right to withdraw from the study: You may choose to stop participating in the study at any time.

Recording: written, pictorial, audio- or video-recording during scientific sampling or interview of focus group will be used in this study. You may choose to allow or dis-allow these recordings. You can request that the recording can be stopped at any time during the interview of yourself or focus groups, either permanently or temporarily, as appropriate to your needs. Only the researcher, his UNISA research supervisor and academic assessor will have access to the recording. Any records will not be used for any other end except for this and other subsequent research projects. Research records will be kept in a safe in the researcher office at Pilanesberg Platinum Mine. Transcription of the records may be done but anonymity will be maintained.

Who to contact if you have questions about the study: In case of having any questions about this study please contact:

Research Supervisor (s):

Doctor Vuyo Mjimba

UNISA Institute for Corporate Citizenship

0733540590

Professor Godwell Nhamo

UNISA Institute for Corporate Citizenship

0731631114

The Principal Researcher: Peace Matangira

PPM - M. C. C. Safety Manager

0724417153

YOU WILL BE GIVEN A COPY OF THIS FORM WHETHER OR NOT YOU AGREE TO PARTICIPATE.

If you agree to participate in this study please sign on the next page. Thank you.

Agreement:

I have read the procedure described above. I voluntarily agree to allow the principal researcher to conduct studies at the M.C.C Group of Companies that is at Pilanesberg Platinum Mines

I have received a copy of this description.

I understand that this (interview/focus group/ research process) will be (pictured/audio-/video-) recorded).

Signature: ______________________ Witness

Date: 3/02/2014. Title: MCCGC Project Manager

Principal Investigator: ______________________ Date: ______________________

I agree to allow this project to continue on this site as proposed and for interviews and scientific sampling methods to be applied. I understand that I can request the project proceedings to be stopped at any time.

Your completion and return of the consent form indicates your consent for this study to be conducted at your site/ person.

Appendix F: Executive Management questionnaire on climate change

UNISA university of south africa

EXECUTIVE MANAGEMENT LEVEL QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

1. Code # of participant……………………………………………………………………………

2. Site code…………………………………………..……………………………………………….

3. Job title of the respondent ……………………………………..……………………………….

4. Department of respondent…………………...…………………………………………………

Instruction: For all answers in the questionnaire mark the applicable with a (x) or (✓)

SECTION A: POLICY AND PLANNING

1. How well developed is MCCGC's climate change mitigation and adaptation policy?

Excellent	**Good**	**Satisfactory**	**Poor**	**None existent**

2. SECTION B: LEGAL AND OTHER REQUIREMENTS

1. Does your company have a legal and other requirements register?

Yes	**No**

2. To what extent is this register developed?

Excellent	**Good**	**Satisfactory**	**Poor**	**None existent**

2

SECTION C: RISK ASSESMENT

1. **Are air emissions identified as a significant operational hazard?**

Yes	**No**

2. **What assessment level has been given to climate change at each of the sites?**

	Significant	Moderate	Low	Insignificant	Un-assessed
PPM					
Tharisa					

3. **Please name the reference document for which the assessment can be found?**

____

____

4. **Which of the following risks associated with climate change have been profiled for PPM and Tharisa?**

Risk	Assessed/ Not Assessed *(Delete the not applicable)*	Reference Document *(Please fill in title)*
Legal	**Assessed/ Not Assessed**	
Physical	**Assessed/ Not Assessed**	
Financial	**Assessed/ Not Assessed**	
Reputational	**Assessed/ Not Assessed**	

SECTION D: OPERATIONAL CONTROL

1. **Are there procedures in your company that address climate change?**

Yes	No

2. **List any policy documents that direct climate change mitigation?**

____

____

3. **List any policy documents that direct climate change adaptation?**

____

____

4. **Please tick in the applicable box to show which training is done to facilitate climate change knowledge for employees at PPM and Tharisa**

Level of training done	Yes	No	Not sure	Unknown
Planned daily tool box talks				
Pre-employment training/ inductions				
Periodic planned awareness training				
Competence based training (Professional skills)				

(Please provide proof or references of where possible)

4

5. **Do current purchasing standards and supply chain engagement protocols consider climate change mitigation and adaptation requirements?** *(Please provide proof)*

Yes	**No**

SECTION E: MONITORING AND EVALUATION

1. **Has a company or site carbon foot print been done?** *(If yes, please show evidence)*

Yes	**No**

2. **How often are air emissions monitoring surveys done?** *(Please provide copies/ reference of records)*

   ____

3. **Are action plans implemented for surveys?** *(If yes please show provide evidence)*

Yes	**No**

4. **Are inspections done inclusive of climate change management?**

Yes	**No**

If the answer to the above is yes, please explain:____

____

____

5. **How often are climate management audits done and presented for executive review?**

(Mark applicable with an (x)/✓)

Weekly	
Monthly	
Quarterly	
Annually	
Other specify______________	

SECTION F: REVIEW SYSTEMS

Describe and show evidence of how the company reviews its current climate change management system?

____

____

Consider the following in your answer:

Safety committee meetings, Management review meetings, Climate managements specific review meetings,

Thank you for your positive participation in the study

Appendix G: Middle management questionnaire on climate change

RESEARCH QUESTIONNAIRE

Research title: Mining Supply Chain's Response to Climate Change: A Case Study of South Africa's MCCGC.

Research Aim: To evaluate the climate change mitigation and adaptation strategies and practices by the Mutual Construction Company Group of Companies (MCCGC).

Location of the Study: This Master of Science research project is being done within the South African borders focusing on a South African company, MCCGC. It focuses on two selected work sites, MCCGC Tharisa and MCCGC Pilanesbergwhere MCCGC is the main mining contractor.

Objectives:

(iii) To document and evaluate the strategy and practices by the MCCGC in mitigating climate change.

(iv) To document and evaluate the strategy and practices by the MCCGC in adapting to climate change.

Methodology: Questionnaires, recorded observations as well as air emissions sampling will be used to collect data. The data will then be scientifically analyzed. Conclusions and recommendations will then be submitted to the MCCGC and UNISA.

Ethics: All participations and data collection will be on an informed consent basis. The rights and ethics considerations for all participants are in the informed consent form. Applicants are advised to participate only after reading and signing the consent form.

Who is conducting and funding the study:

The study is being primarily conducted and self funded by Peace A. Matangira (UNISA Student: **4837-075-4).**

Nominally the MCCGC can provide funding on approval. The project however is not dependant on the nominal funding.

What you will be asked to do in the study: You will be asked to respond to a questionnaire and possibly to respond to an interview. Participation is voluntary.

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MID MANAGEMENT LEVEL QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

5. Code # of participant...

6. Site code...

7. Job title of the respondent..

8. Department of respondent..

SECTION A: POLICY AND PLANNING

1. **How well developed is MCCGC's climate change mitigation and adaptation policy?**

Excellent	**Good**	**Satisfactory**	**Poor**	**None existent**

2. **In your opinion how effective is the policy in addressing climate change management?**____

____

____

3. **In brief please outline, what climate change management objectives and targets have you outlined for 2011, 2012, 2013 and 2014?**

Year	**Objective**	**Target**	**By who**	**Status**
2010				
2011				

2012				
2013				
2014				

4. Please quantify the number of set objectives and targets aimed at climate change mitigation and adaptation

Year	**# of mitigations objectives**	**# of adaptation objectives**
2010		
2011		
2012		
2013		
2014		

5. Please indicate the t extent of clarity on climate change adaptation responsibilities as outlined in your written appointments?

Clearly defined	**Briefly stated**	**Implied generally**	**Non existent**	

6. What does MCCGC policy say about climate change mitigation?____

____

____

7. What does MCCGC policy say about climate change adaptation?

____

____

____

8. How would you rate the provisions made within the MCCGC site budget for climate change programmes?

Excellent	Good	Satisfactory	Poor	None existent

9. Please insert the approximate provisional amounts of money spent/ set aside for climate change management over the past five years.

Year	Direct expenditure on climate change management projects	Indirect expenditure on climate change management projects
2010		
2011		
2012		
2013		
2014		

SECTION B: LEGAL AND OTHER REQUIREMENTS

1. Does your company have a legal and other requirements register?

Yes	No

2. To what extent is this register developed?

Excellent	Good	Satisfactory	Poor	None existent

3. Outline any legal and other requirements that you know which relate to climate change mitigation?

____

____

____

4. Outline any legal and other requirements that you know, which relate to climate change adaptation.

____

____

____

SECTION C: RISK ASSESMENT

5. Does the site conduct risk assessments?

Yes	No

6. Are air emissions identified as a hazard?

Yes	No

7. What level of risk assessments is conducted (Mark applicable with X or✓)?

Risk Assessment Level	Done	Not done
Pre-use checklists for vehicles		

Daily pre-task risk assessment		
Issue based risk assessment		
Baseline risk assessment		

9. List the environmental activities of MCCGC operations that lead or contribute to climate change?

____

____

____

____

10. List the impacts of climate change that you think can/ are occurring at your site due to climate change?

____

____

____

11. What climate change mitigation measures have been identified for your operation?____

____

____

12. What climate change adaptation measure have been identified for your operations?____

____

____

13. How do you track the identified mitigation and adaptation measures?

____

____

SECTION D: OPERATIONAL CONTROL

1. **Are there procedures in your company that address climate change?**

Yes	**No**

2. **In your own opinion are these procedures well developed to address climate change?**

Yes	**No**

3. **If the answer to question (2) above is (No) please explain why you say so.**

____

____

____

____

4. **List any procedures that target climate change mitigation?**

____

____

5. **List any procedures that target climate change adaptation?**

____

____

6. **Which of the following training levels in relation climate change management**

Level of training done	**Yes**	**No**
Planned daily tool box talks		
Pre-employment training/ inductions		
Periodic planned awareness training		
Competence based training (Professional skills)		

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(Please provide proof)

7. Do current purchasing standards and supply chain engagement protocols consider climate change mitigation and adaptation requirements? *(Please provide proof)*

Yes	No

SECTION E: MONITORING AND EVALUATION

6. Has a company or site carbon foot print been done? *(If yes, please show evidence)*

Yes	No

7. How often are air emissions monitoring surveys done? *(Please provide copies of records)*

8. Are action plans implemented for deviations or identified improvement opportunities in the air emission surveys that are conducted for your operations? *(If yes please show provide evidence)*

Yes	No

9. Are inspections done inclusive of climate change management?

Yes	No

If the answer to the above is yes, please explain:

____

____

10. How often are environmental management audits which include climate change management audits done?

(Mark applicable with an (x)/✓)

Weekly	
Monthly	
Quarterly	
Annually	
Other specify______________	

SECTION F: REVIEW SYSTEMS

Using examples describe how the company reviews its current climate change management system?

____

____

Consider the following in your answer:

Safety committee meetings, Management review meetings, Climate managements specific review meetings

Thank you for your positive participation in the study

Appendix H: Operational employee's questionnaires on climate change

RESEARCH QUESTIONNAIRE

Research title: Mining Supply Chain's Response to Climate Change: A Case Study of South Africa's MCCGC.

Research Aim: To evaluate the climate change mitigation and adaptation strategies and practices by the Mutual Construction Company Group of Companies (MCCGC).

Location of the Study: This Master of Science research project is being done within the South African borders focusing on a South African company, MCCGC. It focuses on two selected work sites, MCCGC Tharisa and MCCGC Pilanesbergwhere MCCGC is the main mining contractor.

Objectives:

(v) To document and evaluate the strategy and practices by the MCCGC in mitigating climate change.

(vi) To document and evaluate the strategy and practices by the MCCGC in adapting to climate change.

Methodology: Questionnaires, recorded observations as well as air emissions sampling will be used to collect data. The data will then be scientifically analyzed. Conclusions and recommendations will then be submitted to the MCCGC and UNISA.

Ethics: All participations and data collection will be on an informed consent basis. The rights and ethics considerations for all participants are in the informed consent form. Applicants are advised to participate only after reading and signing the consent form.

Who is conducting and funding the study:

The study is being primarily conducted and self funded by Peace A. Matangira (UNISA Student: **4837-075-4).**

Nominally the MCCGC can provide funding on approval. The project however is not dependant on the nominal funding.

What you will be asked to do in the study: You will be asked to respond to a questionnaire and possibly to respond to an interview. Participation is voluntary.

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UNISA university of south afric

OPERATIONAL EMPLOYEES QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

1. Code # of participant………………………………
2. Site code………………………………………………………………………………
3. Job title of the respondent……………………………………………
4. Department of respondent…………………………………………………………………

SECTION A: POLICY AND PLANNING

1. What does MCCGC environmental policy say about climate change management?

____

____

____

2. How clearly do you understand your responsibilities towards climate change as outlined in your contract/ job description or appointment letter?

Clearly defined	**Briefly stated**	**Implied generally**	**Non existent**	

3. Mark with an (x) or (✓), the document in which outlines your duties to manage climate change?

Contract of employment	**Job Description**	**Appointment letter**	**None exists**

4. From your experience answer (Yes) or (No) to the following statements?

Management involves us when planning to manage climate change.	**Yes**	**No**
I know the MCCGC 2014 objectives and targets for climate change.	**Yes**	**No**

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5. Have you seen the 2014 MCCGC objectives and targets for climate change management?

Notice Board	Yes	No
Office	Yes	No
Change rooms	Yes	No
Other, specify	Yes	No
Never seen	Yes	No

SECTION B: LEGAL AND OTHER REQUIREMENTS

1. Does your company have a legal and other requirements register?

Yes	No	Not sure

2. What legal and other requirements do you know of that are aimed at addressing the climate change concern?

____
____
____

SECTION C: RISK ASSESMENT

1. Do you ever conduct risk assessments that focus managing air emissions?

Yes	No

2. **Focusing on air emissions, what level of risk assessments do you conduct?**

Risk Assessment Level	**Done**	**Not done**
Pre-use checklists for vehicles		
Daily pre-task risk assessment		
Issue based risk assessment		
Baseline risk assessment		

3. **Which one of the below issues on your site contributes to climate change?**

Air emissions from heavy duty machines	
Diesel combustion by mobile machines	
Use of paper in offices	
This has never been discussed	

Other:

___

___

3. **Are you aware of the positive impacts of climate change to you and your site?**

Yes	**No**

b. List a few examples;

___

___

4. **Are you aware of the negative impacts of climate change for you and your site?**

Yes	**No**

b: List a few examples:

___

SECTION D: OPERATIONAL CONTROL

1. **Are there procedures in your company that address climate change?**

Yes	No

2. **In your own opinion are these procedures well developed to address climate change?**

Yes	No

3. **If the answer to question (2) above is (No) please explain why you say so.**

____

____

4. **List any procedures that target climate change mitigation?**

____

____

5. **List any procedures that target climate change adaptation?**

____

____

6. **Which of the following training levels in relation climate change management**

Level of training done	**Yes**	**No**
Planned daily tool box talks		
Pre-employment training/ inductions		
Periodic planned awareness training		
Competence based training (Professional skills)		

SECTION E: MONITORING AND EVALUATION

1. Has a company or site carbon foot print been done? *(If yes, please show evidence)*

Yes	No

2. What inspections do you do to reduce GHG r emissions?

____

____

3. How often a environmental management audits done?

(Mark applicable with an (x)/✓)

Weekly	
Monthly	
Quarterly	
Annually	
Other specify_______________	

Thank you for your positive participation in the study

Appendix I: Executive Management Interview Guide

RESEARCH INTERVIEW GUIDE

Research title: Mining Supply Chain's Response to Climate Change: A Case Study of South Africa's MCCGC.

Research Aim: To evaluate the climate change mitigation and adaptation strategies and practices by the Mutual Construction Company Group of Companies (MCCGC).

Location of the Study: This Master of Science research project is being done within the South African borders focusing on a South African company, MCCGC. It focuses on two selected work sites, MCCGC Tharisa and MCCGC Pilanesbergwhere MCCGC is the main mining contractor.

Objectives:

(v) To document and evaluate the strategy and practices by the MCCGC in mitigating climate change.

(vi) To document and evaluate the strategy and practices by the MCCGC in adapting to climate change.

Methodology: Questionnaires, recorded observations as well as air emissions sampling will be used to collect data. The data will then be scientifically analyzed. Conclusions and recommendations will then be submitted to the MCCGC and UNISA.

Ethics: All participations and data collection will be on an informed consent basis. The rights and ethics considerations for all participants are in the informed consent form. Applicants are advised to participate only after reading and signing the consent form.

Who is conducting and funding the study:

The study is being primarily conducted and self funded by Peace A. Matangira (UNISA Student: **4837-075-4).**

Nominally the MCCGC can provide funding on approval. The project however is not dependant on the nominal funding.

What you will be asked to do in the study: You will be asked to respond to a questionnaire and possibly to respond to an interview. Participation is voluntary.

Executive Management Interview guide

1. There has been a lot of talk about climate change and global warming, what policy has been adopted by MCCGC in regards to this phenomenon?
2. Has MCCGC assessed and profiled the risks associated with climate change? ***(Note to the interviewer: - probe further as to the kinds of risks identified)***
3. Describe how climate change is managed by MCCGC (Interviewer to probe for mitigation then adaptation strategies including the ***management elements of: systems e. g. ISO 14001, management commitment, planning, training, legal awareness, staffing, risk assessment, standards, monitoring, evaluation and review.***
4. Comparatively, for the past five years how much does MCCGC spend on climate change management initiatives, per year?

Year	*Estimate Amount Spent on Climate Change*	*Amount on adaptation*	*Amount on mitigation*
2010			
2011			
2012			
2013			
2014			

5. Has MCCGC participated in the voluntary Carbon Disclosure Project since its inception? (probe on emissions monitoring and trends noted)

Appendix J: Middle Management Interview Guide

RESEARCH INTERVIEW GUIDE

Research title: Mining Supply Chain's Response to Climate Change: A Case Study of South Africa's MCCGC.

Research Aim: To evaluate the climate change mitigation and adaptation strategies and practices by the Mutual Construction Company Group of Companies (MCCGC).

Location of the Study: This Master of Science research project is being done within the South African borders focusing on a South African company, MCCGC. It focuses on two selected work sites, MCCGC Tharisa and MCCGC Pilanesbergwhere MCCGC is the main mining contractor.

Objectives:

(vii) To document and evaluate the strategy and practices by the MCCGC in mitigating climate change.

(viii) To document and evaluate the strategy and practices by the MCCGC in adapting to climate change.

Methodology: Questionnaires, recorded observations as well as air emissions sampling will be used to collect data. The data will then be scientifically analysed. Conclusions and recommendations will then be submitted to the MCCGC and UNISA.

Ethics: All participations and data collection will be on an informed consent basis. The rights and ethics considerations for all participants are in the informed consent form. Applicants are advised to participate only after reading and signing the consent form.

Who is conducting and funding the study:

The study is being primarily conducted and self funded by Peace A. Matangira (UNISA Student: **4837-075-4).**

Nominally the MCCGC can provide funding on approval. The project however is not dependant on the nominal funding.

What you will be asked to do in the study: You will be asked to respond to a questionnaire and possibly to respond to an interview. Participation is voluntary.

Middle Management Interview guide

1. What is your understanding of the term climate change?
2. Please explain the MCCGC policy on climate change management?
3. What vulnerabilities and opportunities exist for MCCGC within the area of climate change and climate change management?
4. With reference to your policy ***(if there is one),*** what actions do you take on a day to day basis to prevent climate change? ***(If there is no policy the question can be asked in general terms).***
    - *Note to interviewer: - Guide interviewee towards emission reduction*
    - *Note to interviewer: - Guide interviewee towards adapting to climate change*
5. What examples can you give of how MCCGC conducts education campaigns on climate change?
6. What technological or engineering mitigation and adaptation strategies are being implemented to manage climate change?

    Probes: what methods

    What materials

    What procedures

    What work instructions
7. Please outline yearly since 2008 how much money is set aside for climate change mitigation and adaptation projects in the MCCGC site?

Year	Estimate Amount Spent on Climate Change	Amount on adaptation	Amount on mitigation
2010			
2011			
2012			
2013			
2014			

8. To your knowledge what are the legal requirements for business to mitigate or adapt to climate change.
9. How are these responsibilities monitored and managed?
10. Please name any external programmes with related stakeholders that are linked to climate change? (Examples -include community based, legislative development).

Appendix K: Editor Certificate

CURWEN CONSULTANCY

THIS IS TO CERTIFY THAT THE THESIS EDITING AND PROOFREADING FOR

PEACE MATANGIRA

WAS PROFESSIONALLY COMPLETED BY

AG Tainton .... Date ....14/03/2017........

B.A. Psych (SA), B.A. Theol (USA), M.A. Rel (USA), TEFL (SA), CELTA (UK)

J Tainton .... Date ....14/03/2017........