DEPARTMENT OF ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM

FINAL REPORT

PRECIOUS METALS BENEFICIATION STUDY

Turnaround Partners

18 July 2007

GLOSSARY OF TERMS

Pgms	Platinum group metals
MQA	Mining Qualification Authority
DME	Department of Minerals & Energy

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EXECUTIVE SUMMARY

he Limpopo Growth and Development Strategy identified platinum mining and beneficiation as one of the seven developmental clusters. Platinum mining in Limpopo is developing into a major sector rivaling developments in the North West Province. The large number of prospecting licences that have been issued, the number of exploration projects underway and planned mine expansions all attest to the high level of activity in the province.

The project on Precious Metals Beneficiation was commissioned by the Department of Economic Development, Environment and Tourism with the aim of gaining a clearer picture of the precious metals mining industry. The research objectives set out in the Terms of Reference required the service provider to ascertain the scope of mining so as to obtain a picture of sustainability of the industry. Other objectives were to ascertain if the province has factor capacity to support associated mining activities, including human resources, knowledge resources, capital resources and infrastructure.

The methodology which was adopted for this study sought to address the requirements of the Terms of Reference. A structured methodology was adopted which commenced with reviewing project expectations with the client and drawing up a workplan. Then a desk top review was conducted, reviewing information held by various sources such as the DME, mining companies, the Chamber of Mines, as well as other local and international sources. Interviews were conducted with the various stakeholders such as the mining companies, DME, Chamber of Mines, etc. At the completion of the data gathering phase, all the data was compiled, analysed and synthesized into reports for the Department.

The project findings reveal that investment in platinum mining is not being matched by similar investments in platinum beneficiation, either at the primary level or value addition level. The province is home to 3 smelters, however these smelters are only serving their sister companies. New entrants into mining will find it difficult to treat their concentrates if there is no independent smelter. There is "talk" of building another smelter in the province but this study could not find concrete plans to do so. The Province also does not have either a base metal or precious metal refinery.

With respect to value adding beneficiation, there is no evidence that any is taking place, neither are there plans to do so. The two major value added platinum products are auto-catalysts, used for controlling automobile emissions, and jewellery. The manufacture of auto-catalysts is dominated by American, European and Japanese multi-national corporations who have located

their plants in major car manufacturing countries. There is, however, only one auto-catalyst manufacturer in South Africa.

The manufacture of jewellery in the province holds more promise since this is not capital or technology intensive. The jewellery industry has developed over the millennia as a cottage industry with design and manufacturing skills being passed on from father to son and/or apprentices. In the last century, formal training institutions have been established. There are at present six universities in South Africa offering degree programmes in platinum design and manufacture. In addition, the Mining Qualification Authority has accredited nine companies as training providers for jewellery design and manufacture. Currently, neither the universities nor the training providers are located in Limpopo.

Platinum mining alone is expected to create employment opportunities at all skills levels. While companies were unwilling to divulge their future employment plans, Anglo Platinum has indicated, in a press statement, a possible employment figure of 20 000 over the next few years. Thus, it would not be unreasonable to assume new employment figures in excess of 50 000 over the next ten years.

The mining activity in the province is envisaged to stimulate increased activity by SMMEs, particularly on the supply of inputs. Unfortunately, the industry has had the practice of opening their procurement to SMMEs only for their non-core products and services. There is a need for government to engage the mining companies on this issue so that SMMEs can gain access to core products such as reagents, protective clothing and other "big ticket" items.

This report has been structured essentially in three parts: Primary Production, Value Addition and Recommendations. The sections on primary production provide detailed information and data on prospecting, exploration and mining. The sections on value addition provide information on the uses of platinum, platinum jewellery technology, education and training and recommendations. A catalogue of suppliers of jewellery manufacturing plant and tools is provided under separate cover.

1. INTRODUCTION

The Study into Precious Metals Beneficiation was commissioned by the Department of Economic Development, Environment and Tourism with the aim of investigating the opportunities relating to the beneficiation of precious metals both upstream and downstream.

Of the two precious metals (gold and platinum), Limpopo is now a leading producer of platinum while there is no stand-alone gold producing mine in the Province. All the gold that is produced in the Province is a by-product of platinum mining. With respect to beneficiation, particularly the manufacture of jewellery, the two metals use the same technology and sometimes the same tools. It is for these reasons that the study focused on platinum.

The Limpopo Growth and Development Strategy identified platinum mining and beneficiation as one of seven developmental clusters. The Province therefore wishes to determine the development impact of this cluster with respect to the opportunities that will support economic growth and the attendant increase in employment, thereby reducing poverty.

2. SCOPE AND OBJECTIVES

2.1 OBJECTIVES

The scope and objectives of the project are outlined in the Terms of Reference which were issued by the Department, as well as in the Project Charter. The objectives are summarized below:

- To identify emerging opportunities relating to platinum beneficiation, focusing on the potential economic opportunities relating to existing and new mines, and the potential from exploration projects
- To estimate the potential economic and socio economic impact to the Province in terms of these development plans, upstream and
- Analyse the downstream processes with a view of determining their economic impacts
- Estimate the extent to which these development plans will stimulate job creation, the development of SMMEs and other economic linkages.

2.2 SCOPE

The scope of the study was as follows:

PRIMARY PRODUCTION

- Identify existing mines

- Identify exploration projects
- Identify new and existing smelters
- Identify new exploration projects
- Compile production data
- Compile employment data
- Identify new and existing refineries.

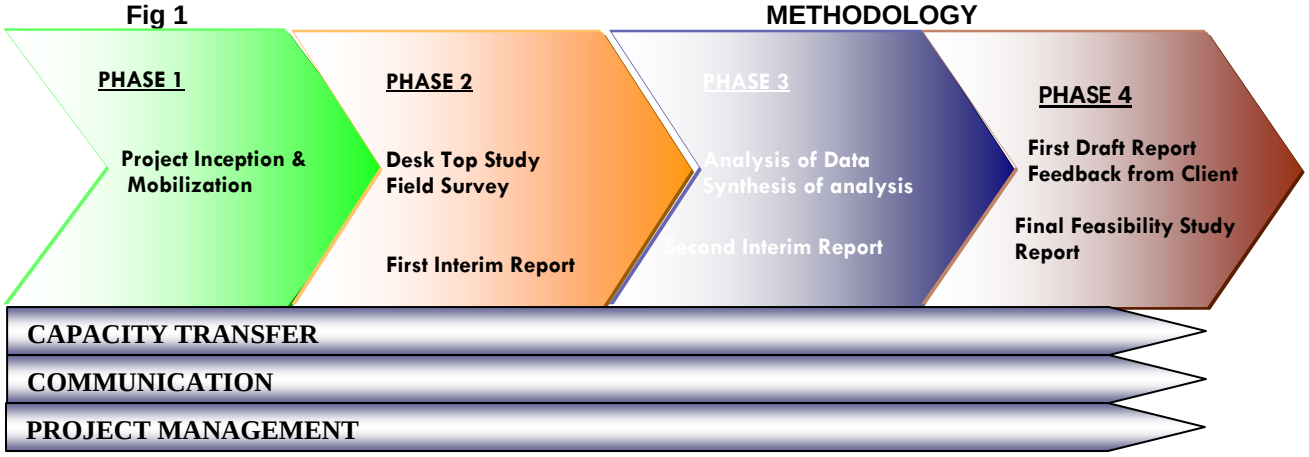
VALUE ADDITION

- Research global trends on demand for platinum products
- Research global trends on uses of platinum
- Identify opportunities for manufacture of platinum products such as auto-catalysts and others
- Determine the economic impact on job creation and opportunities for SMMEs
- Identify constraints such as capital, skills infrastructure, etc.

3 METHODOLOGY

The methodology which was utilized in this study is summarized in the graphics presented below, and discussed in the subsequent paragraphs. It is a structured approach beginning with project inception up to final study report.

Fig 1 **METHODOLOGY**



PROJECT INCEPTION
- Organise project
- Confirm client expectations
- Identify stakeholders
- Develop study framework

MOBILIZATION
- Mobilize project resources & setup team.
- Lists of entities to include in Field Survey
- Appointments with Field Survey participants.

DESK TOP STUDY
- Review existing literature
- DME/ Chamber of Mines
- Mining companies
- Other published data.

FIELD SURVEY
- Interviews with Mining companies/ DME/ and other study participants.

FIRST INTERIM REPORT

ANALYSIS
- Analysis of data from Desk top survey.
- Analysis of data from Field Survey.

SYNTHESIS
- Synthesis of all data

2nd INTERIM REPORT

FINAL REPORT
- Feedback from Client - 2nd Interim Report
- First Draft Report
- Feedback from Client

FINAL FEASIBILITY STUDY REPORT

3.1 PHASE 1: INCEPTION & MOBILIZATION

The work conducted during Phase 1 of the project is detailed below.

3.1.1. INCEPTION

Work on the project started with reconfirming the client's expectations as far as the project outputs, reporting channels and conduct of the study. This offered an opportunity for the consultants to clarify with the client as far as additional instructions and deliverables. The result of this exercise was the production of the Project Charter and Project WorkPlan. The Project WorkPlan was presented to the Department and was approved.

3.1.2 MOBILIZATION

The initial activities entailed project planning and mobilization of resources required for the execution of the project. Data collection forms, questionnaires and analytical tools for use during the study were assembled and tested. Field survey participants were identified and a list of participants was made.

3.2 PHASE 2: DATA GATHERING

3.2.1. DESKTOP STUDY

This entailed a review of published information. Data was sourced from sources such as DME, Chamber of Mines, the Department of Labour, mining and exploration companies, smelters and refineries. Local as well as international publications were consulted.

3.2.2 FIELD SURVEY: INTERVIEWS

Interviews were conducted with various stakeholders, as shown below:

MINING COMPANIES

Interviews were conducted with companies which are currently involved in platinum mining. The aim of the interviews was to access data relating to current and past production. Some of these companies are also involved in exploration activities.

DME

Interviews were held with DME officials. The aim of the interviews was to access information relating to prospecting licenses issued, exploration projects currently underway.

CHAMBER OF MINES.

The aim of contact with the Chamber of Mines was to access any intelligence which they may have with regard to the state of the platinum industry, as well as any prospective projects.

DEPARTMENT OF LABOUR

Interviews with the Department of Labour were aimed at sourcing information with regard to employment figures within the mining sector.

3.3 PHASE 3: ANALYSIS & SYNTHESIS

At the conclusion of the data gathering phase the data was collated and analysed. Preliminary conclusions were derived which were presented in the Second Interim Report. Further analysis and synthesis have now been conducted and are presented in this Draft Final Report.

3.4 PHASE 4: PROJECT REPORTS

This phase entails combining of all the project phases: desk top study, field survey, analysis and synthesis into a body of work to be presented to the client. The initial report is the Draft Final Report which will be presented to the client. Feedback will be sought from the client, and after incorporating this feedback, a Final Project Report will be prepared and presented to the client.

3.5 CLOSE-OUT SESSION

A Close-Out session will be conducted with the client. This session will afford the consultants an opportunity to present lessons learned to the client and present any other observations which bring value to the project.

3.6 CONCURRENT ACTIVITIES

In addition to the core activities of the project, other activities taking place were as follows:

- Capacity Transfer: This is an important aspect of the projects which we engage in and we invariably ensured that there was continuing passing on of skills to those persons that we worked with during projects.
- Consultation and communication: Ongoing consultation and communication with the client enabled the client to be kept informed of developments as the project progressed. The consultations also

ensured that we got feedback about the requirements of the client and whether these were being met.

- Project Management: This was another key aspect of the project. This activity ensured that the project progressed on schedule, that regular status reporting took place, that project issues were resolved and that quality work was delivered to meet the client's requirements.

3.7 The Project Team Structure

Team Leader

The Team Leader had overall responsibility for timely and quality delivery of the project. He was the project's quality controller. The team leader for this project was Mr Michael T. Wakatama.

Project Consultant

The Project Consultant was responsible for the day-to-day project execution. He was responsible for the deliverables. The project consultant for this project was Mr Surrender Ncube.

4. FINDINGS: Primary Production

4.1 PROSPECTING LICENCES FOR PLATINUM

Comprehensive data on prospecting activities in the Limpopo Province is shown in Appendix I. Prospecting is taking place in many areas of the Province. Table 1 below gives the number of licences issued per area.

Table 1: PROSPECTING LICENCES PER AREA

Area	# of Prospecting Licences
Polokwane	42
Rustenburg	20
Mokerong	31
Lydenburg	38
Mokerong 2	13
Potgietersrus	36

Nebo		13
Ellisrus		8
Phalaborwa		4
Letaba		9
Groblersdal		8
Messina		3
Warmbad		8

Source: DME: Granted Prospecting Applications for Platinum in Limpopo Region

- Table 1 and Appendix I show that the dominant areas of prospecting are in Polokwane, Rustenburg, Mokerong, Mokerong 2, Lyndenburg, Potgietersrus and Nebo. These prospecting areas are in the vicinity of producing platinum mines, as well as several exploration projects.

- The major mining companies in the province, namely, Anglo Platinum, Lonmin Northam and Impala do not seem to be prospecting much, as they already hold substantial ground with mining rights.
- On the ground (or field) there is no visible prospecting activity. The drilling rigs that are present in the area are in support of advanced exploration projects.

Therefore, it can be safely assumed that most prospecting ground is held for speculative purposes with a view of attracting either a junior or major company, or both.

- It should also to be noted that the multiplicity of prospecting companies are holding ground where the mineralized reefs are far deeper than in the ground currently held by the major mining companies. The development of mining projects in these areas will certainly be more costly due to the need to develop deep level mines.
- At some stage, the principle of "use it" or "lose it" may affect a number of these companies, thus opening the ground to other players or other existing players may expand their holdings.
- In general, the number of players in prospecting augers well for the future of platinum mining in the Limpopo Province. However, the majority

of the companies involved come from Gauteng, with only a small number from Limpopo.

- If the price of platinum related metals continues to be attractive, prospecting activity will hopefully be maintained for a long time.
- The graduation of activity from prospecting to exploration is a major step which can lead other investors to think seriously about setting up refineries.
- Employment generation in prospecting is usually minimal, consisting of bands of casual labourers doing either trenching or geochemical sampling under the supervision of a Geologist, usually a contractor or consultant.

4.2 EXPLORATION PROJECTS

The table below summarizes the exploration projects currently underway, characterized by their various stages. Further details of exploration projects in the Limpopo Province are given in Appendix II

.

TABLE 2: EXPLORATION PROJECT CATEGORIES

Status		No. of Projects
IE- Initial Exploration		7
AE-Advanced Exploration		12
PFS- Pre Feasibility Study		4
FS-Feasibility Study		3
CON-Construction		2
Total		**28**

Source: Barker's Platinum Map of Southern Africa, 2nd Edition

4.2.1 INITIAL EXPLORATION

These projects are almost all restricted to the Northern Sector of the Bushveld Complex of Limpopo. The companies in this category are as follows:

TABLE 3: INITIAL EXPLORATION PROJECTS

Company		# of Projects
Akanani Mining		1
Anoorag Resources		2
Platinum Australia		1
Platinum Group Metals		1
Platreef Resources		1
Superior Mining		1
Total		7

Source: Barker's Platinum Map of Southern Africa, 2nd Edition

4.2.2 ADVANCED EXPLORATION

Several companies across the province have advanced exploration projects as follows:

TABLE 4: ADVANCED EXPLORATION PROJECTS

Company		# of Projects
Anglo Platinum		1
Boynton Investments		2
Maude Mining		1
Aim Resource		1
Eersteling Gold		1
Pan Palladium		1
Southern Era		5
Total		12

Source: Barker's Platinum Map of Southern Africa, 2nd Edition

4.2.3 PRE-FEASIBILITY STUDIES

There are only four (4) companies in this category with one project each as follows: Pan Palladium, Anoorag Resources, Platinum Group Metals and Lonplats

4.2.4 FEASIBILITY STUDIES

Three (3) companies are conducting feasibility studies, with one project each as follows: Platinum Australia, Platreef Resources, and Lonplats.

4.2.5 CONSTRUCTION

There are only two (2) companies which have projects under construction in preparation for mining and these are Anglo Platinum and Impala Platinum at their Twickenam and Marula Projects, respectively.

Of the 28 exploration projects, only seven (7) have given estimated or projected PGM output as follows:

TABLE 5: PROJECTED PGM OUTPUT

Project		Projected Precious Group Metals Output (ounces/year)
Twickenam (Angloplats)		398,000
Marula (Impala)		382,000
Boikgantsho (Anooraq)		134,000
Turfspruit (Platreef)		250,000
Lonmin II (Lonplats)		327,000
Voorspoed (Southern Era)		95,000
Doornvlei (Southern Era)		95,000
Total		**1,581,000**

Sources (1) Barker's Platinum Map of Southern Africa, 2nd Edition
(2) DME Operating Mines and Quarries in South Africa
(3) DME- PGM Mines in South Africa 2007 Edition

The above projected figures are significant in many ways. The combined output of about 1,581, 000 ounces rivals the present annual output of all the mines which stands at about 2,000,000 ounces per year.

If the above projects come to fruition in the next five years, a conservative growth rate in platinum output of about 20% per year can be anticipated.

On the basis of the anticipated growth rate, ripple effects will be felt throughout the platinum value chain in terms of employment, social and economic development etc.

More importantly the pressure to come up with additional smelters and refineries will mount. Even on a toll basis, the current facilities would be overwhelmed to a point of not being able to cope.

Table 6: PLATINUM-GROUP METAL PRODUCING MINES AND COMPANIES IN THE LIMPOPO PROVINCE

COMPANY		MINE
Anglo Platinum Ltd		Lebowa Platinum Mines
		Modikwa Platinum Mine
		Potgietersrus Platinum
		Rustenburg Platinum Mines (Amandelbult)
		Rustenburg Platinum Mines (Union)
Impala Platinum Ltd		Marula Platinum Mine
Lonmin Platinum Ltd		Lonmin Platinum Limpopo
Northam Platinum Ltd		Northam Platinum Mine

Source: DME - PGM Mines in South Africa, 2007 Edition.

Notes:

1. Lebowa Platinum Mine – Owned 100% by Anglo Platinum
2. Modikwa Platinum Mine-Owned 50% by Anglo Platinum and 41.5% by African Rainbow Minerals, locals 8.5%.
3. Potgietersrus Platinums – owned 100% by Anglo Platinum.
4 Rustenburg Platinum Mines (Amandelbult Section)-owned 100% by Anglo Platinum
5. Rustenburg Platinum Mines (Union Section) – owned 85% by Anglo Platinum, 15% locals
6. Marula Platinum Mine – owned 77.5% by Impala, Marula Community 7.5%, Mmakau Mining (Pty) Ltd 7.5%, Tubatse Platinum (Pty) Ltd 7.5%
7. Lonmin Limpopo Mine-owned 100% by Lonmin Platinum.
8. Northam Platinum Mine-owned 50% by Northam Platinum Mines Ltd, 22.5% by Anglo Platinum, 22,5% by Mvelaphanda Holdings.

TABLE 7: PLATINUM PRODUCTION STATISTICS: LIMPOPO 2006

Name of Mine	Production Statistics						
	A	B	C	D	E	F	G
1. Lebowa	109	217	2,282	1,653	2,372	1,990	4,51
2. Modikwa	146	360	1,623	1,264	1,838	896	4,43
3. Potgietersrus	186	420	66,136	4,595	1,152	976	3,90
4. Amandelbult	648	1140	8,136	6,926	10,579	3,446	5,29
5. Union	327	608	4263	5,926	6,801	4,099	3,65
6. Marula	239	*	*	971	*	*	3,92
7. Lonmin	*	113	*	*	*	*	*
8. Northam	*	365	*	2,303	*	*	5,5

Sources: Angloplats Annual Report 2006
Implats Annual Report 2006
Lonmin Annual Report 2006

Key:

A. Platinum produced (x1000 ounces)
B. PGM's produced (x1000 ounces)
C. Tons Broken (x1000 tonnes)
D. Tons milled (x1000 tonnes)
E. Enrolled employees
F. Contract workers
G. Headgrade (g/t, 4E)
* Data not available

4.3 PLATINUM PRODUCING MINES

In the Limpopo Province, there is a total of eight (8) platinum producing mines (see Table 6)

- Anglo Platinum owns five(5) of the mines, namely:
  - Lebowa
  - Modikwa
  - Potgietersrust
  - Rustenburg (Amandelbult)
  - Rustenburg (Union)
- Impala Platinum owns Marula Mine.
- Lonmin Platinum owns Lonmin Platinum Limpopo
- Northam Platinum owns Northam Mine.

Of the eight(8) mines, Northam mine, the Amandelbult and Union Sections of Rustenburg Mines are in the Western Limb of the Bushveld. Of the remaining six(6) mines only one(1) is in the Northern Section (i.e Potgietersrust) and the remaining four(4) are in the Eastern Limb.

Appendix V provides a summary of production statistics for all the mines in the Limpopo province for the 2006. The tables in Appendix V detail the statistics for each mine from 2002-2006 (where the data is available).

From Appendix V, it can be seen that there is a direct correlation between platinum (or PGM's) produced, tonnes broken (or milled) and total labour.

4.4 SMELTERS

The Republic of South Africa has a total of six (6) smelters, owned as follows:

- Angloplats (3)
- Implats (1)
- Lonplats (1)
- Northam (1)

Of the six(6) smelters, three (3) are in Limpopo as follows:

- Limpopo (Angloplats), near Polokwane
- Union (Angloplats), near Northam
- Northam (Northam), in Northam

4.5 CONCENTRATES

- The concentrates produced from all the Angloplats mines in Limpopo are either treated at Polokwane Metallurgical Complex or at the Union Smelter. The smelters matte is in turn sent to Angloplats' Rustenburg refinery for refining into metal.
- The concentrates from Implats' Marula mine are sent to Implats' Refinery at Springs in Johannesburg.
- Likewise, Lonplats concentrates from Lonmin Limpopo Platinum are sent to the company's' Rustenburg smelter before being sent to their refinery at Brakpan in Johannesburg.
- The concentrates from Northam Mine in Thabazimbi are smelted at a smelter in the vicinity of the mine before the matte is sent for refining in Germany. This is the only company which sends its matte out of the country for refining.

4.6 REFINERIES

Currently the Limpopo Province has no platinum refineries. All the refining is done either in Rustenburg (by Angloplats), Springs (by Impala), Brakpan (by Lonplats) and Germany (by Northam).

Platinum is the major product that comes out of the refining process and constitutes more than 50% of the value. The complete list of products is as follows:

- Platinum
- Palladium
- Rhodium
- Ruthenium
- Iridium
- Osmium
- Gold
- Nickel
- Copper
- Cobalt Sulphate
- Sulphuric acid (this is produced from excess sulphur dioxide (S02) during the smelting process)

5. INFRASTRUCTURE DEVELOPMENTS

The improvement of water supply facilities primarily to mines in the area, but aso targeting the surrounding rural communities and towns, (e.g. the building of the De Hoop Dam on the Steelpont river) has been started.

The associated activities to the building of the De Hoop Dam will be

i. raising dam wall at Boshielo Dam flag
ii. 25km of new road
iii. 3 bridges
iv. 300km of pipelines and associated pump stations

6 AVAILABILITY OF INFORMATION

Data relating to mineral production e.g. Lonmin Limpopo, Northam and Marula Mines has yet to be received. Data relating to labour distribution has proved impossible to get, either from DME, Dept of Labour and the mines themselves, despite the legal obligation of labour equity statistics. Specific data relating to procurement and SMME's involvement is difficult to obtain, except in general terms.

The lack of availability of some information has meant that there are still gaps as far as developing a complete picture of the actual performance of the platinum operations.

7. OPPORTUNITIES FOR LIMPOPO IN PRIMARY PRODUCTION

The data gathered to date indicates that there are several opportunities for economic and social developments in the following areas:

7.1 MINING SERVICES

The volume of activities in prospecting, exploration, construction, mining, concentration and smelting opens up a new front for high level service industries, e.g. diamond drilling, analytical services, consultancy in mining, geology and mineral processing, management consultancy etc.

7.2 HUMAN RESOURCE DEVELOPMENT

Even though the Mining Charter obligates mining companies to have extensive programs to support their operations, it is incumbent upon the province and its educational institutions to compliment their efforts. Appropriate curricula

should be developed in consultation with all stakeholders, e.g. the Provincial Government, Chamber of Mines and the educational institutions.

7.3 PROCUREMENT OPPORTUNITIES FOR SMME'S

The scale of mining related activities in the province offers immense opportunities for SMME's to supply inputs and related services. A number of companies, in accordance with the mining charter, have schemes in place to support SMME's.

7.4 NEED FOR MORE SMELTERS AND REFINERIES

As a result of increased exploration activity leading to expansions of existing mines and the opening up of new ones, it becomes imperative that smelting capacity in the province be improved.

The present three(3) smelters are only serving their sister companies. New entrants into mining will find it difficult to treat their concentrates if there are no independent smelters. The province does not also have either base metal or precious metal refineries. It is also imperative that independent refineries be set up to cope with increased demand.

Such massive investments can only occur if the Provincial Government offers appropriate incentives to attract either foreign or local investors.

7.5 SMALL SCALE MINING

Platinum Mining is usually conducted on a relatively large scale. However, it is possible for relatively small mines to work alongside the large ones. Small mines easily render themselves to common service facilities such as concentration, smelting and refining. Such a development can only occur if appropriate financing schemes and incentives are put in place to support previously disadvantaged population groups. Appropriate training facilities for these groups would also have to be set up.

7.6 GENERAL OPPORTUNITIES

General opportunities, such as provision of services and goods to the developing platinum mining sector, will be part of the PGM development cluster in Limpopo .

7.7 VALUE ADDITION

After mining and related activities, one of the most important aspects of value addition is the manufacturing of finished products from the refined metal. The main applications of platinum are in auto-catalysts and jewellery. The local manufacture of jewellery is relatively simple provided there is appropriate training. With appropriate incentives, the province may be able to attract vehicle component manufactures.

8 VALUE ADDITION

8.1 THE PLATINUM VALUE CHAIN

The table below gives a summary of the platinum value chain.

TABLE 8: THE PLATINUM VALUE CHAIN

Activity	Product
I. Exploration	Grade and tonnage
II. Feasibility Study	Bankable document, mining and processing specification
III. Construction	Surface Infrastructure, civil works, milling and mining infrastructure
Iv. Mining	Ore extraction (mill headgrades of 4-7 grams per ton, 4E's, e.g., platinum, palladium, rhodium and gold)
V. Concentration	Ore crushing, froth flotation, to produce concentrates grading 100-1000 grams per ton PGM's, i.e. 4E's
VI. Smelting	Drying and smelting at 1500ºC to produce S02 for Sulphuric acid and converter matte with more than 1400 grams per ton PGM's
VII. Refining	Firstly metal refining to remove sulphur (to make sodium sulphate) and base metals (e.g., nickel, copper and cobalt sulphate) to produce PGM, Secondly, separation and concentration purification, to produce insoluble PGM's and soluble precious metals (e.g. platinum, palladium, rhodium, ruthenium, iridium, osmium and gold
VIII. Manufacturing	Manufacturing various products, e.g. autocatalysts etc.

Source: TAP

The chain begins with exploration followed by feasibility study, construction, mining, concentration, smelting, refining and manufacturing.

PGM's (Platinum Group Metals) comprise mainly platinum, and to a lesser extent palladium, rhodium and gold. Platinum and the related minerals have identical uses or applications as shown in Appendix III, and these are mainly in auto-catalysts, chemical, jewellery, electrical, glass, investment and petroleum industries.

8.2 AUTO-CATALYSTS

Platinum is used in the manufacture of three way converters to promote the reductions of nitrous oxide (NO2), liberate oxygen (O2) used to convert carbon monoxide (CO) and hydrocarbons to carbon dioxide (CO2) and water via oxidation catalysts.

An upward trend in vehicle manufacture throughout the world, coupled with stringent emission standards and high fuel prices will continue to spur platinum demand. Diesel vehicles, both light and heavy were the foundation for increased platinum demand, as the voluntary fitment of diesel particulate filters assured early compliance of soon-to-be-enacted legislation.

8.3 CHEMICAL

Process catalysts in the silicone industry are the single largest consumers of platinum in the chemical sector. Catalytic gauze is used to produce nitric acid (HNO3) for fertilizers another application.

8.4 ELECTRICAL

The increase in demand for computer hard disks is driving demand in this sector. Platinum coatings enhance data storage on discs. In the steel industry platinum is used to make thermocouples.

The principle of fuel cell technology has been known since 1839. Growing concerns over the environment and the promulgation of stricter emission legislation focused attention on the fuel cell as a clean and efficient producer of energy. Platinum is used as a primary catalyst in a number of fuel cell technologies including that of the proton exchange electrolyte membrane fuel cell.

8.5 GLASS

Platinum is essential in the precise, highly automated process that produces glass substrates with exceptionally clean, smooth flat surfaces. Its inherent dimensional stability qualities are essential to the successful manufacture of liquid crystal display (LCD) screens. Other applications include fiberglass production, TV and computer monitors.

8.6 JEWELLERY

In jewellery, platinum dominates the bridal sector. Demand remains strong at the high end of the market. Jewellery applications constitute the second most important market for platinum after auto-catalysts.

8.7 PETROLEUM

Platinum catalysts are used in the reforming and isomerization steps in the refining process. Gas to liquid plants of the future will spur demand in this sector. Once gas has been converted to a liquid product, it is processed in a way similar to conventional refinery processes using platinum catalysts.

8.8 INVESTMENT

In this sector, platinum is used to make coins and bars, in much the same way as gold.

8.9 OTHER USES OF PLATINUM

- Platinum tipped spark plugs and oxygen sensors.
- Platinum is a component of biomedical devices. It is the most biocompatible of all metals, it conducts electricity well, its hard and resistant to corrosion, workable, and radiopaque (visible under X-ray)
- Platinum is used both in casting blades and in coatings required to increase their longevity in the very harsh operating conditions of a modern turbine engine. This application is increasingly become important to a point where it is now the fourth largest of platinum' applications.

9 CONSIDERATIONS FOR DIRECT FOREIGN INVESTMENT

Except for jewellery, the manufacture of autocatalysts and platinum products for industrial applications are technology and capital intensive. There are only a few players, with the industry dominated by Johnson Matthey PLC which is based in the United Kingdom.

Johnson Matthey have an autocatalyst manufacturing facility in Germiston, east of Johannesburg, with other world-wide facilities in the USA, UK, Belgium, Mexico, Argentina, Japan, Malaysia, India and China. These facilities are located in countries and regions where automobiles are manufactured in high volumes. Since South Africa is a comparatively low volume producer Johnson Matthey established a manufacturing facility only after the SA Government had put in place a support mechanism (Motor Industry Investment Programme) for exports of motor vehicles and components. This mechanism made it profitable for Johnson Matthey to manufacture locally. Otherwise, it would have been content to import this product. Thus, one would expect Johnson Matthey to increase its production in line with the growth of the SA motor vehicle industry. Similarly, one would not expect other companies to enter the Sub Saharan Africa market while Johnson Matthey is in a commanding position.

International manufacturers of industrial platinum products are likely to use similar rationale, preferring to either expand existing operations or locating their plants closer to their major customers in the Americas, Europe and Asia. Under the circumstances, a South African company wanting to manufacture these products would either have to buy the technology or develop its own technology. Such a company would have to have superior competitive advantages in order to enter the market.

The above analysis does not hold with investments in the manufacture of platinum jewellery. Participants in this sector range from so called cottage industries or very small players, to well resourced companies. In other words, barriers to entry are comparatively low.

There are three primary drivers to jewellery manufacture, i.e. low wages since this is labour intensive, superior design skills and equally superior marketing skills.

10. PLATINUM JEWELLERY

10.1 INTRODUCTION

The manufacture of jewellery is both a craft and an art form that has been practiced over many centuries. Over the centuries, this has been a cottage industry, with the skills being passed from father to son. The jewellery industry of today is now a global and multi-billion dollar industry dominated by big design studios and manufacturers. These mass producers churn out millions of jewellery pieces per year. However, small and labour intensive craft shops have

survived and some have thrived by producing either unique, one-off pieces or a limited range of designs.

Jewellery technology has remained basically unchanged over the centuries. What has changed, however, is the tools and machinery which make the manufacture easier and faster. Some manual processes have been semi-or wholly automated, with small manufacturers using semi-automated tools. The transformation of the industry has also seen the formalization of training in both the design and manufacture of jewellery. Whereas these skills were passed from father to son or acquired through an apprenticeship programme, universities and colleges now offer degrees and diplomas in jewellery design and manufacture. At present, six South African universities and colleges offer programmes in jewellery design and manufacture. There are also SETAs that offer training in design and manufacture.

The historical metal jewellery materials, gold and silver, have now been joined by platinum and other platinum group metals (e.g. palladium). But, working with platinum is very different from working with gold. While gold is soft and melts at relatively lower temperatures, the opposite is true for platinum. Thus, platinum requires specialized tools, equipment, supplies and expertise.

10.2 JEWELLERY TECHNOLOGY

10.2.1 STAMPING

This commonly used process produces hollow, lightweight jewellery such as earrings, broaches, etc. A thin sheet or strip of platinum is placed between a series of matching halves of hardened steel dies and blanked out and then progressively punched to form the required shapes. A hand operated fly press would be suitable for a small producer, otherwise, one could use a modern hydraulic press.

A small operator would have to contract a tool maker to manufacture the steel dies. These could be quite expensive, hence, stamping is ideal where high numbers of pieces are to be produced.

10.2.2 LOST WAX (OR INVESTMENT) CASTING

The lost wax casting process is one of the oldest metal technologies which was developed for copper and gold in the Middle East around 4000BC. The process

has since been adapted for platinum using specialized casting machines. Such a machine would cost upwards of R200 000.00

10.2.3 HOLLOWARE

Hollow jewellery can be produced using various techniques where a metal strip is formed into tubes. These can then be shaped into circles or other shapes, welded or soldered and then polished.

10.2.4 CHAIN MAKING

Chains of various patterns can be produced on specialized chain machines using round, oval or square wire. More complex chains can be made from stamped components which are bent and interlocked.

10.2.5 SOLDERING

Soldering is a very important process for joining various components into the finished jewellery piece. It involves heating the pieces to be joined and applying the soldering alloy which melts and runs along the joint. In small workshops, heating is typically by a gas torch.

10.2.6 FINISHING

With few exceptions, all jewellery has to be polished at the end of the manufacturing process. Polishing methods and tools range from polishing wheels in small workshops to mechanized polishing methods used by mass producers.

10.3 EDUCATION AND TRAINING

10.3.1 TRAINING

Education and training in jewellery design and manufacture is being offered by six South African Universities and colleges, as well as some SETAs under the wing of the Mining Qualification Authority (MQA). The six universities and colleges are being supported by Anglo Platinum with the objective of "…. Promoting excellence and technology, in both design and manufacture within the jewellery industry". (Source: www.angloplatinum.com/jewellery/education).

10.3.2 INSTITUTIONS OFFERING JEWELLERY TRAINING

The institutions that are being supported are:

- **Tshwane University of Technology, Department of Jewellery Design and Manufacture**

- Training in platinum manufacturing skills for a large component of third year students' practical training.

- **University of Stellenbosch, Faculty of Fine Arts**.
  - The department offers a four-year degree programme in design and manufacturing.
- **University of Johannesburg, Faculty of Art Design and Architecture**.
  - The Anglo American Chairman's fund has contributed towards the establishment of a platinum design and manufacture studio.
- **Cape Peninsula University of Technology**
  - The university has an established platinum studio.
- **College of Cape Town**
  - This is a further education and training college that trains apprentices for the Cape Town jewellery industry.
- **Durban University of Technology, Faculty of Arts**
  - The faculty offers a programme that is nationally and internationally recognized.

10.3.3 LIMPOPO UNIVERSITIES

- The University of Limpopo plans to offer diploma and degree programmes in Geology, Minerals and Metallurgy. The former will commence in January 2008, with the latter commencing in 2009.
- The University of Venda, through its Department of Mining and Environmental Geology offers a certificate diploma and degree courses with a bias towards health and safety, mine inspection and rehabilitation.

10.3.4 ACCREDITED TRAINING PROVIDERS

To date, the MQA has accredited nine companies as training providers for jewellery manufacturing and design. As the table below indicates, the majority of these organizations operate in Gauteng Province.

TABLE 9: ACCREDITED TRAINING PROVIDERS

TRAINING PROVIDER	**PROVINCE**	**TELEPHONE #**
Infundiso Skills Development	Gauteng Mpumalanga	012 335 8261
MINTEK	Gauteng	011 7094581
Frany Jewellers	Gauteng	012 8111550
Cape College	Western Cape	021 4046700

Port Elizabeth College	Eastern Cape	041 5857771
Intsika Skills Beneficiation	Gauteng	011 873 2261
Vukani Ubuntu	Gauteng	012 373 9849
Goldfields FET College	Free State	057 3951344
Duncan Jewellers	Western Cape	021 4265888

Source: Mining Qualification Authority

A complete list of approved training providers in all aspects of mining and processing is provided as Appendix VIII.

10.4 DEMAND FOR PLATINUM JEWELLERY

The demand for platinum jewellery has been increasing steadily over the period 1980 - 1999. Over the years, the major markets for platinum jewellery have been China (45%), Japan (26%) and North America (26%). However, demand for platinum jewellery has been declining over the last few years because of the increase in the price of platinum (See the table 10 below).

TABLE 10: PLATINUM JEWELLERY DEMAND

Year	Demand (000 oz)
2006	1 740
2005	1 965
2004	2 160

Source: Johnson Matthey (2006)

Palladium, another precious group metal, has seen increased application in jewellery manufacturing, because of its much lower prices. (see table below).

TABLE 11: PALLADIUM JEWELLERY DEMAND

Year	Demand (000 oz)
2006	1 120
2005	1 430
2004	930

Source: Johnson Matthey (2006)

Global demand for palladium continues to be supported by its use in white gold and platinum alloy jewellery.

10.5 ECONOMIC IMPACT ASSESSMENT

Jewellery is a fashion item although it is also viewed as an investment in countries such as India, China and the Middle East. Generally, jewellery design and manufacturing has tended to be concentrated in the fashion capitals of the world. South Africa is no different, with Cape Town and Johannesburg being the major centres of jewellery design and manufacturing. Hence, these two cities have developed the requisite skills and expertise.

From the foregoing, the one major challenge, albeit a short-term one, is the acquisition of skills in the design and manufacturing of platinum jewellery. At present, there are no educational and training institutions operating in Limpopo. At the same time, associated skills such as tool and die manufacturing in the Province are in short supply. However, the dies could be purchased from manufacturers in other provinces or imported from overseas, with China and India being the least expensive sources.

Over time, the paucity of skills can be overcome by first, encouraging the local universities to establish platinum jewellery design and manufacturing programmes. Secondly, other training institutions could be established with the assistance of the Provincial Government.

11. CONCLUSIONS

11.1 PRIMARY PRODUCTION

The conclusions with regards to precious metals primary production are as follows:

- Currently platinum is the leading metal produced in the Province in terms of value.
- The centre of gravity in the platinum industry in South Africa is rapidly moving from Rustenburg to Polokwane.
- The extensive amount of prospecting and the large number of exploration projects indicates that there will be a continuous stream of new mines coming into production.
- The entry of new mines will require, amongst others the setting up of new smelters and refineries in the province in order to cope with the demand.
- The expansion of the PGM industry in Limpopo will fully subscribe to the PGM Cluster. The activities associated with the cluster cuts across all

sectors of the economy, particularly labour, capital, procurement, education, infrastructure, social services, manufacturing, etc.

11.2 VALUE ADDITION

- With the expansion of platinum production in the Province, there are opportunities for small and medium sized companies to start platinum jewellery manufacturing.
- The other forms of platinum production such as auto-catalysts requires high capital intensive plants which may not be able to profitably compete with world leaders.
- Jewellery manufacture is well suited to small and medium sized companies.
- Jewellery making equipment is being manufactured and offered from reputable makers and available at prices which a well resourced SMME could afford. See Appendix IX for a sample of equipment catalogue.
- Training is being offered by accredited service providers, for jewellery design and manufacture.
- Demand for platinum jewellery has been growing steadily over the years, even though there has been some decline due to high prices.

12. RECOMMENDATIONS

12.1 PRIMARY PRODUCTION

The recommendations emanating out of this study so far are as follows:

- The province should investigate possible assistance to the development of small to medium scale platinum mines by coming up with the right incentives, and finance.
- The province should actively support the setting, up of additional smelting capacity and new base and precious metal refineries.
- The Province should encourage training of young persons in order to equip them with skills that will make them employable by the expanding platinum mining sector.
- The Province should consider engaging with the mining companies in order to encourage sourcing of goods and service from locally based SMMEs.

- Similary, there should be efforts to capacitate local SMMEs with skills so that they can effectively service the growing mining sector, especially services.

12.2 VALUE ADDITION

- The Province should encourage the establishment of small to medium sized platinum jewellery manufacturing enterprises.
- The province could assist with the capital to set up such ventures, either with loans, grants or combinations thereof.
- A skilled workforce will be they key to the growth of the sector, and the key to improving incomes in the Province.
- Training is available with accredited service providers out of the Province, some trainees should be encouraged to enroll at these colleges initially in order to get the skills programme off to a quick start.
- In the long term, the Province should encourage the establishment of similar training programmes at the local institutions such as the University, technical colleges or other institutions.

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APPENDIX I : CURRENT PROSPECTING LICENCES FOR LIMPOPO PROVINCE

NAME OF COMPANY	AREA												
	A	B	C	D	E	F	G	H	I	J	K	L	M
1. Bakgaga Mining	5												
2. Tameng Mining and Exploration (Pty) Ltd	1	1											
3. African Crest Resource (Pty) Ltd		1	2										
4. Izingwe Crest			3										
5. Izingwe Capital				1									
Khumo Mining Investments (Pty) Ltd			4										
6. African Consolidated Mineral Exploration	2				1								
7. All Africa Platinum						4							
8. Umtha Resources (Pty) Ltd		1	1	1	2	1							
9. Falconbridge Ventures of Africa (Pty) Ltd					3		2						
10. Rustenburg Platinum Mines Limited			2			2							
11. Taung Platinum Exploration (Pty) Ltd				1	3								
12. Platinexco (Pty) Ltd			1			1							
13. Platreef Resources (Pty) Ltd				4	4								
14. Eersteling Gold Mining Co. Ltd			2			1		3					
15. Impala Platinum Limited			2										
16. Premetals Limited				2					3				
17. Nkwe Platinum (East) (Pty) Ltd	2												
18. Corridor Mining Resources (Pty) Ltd		1	2										
19. Serwalo Platinum (Pty) Ltd	1												
20. Akanani Mining (Pty) Ltd			1										
21. Sekhukhune Rhyme Thulare			1			5							
22. Minex Projects (Pty) Ltd			1										
23. Siyanda Resources (Pty) Ltd		3								6			
24. Messina Platinum Mines Limited				1									
25. Multidirect Investment 181 (Pty) Ltd	3					2	1						
26. Zelby 1564 (Pty) Ltd	3				1								
27. Pan Palladium Sa (Pty) Ltd							2				6		
28. Southernera Diamond Inc						1							
29. Pelonton Capital Investments	5					6							
30. Umnotho we Sizwe Resources	1				1	2							

(Pty) Ltd	1
31. Platinum Group Metals (Rsa) (Pty) Ltd	2 3 2
32. South African Mineral Development	3 2 3
33. Afro Multi Minerals (Pty) Ltd	1 3
34. Ex Terra (Pty) Ltd	
35. K and R (Pty) Ltd	3
36. Lenaka Mining (Pty) Ltd	3
37. Plateau Resources (Pty) Ltd	1
38. Desert Charm Trading (Pty) Ltd	3
39. Samancor Chrome Limited	3
40. Vulisonga Holdings (Pty) Ltd	2
41. Abrina 1998 (Pty) Ltd	1
42. Arcon Mining (Pty) Ltd	3 1
43. Biz Africa 1866 (Pty) Ltd	1 2
44. Fine Asset Investment 34 (Pty) Ltd	4
45. Katumelo Exploration and Mining (Pty) Ltd	2 4 1 2
46. Baepi Mining (Pty) Ltd	3
47. Versatex Trading 12 (Pty) Ltd	1
48. Izinyoni Trading 277 (Pty) Ltd	1
49. Puselo Investments (Pty) Ltd	
50. Bongani Edmond kunene	2
51. Tongda Development (Pty) Ltd	1
52. Aureus Industrial and Mining Operations	1 3
53. Analisa Mining and Industrial Services	1 2
54. Micawber 469 (Pty) Ltd	3
55. Sika Bopha Trading (Pty) Ltd	1
56. Cherry Moss Trade and Investment 73 (Pty) Ltd	1 3
57. Bolotola Investment Holdings (Pty) Ltd	1 2
58. Marllowe Trading (Pty) Ltd	3
59. Meritum (Pty) Ltd	2
60. Ndilo Mineral Resources (Pty) Ltd (No Data)	2 4
61. Formador Veertien (Pty) Ltd	1
62. Buyisela Mining Resources (Pty) Ltd	1 3
63. Mineral Capital Assets (Pty) Ltd	3

64. Tjate Platinum Corporation (Pty) Ltd 65. Angelica Platinum Mining (Pty) Ltd 66. Madibeng Promotions 67. A Naka Tsa Kgomo Investment Holdings (Pty) Ltd 68. Nako Mining and Industrial Services (Pty) Ltd 69. Umbono Platinum Mining 70. Genorah Resources (Pty) Ltd 71. Nozala Coal (Pty) Ltd 72. Nyeleti Minerals (Pty) Ltd 73. Diketso Capital 74. Southern Sphere Mining and Development 75. Anglogold Ashanti Limited 76. Ukana Trading Investments (Pty) Ltd 77. Interplay Trading 89 (Pty) Ltd 78. Golden Falls Trading 458 (Pty) Ltd 79. Zendra Van Wyk 80. AFC Limited 81. Sekoko Resources (Pty) Ltd 82. Nungu Trading 416 (Pty) Ltd	3 1
Totals (Grand Total)	42 20 31 38 13 36 13 8 4 9 8 3 8 (233)

Source: DME: Granted Prospecting Applications for Platinum in Limpopo Region

AREA	#OF CURRENT PROSPECTING ICENCES
A – Polokwane	42
B – Rustenburg	20
C – Mokerong	31
D – Lydenburg	38
E – Mokerong 2	13
F – Potgietersrus	36
G – Nebo	13
H – Ellisrus	8
I – Phalaborwa	4
J – Letaba	9
K – Groblersdal	8
L – Messina	3
M – Warmbad	8

Source: DME: Granted Prospecting Applications for Platinum in Limpopo Region

APPENDIX II:ADVANCED PLATINUM PROJECTS IN THE LIMPOPO PROVINCE

Sector	Ownership	Project	Status	Proj.PGM Output (oz's)
I. Western	N/A	N/A	N/A	
II. Eastern	Angloplats	Ga-Phasha	AE	N/A
		Twickenam	CON	398 000
	Boynton Invsts	Grootboom	AE	N/A
		Mphatele	AE	N/A
	Impala Platinum	Marula	CON	382 000
	Maude Mining	Tjate	AE	N/A
III. Northern	Aim Resources	Mokopane	AE	N/A
	Akanani Mining	Akanani	IE	N/A
	Eersteling Gold	Rooipoort	AE	N/A
	Pan Palladium	Aurora	AE	N/A
		Grass Valley	PFS	N/A
	Anooraq Resources	Boikgantsho	PFS	134 000
		Central	IE	N/A
		Kwanda	IE	N/A
	Platinum Australia	24 Rivers	IE	N/A
		Smokey Hills	FS	N/A
	Platinum Group metals	Tweespalk	IE	N/A
		War Springs	PFS	N/A
	Platreef Resources	Rietfontein	IE	N/A
		Turfspruit	FS	250 000
IV. Middle	Superior Mining	Bakgaga	IE	N/A
	Lonmin Platinum	Lonmin II	FS	327 500
		Lonmin III	PFS	N/A
	Southern Era*	Zebediela	AE	N/A
		Millenium Project	AE	N/A
		Voorspoed Section	AE	95 000
		Doornvlei Section	AE	95 000
		Dwaalkop Project	AE	N/A

Notes:

I. – Western Sector – Area North of Rustenburg, e.g. Northam and Thabazimbi
II. – Eastern Sector – Area between Steelpoort to the South and Lebowa Mine to the North
III. – Northern Sector – Area from Mokopane northward towards Gilead
IV. – Middle Sector – Area between Lebowakgomo and Mokopane, i.e. Zebediela

* - Southern Era projects only appear on the platinum map and not in DME reports. As of June 2005, all of Southern Eras' interests were acquired by Lonmin Platinum.

Abbreviations:
AE – Advanced Exploration
IE – Initial Exploration
CON – Construction
FS – Feasibility Study
PFS – Pre-Feasibility Study
N/A – Not applicable (or data not available)

Source: DME: PGM Mines in SA, 2007 Edition

APPENDIX III: PLATINUM DEMAND 1996 - 2005

ANNUAL PLATINUM DEMAND BY APPLICATION (METRIC TONNES)										
Application	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Autocatalysts (recycled)	58.5 (10.9)	56.9 (11.5)	56.0 (12.6)	50.1 (13.1)	58.8 (14.6)	78.4 (16.5)	80.2 (17.2)	101.7 (20.1)	108.6 (21.5)	118.8 (23.9)
Chemical	7.2	7.3	8.7	10.0	9.2	9.0	10.1	10.1	10.1	10.4
Electrical	8.6	9.5	9.3	11.5	14.2	12.0	9.8	8.1	9.3	11.2
Glass	7.9	8.2	6.8	6.2	7.9	9.0	7.3	6.5	9.0	11.0
Investment (Small) Large)	3.4 4.0	5.6 1.9	6.5 3.3	2.8 2.8	1.2 (3.1)	1.6 1.2	1.4 1.1	0.9 (0.5)	0.9 (0.5)	0.9 (0.5)
Jewellery	61.9	67.2	75.6	89.6	88.0	80.6	87.7	78.1	67.2	61.0
Petroleum	5.8	5.3	3.9	3.6	3.4	4.0	4.0	3.7	4.7	4.8
Other	7.9	9.2	9.5	10.4	11.7	14.5	16.8	3.7	14.6	14.6
Total	154.3	159.6	167.0	173.9	176.7	193.8	201.2	203.1	203.4	208.4

Source: (1) Johnson Mathey PLC Report 2006
(2) Chamber of Mines SA - Facts and Figures 2005

APPENDIX IV: LABOUR STATISTICS IN THE MINING SECTOR

YEAR	A	B	C	D
1995	598,845	91,528	11,900	120
1996	572,066	93,304	12,130	125
1997	553,542	90,876	11,800	130
1998	471,832	89,791	11,670	220
1999	436,472	91,269	11,860	415
2000	417,559	96,273	12,500	490
2001	406,994	99,575	12,900	560
2002	415,988	111,419	14,480	690
2003	435,628	127,672	16,600	755
2004	448,909	150,630	19,400	760
2005	443,300	155,030	19,600	800

Key A - Total employees all mines in RSA

B - Total employees all PGM mines in RSA

C - Total employees all PGM mines in Limpopo

D – Total women employees in Limpopo PGM mines

Sources – (1) Mineral Statistics Tables, 1984-2005, Bull. No.131/2006. DME,

(2) Limpopo Mining and Industries, 2007,

(3) Estimated from Employment Equty Statistics (Lebowa Mines)

APPENDIX V: PRODUCTION STATISTICS: PLATINUM MINES.

	LEBOWA PLATINUM MINES					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	102,0	105,1	113,6	110,0	109,2	
PGM's	192,6	201,7	222,1	217,7	216,6	
Production Statistics						
Tons milled (x1000)	1919	1976	2177	2069	2282	
Tons broken (x1000)	1547	1535	1789	1609	1653	
Permanent employees	2788	2311	2029	2140	2372	
Contract workers	n/a	1195	1699	1894	1990	
Head grade (g/t,4E)	4,46	4,61	4,51	4,66	4,51	

Source: Angloplats Annual Report, 2006

	MODIKWA PLATINUM MINES					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	25,1	86,2	114,0	128,2	145,6	
PGM's	53,7	204,9	276,6	328,3	360,1	
Production Statistics						
Tons milled (x1000)	459	1484	1384	1481	1623	
Tons broken (x1000)	488	1211	1182	1304	1264	
Permanent employees	850	1057	1215	1470	1838	
Contract workers	n/a	1097	880	864	896	
Head grade (g/t,4E)	2,52	3,23	4,09	4,14	4,43	

Source: Angloplats Annual Report, 2006

	POTGIETERSRUS PLATINUM MINES					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Platinum	165,3	188,9	196,0	200,5	185,5	416,0
PGM's	349,4	411,0	431,9	443,4	420,1	900*
Production Statistics						
Tons milled (x1000)	39672	48444	54026	56799	66136	80000*
Tons broken (x1000)	4375	4465	4470	4535	4595	7200*
Permanent employees	1112	1124	1132	1107	1152	2000*
Contract workers	n/a	586	776	877	876	900*
Head grade (g/t,4E)	3,53	3,99	4,12	4,03	4,90	3,9*

* Estimated for year 2007.
Source: (1) Angloplats Annual Report, 2006
(2) Mining Mirror Vol 19 No2, August 2006

	RUSTERNBURG PLATINUM MINES (Amandelbult Section)				
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**
Platinum	711,0	634,6	605,6	548,9	647,8
PGM's	1228,6	1102,0	1048,4	992,9	1139,8
Production Statistics					
Tons milled (x1000)	7539	7757	6972	6999	8136
Tons broken (x1000)	7072	6956	6458	6000	6974
Permanent employees	9607	9595	9518	9705	10579
Contract workers	n/a	2769	2878	2820	3446
Head grade (g/t,4E)	5,86	5,76	5,69	5,58	5,29

Source: Angloplats Annual Report, 2006

	RUSTERNBURG PLATINUM MINES(Union Section)					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	284,7	313,2	319,6	310,1	327,2	
PGM's	154,7	572,0	581,6	595,0	607,7	
Production Statistics						
Tons milled (x1000)	3707	4041	4196	4863	4263	
Tons broken (x1000)	4562	5882	6209	6258	5926	
Permanent employees	6240	6090	6283	6423	6801	
Contract workers	*	2824	3289	3932	4099	
Head grade (g/t,4E)	4,34	4,18	3,73	3,55	3,65	

* data not available
Source: Angloplats Annual Report, 2006

	RUSTERNBURG PLATINUM MINES(Union Section)					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	*	*	*	140.5	239.3	
PGM's	*	*	*	*	*	
Production Statistics						
Tons milled (x1000)	*	*	*	*	*	
Tons broken (x1000)	*	*	*	766	971	
Permanent employees	*	*	*	*	*	
Contract workers	*	*	*	*	*	
Head grade (g/t,4E)	*	*	*	3.73	3.92	

* data not available

Source: Implats Annual Report 2006

	LONMIM LIMPOPO PLATINUM MINES(Union Section)					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	*	*	*	*	*	
PGM's	*	*	*	*	113.4	
Production Statistics						
Tons milled (x1000)	*	*	*	*	*	
Tons broken (x1000)	*	*	*	*	*	
Permanent employees	*	*	*	*	*	
Contract workers	*	*	*	*	*	
Head grade (g/t,4E)	*	*	*	*	*	

* data not available
Source: Lonmin Annual Report 2006

	NORTHAM PLATINUM MINES(Union Section)					
Refined Production (0z's x 1000)	**2002**	**2003**	**2004**	**2005**	**2006**	
Platinum	*	*	*	*	*	
PGM's	*	*	*	*	350	
Production Statistics						
Tons milled (x1000)	1931	2219	2233	2150	2303	
Tons broken (x1000)	*	*	*	*	*	
Permanent employees	*	*	*	*	*	
Contract workers	*	*	*	*	*	
Head grade (g/t,4E)	5.3	5.3	5.5	5.6	5.5	

* data not available
Source: Modern Mining Vol 2 No. 6, June 2006

APPENDIX VI: PROJECT CHARTER

LIMPOPO PROVINCIAL GOVERNMENT

DEPARTMENT OF ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM

PRECIOIUS METALS BENEFICIATION RESEARCH PROJECT

1. Introduction

Limpopo Province has a very strong mining sector, contributing almost 20% to the output of the provincial economy. However, most of the mining activities are focused on the extraction of raw materials and there is a very little local beneficiation. There are also companies that are supplying products and inputs to the mines and the perception is that they are mainly emanating from the Gauteng Province.

In 2002 President Mbeki in one of his pronouncements directed the Department of Trade and Industry (DTI) to develop sector specific strategies which would inform development in South Africa. DTI has now produced a draft document which is now being finalised and will become the basis of provincial strategies addressing the development of mining in Limpopo. The province has in the meantime commissioned Mintek to develop a mining strategy and hopes that the document will be submitted by July 2007. Mintek has been requested to conduct a scan of the minerals in the province as well as investigate the input supply in the mining sector.

2. BACKGROUND AND OBJECTIVES

The Limpopo Development Growth Strategy identified platinum mining and beneficiation as one of seven developmental clusters. It is the over-riding objective of the province to determine the development impact of this cluster with respect to these opportunities that will support economic growth and the attendant increase in employment, thereby reducing poverty.

The Department of Economic Development, Environment and Tourism, in fulfilment of its mandate, has commissioned this research project to investigate

the opportunities relating to the beneficiation of platinum, both upstream and downstream. The research will focus on existing and new platinum mines, the smelter that has been constructed, as well as a refinery that may be constructed in future. The research will also seek to determine the potential opportunities for the manufacture of high value added products such as auto-catalysts, acid and fuel cells, glass, etc. The objectives can be encapsulated as follows:

- Identify emerging opportunities relating to platinum beneficiation, focusing on the potential economic opportunities relating to existing and new mines and the potential from exploration projects.
- Estimate the potential economic and socio economic impact to the province in terms of these development plans, upstream and;
- Analyse the downstream processes with the view of determining their economic impacts.
- Estimate the extent to which these development plans will stimulate job creation, the development of SMMEs and other economic linkages.

3. PROJECT SCOPE

The research will be conducted through field research and archives, as well as desk-top studies. The purpose of the field research and archives is to collect data and other relevant information, while the purpose of the desk-top studies is to benchmark value added products. This will be followed by an analysis and synthesis of the information in order to determine developmental impacts.

4. ASSUMPTIONS AND CONSTRAINTS

The successful completion of this project is premised on the assumption of the availability of requisite information and free access to the information. It should be noted that mining companies guard their information jealously. Thus, it is assumed that the Department of Minerals and Energy will have adequate information.

It is further assumed that the consultants will have easy and timely access to provincial and local government officials and other stakeholders.

At this point in time, no major constraints in executing this project are envisaged.

5. RELATED PROJECTS

The one project that is related to this project is the FEASIBILITY STUDY OF INDUSTRIAL PARKS. There may be other projects that have been commissioned by the relevant departments. The Feasibility Study of Industrial Parks is relevant to this study in so far as the potential opportunities for value addition are concerned, especially with respect to manufacturing space for SMMEs.

6. RISKS

The risks pertaining to the successful and timely completion of this project are as follows:

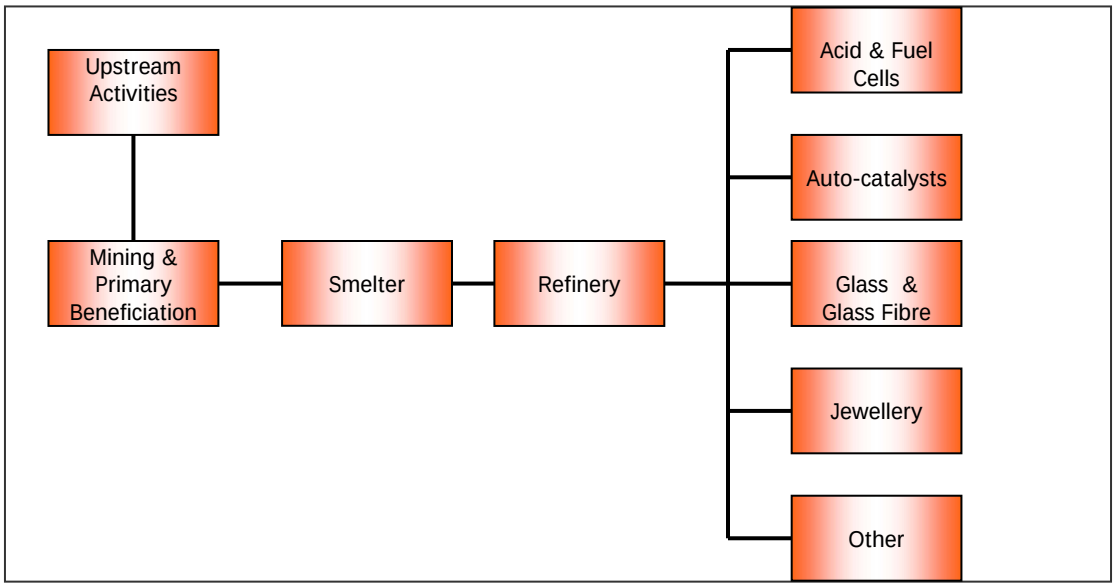
- Availability and timely access to information;
- Timely access to stakeholders; and
- Timely feedback on Progress Reports.

7. QUALITY MANAGEMENT APPROACH

The Team Leader shall be responsible for quality assurance, check each report/submission for accuracy and integrity.

8. TOOLS AND TECHNIQUES

The project will rely on templates to collect relevant data (See Appendix 1). The platinum beneficiation value chain what will be analysed is shown below:



Developmental impacts will be evaluated ate each point in the value chain, with a particular focus on job creation and the development of SMMEs.

10 WORK PLAN

The Work Plan is shown on Attachment 1.

11 TEAM CONTACT DIRECTORY

- Michael T. Wakatama (MTW) - Team Leader
  - Tel # 011 326 4965
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  - Cell: 072 246 2487
  - e-mail: michaelw@blackstonecap.co.za
- Sarenda Ncube
  - Cell: 072 858 5760
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APPENDIX VII TERMS OF REFERENCE

PRECIOUS METALS BENEFICIATION

1. Problem Identification

Limpopo province contributes less towards the domestic economy (in terms of GDP, at only 4%) than its share in the national population and the total land area (10%). The province has the highest population growth rate in South Africa. The large population relative to the small formal economy results in generally low levels of GDP per capita and therefore generally low levels of incomes.

Unemployment for the province is also much higher than the national average resulting in the second highest unemployment rate nationally. People are forced to seek employment outside the province, as indicated by high levels of male absenteeism.
Limpopo province economy is therefore small relative to its share in national population and land area. Secondly, the formal economy is very open, which implies a significant cross-border flow of goods, services and factors of production. Primary and secondary goods production is exported from the province, whereas consumption and other intermediary goods and services are sourced from outside the province. The implication is a loss in potential employment and income that could be generated through the processing of goods produced locally.

Limpopo Province has a very strong mining sector, contributing almost 20% to the output of the provincial economy. However, most of the mining activities are focused on the extraction of raw materials and there is a very little local beneficiation. There are also companies that are supplying products and inputs to the mines and the perception is that they are mainly emanating from the Gauteng Province.

In 2002 President Mbeki in one of his pronouncements directed the Department of Trade and Industry (DTI) to develop sector specific strategies which would inform development in South Africa. DTI has now produced a draft document which is now being finalised and will become the basis of provincial strategies addressing the development of mining in Limpopo. The province has in the meantime commissioned Mintek to develop a mining strategy and hopes that the document will be submitted by July 2007. Mintek has been requested to conduct a scan of the minerals in the province as well as investigate the input supply in the mining sector.

The Department of Economic Development Environment and Tourism in fulfilment of its mandate has commissioned this research to investigate precious metals beneficiation taking into account the factor endowment of the province, human resources, physical resources, knowledge resources, capital resources and infrastructure. The research will address the specific objectives outlined herein.

2. Research Objectives

- To ascertain if procurement policy by the mines is being adhered to as stipulated by the mining charter so as to benefit HDI.
- To ascertain the scope of mining activity so as to obtain a picture of the sustainability and profitability of the industry.
- To find out if the province has factor capacity to support associated mining activity, including human resources, knowledge resources, capital resources and infrastructure.
- Where skills are lacking, to ascertain whether institutions such as University of Venda and University of Limpopo are making progress in supporting skills development in the mining sector.

3. Research Questions

- Is procurement policy as stipulated by mining charter being followed (key consideration to HDI)?
- Is the mining industry within the province sustainable enough to provide employment, and furthermore to divert resources to?
- What is the composition of mineral factor endowment, and typically what skills are needed?
- Can skills be obtained from the province and is there capacity for skills development where certain skills are lacking?

4. Scope of Work to Be Undertaken

- Field Research (key mines by districts).
- Interviewing, data gathering and interpretation from mining industry stakeholders
- Review of state procurement policy and verification with current procurement by the mines.

5. Identification Of Key Stakeholders

- DTI
- Minitech
- DME
- Tertiary institutions

6. Deliverables

A report will be submitted with two hard copies and a soft copy on a cd. The report will cover the following sections:

- Executive Summary
- Background to Research
- Methodology
- Findings
- Interpretation of results/conclusion
- Recommendations

APPENDIX VIII APPROVED TRANING PROVIDERS

PROGRAMME APPROVALS

Scope	Contact Person	Email address	Telephone number	Cell number
Rock Engineering; Occupational health and Safety.	J. ENSLIN	jenslin@irca.co.za	011 329 1790	
ABET	W.B Nxumalo	aldaa@lantic.net	013 690 3250	082 724 2618
Mineral Excavation (Operating Earth Moving Equipments)	Paul Sethusa	psethusa@barloworld-equipment.com	011 929 0142	082 806 1759
Jewellery Manufacturing and Design	R. Hamza	rhamza@cct.edu.za	021 404 6700	021 404 6701
Jewellery Manufacturing and Design	I.J Peters	sakkie@goldfields-college.edu.za	057 395 13014	057 395 1344
Engineering	Patricia M. Galeboe	ntti@kingsley.co.za	027 744 1360	083 996 2388
Jewellery Manufacturing and Design	Dr. S.A. Voss	sarel@rrc.ac.za	041 585 7771	041 585 5436
Fitting and Machining, Platter/Boilermaking and Electrical	Chrito Ferreira Johan Swanepoel	ferreira@vcorporate.co.za jswanepoel@vuselelacollege.co.za	018 462 4255	018 484 2628
Engineering, Mineral Excavation	M du Bruyn	mdubruyn@westcol.co.za	011 693 3608	011 412 3047

Scope	Contact Person	Telephone number	Cell number	Fax	Province
Engineering	Joshua Francois Van Niekerk	057 353 1188	082 783 6836	057 353 3541	Free State
Engineering; **Occupational Health and Safety**	L Vanjaarsveld	011 257 3027	082 655 3767	011 257 3311	North West
Engineering; Mineral Excavation; ABET.	D. PIETERSE	011 779 1113	083 288 7094	011 779 1019	Northern Cape
Engineering (On the Job); Mineral Excavation; ABET, **Occupational Health and Safety**	R. PATTERSON	013 691 5210	082 854 0665	013 691 9399	Mpumalanga
Geology; Integrated Environmental Management; Engineering; Mineral Excavation; Metallurgy; Assaying; ABET; Strata Control; Sampling Technical Valuation; Evaluation Projects;Occupational Safety Winding Engine Driving	Roselyn Kemp	014 596 0152	083 455 7041	014 596 0162	North West
Engineering; Mineral Excavation; Assaying; Strata Control/ Rock Engineering; Integrated Environmental Management; Geology; ABET; Metallurgy/Mineral Processing; Mineral Surveying; Occupational Medicine; **Occupational Health and Safety**	Willie Jacobs	018 6075	082 376 6129	018 478 6065	North West
Winding Engine Driving; **Occupational Health and Safety**	P.H Myburg	018 462 4858		016 464 4469	North West
Mineral Excavation, ABET, Engineering (On the Job)	Casper Strydom	013 712 8500		013 712 9060	Mpumalanga
Mineral Excavation, ABET	M. Kee	018 789 9030	082 871 4548	018 789 9479	North West
Engineering; Mineral Excavation; Metallurgy	A.F. ROUX	013 692 3121	082 894 8913	013 692 8173	Mpumalanga
Mineral Excavation;Engineering, **Occupational Health and Safety**	Teresa De Wet	011 495 2241		011 495 2400	Gauteng
Enginerring, Mineral Excavation, ABET (Level 1 - 4)	James T van Zyl	027 807 2927	076 927 8118	027 807 1525	
Engineering, Mineral Excavation, Metallurgy, ABET, Occupational Safety	Koos Nel	012 305 2561		012 305 2646	Gauteng
Engineering	N. Ross	053 838 7205	083 262 2600	053 838 7539	Northern Cape
Mineral Excavation; ABET;Engineering;Metallurgy	D. Stander	053 385 2143	083 308 0809	053 385 2533	Northern Cape
Mineral Excavation; ABET; Engineering; Metallurgy	J. VAN DE RIET	054 838 7244			Northern Cape
Engineering Mineral Excavation Metallurgy	A. R. ESTERHUYSE	015 575 2201	082 878 0278	015 575 2018	Limpopo
ENVIRONMENT & TOURISM Diamond processing and Evaluation	T.BARNES	011 334 5917	082 770 1171	011 334 5917	Gauteng
Rock Engineering,Mineral Excavation and Strata Control	K. Viljoen	018 771 3892	082 494 5152	018 771 3892	North West

Engineering	D.V. Venter	011 472 3443/6		011 672 3888	Gauteng
Jewellery Design and Manufacturing	I. Nkwe	012 335 8261		012 335 5399	Gauteng
Engineering; Mineral Excavation; Metallurgy; Assaying; ABET	Elsabe Howes	014 569 6804		014 569 6715	North West
Jewellery Design and Manufacturing	Stanley Mkize	011 873 2261	083 563 1666	011 892 3558	Gauteng
Metallurgy / Mineral Processing	Jan Van Dyk	015 491 8115	082 593 7465	015 491 8115	Limpopo
Mineral Excavation	Hugo Coetzee	012 683 9000		012 663 2076	Gauteng
Engineering; Mineral Excavation; Metallurgy; ABET	H.H. SPANGENBURG	053 739 1233	083 304 1128	053 739 1204	Free State
Geology; Engineering; Mineral Excavation; Metallurgy; Assaying; ABET; Strata control; Sampling Tech. Evaluation; Integrated Environmental Management; Mineral Surveying;Occupational Medicine	L. De Klerk	014 571 2337	083 651 8276	014 571 2446	North West
Mineral Excavation; **Occupational Health and Safety**	Casper Leonard	014 533 3537	082 743 4031	014 533 3537	North West
Mineral Excavation	H. Tshehla	011 393 3586		088011 393 3586	Gauteng
Mineral Excavation; ABET; Engineering; Metallurgy; **Occupational Health and Safety**	Deon Van Wyk	017 616 2304		017 616 2609	Mpumalanga
Metallurgy / Mineral Processing	Rebecca Sands		083 228 6102	086 671 0883	North West
Mines Rescue Services	C. De Klerk	018 781 1141	082 550 6111	018 781 1085	North West
Small Scale Mining and Jewellery	Barbara Baloyi	011 709 4580	082 337 4831	011 709 4581	Gauteng
Mineral Excavation; **Occupational Health and Safety**	N. GELDENHUYS	015 781 5973	082 429 4560	015 781 5973	Limpopo
Mineral Excavation; ABET; Engineering(On The Job)	W. De Bruin	018 781 7077		018 781 7082	North West
Engineering; Mineral Excavation; ABET; **Occupational Health and Safety**	Marius van Rensburg	014 784 3190		014 7850 126	North West
Occupational Medicine; Geology; Integrated Environmental Management; Engineering; Mineral Excavation; Metallurgy; Assaying; Occupational Safety; Strata Control; Evaluation (project sampling); ABET; **Occupational Health and Safety**	J. HOLMES	015 780 2727	082 802 5590	015 780 2732	Limpopo
Mineral Excavation	David Van Niekerk	083 280 5645	082 788 7511	014 597 1765	Limpopo
ABET	Tobie Ferreirs	015 491 5419 011 883 5229	083 272 3312	011 883 5226	Limpopo
Occupational Medicine; Occupational Hygiene; Occupational Safety; Geology**;** Integrated Environmental					

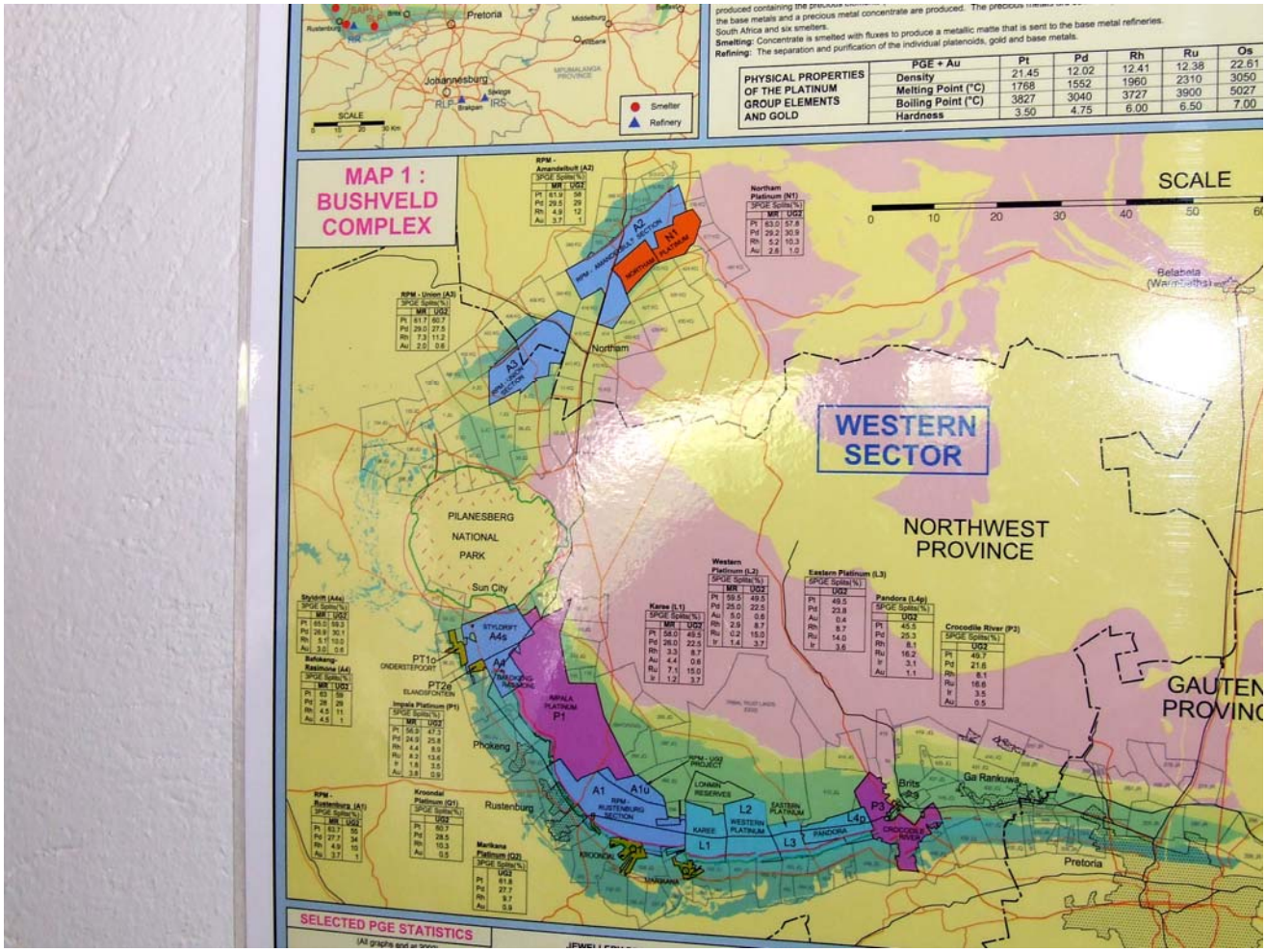
Winding Engine Driving	G.H.J Verwy	011 913 4243		011 916 3510	Gauteng
Jewellery Design and Manufacturing	Belinda Msiza	012 326 8534		012 653 0215	Gauteng
Mineral Excavation	S Jansen	014 594 2525	082 554 0596	014 594 0023	North West
Occupational Medicine; Geology; Integrated Environmental Management; Engineering; Mineral Excavation; Metallurgy; Assaying; Occupational Safety, **Occupational Health and Safety**	S. Scheepers	014 597 8455	082 579 6012	014 590 6002	North West
Mineral Excavation, Metallurgy; **Occupational Health and Safety**	Monty Montgomery	011 949 2266 011 949 1608		011 949 1534	Gauteng
ABET	Jan Schoeman	011 812 9638	082 854 5158	011 812 9653	Gauteng
Diamond Processing; **Occupational Health and Safety**	Norman Landman	015 293 2360	084 803 7200	015 287 0439	Limpopo

APPENDIX IX: CATALOGUEJEWELLERY MAKINGEQUIPMENT

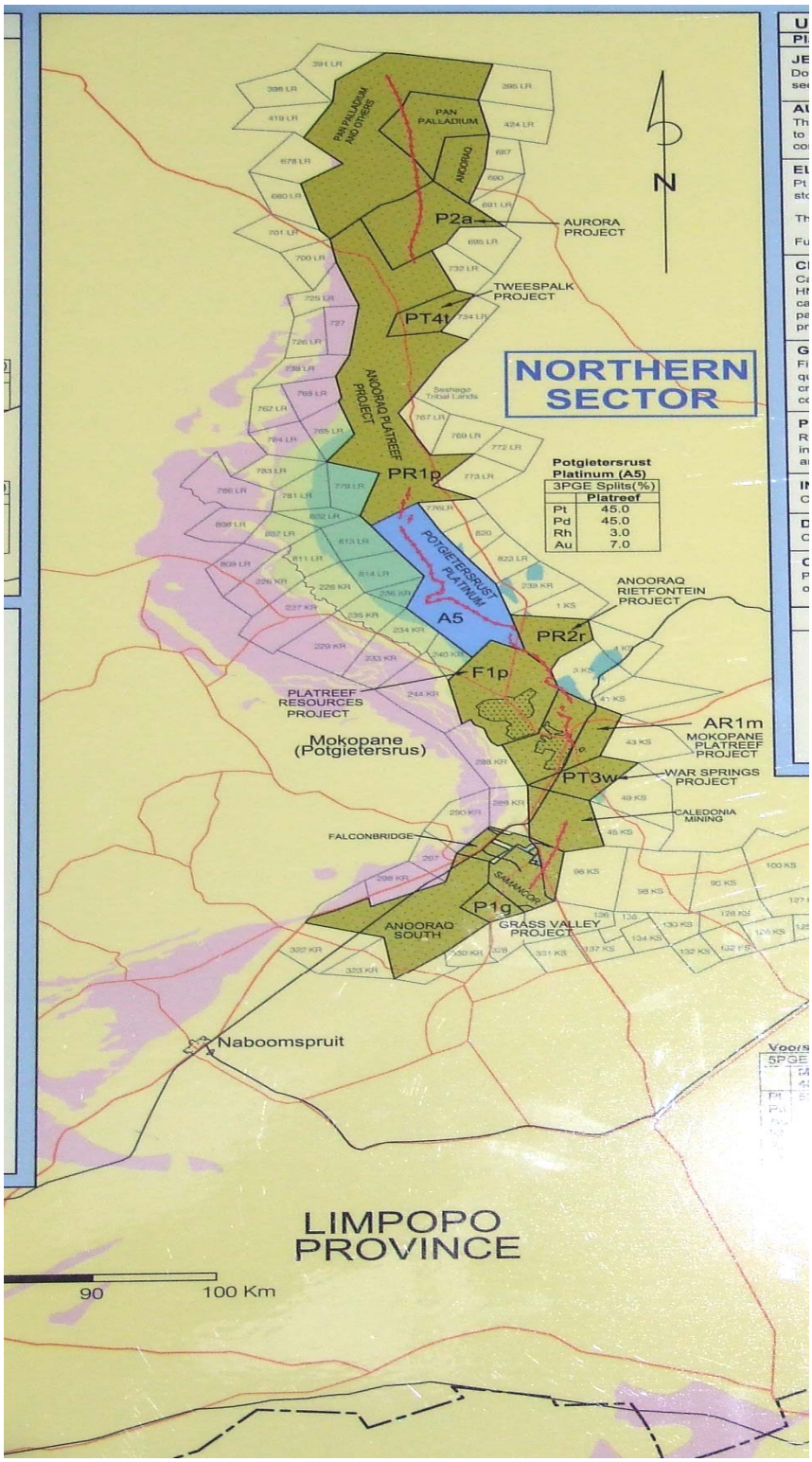
ATTACHMENT

APPENDIX X: MAPS

MAP1: WESTERN SECTOR



MAP 2: NORTHERN SECTOR



MAP 3 **EASTERN SECTOR**