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1. INTRODUCTION

Environomics and NRM Consulting were appointed by the national Department of Environmental Affairs (DEA) in partnership with the Limpopo Department of Economic Development, Environment and Tourism (LEDET) and the Waterberg District Municipality (WDM) to undertake the compilation of an Environmental Management Framework (EMF). The EMF will support decision-making in the Waterberg District Municipality area in order to facilitate appropriate and sustainable development.

The EMF must:

- Identify the geographical area to which the EMF applies;
- specify attributes of the environment in the area including the sensitivity, extent interrelationship and significance of those attributes;
- identify any parts in the EMF area to which the specified attributes relate;
- state the conservation status of the area and/or its relevant parts;
- state the environmental management priorities in the area;
- indicate the kind of activities that would have a significant impact on the attributes in the area and those that would not;
- indicate activities that would be undesirable in the area or in specific parts of the area; and
- meet any other requirement specified by the Minister or MEC.

The Project Team for this EMF consists of:

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    - Ms. D. Claassen
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- NRM Consulting
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Environomics and NRM consulting are working in association with:

- MetroGIS (Mapping & GIS work)
    - Mr. D. Jansen van Vuuren
    - Mr. L. du Plessis
    - Mr. D. de Witt
- Mark W Nixon Attorney (Legal aspects, land and mineral rights issues)
    - Mr. S. Collins
- David Hoare Consulting (Biological environment specialist)
    - Dr. D. Hoare
- Sustainable Futures ZA (Public participation)
    - Mr. S. Johnston
- Terrasoil Science (Agricultural and soil specialist)
    - Dr. J. van der Waals
- Dr. J. Pistorius (Cultural and historical specialist)

1.1. THE ENVIRONMENTAL MANAGEMENT FRAMEWORK AREA

The EMF area comprises of the Waterberg District Municipality area. It covers approximately 49 523 km^2 and is the largest district in the Limpopo Province.

It is mostly rural in nature with dispersed and fragmented urban areas. The major towns include:

- Along or in the vicinity of the N1 route:
    - Pienaarsrivier
    - Bela-Bela (Warmbaths)
    - Modimolle (Nylstroom)
    - Mookgophong (Naboomspruit)
    - Mokopane (Potgietersrus), and
    - Mokerong
- South of the Waterberg formation, Northam, Swartklip, Amandelbult, and Thabazimbi;
- North of the Waterberg formation, Lephalale; and
- In the centre of the Waterberg formation, Vaalwater.

It contains six local municipalities, namely:

- Bela-Bela
- Lephalale
- Modimolle
- Mogalakwena
- Mookgophong
- Thabazimbi

Map 1: Waterberg District Municipality

1.2. THE PURPOSE OF THE EMF

The purpose of this EMF is to develop a framework that will integrate policies and frameworks, and align different government mandates in a way that will streamline decision-making to improve cooperative governance and guide future development in an environmentally responsible manner.

The specific objectives of the EMF include:

- Encourage sustainable development;
- establish development priorities;
- identify strategic guidance and development management proposals;
- identify the status quo, development pressures and trends in the area;
- determine opportunities and constraints;
- identify geographical areas in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- specify additional activities within identified geographical areas that will require an EIA based on the environmental attributes of such areas;
- specify currently listed activities that will be excluded from EIAs within certain identified geographical areas based on the environmental attributes of such areas; and
- develop a decision support system for development in the area to ensure that environmental attributes, issues and priorities are taken into account.

1.3. THE EMF PROJECT PROCESS

1.3.1. Data gathering and capturing process

The Status Quo Report draws on many sources of information. Extensive existing data for the area was collected from different sources. This data was analysed and refined by the project specialists. New data was captured using the most recent available satellite images.

Ground verification took place in the latter half of June in order to confirm the accuracy of certain data set. Studies already completed in the area as well as studies that are currently underway were consulted as far as possible.

1.3.2. Public participation

The public participation for this project was divided into three phases. These phases attempted to ensure that the views of the Stakeholders and Interested and Affected Parties (I&AP's) would be reflected and considered during the EMF process.

In the first phase the public was notified of the project. Stakeholders were identified and a register of Interested and Affected Parties (I&AP's) was created. The first phase included these specific actions:

- Initial meeting with the client;
- the compilation of a database of potential Stakeholders and I&AP's;
- the preparation of an Information and News document to inform participants about the EMF project;
- the preparation of project advertisements published in regional newspapers;
- personal invitations to known I&AP's to inform them of the EMF process and invite them to attend the open days; and
- the distribution of the information document to stakeholders, relevant district municipal officials and members of the community within the EMF area.

The aim of the second phase was to provide I&AP's with more information regarding the proposed research project and to create a platform where interested and affected parties could define and spatially represent the desired state of the environment, and development of the study area.

Focus group meetings involving stakeholders were held soon after the completion of the status quo assessment and focused on the findings of this assessment, including the identification of current developments and the identification of environmentally sensitive and agriculturally valuable land.

The main objectives of phase two was to:

- Disseminate information regarding the proposed project to key stakeholders;
- supply them with more information regarding the EMF process;
- answer any questions regarding the project and process;
- revisit and verify I&AP issues and concerns as identified during the previous phase;
- note any additional issues and concerns;

- receive input regarding the public participation process and the proposed development; and
- supply preliminary information regarding the findings of the environmental studies being undertaken (if available).

The third phase was the formal process. During this phase the draft EMF document was advertised as required by law and made available in appropriate formats for inspection. Stakeholders and registered I&AP's were notified and given adequate time to review, consider and comment on the draft EMF document.

Stakeholders are specific individuals, companies and/or organisations that are identified as being directly affected by the project and who play an important role in the area. Specific inputs were required from stakeholders in order to ensure adequate representation of expectations and needs of sectors or areas.

Interested and affected parties are defined as being any person or organisation that have an interest in the project or are affected by it and would like to participate in the process. This may include stakeholders that have not been identified.

1.4. THE PURPOSE OF THIS REPORT

The purpose of this report is to serve as background information for:

- the identification of opportunities and constraints;
- the establishment of the desired state of the environment for the EMF area; and
- to be used as background information for the completion of the EMF.

It was also used as a communication mechanism in discussions with stakeholders, including member of the project Steering Committee, the district municipalities as well as stakeholders from the private sector.

2. ENVIRONMENTAL ATTRIBUTES

2.1. GEOLOGY, LANDSCAPE AND SOILS

2.1.1. Introduction

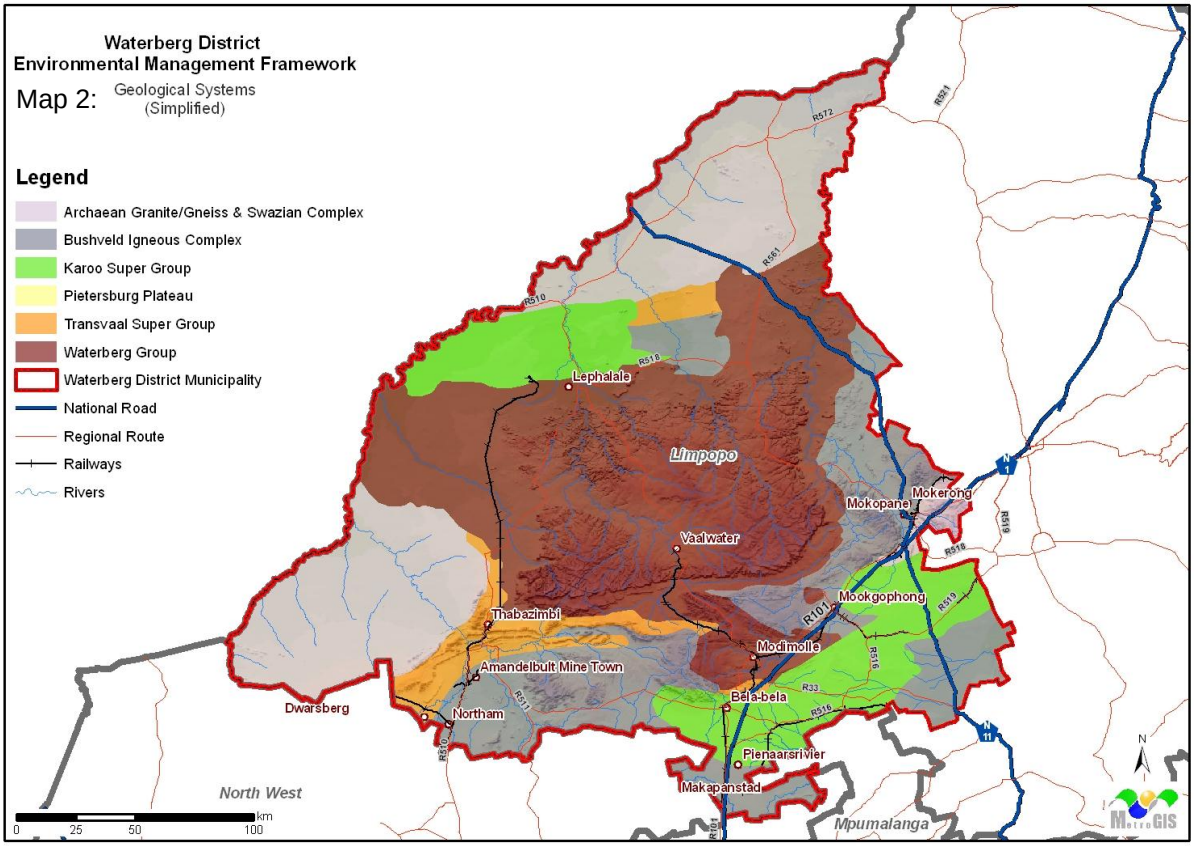
The geology of the Waterberg District forms the foundation for the development of the landscape, soils and vegetation cover that developed upon it over millions of years. It is also the source of minerals that form the backbone of the economy of the district. Geology can be described in several ways. Because the Status Quo Report is a working document that must provide input into the later more strategic phases of the EMF the description of the geology, landscape and soils has been broken down into the following components so that it can be used to inform decision processes in the rest of the EMF project:

- Geology
    - Geological Systems
    - Dominant Rock Types
    - Mineral potential
- Landscape
    - The Waterberg Plateau
    - The Transvaal Plateau Basin
    - The Pietersburg Plain
    - The Limpopo Depression
    - Terrain morphology and areas with special character
    - Steep slopes
- Soil (land) types
- Land capability for dryland agriculture
- Interpreted soils data
- Agricultural potential
- Soils and wetlands
- Resource related conflict

2.1.2. Geology

2.1.2.1. Geological systems[1]

The geological systems that occur in the EMF area are depicted (in simplified format) on Map 2: Geological Systems and is described in the sections below.



(a) The Transvaal Super Group

The Transvaal Super Group consists of clastic and chemical sediments and volcanic rocks which were laid down in a basin elongated in an east-west direction and rest conformably on older Swazian rocks.

Chuniespoort Group

The group consists predominantly of carbonate rocks and was known in the part as the Dolomite series.

[1] The main source of information used in this section is:D.J.L. Visser, 1989. *The Geology of the Republics of South Africa, Transkei, Bophutatswana, Venda, Ciskei and the Kingdoms of Lesotho and Swaziland*. Geological Survey, Republic of South Africa.
&
McCarthy T., Rubidge B. (2005) *The Story of Earth & Life A southern African perspective on a 4.6 – billion-year journey*. Struik Publishers, Cape Town

The Malmani Subgroup and Assen Formation

This formation consists of an alternation of chert-bearing and chert-free dolomite, on the basis of which it may be subdivided further into four, or in some places even five formations. At the base carbonaceous shale and quartzite are found in some localities and the contract with the underlying Black Reef Formation is gradational. Elsewhere it is conformable. The beds dip everywhere towards the inside of the basin, the dip amounting to only a few degrees.

Penge and Langrant Formations

The first is developed at its best to the east of Chuniespoort, where it is composed of banked ironstone, carbonaceous shale, subordinate carbonate rocks and breccia, and attains a maximum thickness of 600 m. In the vicinity of Thabazimbi, the formation is composed only of branded ironstone, hardly 300 m thick, which forms the top of the Chuniespoort Group in these areas. Dips are moderate (20-30 degrees) and towards the inside of the basin.

(b) Karoo Super Group

The Karoo Super Group is subdivided into four "series", namely, the Dwyka, Ecca, Beaufort and Stormberg. The Karoo Sequence is made up out of sedimentary rocks and consists of:

- The main Karoo basin, which extends from the Western Cape Province eastwards to the Indian Ocean, and northwards into Limpopo;
- The Lebombo area (outside the EMF area);
- The Sprinbok Flats to the east of Modimolle, overlying rocks of the Bushveld Igneous Complex, especially in the area of Nylsvley (within the EMF area); and
- The Waterberg coalfield directly to the north east and west of Lephalale.

The sequence was deposited in a vast intracratonic basin, which attained its maximum depth in the south, with a few satellite basins to the north.

Ecca Group

Rocks belonging to this group crop out especially in the marginal areas of the main Karoo basin, as well as on the Springbok Flats (within the EMF area). The main basin was probably a closed, inland depression that was shallow on the northern side, but deeper towards the south, where it was characterised by marine incursions. In this respect the basin would have resembled the present Black Sea, with the exception that it was larger and shallower. In the north sedimentary material was transported

principally from the north and the north-east, and in the south from the south-east, the south and the west, depending on the position in the basin. In the north-eastern part the sediment was deposited mainly under deltaic conditions on a stable continental shelf. Towards the south the sediments become finer grained and more characteristic of flysch deposits. This facies change from north to south is also reflected in the lithostratigraphic classification of the group. In the south eight formations were identified, four in the west and three to the north and north-east.

A further important lithological characteristic of this group is the fact that it consists principally of dark-grey shale, which is rich in carbon in places, together with interbedded sandstone units, which are found only along the edges of the basin, especially in the north-eastern and southern parts. The shale is laminated and, on weathering, breaks up into plates and flacks. The arenaceous interbeds vary from dark greywacke to whitish grit. Cross-bedding occurs seldomly, except in the northern facies, and upward-fining depositional cycles are practically absent, except in the north-eastern part of the basin. Plant fossils, especially the *Glossopteris* flora, are fairly widespread, but reptilian fossils are absent, the exception being *Mesosaurus*, which is found in the Whitehill Shale Formation in the south.

The Vryheid Formation

This formation follows conformably, and in most localities by way of a transition, on the Pietermaritzburg Shale Formation, from the southern part of Natal northwards. Along the northern rim of the basin it rests either on the Dwyka Formation or on an uneven floor of pre-Karoo formations.

The formation is characterised by thick beds of yellowish to white, cross-bedded sandstone and grit, which alternate with beds of soft, dark-grey, sandy shale and a few seams of coal. Plant fossils, in particular the *Glossopteris* flora and related species, are plentiful and trace fossils are also common. The coal seams and the torbanite of the eastern Transvaal are confined to a limited thickness of strata, more or less in the middle of the formation, with the exception of the Witbank coalfield on the Orange Free State goldfields, where they are found at the base of the formation.

Beaufort Group

This group covers the largest area, more or less 200 000 km^2, in the Karoo basin and reaches a maximum thickness of 6 000 m, in the Eastern Cape Province. It is also composed of an alternation of arenaeous and argillaceious sediments, which are terrestrial deposits, in contrast with the predominantly marine deposits of the Ecca Group. The argillaceous deposits are mainly greenish-grey, bluish-grey or red and

purple mudstone which is inclined to weather into blocks. The arenaceous deposits are composed of yellowish, “dirty”, i.e. immature, sandstones which are present throughout the group and are characterised by cross-bedding. Upward-fining, fluvial depositional cycles are ubiquitous in the group, and reptilian fossil remains are generally encountered, which emphasises the transition from a marine to a terrestrial environment. Deposition therefore took place in an enclosed foreland basin, of which the east-west axis migrated considerably farther northwards, compared with that of the partly enclosed inland sea in which the Ecca Group was deposited.

(c) Waterberg Group

The Waterberg basin is bounded on the southern side by the Waterberg and Sandriviersberg, and stretches northwards for roughly 90 km up to Lephalale, where it is bounded on the northern side by Karoo rocks, the contact being a fault. There is an offshoot towards the west, into Botswana, and another towards the north, up to the Blouberg.

Sedimentological studies performed on rocks of the Waterberg Group point towards the Transvaal Sequence and the Bushveld Complex as the more important source rocks and that the material was transported essentially from the north by an active river system which had migrated over a flood plain, some 40 km wide. Arid conditions, during which material could have been transported and deposited by wind action, could therefore have developed locally.

The age of the group is approximately 1 700 Ma. It is based on the fact that the Palala Granite, with an age of 1 770 Ma, is displaced by the Abbottspoort fault, but this fault does not affect the Makgabeng Formation, a part of the Waterberg Group, nearby, which means that the Makgabeng Formation is younger than 1770 Ma.

Nylstroom Subgroup

In the Modimolle and Alma areas the lower part of the Waterberg Group is developed, in which the Swaershoek and the Alma Formations are distinguished.

The Swaershoek Formation constitutes the base of the Waterberg Group and builds the Hoekberge to the west of Bela-Bela and the Swaershoek Mountains to the north of Modimolle. It rests unconformably on rocks of the Rooiberg Group and the Glentig Formation, and locally also on the Lebowa Granite Suite. It becomes thinner towards the west and eventually wedges out near Gatkop. Towards the north-east it is overlapped and covered by the Makgabeng Formation.

It is composed largely of reddish and brownish, medium- to coarse-grained sandstone with intercalations of siltstone, shale and conglomerate, and flows of trachytic lava with associated tuffaceous greywacke in the upper part thereof. In the Nylstroom basin the dips are shallow and towards its interior. The maximum thickness is 2 500 m.

The Alma Formation follows conformably on the Swaershoek Formation and is typically developed in the Alma trough. The characteristic rock type is a greenish-grey greywacke, followed by feldspathic and micaceous sandstone and feldspathic grit. The rocks are well bedded, dip moderately to the north and attain a thickness of 3 000 m. To the north-west the Skilpadkop Formation overlaps on to it, whereas to the north-east it wedges out between the overlying Setloale/Makgabeng and the underlying Swaershoek Formation.

Matlabas Subgroup

In this subgroup the Skilpadkop, Aasvoëlkop, Setlaole and Makgabeng Formations are distinguished. The first two are found in the western, southern and central parts of the basin, and the last two farther towards the east and the north.

South of Vaalwater Skilpadkop Formation follows para-conformably, but elsewhere with an angular unconformity on the Alma Formation. It is composed mainly of purplish-brown grit, conglomeratic grit, sandstone and conglomerate. The upper sandstone has a whitish to yellowish colour.

The Setlaole Formation is found in the eastern part of the Waterberg basin and is correlated with the Skilpadkop Formation. It is also composed of purple grit, sandstone and conglomerate, with tuff, ignimbrite, mudstone, arkose and laminated sandstone and clay-pallet conglomerate intercalated in the lower part of the grit.

To the north-west as well as towards the north-east this formation is overlapped by the succeeding Aasvoëlkop and Makgabeng Formations, but south of Villa Nora, where it was deposited on Nebo Granite and on rocks of the Rooiberg Group, it forms the base of the Waterberg Group. Dips are moderate and towards the north on the south side, but shallow and towards the south on the north side of the basin. The thickness amounts to 450 m in the Sterk River Valley but increases to 600 m towards the west.

The Aasvoëlkop Formation occurs as a narrow strip on the south side of the Sandriviersberg and of the Waterberg farther to the west, where it follows conformably on the Skilpadkop Formation and dips moderately towards the north. Towards the west it overlaps on to the older formations, eventually even on to the Archaean granite-

gneiss. Along the eastern rim of the basin the Nebo Granite forms the floor over a considerable distance, and south of the Blouberg it overlaps on the Hout River Gneiss.

In the south and the west the lower part of the formations is composed of siltstone, mudstone and shale with intercalated sandstone, followed by an alternation of siltstone and fine-grained, feldspathic, gritty and conglomeratic or ferruginous sandstone and locally also clay-pellet conglomerate. A fine-grained, white sandstone forms the top of this formation.

The Makgakeng Formation is composed entirely of pale-yellowish to pale reddish-brown sandstone, slightly feldpathic at the base and is especially well developed south of the Blouberg, where it builds the Makgabeng Plateau. It is characterised by cross-bedding on a large scale and is most probably of Aeolian origin. The thickness varies from 300 to 600 m in the south and the west, but increases to 1000 m in the north-east. It is correlated with the Aasvoëlkop Formation.

Kransberg Subgroup

Rocks belonging to this subgroup occupy the central part of the Waterberg basin and are classified into the Sandriviersberg, Mogalakwena, Cleremont and Vaalwater Formations.

The Sanriviersberg Formation builds the Sandriviersberg south of Vaalwater, the Waterberg to the west thereof and also occupies the terrain to the south of Lephalale. It is composed of coarse, gritty, yellowish sandstone which is cross-bedded throughout, with ferruginous lamellae along the planes of cross-bedding. It is approximately 1250m thick.

The Mogalakwena Formation is found in the eastern part of the Waterberg basin, in which direction the rocks become increasingly conglomeratic and ferrugineous. It is composed of pale to dark purplish-brown, coarse sandstone and grit, with beds of conglomerate and boulder conglomerate present at the base, roughly in the middle and near the top of the formation. It is especially well developed in the environs of Marken, where it attains a thickness of 1 200 to 1 500 m.

The Cleremont Formation crops out as a narrow strip around the central part of the Waterberg basin, which is occupied by the youngest or Vaalwater Formation. It is composed of a white, particularly coarse-grained sandstone with a fine-grained, purplish, micaceous sandstone developed locally at the base. The dips are shallow and directed towards the interior of the basin, and the formation is scarcely 125 m thick.

The Vaalwater Formation occupies the central part of the Waterberg basin, particularly around Vaalwater and further to the north and the north-west. A whitish, yellowish or pale-reddish, medium to fine-grained sandstone is present at the base, but higher up the sandstone becomes feldspathic and micaceous, with alternating beds of arkose and varicoloured, micaceous siltstone and shale. The thickness amounts to 475 m.

Koedoesrand Formation

Rocks belonging to this formation build the Koedoesrand to the north of Villa Nora. They occupy a narrow strip, elongated in an east-west direction and on the north and south sides by normal faults. The Abbottspoort fault is on the south side. On the west side the rocks abut against the Palala Granite, which is intrusive into them (Visser 1953).

Lithologically the lower part of the formation is composed of quartzitic sandstone, quartz-sericite schist and soft shale. Conglomerate beds preponderate in the middle portion, whereas the upper part is composed of sandstone and grit, with several pebble beds. The sediments are brown, and purple in places, the quartzites are thickly bedded and cross-bedded as well, which indicates a direction of transport of the sediments from the west. The pebbles in the conglomerate indicate that the Archaean rocks to the north supplied most of the sedimentary material. The thickness is approximately 480 m.

Except for the absence of volcanic rocks, the formation can be correlated with the Swaershoek Formation on lithological grounds.

(d) Bushveld Igneous Complex

This complex is the largest layered complex in the world and covers an area of nearly 65 000 km^2. In addition to its scientific importance, it also harbours important sources of platinum and chromium.

The four lobes comprise of an eastern lobe stretching from Belfast in the south up to the environs of Chuniespoort; a western lobe stretching from Pretoria via Rustenburg and the Pilansberg up to Thabazimbi (partly within the EMF area), a southern lobe which is largely covered by Karoo rocks but stretches as far south as Argent, Bethal and Hendrina, and a northern lobe stretching from Mokopane (within the EMF area) to the vicinity of Villa Nora. The four lobes are arranged around two axes, each approximately 350 km in length and orientated in north-north west and east-north-east directions respectively. The basic rocks crop out all along the peripheries of these lobes.

Rashoop Granophyre Suite

The greater part of the Rashoop Granophyre Suite originated as a plutonic equivalent of the Rooiberg Group. This suite is found in all parts of the Bushveld Complex. The roof of the granophyric rocks is formed by either volcanic rocks of the Rooiberg Group or sedimentary rocks of the Pretoria Group.

The suite is composed principally of granophyre, granophyric granite, granophyre porphyry and pseudogranophyre. All these rocks are made up of quartz and orthoclase, with subordinate hornblende and biotite.

The Rooikop Granophyre Porphyry occurs in the form of sheet-like intrusions which are confined to the Rooiberg Group and are also present in the Loskop Formation. It is composed of phenocrysts of quartz and potash feldspar in a granophyric ground mass. It is regarded as of magmatic origin and related directly to the Stavoren Granophyre.

The Zwartbank Pseudogranophyre is found mainly to the north-east of Rustenburg and to the north-west of Mokopane, quite often together with the Stavoren-type granophyre, and it is characterised by the presence of sedimentary inclusions. Although the texture of the rock resembles that of the Stavoren Granophyre, it is irregular and not the result of micrographic intergrowth. The potash feldspar, partially replaces the quartz, to yield a texture, which resembles a micrographic intergrowth. The quartz grains form optically continuous zones, which stretches over a few millimeters and are enclosed in one or more feldspar crystals. The rock is probably of metamorphic-metasomatic origin.

Rustenburg Layered Suite

Rocks belonging to this suite are characterised by a well-developed igneous layering, and various rock units which form part of it have a fairly uniform composition and may be traced over appreciable distances. In the eastern part of the complex a complete succession is exposed and in the western and northern parts, where exposures are considerably less, a good deal of lithostratigraphic information was obtained from borehole cores.

The Zoetveld Subsuite is found to the south of Mokopane and has been classified into three units: the Volspruit Pyroxenite, composed of bronzitite with interlayers of chromitite, is present at the base, this is followed by the Drummondlea Harzburgite-Chromitite, composed essentially of an alternation of layers of harzburgite and chromotite; the Moordedrift Harzburgite-Pyroxenite at the top is composed of an alternation of layers of harzburgite and pyroxenite, with some interlayers of chromotite.

The Grasvally Norite-Anorthosite is found in the Mokopane area and is grouped together with the Mapela Gabbro-Norite. It consists of an alternation of norite, anorthosite and pyroxenite, with interlayers of chromotite, and therefore shows some similarity with the Mathlagame Norite-Anorthosite further to the west. The relation to the underlying rocks is discordant.

The Mapala Gabbro-Norite is found in the Mokopane area, together with the Grasvally Norite-Anorthosite. It has a platiniferous plat reef, approximately 200 m thick, at the pyroxenite, altogether 600 m thick. The upper part of the unit consists of gabbro, roughly 1 500 m thick, with a prominent layer of noritic troctolite near the base and a pyroxenite marker bed at the top. The Plat reef itself is composed of harzburgite, which is very seldom pegmatitic, at the base, followed by feldspathic pyroxenite which passes upwards into porphyritic pyroxenite. Veins and specks of chromitite are found right through the reef. The relation with the floor rocks is discordant, and the formation transgresses towards the north on to the Archaean granite.

The Villa Nora Gabbro-Anorthosite. The rocks composing of lithostratigraphic units are distinguished from the foregoing by the appearance of magnetite in appreciable quantities. Igneous layering is conspicuous as a result of a varying content of magnetite, olivine, pyroxene and plagioclase. It forms part of what is known informally as the Upper Zone.

The Molendraai Magnetite Gabbro forms the uppermost part of the Rustenburg Layered Suite in the Mokopane area. It is approximately 1 100 m thick and is composed of alternative layers of gabbro, magnetite gabbro, anorthosite, magnetitite and olivine diorite. The main magnetitite band, one of twenty, found near the base and a layer of fayalite diorite forms the top of the succession.

The Villa Nora Gabbro-Anorthosite crops out just to the north of Villa Nora and to the south of the Koedoesrand, in a terrain in which outcrops are few. The constituent rocks are magnetite gabbro and anorthosite, with a number of interlayers of magnetitite, and the unit therefore corresponds best with the Molendraai Magnetite Gabbro towards the east and the south-east, although the lower part might possibly be compared with the upper part of the Mapela Gabbro-Norite.

(e) Archaean Granite/Gneiss and Swazian Complex

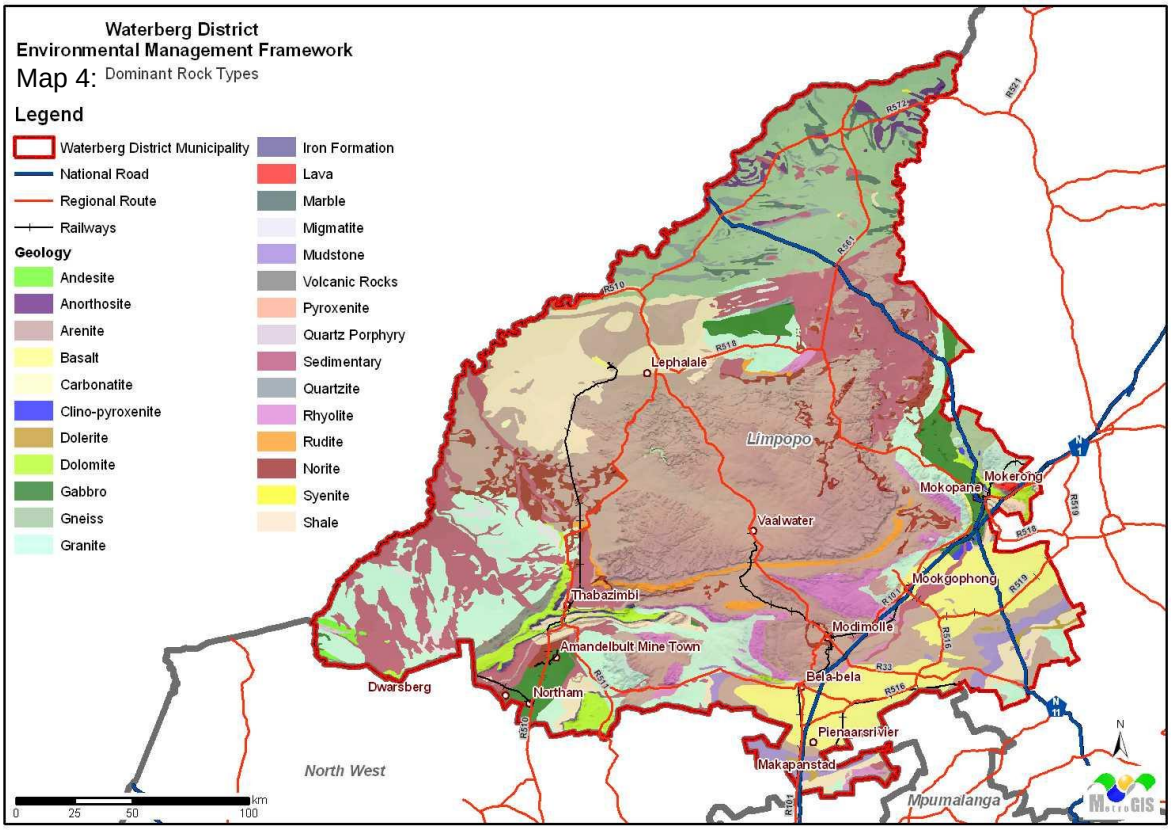
The Limpopo Depression to the south-west of the Waterberg and to the north of the Waterberg consists almost entirely of Old Swazian Granite and Gneiss formations. The Maladrift Group which is part of the Beit Bridge Complex is the most dominant in the area and is made up of lucucratic quartz-feldspar gneiss which also contains garnet

and amphibole, together with interbeds of pink hornblende gneiss. Map 3: Lithology, provides more detail on the geology of the area.

Map 3: Lithology

Dominant rock types[2]

Dominant rock types in the EMF are indicated on Map 4: Dominant Rock Types and described in the sections below.



(a) Andesite

Andesite is the volcanic equivalent of diorite, occurring as a dark-coloured and fine-grained but rarely glassy rock in lava flows and minor intrusions. It consists of sodic plagioclase, usually andesine, with roughly equal amounts of ferromagnesian minerals, such as hornblende and augite, or more rarely biotite. All these minerals can occur as phenocrysts if the rock is porphyrirtic. Its dark-grey or even black colour when fresh makes it difficult to distinguish from basalt, except that it usually weathers to a distinctly purplish crust, rather than forming a brownish crust more typical of basalt. If altered, it often appears purplish or dark mauve throughout the rock.

(b) Anorthosite

Anorthosite is a light coloured gabbro, which consists essentially of calcic feldspar, usually labradorite or bytownite, containing only a little augite and hypersthene, or

[2] The main source of information used in this section is: Roberts J.L, 1998. *A Photographic Guide to Minerals, Rocks and Fossils*. New Holland Publishers (UK) Ltd

occasionally olivine. It occurs as distinct layers in gabbroic intrusions, or as a large intrusive mass on its own.

(c) Arenite

Is a sedinmentary clastic rock with sand grain size between 0.0625 mm (0.00246 in) and 2 mm (0.08 in) and contain less than 15% matrix. The related adjective is arenaceous. The equivalent Greek-derived term is Psammite, though this is more commonly used for metamorphosed sediments.

Since it refers to grain size rather than chemical composition, the term is used for example in the classification of clastic carbonatic limestones, as the granulometrically equivalent term sandstone is not appropriate for limestone. Other arenites include sandstones, arkoses, greensands and greywackes.

Arenites mainly form by erosion of other rocks or turbiditic re-deposition of sands. Some arenites contain a varying amount of carbonatic components and thus belong to the rock-category of carbonatic sandstones or silicatic limestones. Arenites often appear as massive or bedded medium-grained rocks with a medium- to wide-spaced preferred foliation and often develop a pronounced cleavage.

(d) Basalt

Basalt is the fine-grained equivalent of gabbro or dolerite, and occurs as lava flows and minor intrusions, particularly dykes. It consists of calcic plagioclase, usually labradorite, together with pyroxene in roughly equal amounts as its essential minerals. Pyroxene is usually augite, but hypersthene may occur in the alkali-poor basalts called tholeiites (from Tholey, in Germany). Quartz is common in the groundmass of olivine-free basalts, but only in small amounts. Basalts are usually very fine-grained but still crystalline rocks, often appearing dull on fractured surfaces. They are commonly dark grey or even black in colour when fresh, and often weather to a brownish crust, rich in hydrated iron oxides.

(e) Carbonatite

Intrusive or extrusive igneous rocks defined by mineralogical composition consisting of greater than 50 percent carbonate minerals. Carbonatites may be confused with marble, and may require geochemical verification. Carbonatites usually occur as small plugs within zoned alkalic intrusive complexes, or as dikes, sills, breccias, and veins. They are, almost exclusively, associated with continental rift-related tectonic settings. The majority of carbonatites are Proterozoic or Phanerozoic in age. It seems that there has been a steady increase in the carbonatitic igneous activity through the Earth's

history, from Archean to present. Nearly all carbonatite occurrences are intrusives or subvolcanic intrusives. This is because carbonatite lava flows are unstable and react quickly in the atmosphere. Carbonatite lavas may not be as uncommon as thought, but have been poorly preserved throughout Earth's history.

(f) Dolerite (Diabase)

Dolerite is the medium-grained equivalent of gabbro, composed essentially of calcic plagioclase and pyroxene in roughly equal amounts, giving it a mottled appearance. It occurs very widely as large dykes, thick sills and volcanic plugs. It is usually dark grey or black when fresh, typically weathering to a dark brown crust, and often affected by spheriodal weathering. The plagioclase feldspar commonly forms an inter-locking meshwork of lath-like crystals. Augite usually occurs as small grains occupying the spaces between the plagioclase laths, but sometimes as larger crystals enclosing the plagioclase laths to give an ophitic texture, occasionally visible in hand specimen.

(g) Dolomite

Dolomite is very similar to calcite, lacking any distinctive features unless it occurs as rhombohedral crystals with curved faces, together with haematite. Often found as a vein mineral, it is also the chief constituent of the rock known as dolomite. Ankerite is an iron-rich dolomite in which iron has substituted for magnesium in the crystal lattice, giving it a darker-brown colour. Siderite FeCO3 is a common constituent of shales and mudstones, occurring as massive but very fine-grained concretions in clay-band ironstones. It can be distinguished from calcite and dolomite by its higher density (SG 3.8 to 4.0), greater hardness (3.5 to 4.5) and darker colour.

Dolomite is often difficult to distinguish from limestone except that calcite readily effervesces in dilute hydrochloric acid when cold, while dolomite only does so feebly unless the acid is heated. Dolomite is not secreted by any living organism, and it can only be precipitated from sea water under conditions of extreme salinity.

(h) Gabbro

Gabbro is a rather dark coloured, coarse-grained igneous rock of basic composition. It is typically composed of calcic plagioclase and pyroxene in roughly equal amounts.So that the rock consists of light and dark minerals. The plagioclas feldspar is usually labradorite, although more calcic varieties occur in eucrite. The pyroxene is usually augite, but orthopyroxene may also be present as hypersthene. Such a hypersthene-gabbro merges into norite if hypresthene is the only pyroxene present. Quartz is present in minor amounts in quartz-gabbros, which are often of more acid composition

than usual. Likewise, olivine is found in olivine-gabbros, often in quite significant amounts.

(i) Gneiss

Gneiss is a coarse-grained metamorphic rock which lacks a well-developed schistosity, but which displays a distinct banding or layering on a small scale. Known as a foliation, it is formed by the segregation of granular minerals like quartz and feldspar into distinct but rather irregular layers, separated by other layers, rich in platy or prismatic minerals such as biotite and hornblende. Gneisses may be formed from sedimentary or igneous rocks. Paragneisses of sedimentary parentage can be recognised by the presence of aluminous minerals like kyanite, sillimanite or cordierite in the rock, while the mineral composition of orthogneisses commonly resembles the igneous rocks from which they were formed.

(j) Granite

Granite is a coarse-grained igneous rock of acid composition and consists essentially of quartz (often in amounts much greater than 10%) and alkali-feldspar, typically occurring as orthoclase, microcline and perthite, but also including albite. Apart from albite, found only in alkali-granite, any plagioclase feldspar present is usually oligoclase, rarely andesine. Minor amounts of biotite and hornblende are common, together with muscovite in some granites and occasionally pyroxenes, which give their name to the rock. Granites usually occur in pale shades of white, pink, red or grey as ferromagnesian minerals rarely make up more than 20% of the rock.

(k) Iron formation

Iron-rich sedimentary rocks, mostly of Precambrian age, containing at least 15% iron. The iron occurs as an oxide, silicate, carbonate, or sulphide, deposited as laminated, deep-water, shelf-sea, and lagoonal sediments, often associated with charts. Other iron formations contain iron-rich ooids, pellets, and intraclasts, representing deposits comparable to shallow marine limestones. The source of the iron in iron formations is the subject of considerable debate; origins from volcanic sources, biochemical precipitation, and the diagenetic replacement of limestones are among the suggestions that have been made.

(l) Lava

This is molten rock expelled by a volcano during an eruption. This molten rock is formed in the interior of some planets, including Earth, and some of their satellites. When first erupted from a volcanic vent, lava is a liquid at temperatures from 700 °C to

1,200 °C (1,300 °F to 2,200 °F). Up to 100,000 times as viscous as water, lava can flow great distances before cooling and solidifying because of its thixotropic and shear thinning properties.

A lava flow is a moving outpouring of lava, which is created during a non-explosive effusive eruption. When it has stopped moving, lava solidifies to form igneous rock. The term lava flow is commonly shortened to lava. Explosive eruptions produce a mixture of volcanic ash and other fragments called tephra, rather than lava flows. The word "lava" comes from Italian, and is probably derived from the Latin word labes which means a fall or slide.

(m) Marble

Marble is a metamorphosed limestone, still consisting chiefly of calcite although other minerals may be present. It typically displays a rather granular texture, whether it is a product of regional or thermal metamorphism. If it is deformed, a weak schistosity may result from the parallel alignment of elongate grains. Marble is usually a whitish or greyish rock, particularly the ornamental varieties used for statuary, but its colour can vary greatly, depending on what impurities in the rock. Some varieties are coloured black by graphite, occurring as minute inclusions within the calcite grains. Typically, marble weathers much like limestone, giving rise to similar features in the landscape.

(n) Migmatite

Migmatite is the name given to any coarse-grained gneiss or schist that consists of a metamorphic host-rock, penetrated in a very intricate fashion by irregular and often discontinuous veins of granitic material. Migmatites are found only in high-grade metamorphic terrains, where they often appear to pass into larger bodies of granitic rock, while they are flanked by zones of high-grade schists and gneisses, often sillimanite-bearing. They most likely are formed by the partial melting of their host-rocks in response to extreme metamorphism under very high temperatures. This would at first produce a melt of granitic composition, which could then be injected as granitic veins into the surrounding rocks.

(o) Shales and mudstone

Shales and mudstones are extremely fine-grained sedimentary rocks, mostly consisting of clay particles less than 1/256 mm in diameter. Produced originally by chemical weathering, especially of feldspar, clay particles eventually settle out in still water as mud, often on the sea floor. This muddy sediment first forms a soft and sticky clay

before all its water is driven out by ever-increasing loads of sedimentary rock, converting it into mudstone or shale.

(p) Volcanic rocks

Volcanic rocks are usually fine-grained or aphanitic to glass in texture. They often contain clasts of other rocks and phenocrysts. Phenocrysts are crystals that are larger than the matrix and are identifiable with the unaided eye. Rhomb porphyry is an example with large rhomb shaped phenocrysts embedded in a very fine grained matrix.

Volcanic rocks often have a vesicular texture caused by voids left by volatiles escaping from the molten lava. Pumice is an example of explosive volcanic eruption. It is so vesicular that it floats in water.

Volcanic rocks are named according to both their chemical composition and texture. Basalt is a very common volcanic rock with low silica content. Rhyolite is a volcanic rock with high silica content. Rhyolite has silica content similar to that of granite while basalt is compositionally equal to gabbro. Intermediate volcanic rocks include andesite, dacite, trachyte, and latite.

Pyroclastic rocks are the product of explosive volcanism. They are often felsic (high in silica). Pyroclastic rocks are often the result of volcanic debris, such as ash, bombs and tephra, and other volcanic ejecta. Examples of pyroclastic rocks are tuff and ignimbrite.

Shallow intrusions, which possess structure similar to volcanic rather than plutonic rocks are also considered to be volcanic.

(q) Pyroxenite (Pyroxene-granulite)

Pyroxenite is a course-grained basic rock consisting of pyroxene and calcic plagioclase, often with some garnet, and banded like other gneisses. The pyroxene is typically hypersthene, although clinopyroxene may also be present. The feldspar often appears dark with a greasy lustre. Devoid of any hydrous minerals like biotite or horneblend, pyroxenite are thought to form by the deep-seated metamorphism of basic igneous rocks under temperatures and pressures that favour the crystallization of anhydrous minerals like pyroxene and garnet. They are found exposed in basement complexes, representing the deepest levels of the continental crust. More acid varieties are known as charnockite or hyperstene-granite.

(r) Quartz porphyry

Quartz porphyry is an intrusive rock of granitic composition in which conspicuous phenocrysts of quartz and alkali-feldspar are set in a much finer-grained matrix of the

same minerals. Such rocks pass into felsites as the phenocrysts gradually become less abundant, typically forming a rather fine-grained rock with few distinctive features. Other intrusive rocks of granitic composition include microgranites and granophyres, in which the crystalline textures are visible to the naked eye even although the individual crystals often do not exceed 1-2 mm in size, unless they occur as phenocrysts. All these rocks are typically light-coloured, especially on weathered surfaces, appearing greyish or sometimes as a striking pink or red.

(t) Sedimentary rocks

Sedimentary rock is a type of rock that is formed by sedimentation of material at the Earth's surface and within bodies of water. Sedimentation is the collective name for processes that cause mineral and/or organic particles (detritus) to settle and accumulate or minerals to precipitate from a solution. Particles that form a sedimentary rock by accumulating are called sediment. Before being deposited, sediment was formed by weathering and erosion in a source area, and then transported to the place of deposition by water, wind, mass movement or glaciers.

The sedimentary rock cover of the continents of the Earth's crust is extensive, but the total contribution of sedimentary rocks is estimated to be only 5% of the total volume of the crust. Sedimentary rocks are only a thin veneer over a crust consisting mainly of igneous and metamorphic rocks.

Sedimentary rocks are deposited in layers as strata, forming a structure called bedding. The study of sedimentary rocks and rock strata provides information about the subsurface that is useful for civil engineering, for example in the construction of roads, houses, tunnels canals or other constructions. Sedimentary rocks are also important sources of natural resources like coal, fossil fuels, drinking water or ores.

(u) Quartzite

Quartzite is a metamorphic rock composed almost entirely of quartz, formed by the recrystallization of a quartz-rich sandstone, and consisting of an interlocking mosaic of quartz grains, all tightly welded together. Although a metamorphic rock, it resembles a quartz-cemented sandstone (or orthoquartzite). Its detrital nature is often only revealed by the presence of feldspar grains (or other distinctive grains such as blue quartz). Quartzite often fractures along a multitude of very smooth joint-planes, displaying a polished appearance, which cut across the individual quartz-grains in the rock. Quartzites are usually white or pale grey, but sometimes pink or even reddish. Sedimentary structures, especially cross-bedding, may be preserved.

(v) Rhyolite

Rhyolite is the volcanic equivalent of granite, forming a very fine-grained rock of acid composition, which typically occurs as lava flows, often of considerable thickness. It consists essentially of quartz and alkali-feldspar, together with sodic plagioclase, which may all occur as phenocrysts set in a very fine-grained or even glassy matrix.

(w) Rudite

Rudite is any sedimentary clastic rock with a grain size exceeding 2 mm (0.08 in) such as conglomerates and breccias.

The term is used in the classification of clastic carbonatic limestones, although the granulometrically equivalent terms conglomerate and breccia are often used for limestone too.

Rudites mainly form by erosion of other rocks or turbiditic re-deposition of pebbles or already consolidated rocks. Some rudites contain rounded components and thus belong to the rock-category of conglomerates, others composed of angular fragments are called breccia. The interstices between the coarse grains are filled with a silicatic or carbonatic matrix. Rudites mostly appear as massive or crudely bedded rocks with a wide-spaced foliation and an irregular and wide-spaced cleavage.

(x) Norite

A coarse-grained, basic igneous rock consisting of essential plagioclase feldspar, orthopyroxene (hypersthene or bronzite) and clinopyroxene (augite), with accessory ilmenite. Orthopyroxene is dominant over clinopyroxene, and the plagioclase is a calcic type (labradorite or bytownite). Norites, like gabbros, are found as layers in many large, layered basic intrusions (see INTRUSIVE), as well as forming intrusions in their own right.

(y) Syenite

Syenite is a light-coloured, coarse-grained igneous rock, rich in alkalis, composed essentially of alkali-feldspar, including albite, and lesser amounts of sodic plagioclase if present as oligoclase or andesine. Minor amounts of biotite, horneblende, sodic amphiboles (riebeckite) or sodic pyroxenes (aegirine) are present as its ferromagnesian minerals. Syenite differs from granite in the lack of quartz, which always makes up less than 5% of the rock. It becomes a quartz-syenite if quartz is present beyond this limit. Alternatively, nepheline rather than quartz may be present in amounts up to 5%, beyond which the rock becomes nepheline-syenite.

2.1.2.2. Mineral potential

The mineral potential of the area is closely related to the geological systems. The Bushveld Igneous Complex, especially in it periphery, contains significant mineral deposits including Platinum Group metals, tin, chromium and granite.

Iron ore occur in the Transvaal Supergroup in the vicinity of Thabazimbi and extensive coal reserves occur in the layers of the Karoo Super Group (both between Lephalale and the Botswana border and in the Nylsvley area where there are several new applications for mining).

2.1.3. Landscape

2.1.3.1. The Waterberg Plateau

The Waterberg Plateau lies to the north of the Bushveld Basin, where it forms a highland area. The highest part of the area is in the south. Kransberg in the south-west towers out above the Limpopo Plain at the foot of the cliff-like escarpment made up of Waterberg Sandstone.

In the south-east the edge of the plateau is also precipitous in the Sand River Mountain and the Hangklip Escarpment. The plateau surface declines gradually to the west, where a well-defined escarpment overlooks the peneplain[3] of the Upper Limpopo Valley. The surface of this area is uneven but its general character is that of an undulating plateau surface with rocky outcrops and thin sandy soils. Most of the surface is covered by grass or bush, but the veld is mostly sour and there are very few areas suitable for cultivation. The case is however different in the river valleys. Although the valley soils are exceedingly sandy, the rivers are generally perennial and large areas of riparian[4] land are irrigable. The Mogol (Sand), Mokgalakwena and Palala Rivers forms the largest of these valleys. Most of the rural population in the area is located in these well-watered strips.

Roughly parallel with the eastern and southern edge of the Waterberg Plateau there are two irregular ridges formed by the Rooiberg felsite and the Bushveld granites. Topographically these ridges form the transition between the Waterberg Plateau and the Bushveld Basin, forming terrace steps from the one to the other.

Although the Waterberg geological formation continues across the Mokgalakwena River northwards to the Blouberg, the surface is so warn down that topographically it

[3] **Peneplain** means a more or less level land surface representing an advanced stage of erosion undisturbed by crustal movements.
[4] **Riparian** means of, or relating to the banks of a natural course of water.

should rather be included in the Limpopo Valley. The surface is not as flat as on the granite further to the north-west, but neither is it truly plateau country. It may perhaps best be considered a transitional area between the Waterberg Plateau and the Limpopo Peneplain.

2.1.3.2. The Transvaal Plateau Basin

The Transvaal Plateau Basin results primarily from the formation of Bushveld lopolith. The region therefore falls naturally into two subdivisions, the basin floor and the periphery.

The surface features of the floor are closely related to the geology. The outer margin of the floor is predominantly flat but forms a discontinuous line of koppies and ridges where it is highly mineralised near its inner margin.

A significant part of the floor of the basin is covered in with horizontal Karoo shales, sandstone and lava (also bearing coal). This area is commonly known as the Springbok Flats, renowned for the fertility of its black clay soils. Unfortunately the rainfall in the area is too low and irregular to take full advantage of the soil. Agriculture is therefore mostly limited to areas that can be irrigated.

2.1.3.3. The Pietersburg Plain

A small part of the Pietersburg Plain lies to the east of the Waterberg Plateau. It is almost entirely a granite surface similar in rock structure to the Limpopo Valley. It is essentially a region forming part of the great South African Plateau but it lies at a lower level than the adjacent highlands and can therefore hardly be called a plateau.

2.1.3.4. The Limpopo Depression

The Limpopo Depression (valley) is a flat plain that lies in a broad depression. Physiographically the floor of the depression is a plain cut mainly in Old Granite. The sequence of events that formed the depression included a post-Waterberg uplift of the surface, the subsequent deposition of Karoo beds, transgressing the Waterberg in the South and the Old Granites in the north. In post-Karoo times the area was subjected to tensional stresses, which resulted in generally northwards sagging. It seems probable that the depression originated in these dislocations and that its extent was limited in the south by the Waterberg beds. To the north however there were no resistant formations that assisted erosion of the relatively soft granite.

Vegetation in the region is bushveld with sweet grassland forming nutritious if sparse grazing. The low and variable rainfall, however, inhibits almost any kind of land utilisation except grazing of the most “extensive” type.

2.1.3.5. Terrain morphology and areas with special character

From the description above it is clear that the landforms in the area are dominated by the Waterberg Plateau. A morphological description of landscape of the area is depicted on Map 5: Terrain Morphology contains the following morphological classes:

- High mountains and hills;
- Mountains and hills;
- Hills;
- Parallel hills;
- Enclosed plains;
- Undulating plains;
- Incised river valleys and hills;
- Terrace;
- Escarpments;
- Large open plains;
- Plateau;
- Table-lands;
- Lowlands with hills.

The Waterberg plateau has an overall character that despite the development of numerous lodges and disturbances such as landing strips still maintains a wilderness character. Similarly the wide open bushveld plains of the Limpopo Peneplain represent a special South African bushveld character. This area of pristine bushveld and small sleepy towns makes for a special character not found elsewhere in South Africa. This character is one of the key selling points that the tourism sector employs in their marketing strategy.

The escarpment is a unique feature of the Waterberg District. It is a valuable natural asset that has a lot of potential especially in the tourism sector. The valleys from which the escarpment can be viewed as well as the escarpment itself should be protected in

some way to ensure that no development takes place there that could affect the character or sense of the place in a negative fashion.

The following morphological features are especially important from a “sense of place” perspective:

- The escarpment as the main topographical feature in the area;
- The enclosed plains from which the escarpment and other surrounding mountains can be viewed;
- The incised river valleys and hills where the wilderness experience is exemplified by the surrounding feeling of enclosure; and
- The high mountains, mountains and hills that give the Waterberg District its distinct visual character.

The maintenance of these landscape features is as important from a conservation perspective as sensitive biological features that should be maintained to ensure the long term ability of the landscape to attract tourist to the area.

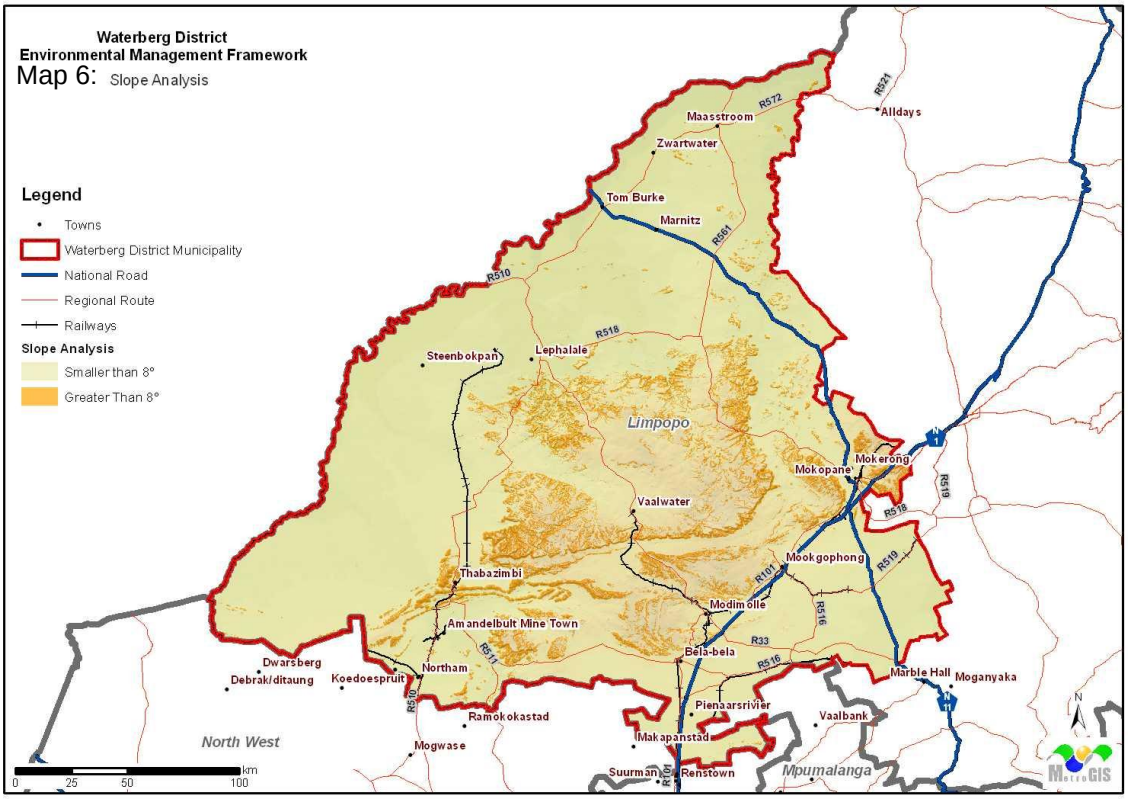
The main treats to the landscape is:

- Open cast mining;
- Metallurgical industries associated with mining;
- Development of large inappropriate resort areas that does not take adequate account of the landscape; and
- The development of landing strips all over the place.

Map 5: Terrain morphology

Steep slopes

Steep slopes are inherently sensitive to change. In keeping with current developments in the EIA policies in the country steeps slopes have been identified in the area. The occurrence of steep slopes in EMF area is depicted on Map 6: Slope Analysis.



2.1.4. Soil types

2.1.4.1. Red-yellow Apedal, freely drained soils (Map Unit Aa to Ai)

This area is dominated by red and yellow soils without water tables belonging to a range of soil forms that have Red Apedal, Yellow-Brown Apedal and red and yellow-brown Neocarbonate B-horizons (lime containing). The categories are as follows:

- **Ab (red, dystrophic and/or mesotrophic):** yellow soils occupy less than 10% of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils;
- **Ac (red and yellow dystrophic and/or mesotrophic):** indicates land with red and yellow soils each of which covers more than 10% of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red and yellow apedal soils;

- **Ad (yellow, dystrophic and/or mesotrophic):** red soils occupy less than 10% of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils;
- **Ae (red, high base status, > 300 mm deep, no dunes)**;
- **Af (red, high base status, > 300 mm, with dunes):** Dunes refer to a regular rather than a single or occasional occurrence;
- **Ag (red, high base status, < 300 mm deep);** and
- **Ah (red and yellow, high base status):** indicates land with red and yellow soils each of which covers more than 10% of the area while high base status soils occupy a larger area than red and yellow apedal dystrophic and/or mesotrophic soils.

Table 1: Broad land types for the Waterberg District Municipality area

Broad Land Type	Area (ha)	Area (%)
Ab	26 878	0.54%
Ac	396 813	8.01%
Ad	94 988	1.92%
Ae	1 463 207	29.52%
Ag	48 52	0.10%
Ah	489 398	9.87%
Ba	84 134	1.70%
Bb	400 380	8.08%
Bc	145 708	2.94%
Bd	251 557	5.08%
Ca	58 388	1.18%
Dc	14 637	0.30%
Ea	400 041	8.07%
Fa	389 489	7.86%
Fb	68 014	1.37%
Fc	173 312	3.50%
La	45 035	0.91%
Lb	448 275	9.04%
Lc	78	0.00%
Total	**4 956 092**	**100%**

2.1.4.2. Plinthic Catena: Upland duplex and margalitic soils rare (Map Unit Ba to Bd)

Unit **Ba** indicates land in which red and/or yellow apedal soils (Hutton, Bainsvlei, Avalon, Glencoe and Pinedene forms) that are dystrophic and/or mesotrophic predominate over red and/or yellow apedal soils that are eutrophic, and in which red soils (mainly Hutton and Bainsvlei) occupy more than a third of the area. The same rule, with appropriate adaptation, applies to units **Bb** (dystrophic and/or mesotrophic, red soils not widespread), **Bc** (eutrophic, red soils widespread) and **Bd** (eutrophic, red soils not widespread).

2.1.4.3. Plinthic Catena: Upland duplex and margalitic soils common (Map Unit Ca)

Unit **Ca** indicates land that qualifies as a plinthic catena (see discussion on map units **Ba** – **Bd**) but which has, in upland positions, margalitic and/or duplex soils (see discussion on map units **Ba** – **Bd**) that together cover more than 10% of the total area.

2.1.4.4. Duplex soils dominant (Map Unit Da to Dc)

Map unit **Dc** indicates land that qualifies for inclusion in D but, in addition to the duplex soils, more than 10% of the land type is made up of soil forms that have one or more of the following diagnostic horizons: vertic, melanic, red structured.

2.1.4.5. One or more of: Vertic, melanic, red structured diagnostic horizons (Map unit Ea)

This unit indicates land with high base status, dark coloured and/or red soils, usually clayey, associated with basic parent materials. A land type, more than half of which is covered by soil forms with vertic, melanic and red structured diagnostic horizons, qualifies for inclusion in unit **Ea** provided it does not qualify for inclusion in units A, B or C. Land types in which these soils cover less than half of the area may also qualify for inclusion (i) where duplex soils occur in the non-rock land but where unit **Ea** soils cover a larger area than the duplex soils, or (ii) where exposed rock covers more than half the land type.

2.1.4.6. Glenrosa and/or mispah forms (other soils may occur) (Map Units Fa – Fc)

This group of map units is intended to accommodate pedologically young landscapes that are not predominantly rock and nor predominantly alluvial or aeolian and in which the dominant soil-forming processes have been rock weathering, the formation of

Orthic topsoil horizons and, commonly, clay illuviation, giving rise typically to Lithocutanic horizons. The soil forms that epitomise these processes are Glenrosa and Mispah. However, exposed rock and soils belonging in almost any of the other 39 soil forms may be found in these land types, provided these other soils do not qualify the land for inclusion in another map unit. Shallow and deep soils of the Oakleaf form (usually on upland sites) developed by rock weathering (e.g. gneiss, aeolianite etc.) are accommodated here. **Fa** refers to land in which lime in the soil is not encountered regularly in any part of the landscape. **Fb** indicates land where lime occurs regularly (there need not be much of it) in one or more valley bottom soils. **Fc** refers to land where lime occurs regularly (there need not be much of it and it need not occur in every soil present) in upland and valley bottom soils. Lime has been used as an indicator of the extent to which youthful landscapes have been leached. Occasionally landscapes are encountered without lime but with accumulations of soluble salts in the soil; these have been included in **Fb** or **Fc** as the case may be.

2.1.4.7. Miscellaneous land classes (map units La – Lc)

La refers to land types with a soil pattern difficult to accommodate elsewhere, at least 60% of which comprises pedologically youthful, deep (more than 1 000 mm to underlying rock) unconsolidated deposits. Common soil forms are Dundee and Oakleaf. L**b** indicates land types with exposed rock (exposed country rock, stones or boulders) covering 60 – 80% of the area. L**c** refers to land types with exposed rock (exposed country rock, stones or boulders) covering more than 80% of the area. The rocky portions of **Ib** and **Ic** may be underlain by soil which would have qualified the unit for inclusions in another broad soil pattern were it not for the surface rockiness.

2.1.5. Land capability data for dryland agriculture

The land capability data for the investigation area is presented on Map 7 and the total areas are provided in Table 2.

Table 2: Land capability and areas for the Waterberg District Municipality

Land Capability Category	Area (ha)	Area (%)
High Total	114323	2.31%
Moderate - High Total	2055032	41.51%
Moderate Total	951309	19.22%
Low - Moderate Total	1746760	35.28%
Low Total	8302	0.17%
Permanently transformed Total	75106	1.52%
Total	**4950831**	**100.00%**

Map 7: Land capability data for dryland agriculture

2.1.6. Interpreted soils data of the Waterberg District Municipality

Soils in the Waterberg District Municipality are very varied and diverse. Specific landform soil zones have already been identified in this area with their physical characteristics such as geology, soils, vegetation outlined including some indications of development potentials and limitations. Natural land type surveys conducted by the land survey staff of the Agricultural Institute for Soil, Climate, and Water (ARC – ISCW) in South Africa since the early seventies are the sources of generalised baseline soil information. Five major soil associations have therefore been identified in accordance with the existing landscape soil relations already perceived in the Waterberg District Municipality area. These are:

2.1.6.1. Weakly developed soils on mountainous catchments, uplands and rocky areas

These consist of Glenrosa or Mispah soil forms or patterns derived from sandstone and quartzite. They are characterised by topsoil that overlies rock or partly weathered rock with or without lime. They are found in the central parts of the district roughly extending eastwards. They therefore tend to be rocky or gravelly, with shallow, loamy sand soils that are acidic and therefore generally unsuitable for arable farming.

2.1.6.2. Dystrophic, red and yellow, freely draining sandy soils

These soils consist of Clovelly and Hutton soil forms or patterns which are highly leached and erodible sandy and/or sandy loams derived from sandstone and quartzite. They tend to be acidic soils of low fertility found in the high rainfall areas of on mountain slopes and foothills. As such, they generally have limited value as arable land but are suitable for afforestation.

2.1.6.3. Plinthic upland duplex and paraduplex soils on undulating middleveld, rugged terrain

The soils are many soil forms or patterns along the catena which can be dystrophic and/or mesotrophic, sandy soils derived from sandstone quartzite and shale. They are generally characterised by topsoil that is distinct from sub-soil with regard to texture, structure and consistency. Major occurrences are roughly towards the eastern side. They are generally utilised as arable land but the risk of erosion is rather high.

2.1.6.4. Red, yellow, apedal freely draining in flat areas

These are the most commonly occurring soils which occupy about 35 to 40% of Waterberg District Municipality with a variety of soil forms or patterns. Clovelly form is most common. The soils are derived from sandstone, quartzite and shale. As a result the soils tend to be dystrophic and/or mesotrophic, sandy and /or loamy soils in the 600 - 800 mm rainfall areas found in the district on flat landscapes. They are suitable for arable farming.

2.1.6.5. Lowland, flood plain, hydromorphic, black and red clay soils on poorly drained sites

Rensburg and Acardia soil forms or patterns are the most common ones in these areas. They are eutrophic with high clay content and thus high base status soils with varying amounts of rock and lithosol, found in localised, poorly drained, low lying or flat areas. These soils are very fertile but difficult to work and very limited in their distribution usually in wetlands or other similar areas prone to seasonal inundation.

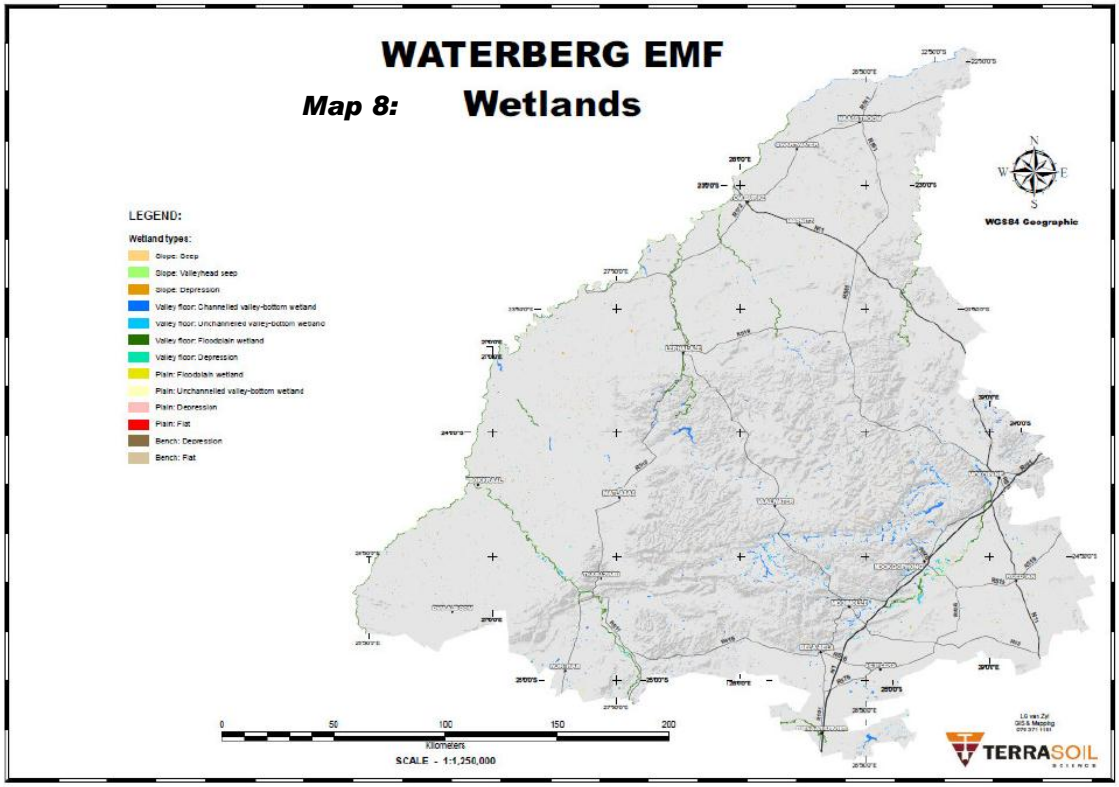
2.1.6.6. Agricultural potential

The agricultural potential of the area is intimately associated with topographical, pedological (soil) and climate determinants. As a general trend the potential for dryland cropping decreases with the rainfall distribution from south to north and west to east. Soil factors do play a role in that shallow, sandy and very high clay content soils also lead to a slight reduction in potential due to a decreased water storage / plant water supply capacity. Threats to this aspect of the land include erratic rainfall and high input costs. This is evident in the number of fields that have been cleared of bush but that are only covered in grass or encroaching bush at the moment. A component of the high input cost is land value that is skewed at present through aspects such as land restitution, increased urban and mining development and foreign land ownership. The bottom line is that with increased costs (costs of inputs, cost of land, etc.) and environmental risks (erratic rainfall, soil degradation, bush encroachment) economically viable crop production options are diminishing.

2.1.7. Wetlands

The wetland data for the investigation area is presented on Map 8. It is important to note that the data was in all probability generated from aerial photographs and satellite images with some use of topographic data. The interpretation of satellite images and aerial photographs rests on the identification of wetland vegetation. In the wetland delineation guidelines as published by DWAF (2005) four wetland indicators are specified. These are:

- Vegetation;
- topography or landscape position;
- soil form and soil wetness.
- These four indicators are to be used together to provide a detailed description of wetland boundaries and functioning and it therefore follows that the wetland data provided in this report (based on vegetation and topography) cannot be used without further elucidation of soil properties on a more detailed scale.



2.1.7.1. Soils and wetlands

The distribution and extent of wetlands in the area is intimately linked to rainfall, geology, topography and soils. In the more mountainous areas dominated by sandstone and other hard rock geology wetland conditions are often expressed as

sheets or large areas of hillslope seepage areas. It is for this reason that large parts of the Waterberg can be identified as wetland. These wetlands are often temporary and dependent on rainfall events. Due to the sandy nature of the soils wetland expression is often in the form of bleached sandy soils covering large parts of the landscape.

The wetlands in the areas dominated by basic igneous geology are often valley bottom wetlands with indistinct seepage areas and wetland boundaries are more abrupt. This is due to the degree of expression of wetness in these soils. A detailed description will be supplied in the detailed report.

In the flat areas to the west where rainfall also decreases the expression of wetlands is more in the form of dry drainage features or pans and structured soil areas as compared to shallower and rocky soils outside of the wetland zones.

2.1.7.2. Resource related conflict

Due to the low rainfall the main conflicts in the area are considered to be between low intensity land uses (game farming, agronomy, conservation) and high intensity land uses (urban development and mining). The nature and outcome of the conflict has far reaching implications for low intensity land uses and tourism. Tourism hinges on the natural and rural identity of the area. It is therefore imperative that dedicated land use planning be conducted for the district to ensure the sustainability of the different components (low intensity land uses / high intensity land uses / tourism).

2.2. CLIMATE

2.2.1. Introduction

The climate of the Waterberg District varies. The northern and western regions of the area experience a hot and semi-arid climate. The southern and eastern regions are more humid and slightly cooler. The Waterberg District receives summer rainfall. The area south-east of the Waterberg formation as well as the Waterberg formation itself receives more rainfall than the surrounding area. Thabazimbi receives the lowest rainfall of the recorded weather stations in the EMF area. Summer temperatures for the area are generally very warm, while winter temperatures are mild to cool.

The data used to generate the charts 1-22 has been obtained from the South African Weather Bureau.

2.2.2. Average maximum temperatures

Average maximum temperatures (degrees celsius) for Weather Stations: Thabazimbi, Lephalale (Ellisras) and Bela-Bela (Warmbaths). The following is a brief description of the information depicted in the Charts 1 to 4.

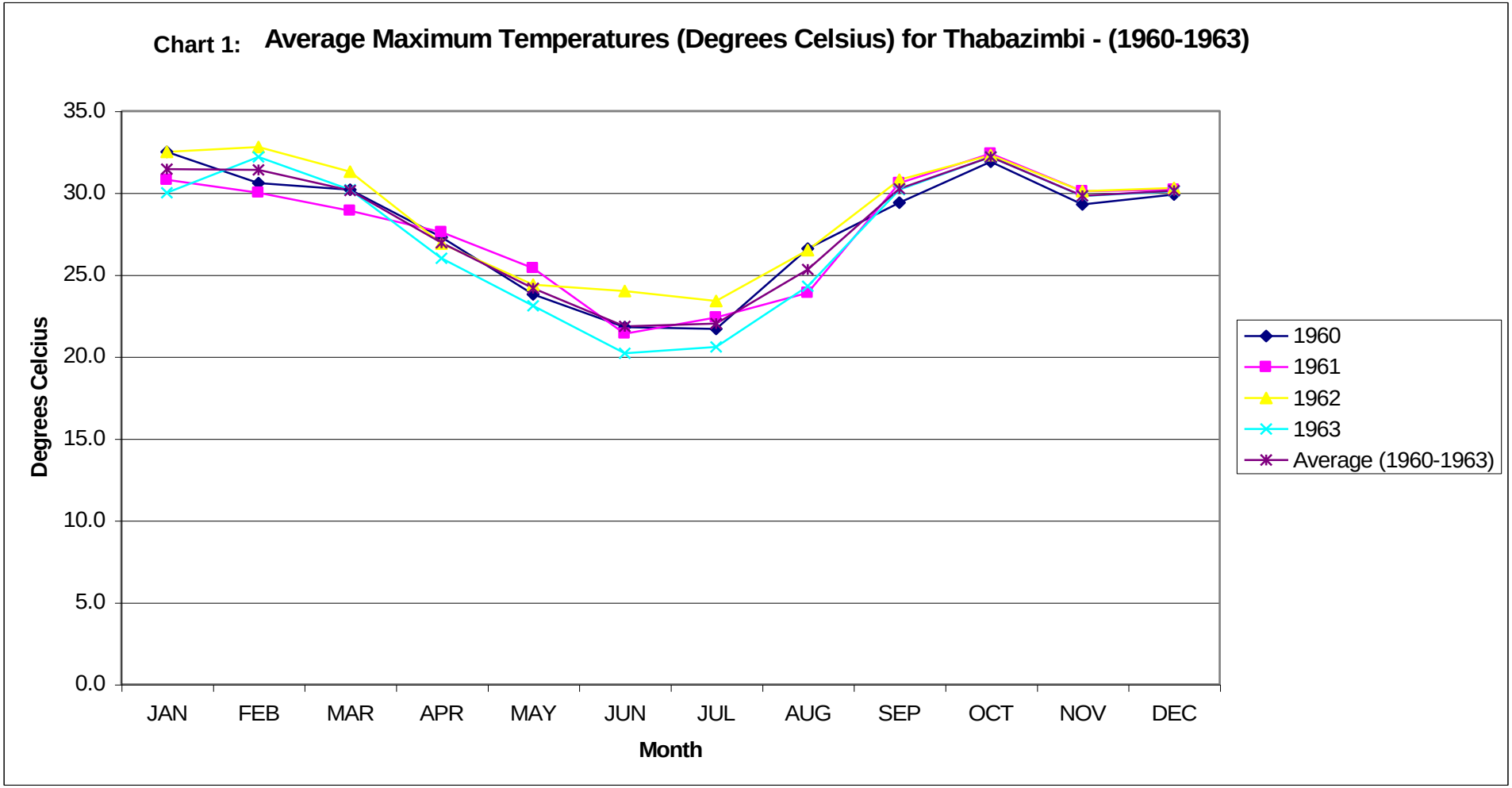
In the years 1990 and 1998 the average maximum temperatures of Thabazimbi appeared to be higher than normal. In contrast the average maximum temperatures of Thabazimbi appeared to be lower than normal in the years 1986 and 1987.

Lephalale (Ellisras) showed above average maximum temperatures in the year 2003. Spikes of the average maximum temperature being lower than the norm occurred in the years 1999, 2001 and 2007.

In Bela-Bela (Warmbaths) the years 2005 and 2007 showed higher average maximum temperatures. While in the year 1981, the average maximum temperature was noticeably lower than in most of the other years.

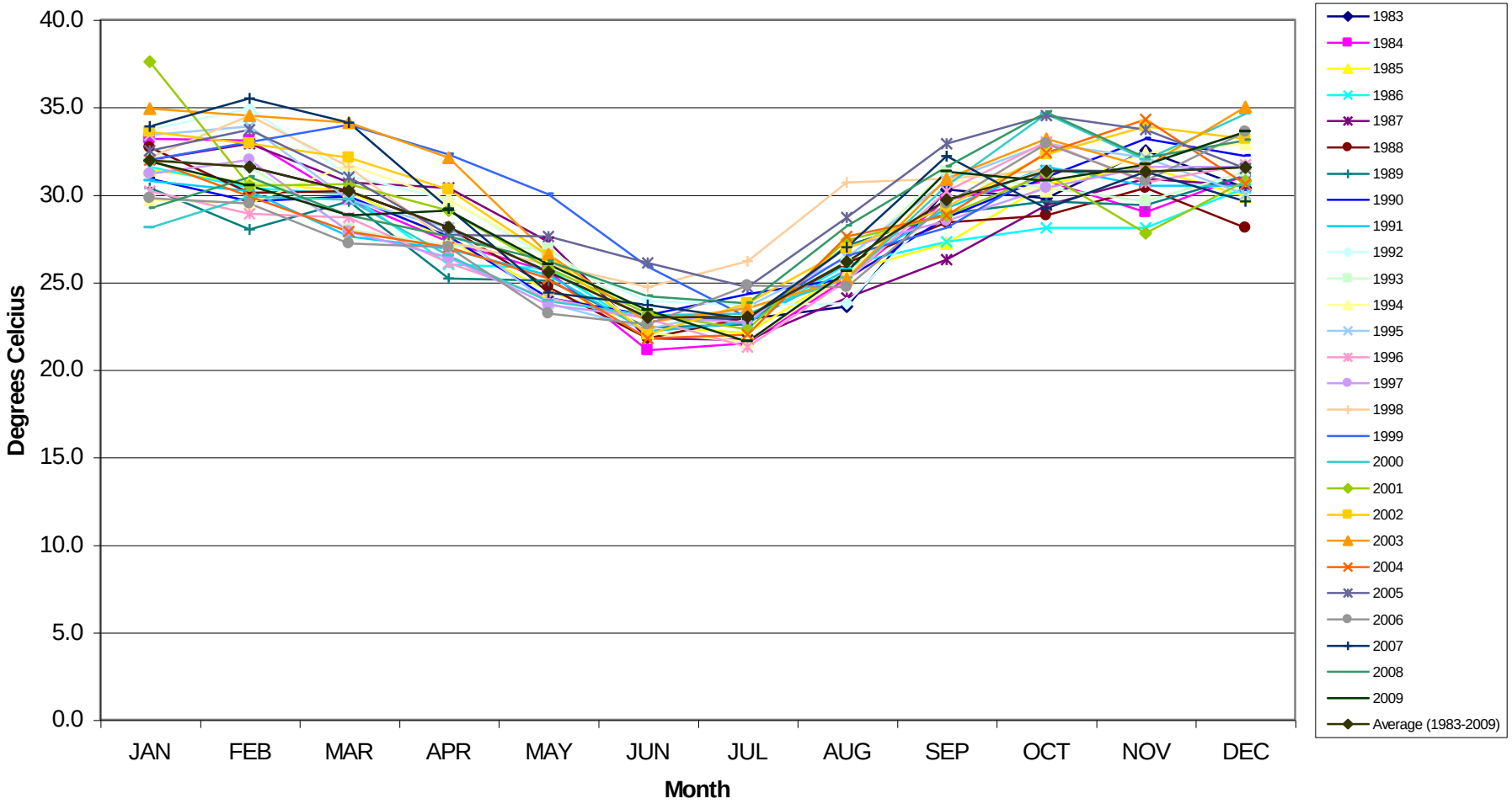
2.2.2.1. Thabazimbi - (1960 - 1963)

Chart 1: Average Maximum Temperatures (Degrees Celsius) for Thabazimbi - (1960-1963)



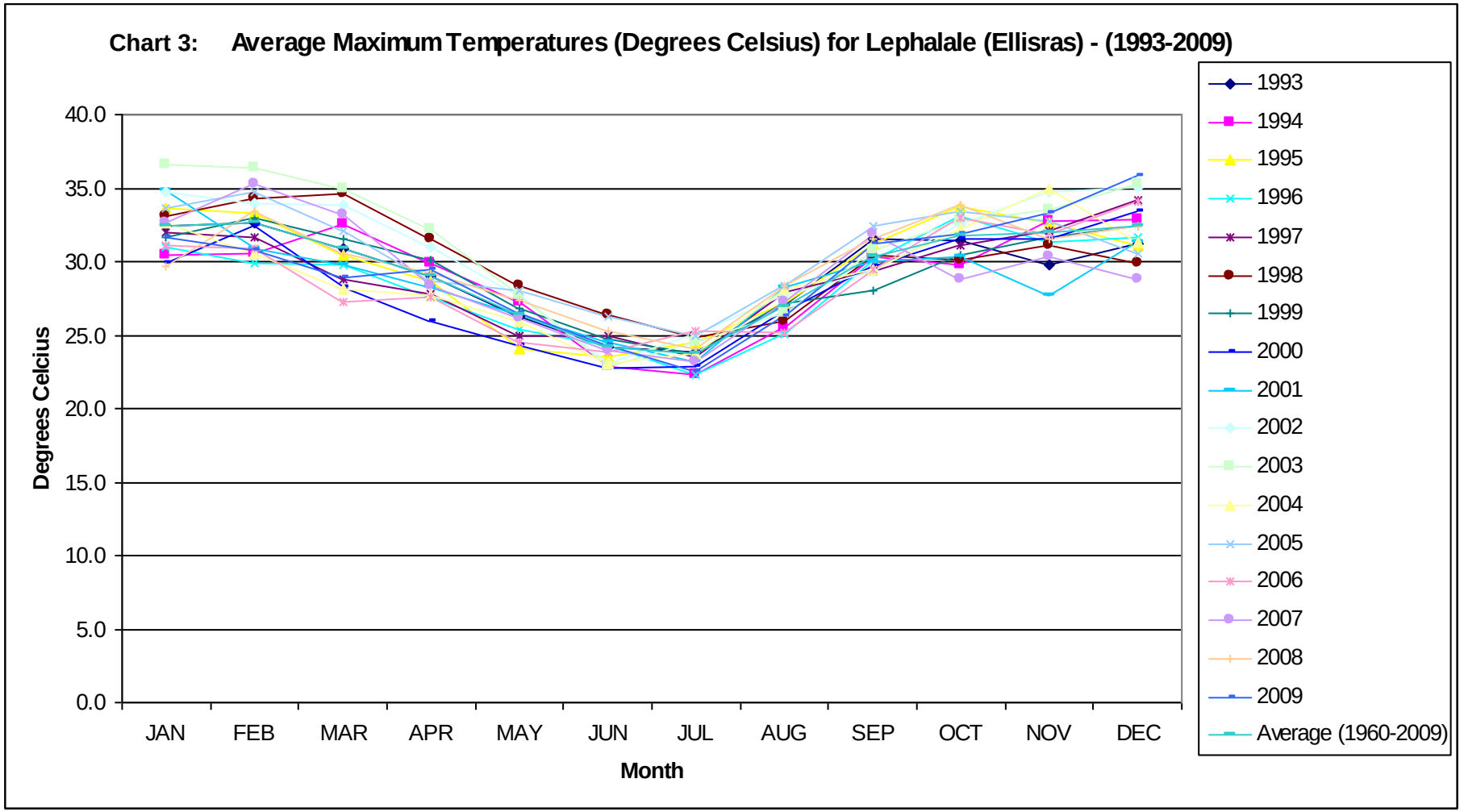
2.2.2.2. Thabazimbi - (1983 - 2009)

Chart 2: Average Maximum Temperatures (Degrees Celsius) for Thabazimbi - (1983-2009)



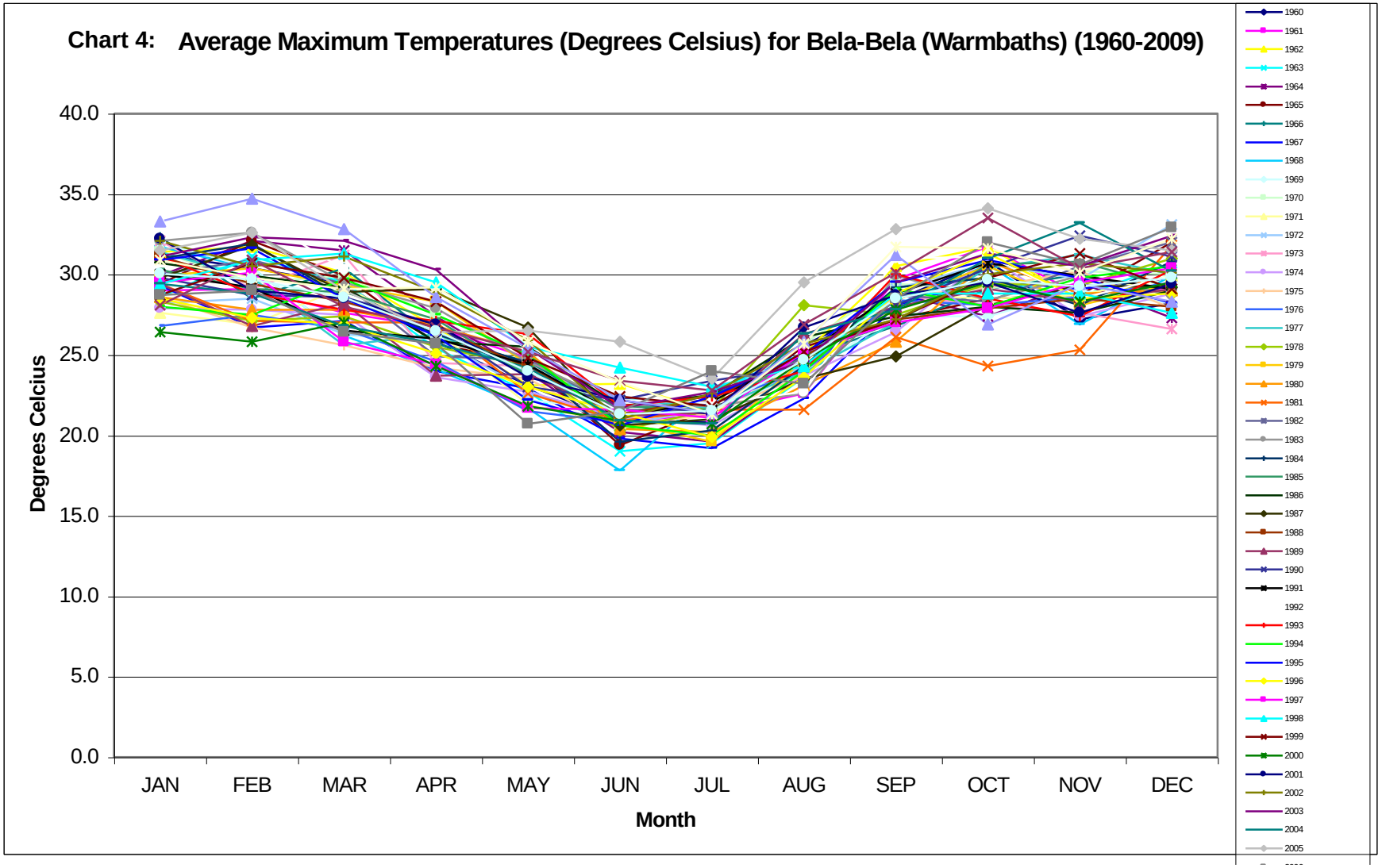
2.2.2.3. Lephalale (Ellisras) - (1993-2009)

Chart 3: Average Maximum Temperatures (Degrees Celsius) for Lephalale (Ellisras) - (1993-2009)



2.2.2.4. Bela-Bela (Warmbaths) – (1960 – 2009)

Chart 4: Average Maximum Temperatures (Degrees Celsius) for Bela-Bela (Warmbaths) (1960-2009)

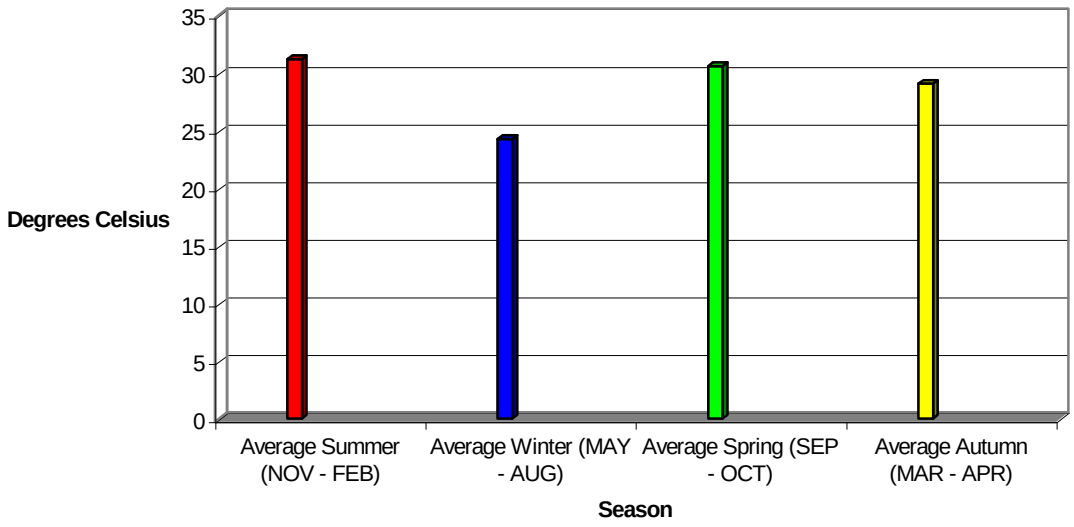


2.2.3. Average seasonal maximum temperatures

Average seasonal (maximum) temperatures (degrees celsius) for Weather Stations: Thabazimbi, Lephalale (Ellisras) and Bela-Bela (Warmbaths)

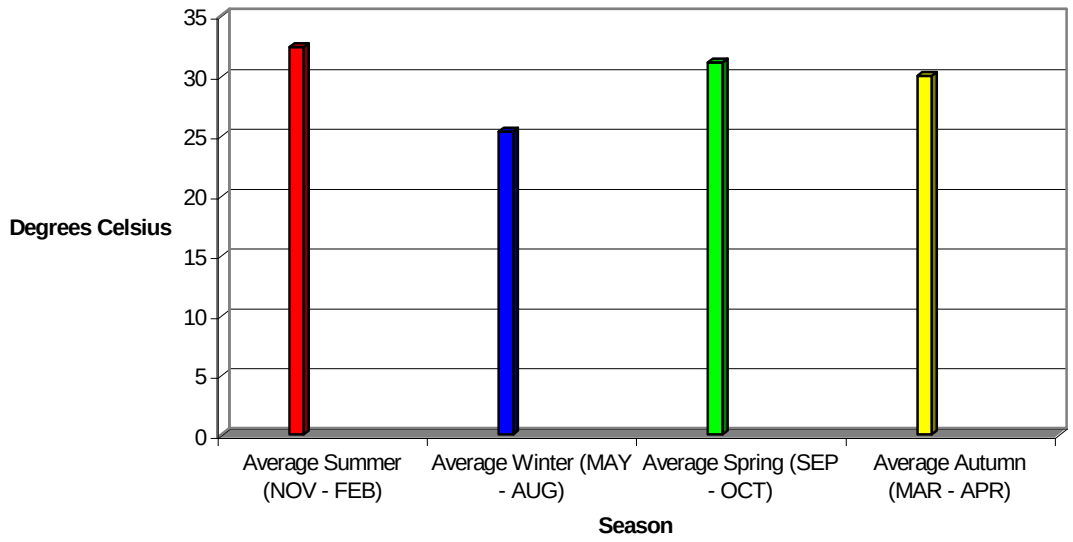
2.2.3.1. Thabazimbi - (1960-1963) and (1983-2009)

Chart 5: Average Seasonal (Maximum) Temperatures (Degrees Celsius) for Thabazimbi (1960-1963) and (1983-2009)



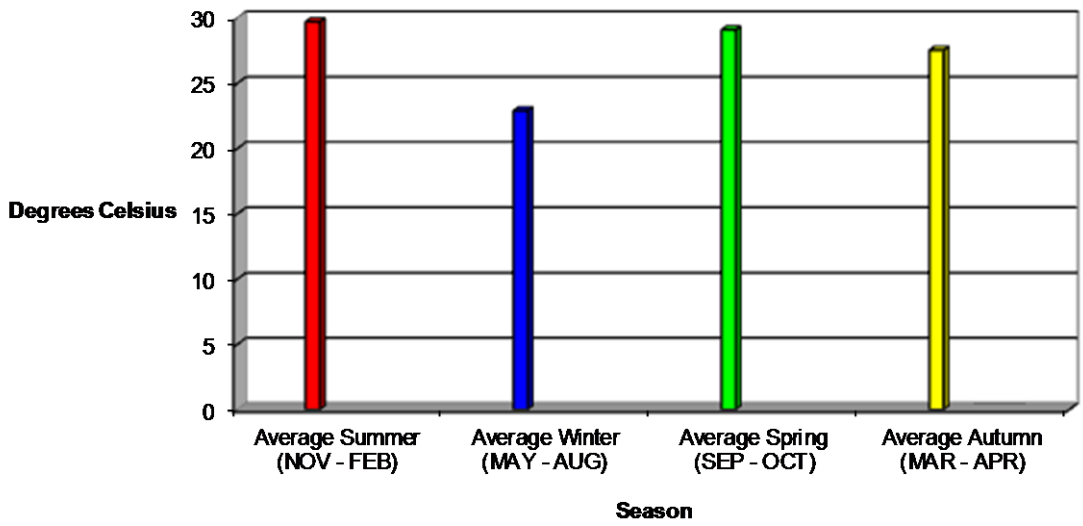
2.2.3.2. Lephalale (Elisras) - (1993-2009)

Chart 6: Average Seasonal (Maximum) Temperatures (Degrees Celsius) for Lephalale (Ellisras) - (1993-2009)



2.2.3.3. Bela-Bela (Warmbaths) – (1960 – 2009)

Chart 7: **Average Seasonal (Maximum) Temperatures (Degrees Celsius) for Bela-Bela (Warmbaths) - (1960-2009)**



See Appendix 2 for temperature (maximum) tables

2.2.4. Average minimum temperatures

Average minimum temperatures (degrees celsius) for Weather Stations: Thabazimbi, Lephalale (Ellisras) and Bela-Bela (Warmbaths). The following is a brief description of the information depicted in the Charts 8 to 11.

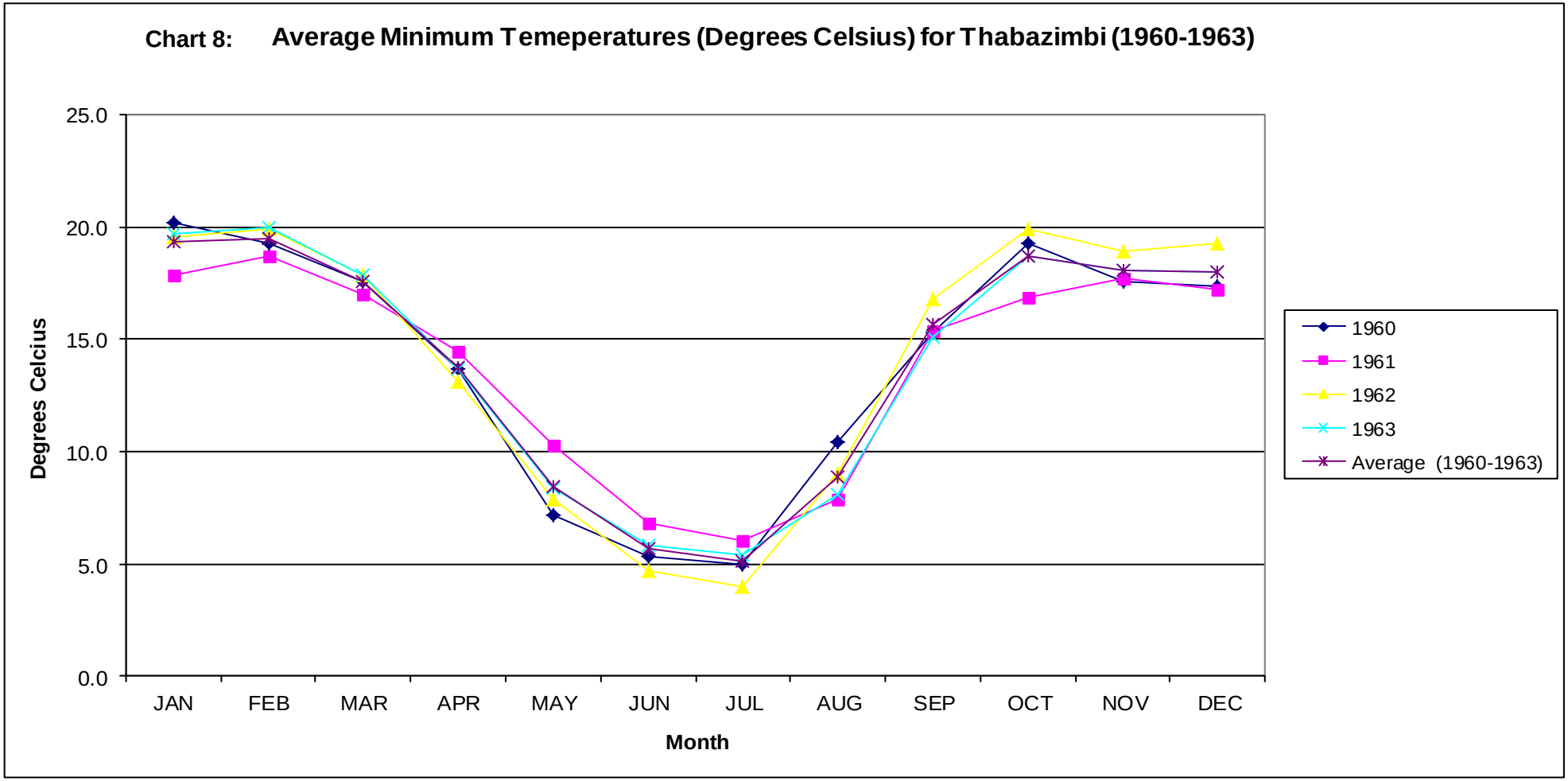
Thabazimbi experienced higher than normal minimum temperatures during the first half of 1999. While in 1994, Thabazimbi experienced a particularly cold winter, showing the lowest recorded average minimum temperatures in July. Considerable fluctuations from the average minimum for the area were experienced in 2000.

In the years 1998 and 2003, Lephalale (Ellisras) experienced higher summer minimum averages than in other years. In the year 1994 lower than normal winter minimum averages were experienced. Lephalale (Ellisras) experienced lower all round minimum averages throughout 2007.

During the winter months of 1961, Bela-Bela (Warmbaths) experienced a higher average minimum than in other years. In June 1978, the lowest average minimum temperatures were recorded. In July of 1964 and 1994, low average minimum temperatures were also experienced. Spikes in the average minimum temperature can also be observed in August 1995 and October 1981, where the temperature appears to be lower than in other years.

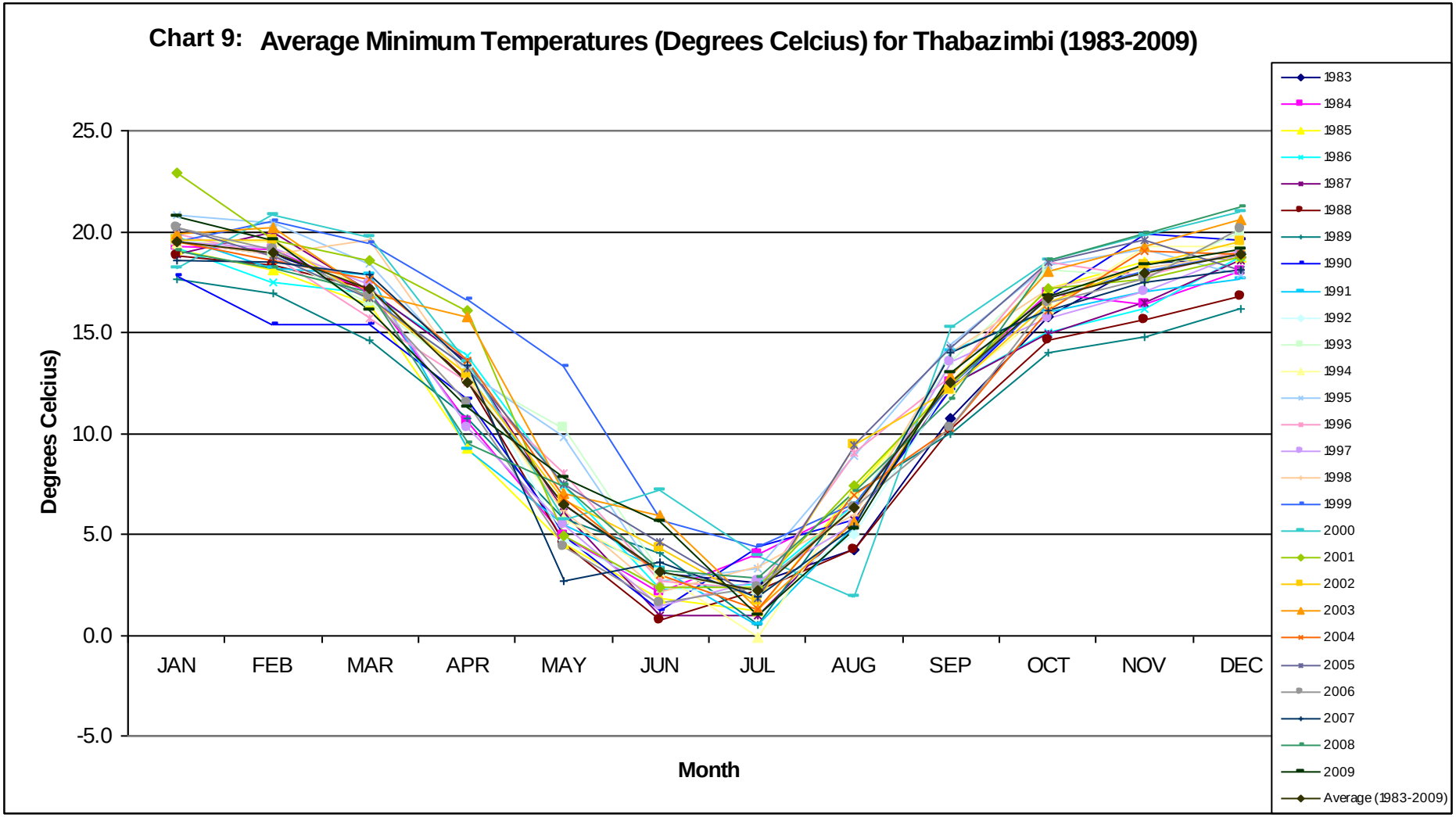
2.2.4.1. Thabazimbi - (1960 - 1963)

Chart 8: Average Minimum Temeperatures (Degrees Celsius) for Thabazimbi (1960-1963)



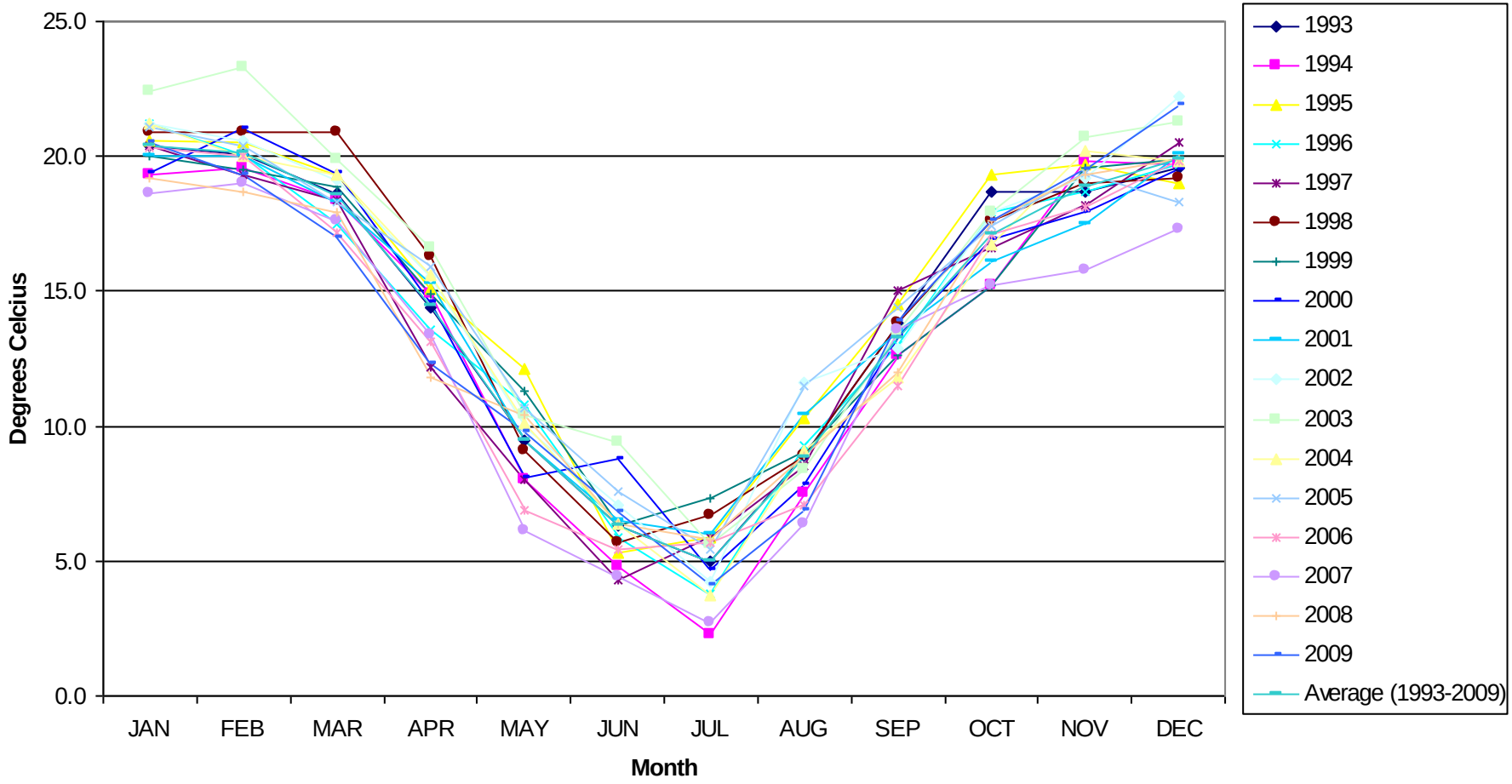
2.2.4.2. Thabazimbi - (1983 - 2009)

Chart 9: Average Minimum Temperatures (Degrees Celcius) for Thabazimbi (1983-2009)



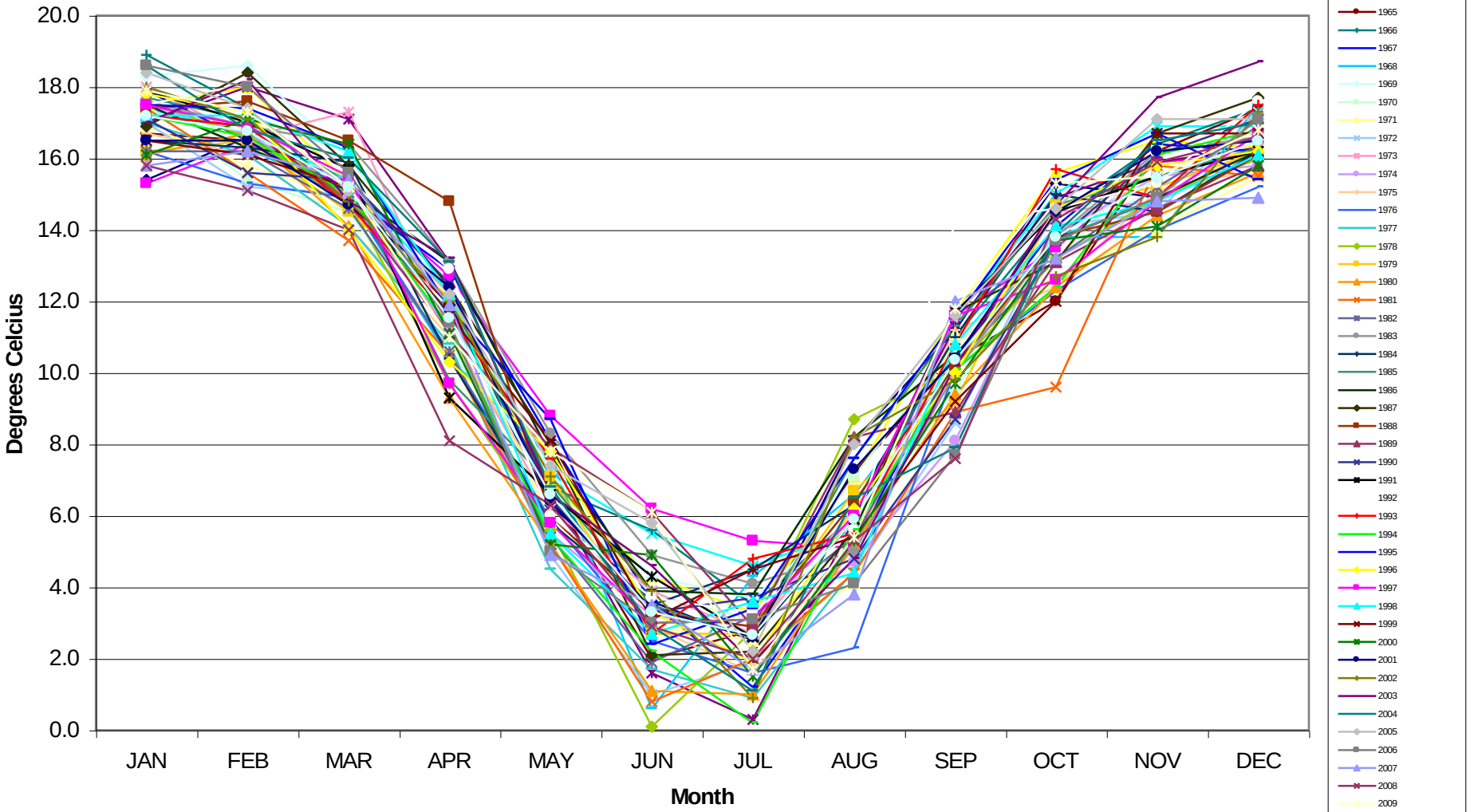
2.2.4.3. Lephalale (Ellisras) - (1993-2009)

Chart 10: Average Minimum Temperatures (Degrees Celsius) for Lephalale (Ellisras) - (1993-2009)



2.2.4.4. Bela-Bela (Warmbaths) – (1960 – 2009)

Chart 11: **Average Minimum Temperatures (Degrees Celsius) for Bela-Bela (Warmbaths) (1960-2009)**

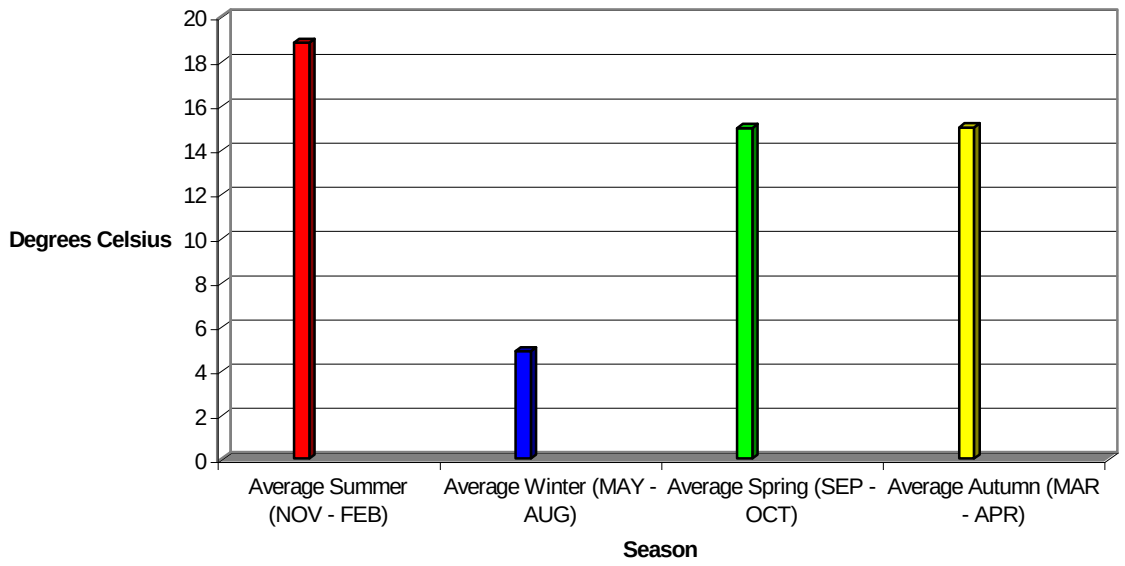


2.2.5. Average seasonal minimum temperatures

Average seasonal (minimum) temperatures (degrees celsius) for Weather Stations: Thabazimbi, Lephalale (Ellisras) and Bela-Bela (Warmbaths)

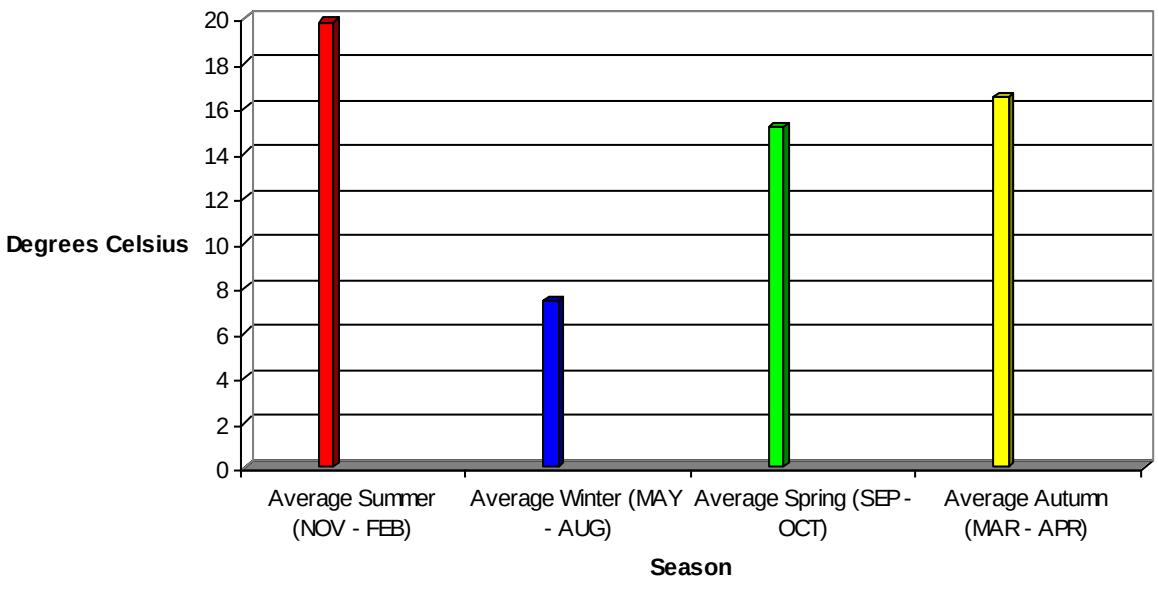
2.2.5.1. Thabazimbi - (1960-1963) and (1983-2009)

Chart 12: **Average Seasonal (Minimum) Temperatures (Degrees Celsius) for Thabazimbi - (1960-1963) and (1983-2009)**



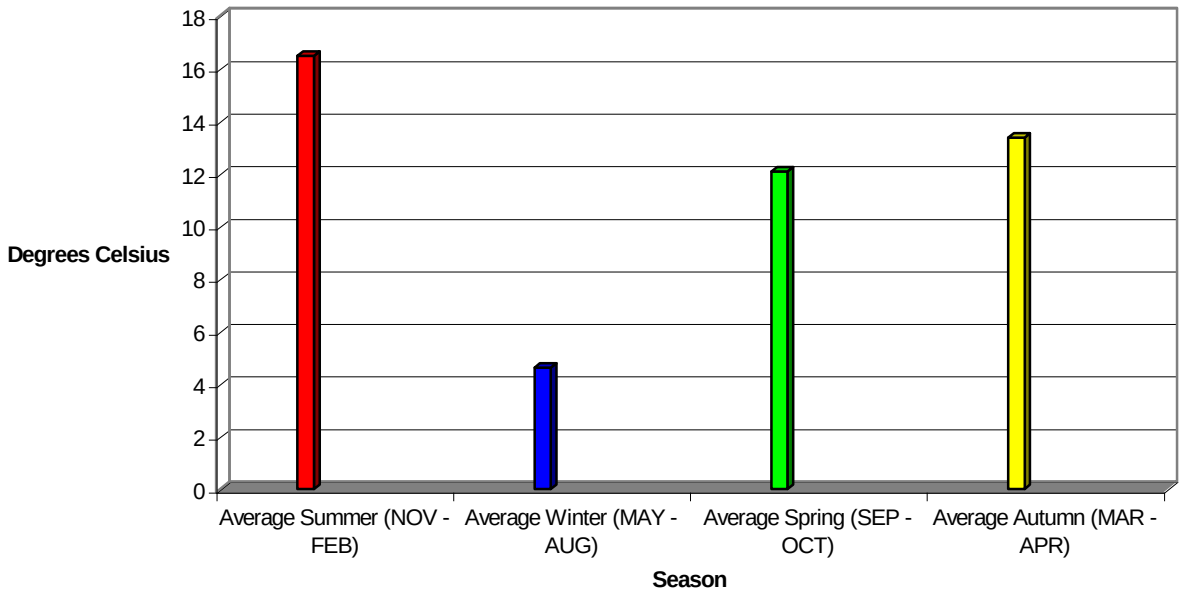
2.2.5.2. Lephalale (Ellisras) - (1993-2009)

Chart 13: **Average Seasonal (Minimum) Temperatures (Degrees Celsius) for Lephalale (Ellisras) - (1993-2009)**



2.2.5.3. Bela-Bela (Warmbaths) – (1960 – 2009)

Chart 14: **Average Seasonal (Minimum) Temperatures (Degrees Celsius) for Bela-Bela (Warmbaths) - (1960-2009)**



See Appendix 2 for temperature (minimum) tables.

2.2.6. Rainfall charts

Average yearly rainfall (mm) for Weather Stations: Thabazimbi, Lephalale (Ellisras), Bela-Bela (Warmbaths), Tom Burke SAPS, Mookgophong (Naboomspruit), Modimolle (Nylstroom), Vaalwater and Dwaalboom.

The following is a brief description of the information depicted in the Charts 15 to 22.

See Appendix 2 for the rainfall tables. Thabazimbi experienced a high average rainfall in February in the years 1983 and 1996. In March of 1991 and 2004 there was a higher average rainfall than in the other years. A similar higher average rainfall was observed in April of 1975 and 1995. High average rainfalls were also recorded in December of 1969, 1998 and 1999.

Lephalale (Ellisras) experienced higher than normal average rainfall in 2007, during the months of September and October. A higher than average rainfall was recorded for the area in January 1997, February 1996, November 2008 and December of 1998. Lephalale (Ellisras) experiences the least amount of rain during the month of August.

In 2007, Bela-Bela (Warmbaths) experienced a low average rainfall throughout most of the year. Higher average rainfall occurred throughout the years during October to April. Most notable of these spikes include, January 2008, February 1975, and December of 1986 and 1989.

Tom Burke recorded a very average rainfall for the area during January 1972 and February 2000. Several high spikes occur during the month of November the highest of which was in 1971.

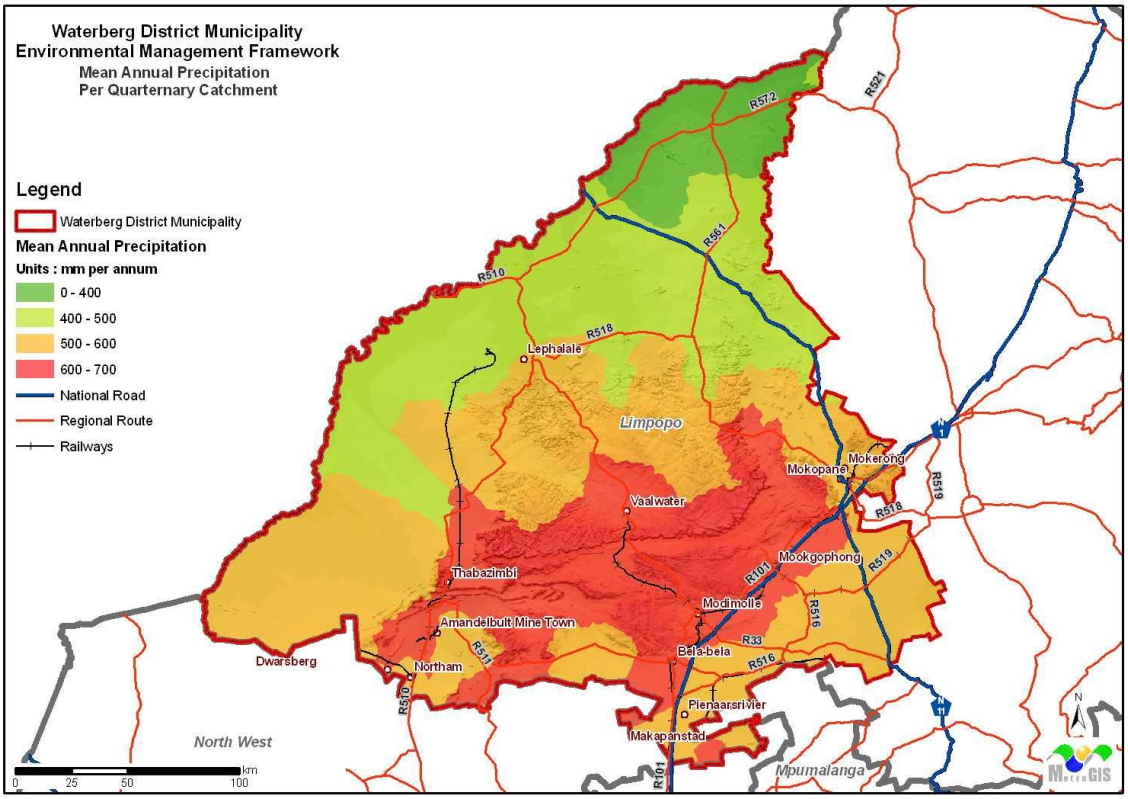
In the month of January, Mookgophong (Naboomspruit) saw a high average rainfall in the years 1975, 1978 and 1996. A high average rainfall was also recorded during the month of February in 2000. In the year 2001, a high average rainfall was recorded in the months of February and December.

Modimolle (Nylstroom) recorded a very high average rainfall in February of 1996. The month of November also shows several years in which a higher than normal rainfall was received.

Vaalwater recorded a high average rainfall in the month of January in the years 1975 and 2009. A higher average rainfall was also recorded in February 2006, March 2004 and December 1995. Unusually high winter rainfall was recorded in 1984 during the months of June and July.

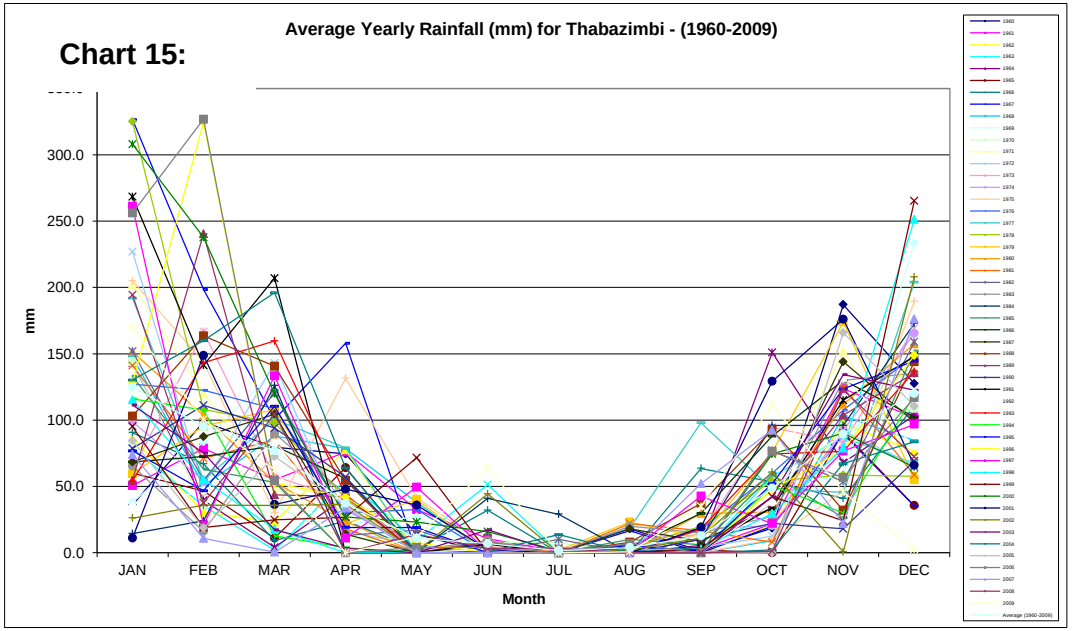
Dwaalboom experiences the lowest average rainfall for the year during the month of July. The average rainfall appears to vary somewhat during the months of October to April.

Map 9: Mean annual precipitation



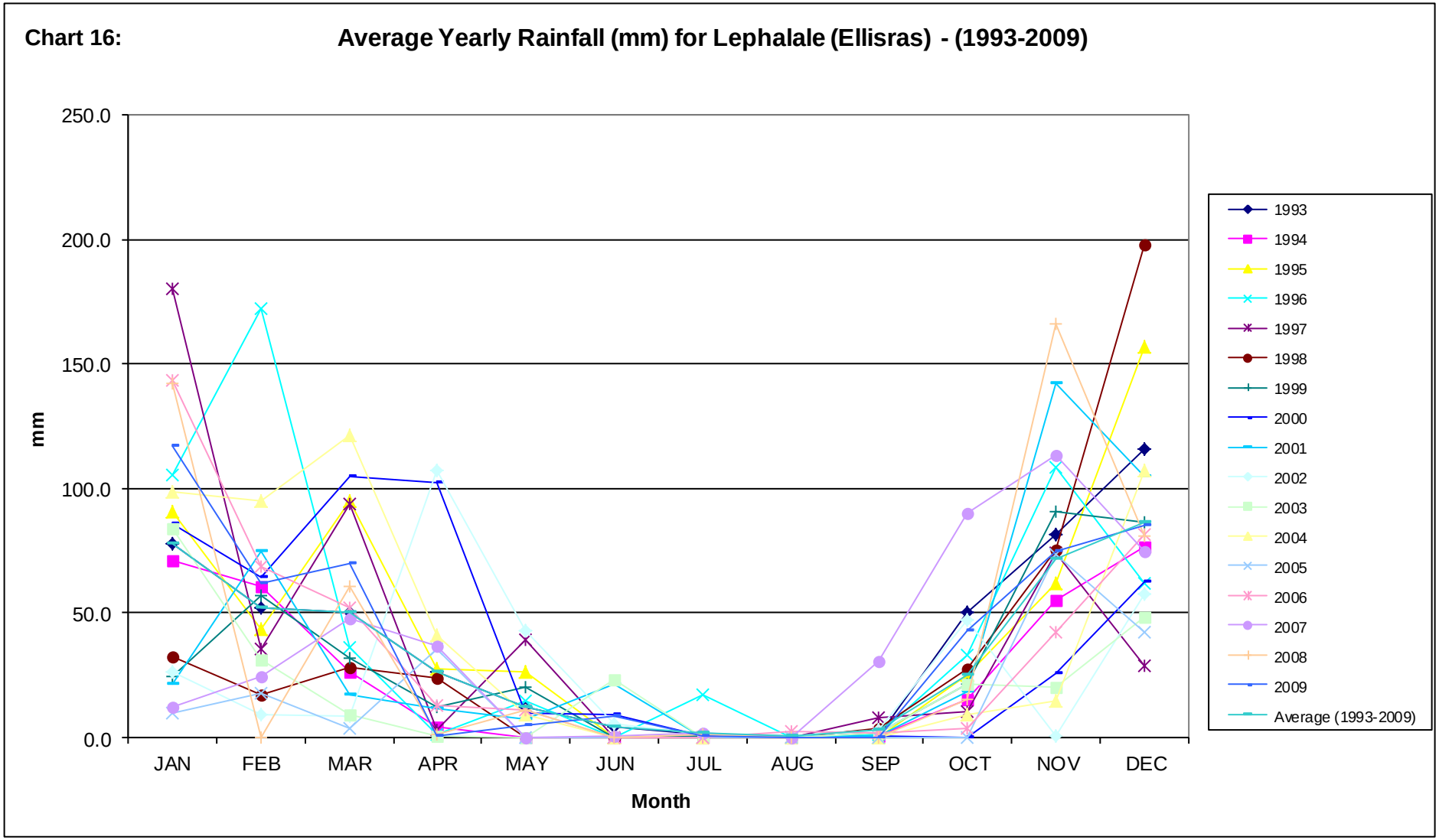
2.2.6.1. Thabazimbi - (1960 - 2009)

Chart 15:



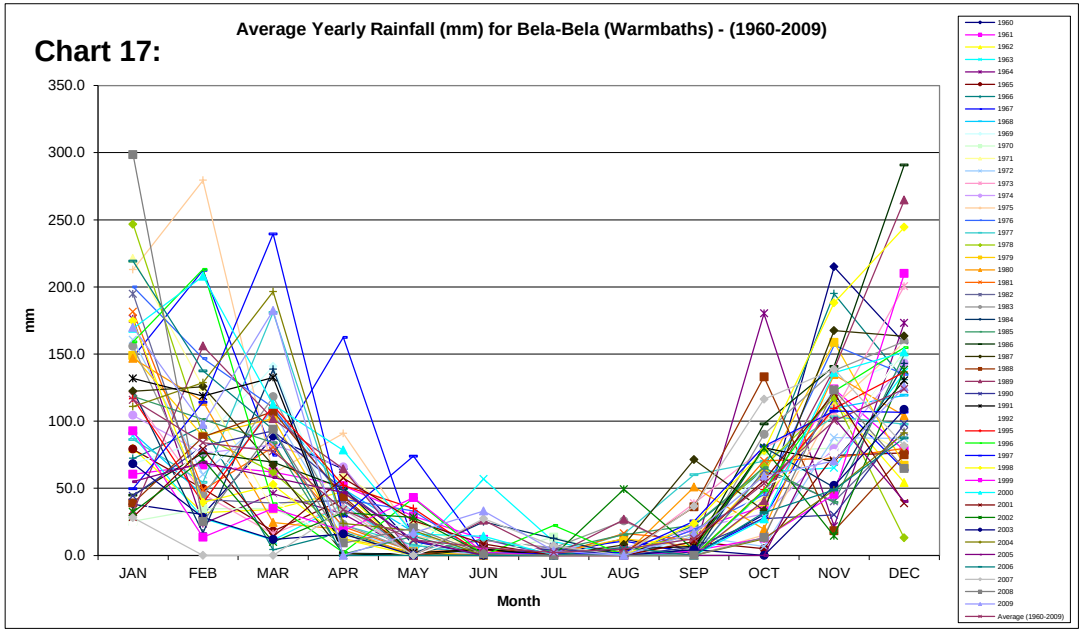
2.2.6.2. Lephalale (Ellisras) - (1993-2009)

Chart 16: Average Yearly Rainfall (mm) for Lephalale (Ellisras) - (1993-2009)



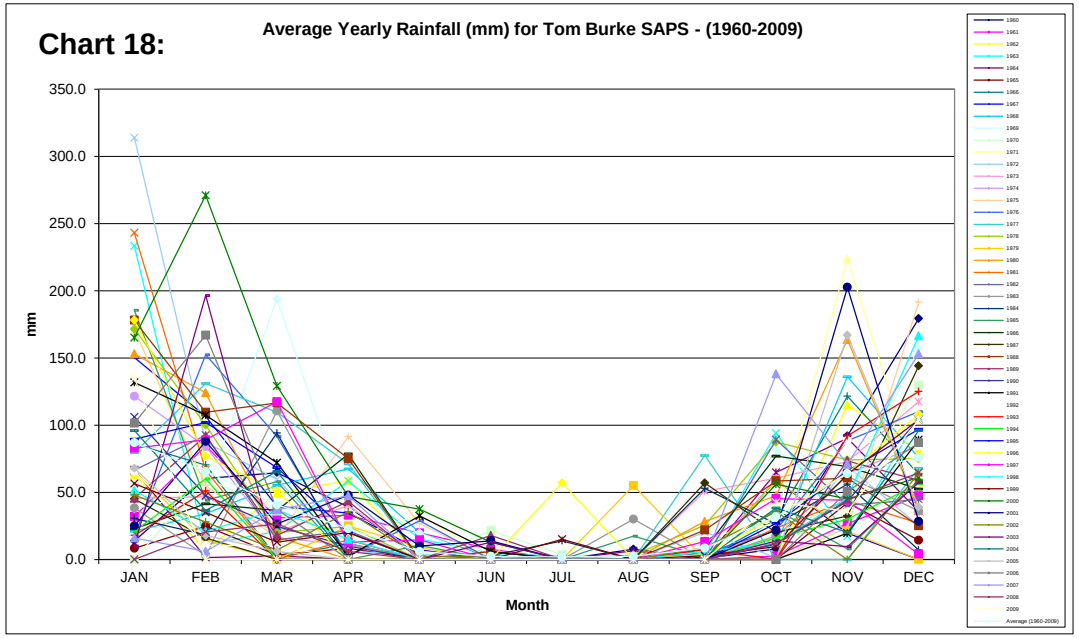
2.2.6.3. Bela-Bela (Warmbaths) – (1960 – 2009)

Chart 17:

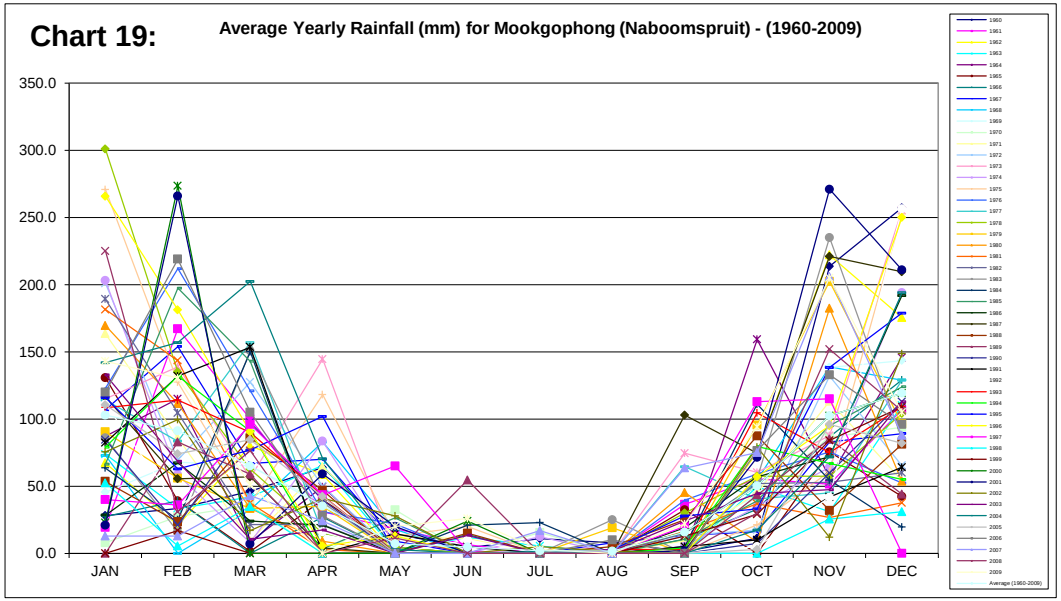


2.2.6.4. Tom Burke SAPS – (1960 – 2009)

Chart 18:

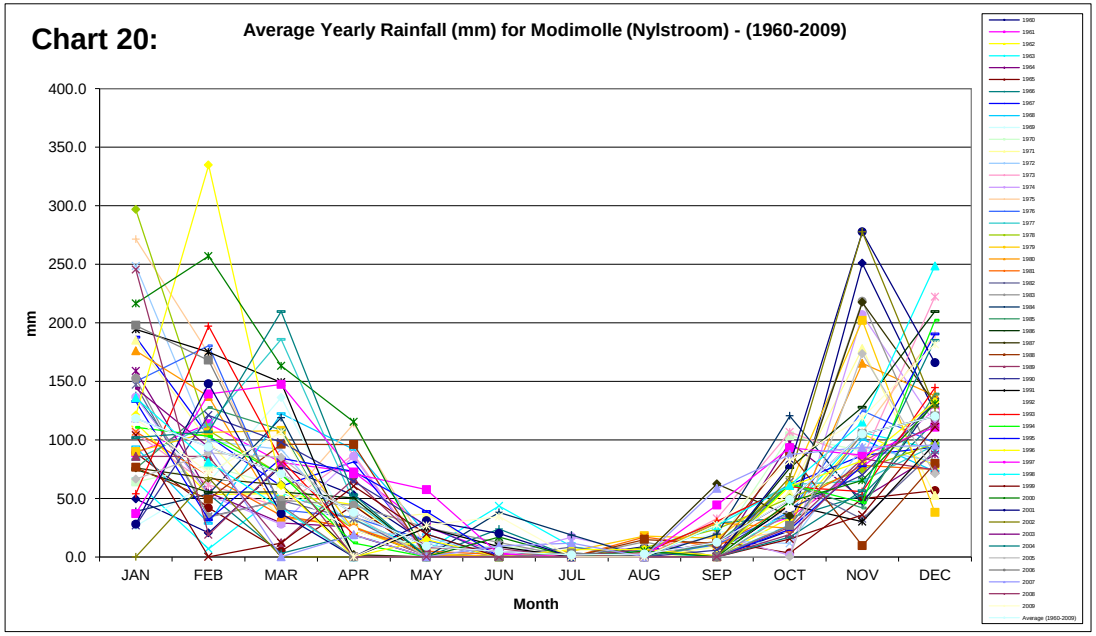


2.2.6.5. Mookgophong (Naboomspruit) – (1960 – 2009)



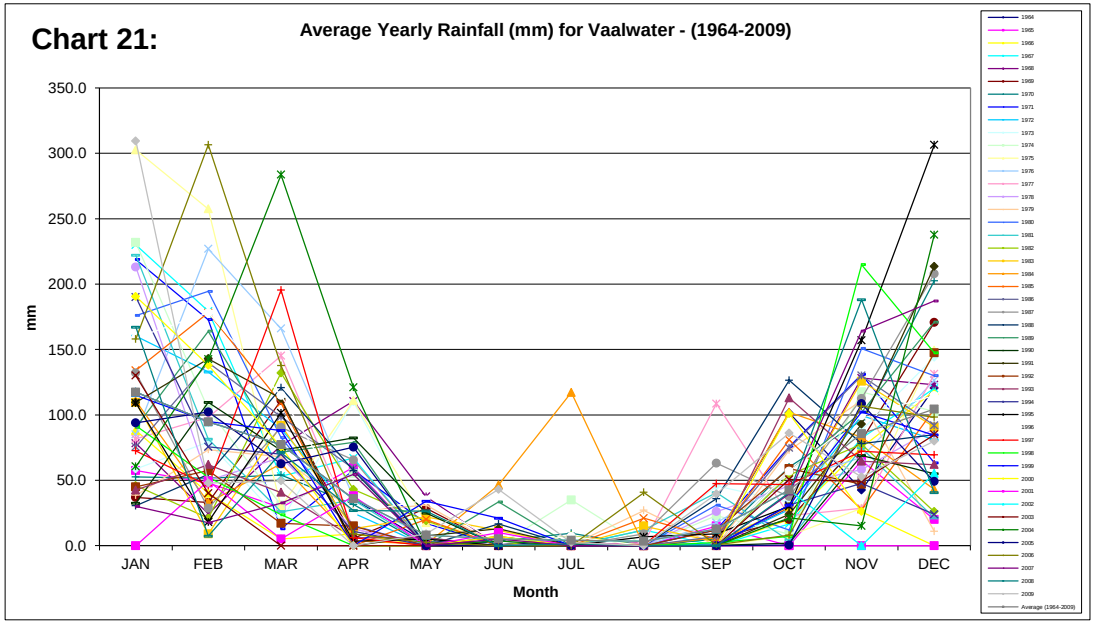
2.2.6.6. Modimolle (Nylstroom) – (1960 – 2009)

Chart 20: Average Yearly Rainfall (mm) for Modimolle (Nylstroom) - (1960-2009)



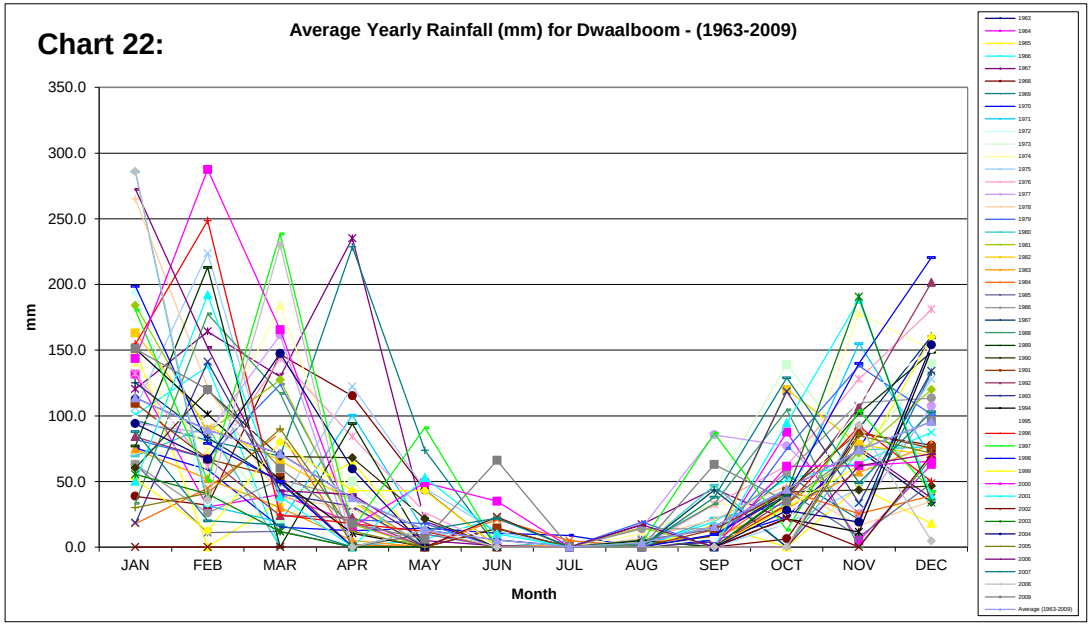
2.2.6.7. Vaalwater – (1964 – 2009)

Chart 21: Average Yearly Rainfall (mm) for Vaalwater - (1964-2009)



2.2.6.8. Dwaalboom – (1963 – 2009)

Chart 22:



2.2.7. Atmospheric conditions

2.2.7.1. Introduction

The following section has been extracted from the Waterberg District Municipality Air Quality Management Plan completed in June 2009. This extract has been used with the permission of the authors Nicola Walton and Nokulunga Ngcukana members of Gondwana Environmental Solutions (Pty) Ltd.

2.2.7.2. Meteorological overview and ambient air quality of the Waterberg

An overview of the macroscale and mesoscale atmospheric circulations influencing airflow and the subsequent dispersion and dilution of pollutants is discussed. The local meteorological conditions in the District are evaluated using surface meteorological data from weather stations operated by the South African Weather Service and the Agricultural Research Institute.

2.2.7.3. Macroscale air circulations

The mean circulation of the atmosphere over southern Africa is anticyclonic throughout the year due to the dominance of three semi-permanent, subtropical high-pressure cells over the subcontinent. Seasonal changes in the intensity and position of the high-pressure cells, together with the influence of the easterlies in the north and westerlies in the south, controls the climate of southern Africa.

Synoptic circulations within the general circulation influence the everyday weather of southern Africa.

Anticyclones centered over the subcontinent are associated with subsidence of air which produces clear, dry, stable conditions. The frequency of occurrence of anticyclones reaches a maximum over the interior plateau in June and July (79%) with a minimum during December (11%). Although the dominant effect of winter subsidence is such that the mean vertical motion is downward, weather occurs when uplift is produced by localised systems. Subsidence associated with anticyclones is conducive to the formation of absolutely stable layers in the troposphere that prevent the vertical transport of pollution. Over the interior plateau, three stable layers occur at 700 hPa, 500 hPa, 300 hPa respectively with another layer at 800 hPa between the plateau and the coast. On days when these stable layers occur, dense haze layers are evident (Tyson *et al*., 1996). Absolutely stable layers at the surface in the form of surface inversions develop due to

cooling during the night. Surface inversions prevent the vertical distribution of pollutants in the atmosphere which can reduce visibility during the early morning. During the day, the stable boundary layer is eroded away by heating and a mixing layer develops which may erode away the surface inversion (Tyson *et al*., 1988). Pollutants trapped below the surface inversion are then able to rise and disperse.

Over southern Africa, semi-stationary easterly waves form in deep easterly currents in the vicinity of an easterly jet. The waves are barotropic (axes not displaced with height) and the perturbations take the form of open waves or closed lows which are evident near the surface. Surface convergence and upper air divergence to the east of the wave produces strong uplift, instability and the potential for precipitation. Ahead of and to the west surface divergence and upper air convergence occurs, ensuring clear, dry conditions. Easterly lows are deeper systems than easterly waves, with surface convergence through the 500 hPa level to the east and divergence to the west. Such phenomena are associated with copius rains if airflow has a northerly component. Tropical disturbances are mainly a summer phenomenon and peak during the summer months of December and February.

Westerly waves are baroclinic, Rossby waves and are tilted westward with height. Westerly waves are associated with surface convergence and upper-level divergence which produce gentle uplift of air. Subsidence and stable conditions occur ahead of the trough with cloud and precipitation to the rear of the trough. Other disturbances in the westerlies include cut-off lows, southerly meridional flow, ridging anticyclones, west-coast troughs and cold fronts. Cold fronts occur together with westerly waves, depressions or cut-off lows. Cold fronts occur most frequently in winter and bring cool weather due to airflow from the south and south-west. Ahead of the front, northerly airflow is associated with divergence and subsidence that brings stable, clear conditions. Behind the front, southerly airflow, associated with low-level convergence causes cool conditions and rain (Tyson and Preston-Whyte, 2000). With the passage of a cold front, wind direction changes from north-west to west and south-west. Most winter rain in the South-Western Cape is associated with north-westerly, pre-frontal winds (Jackson and Tyson, 1971). These north-westerly winds and rain will cleanse the atmosphere of any accumulated pollutants (Jury *et al*., 1990).

2.2.7.4. Mesoscale air circulations

Air transport near the surface can either be induced by horizontal spatial discontinuities in temperature, pressure and density fields or by topographically induced local winds such as those on slopes and in valleys. Such mesoscale circulations have implications for the transport and recirculation of pollutants in an airshed.

On slopes, differential heating and cooling of the air produces local baroclinic fields (Figure 1). During the day, the absorption of radiation by the slopes warms the air near the surface, initiating low-level, up-slope anabatic flow with an upper-level return flow to complete the closed circulation. During the night, the mechanism and the circulation are reversed as surface cooling produces down-slope katabatic flow and its return flow. The formation of frost hollows and the accumulation of fog and pollutants are associated with down-slope flow (Atkinson, 1981).

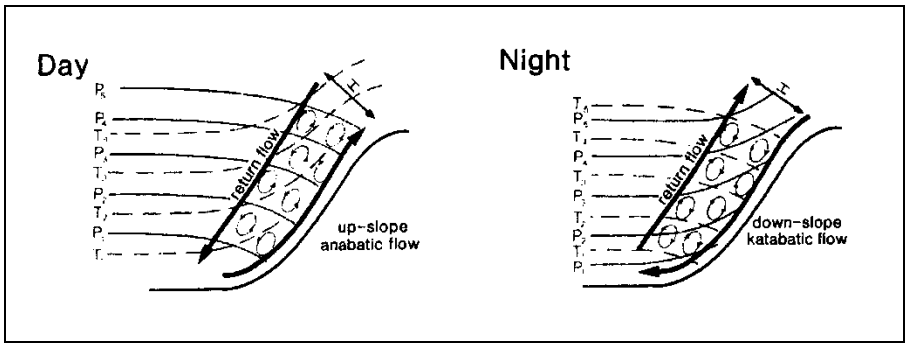


Figure 1: Diurnal variation of local winds on slopes (after Tyson and Preston-Whyte, 2000).

Within valleys, local airflow is dependent on the geometry (depth and orientation) of valleys and the time of day or night (Tyson and Preston-Whyte, 2000). In valleys whose slopes are equally heated (east-west valleys), early morning circulations are up-slope and down-slope in the evening. During the day, up-valley valley winds occur with an upper-level anti-valley wind to complete the closed circulation. During the night, down-valley mountain winds and the return anti-mountain wind occur. In valleys at right angles to the rising and setting sun (north-south valleys), the flow patterns are similar except that a unicellular circulation is set up at sunrise and sunset. These wind fields control the transport and dispersion of low-level pollutants within valleys (Tyson *et al*., 1988). Nocturnal mountains winds can transport pollution long distances down valleys under stable conditions while daytime valley winds can effectively disperse and dilute pollution

trapped within the valley. Valley winds dominate and are strongest in summer when heating is greatest while mountain winds dominate and are strongest in winter when cooling is strongest (Tyson and Preston-Whyte, 2000).

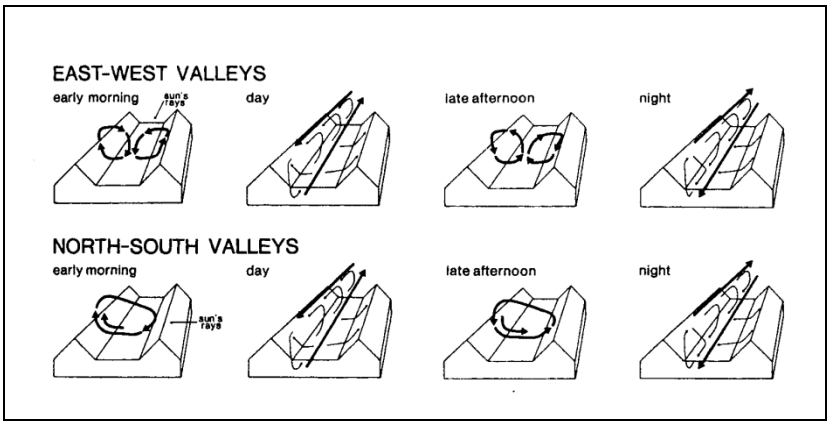


Figure 2: Diurnal variation of local winds in valleys (after Tyson and Preston-Whyte, 2000).

2.2.7.5. Wind field

Characterisation of the wind field in the Waterberg District was undertaken using surface meteorological data from available weather stations in the District. Surface meteorological data was obtained from the South African Weather Service (SAWS) station in Bela-Bela, Thabazimbi, Lephalale and Mokopane. The Agricultural Research Council (ARC) also operates a network of monitoring stations in the District as part of a larger National Meteorological Monitoring Network. Meteorological parameters were obtained from these stations for the period January 2004 – December 2008. A summary of the meteorological stations operated in the Waterberg District is provided in Table 3.

Table 3: Meteorological stations operated by the Agricultural Research Council and South African Weather Services in the Waterberg District

Monitoring Agency	Station Name	Town	Latitude (°S)	Longitude (°E)	Status	Monitoring Period	Parameters Measured	Averaging Period
Agricultural Research Council	Staankraal	Waterberg	-24.48734	27.12459	Active	Jan 2007 - Current	Wind speed, Wind direction, Temperature, Humidity, Radiation, Rainfall	10 sec intervals
	Marakele Towers	Thabazimbi	-24.29937	27.70002	Active	Jan 2004 - Current	Wind speed, Wind direction, Temperature, Humidity, Radiation, Rainfall	10 sec intervals
	Besproeiingsraad	Crocodile River	-24.8815	27.52056	Active	Jan 2005 - Current	Wind speed, Wind direction, Temperature, Humidity, Radiation, Rainfall	10 sec intervals
	Doornfontein	Nylstroom	-24.56453	28.31893	Active	Jun 2003 - Current	Wind speed, Wind direction, Temperature, Humidity, Radiation, Rainfall	10 sec intervals
	Bergfontein	Lephalale	-23.81678	27.77841	Active	Aug 1995 - Current	Wind speed, Wind direction, Temperature, Humidity, Radiation, Rainfall	10 sec intervals
South African Weather Services	Warmbaths	Bela Bela	-24.9000	28.3300	Active	Unknown	Wind speed, Wind direction, Temperature, Humidity, Pressure, Rainfall	5 min intervals
	Ellisrus	Lephalale	-23.6800	27.7000	Active	Unknown	Wind speed, Wind direction, Temperature, Humidity, Pressure, Rainfall	5 min intervals
	Potgietersrus	Mokopane	-24.2050	29.0110	Active	Unknown	Wind speed, Wind direction, Temperature, Humidity, Pressure, Rainfall	5 min intervals
	Thabazimbi	Thabazimbi	-24.5820	27.4170	Active	Unknown	Wind speed, Wind direction, Temperature, Humidity, Pressure, Rainfall	5 min intervals

Wind roses summarise the occurrence of winds at a location, representing their strength, direction and frequency. Calm conditions are defined as wind speeds less than 1 $m.s^{-1}$. Each directional branch on a wind rose represents wind originating from that direction. Each directional branch is divided into segments of different colours which are representative of different wind speeds. Wind speed classes are represented as 1 – 2 $m.s^{-1}$ (slow), 2 – 4 $m.s^{-1}$ (moderate), 4 – 6 $m.s^{-1}$ (strong) and > 6 $m.s^{-1}$ (fast).

Significant variation in the wind field is observed in the Waterberg indicative of the strong underlying topographical influence on the prevailing meteorological conditions. The Thabazimbi station has prevailing winds predominantly from the north. The Marakele Towers station, located to the north-east of Thabazimbi in the Kranskop Mountains, has moderate to fast winds originating from the north-east, east-north-east and east. The Bergfontein station outside Lephalale, has a slight topographical influence with winds originating from the north-north-east and north-east. A similar wind field is observed at the Lephalale station in Lephalale town. The local-scale topographical influence of Makapan's valley is evident in the airflow recorded at the Mokopane station, with winds having a strong northerly component. The Doornfontein station in Nylstroom has slow to moderate winds originating from various directions. A high percentage of calm conditions are recorded at this station given its location within the mountain ranges. To the south of the Waterberg District, winds at Bela-Bela originate from the north, north-east and east-north-east. The Crocodile River station to the west of Bela-Bela has slow winds with a high percentage of calms measured at this station.

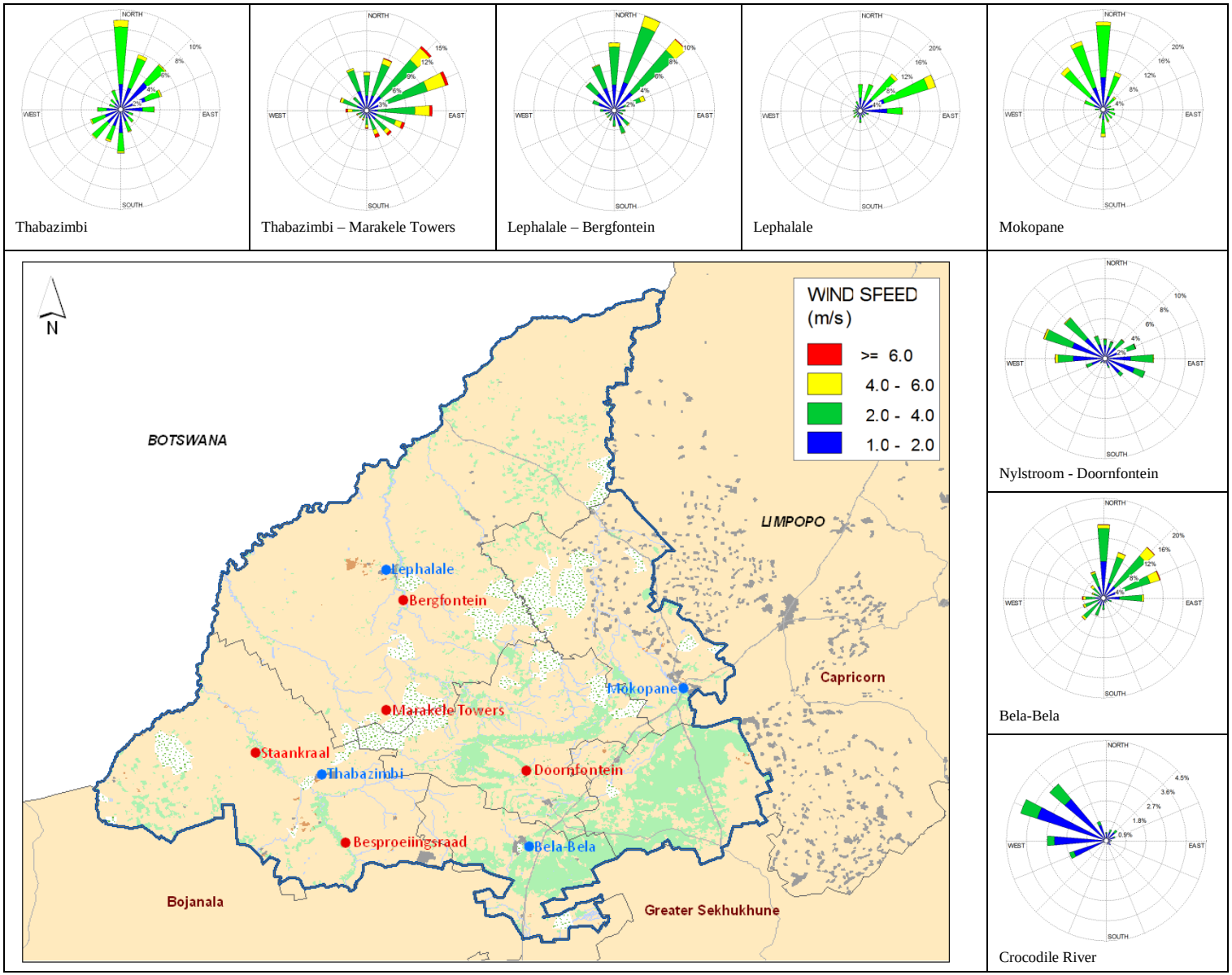


Figure 3: Period surface wind roses for the Waterberg District Municipality for the period 2004 – 2008

The diurnal variation in winds in the Waterberg District is given in Figures 3 to 7. The micro-scale influence of the underlying topography on wind patterns is evident in the diurnal signatures recorded at the meteorological stations. A lower percentage of calm conditions are recorded during the day-time.

Airflow at the Thabazimbi station remains relatively unchanged during the day-time and night-time, with a slight increase in winds from the south during the afternoon. At Marakele towers, airflow is predominantly from the easterly sector, although westerly components are recorded during the afternoon period. Winds at the Bergfontein station in Lephalale originate predominantly from the north-east and north-north-east, with a shift again observed in the mid to late afternoon. Diurnal airflow at the Lephalale station remains relatively unchanged. At the Mokopane station, winds originate predominantly from the northerly sector during the night-time, with additional southerly components during the day-time. At the Nylstroom station, airflow patterns remains relatively unchanged during the day-time and night-time with winds predominantly from the easterly and westerly sectors. A distinct diurnal variation is observed at Bela-Bela, with prevailing winds from the north and north-east during the night-time. An increase in wind speeds is observed during the day-time with additional wind components from the south-westerly direction. At the Crocodile River station, winds alternate from the westerly sector during the day-time to an easterly sector during the night-time. A high percentage of calm conditions are measured at this station, both during the day-time and night-time.

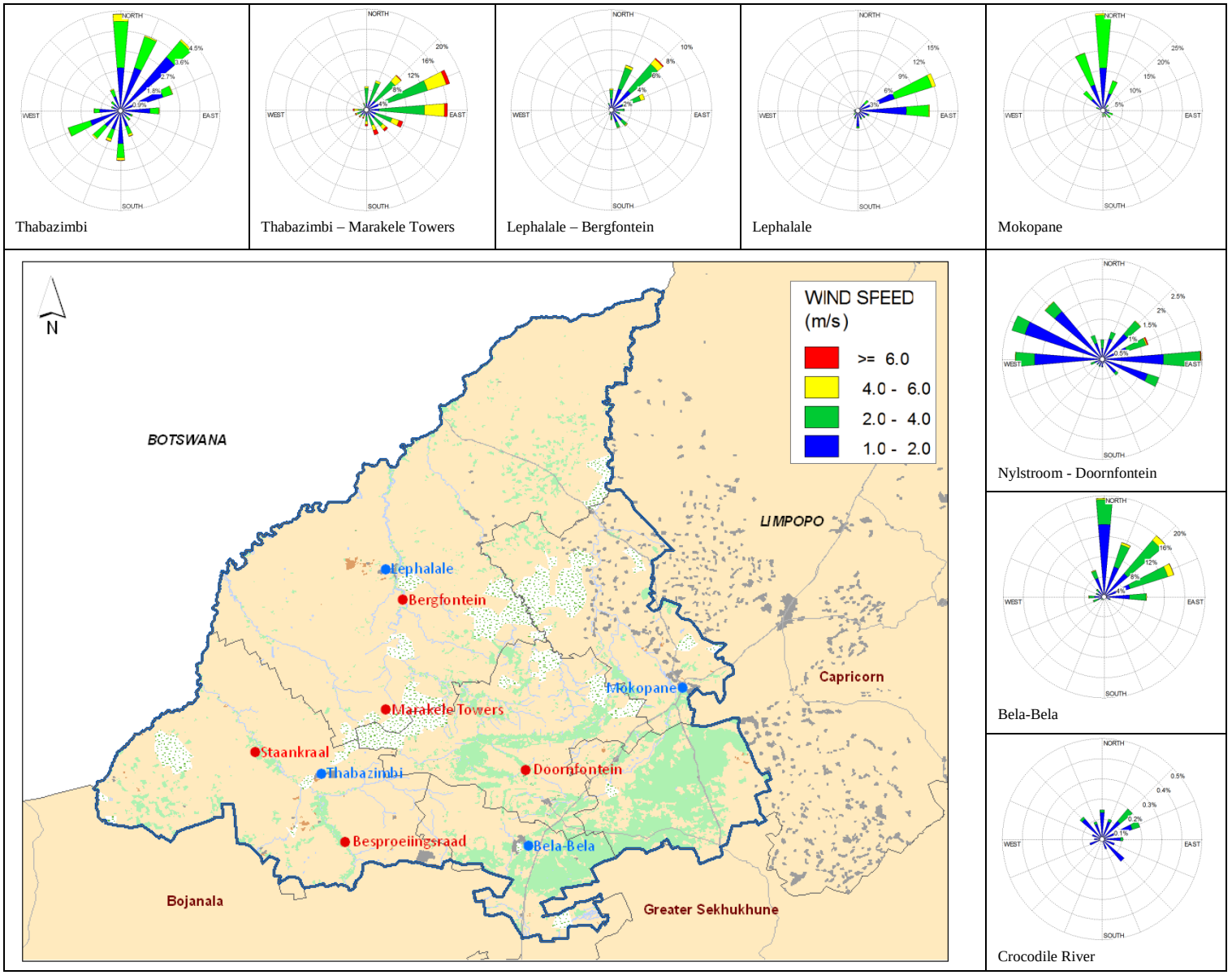


Figure 4: Diurnal wind roses (00:00 – 06:00) for the Waterberg District Municipality for the period 2004 – 2008

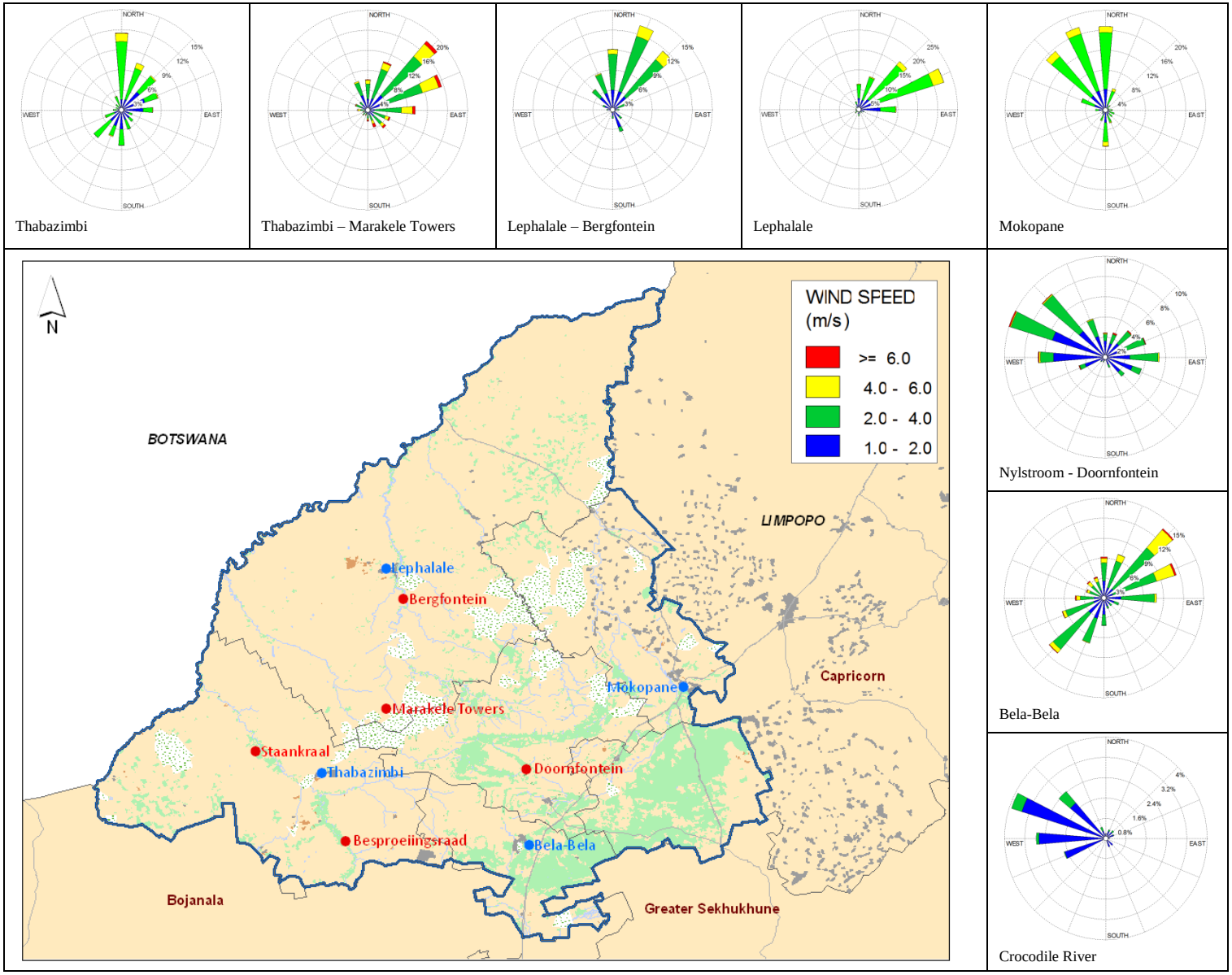


Figure 5: Diurnal wind roses (06:00 – 12:00) for the Waterberg District Municipality for the period 2004 – 2008

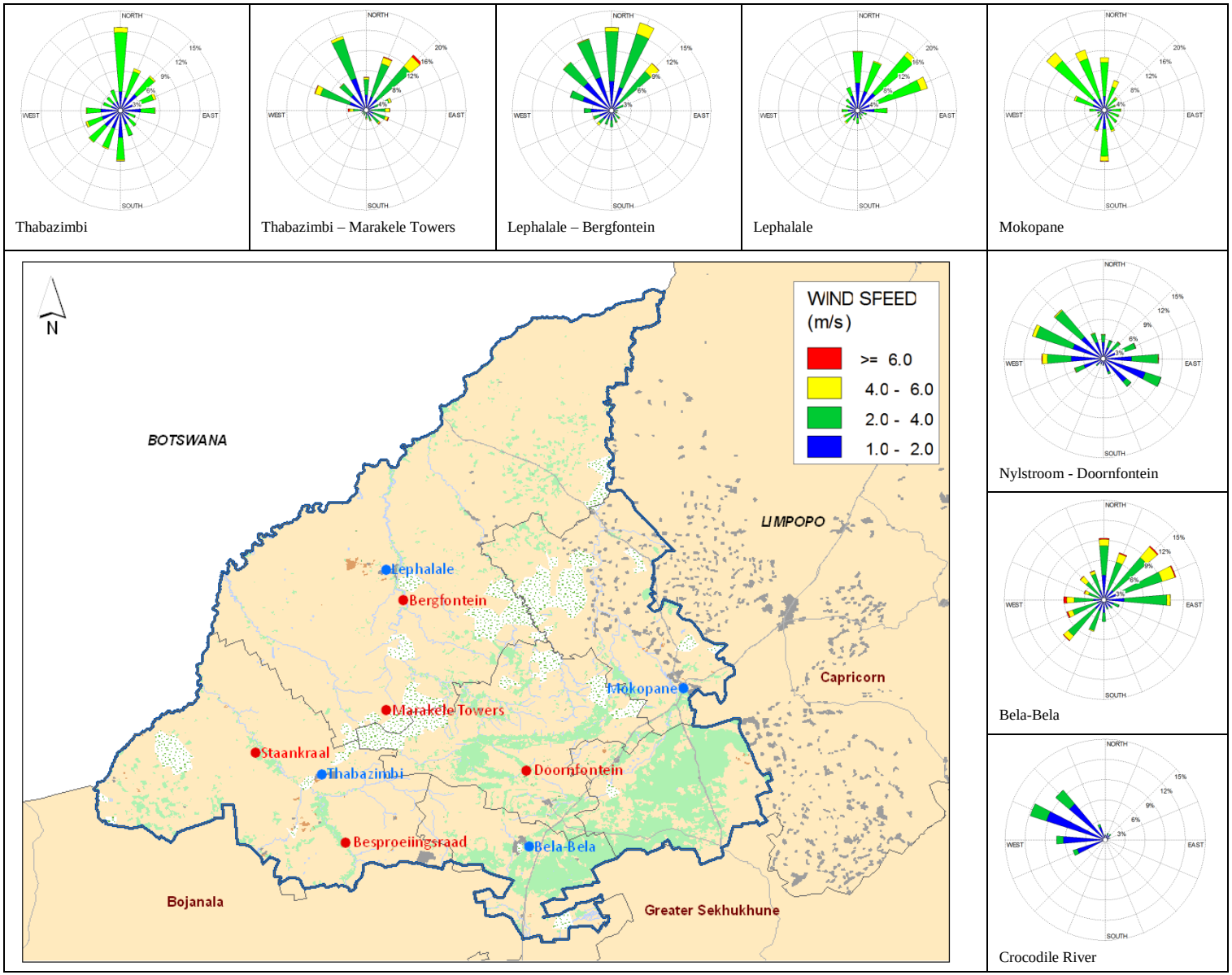


Figure 6: Diurnal wind roses (12:00 – 18:00) for the Waterberg District Municipality for the period 2004 – 2008

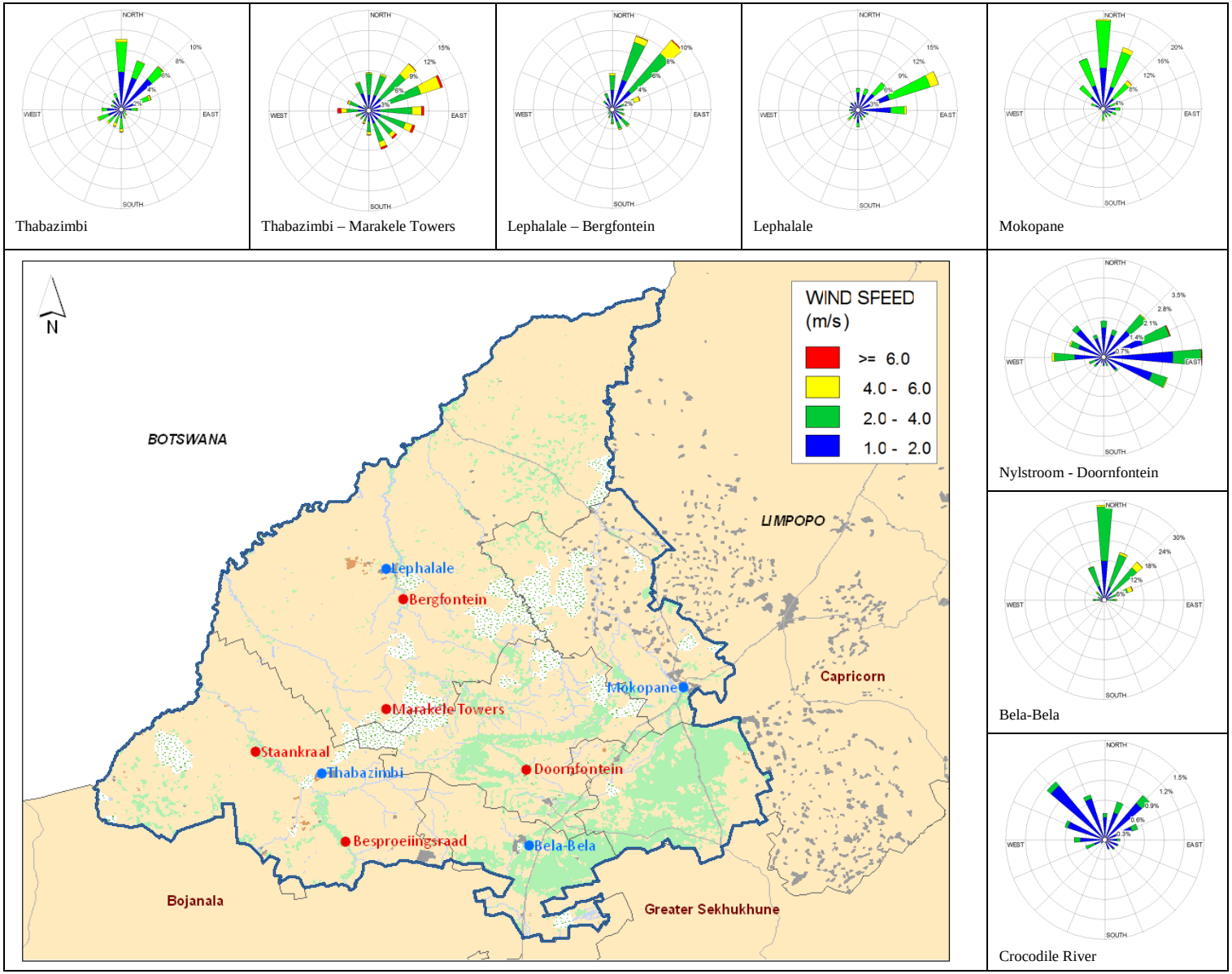


Figure 7: Diurnal wind roses (18:00 – 24:00) for the Waterberg District Municipality for the period 2004 – 2008

2.2.8. Conclusion

No measurable evidence of global warming can be discerned from the available information due to the natural fluctuations that occur. Information for a much longer period, which is currently not available, will be necessary to draw firm conclusions in this regard.

The meterological conditions will also have an effect on the ambient air quality of the area. These conditions need to be taken into account when considering the effects of air pollution in the various regions.

2.3. HYDROLOGY

2.3.1. General description of the hydrology in the EMF area

There are two Water Management Areas that fall within the EMF area, Limpopo WMA and the Crocodile (West) and Marico WMA. The Limpopo Water Management Area (WMA) is the northern most water management area in the country and represents part of the South African portion of the Limpopo Basin, which is also shared by Botswana, Zimbabwe and Mozambique. The Limpopo WMA consists of a number of catchments, which are mostly independent of each other. The Crocodile West Marico WMA is situated to the west and forms the Boundary with Botswana. Only the north or northeast corners lie in within the EMF area.

There are two main rivers of importance, the Lower Crocodile River and the Mokolo River. The Mokolo River, also sometimes called the Mogol River or the Mogolo River is one of the main rivers in the EMF area. The river and its tributaries rise in the western part of the Waterberg between 1200 and 1600 metres above mean sea level. It originates in a flattish, open area with numerous koppies. After flowing through a steep gorge the river emerges above the town of Vaalwater. From here it flows through a relatively flat area until it enters the Mokolo Dam. From the dam, it flows through another gorge before entering the Limpopo Plain, near the junction with the Rietspruit. The Mokolo River proceeds to flow through flat sandy areas until it reaches the Limpopo River.

The Lower Crocodile River, downstream of the confluence of the Elands River falls within the study area. The river has two large tributaries, namely the Sand River and the Bierspruit, which join the Crocodile River west of the town of Thabazimbi. The Lower Crocodile River flows in a north/north-westerly direction until the confluence with the Marico River. After the confluence the river is known as the Limpopo River.

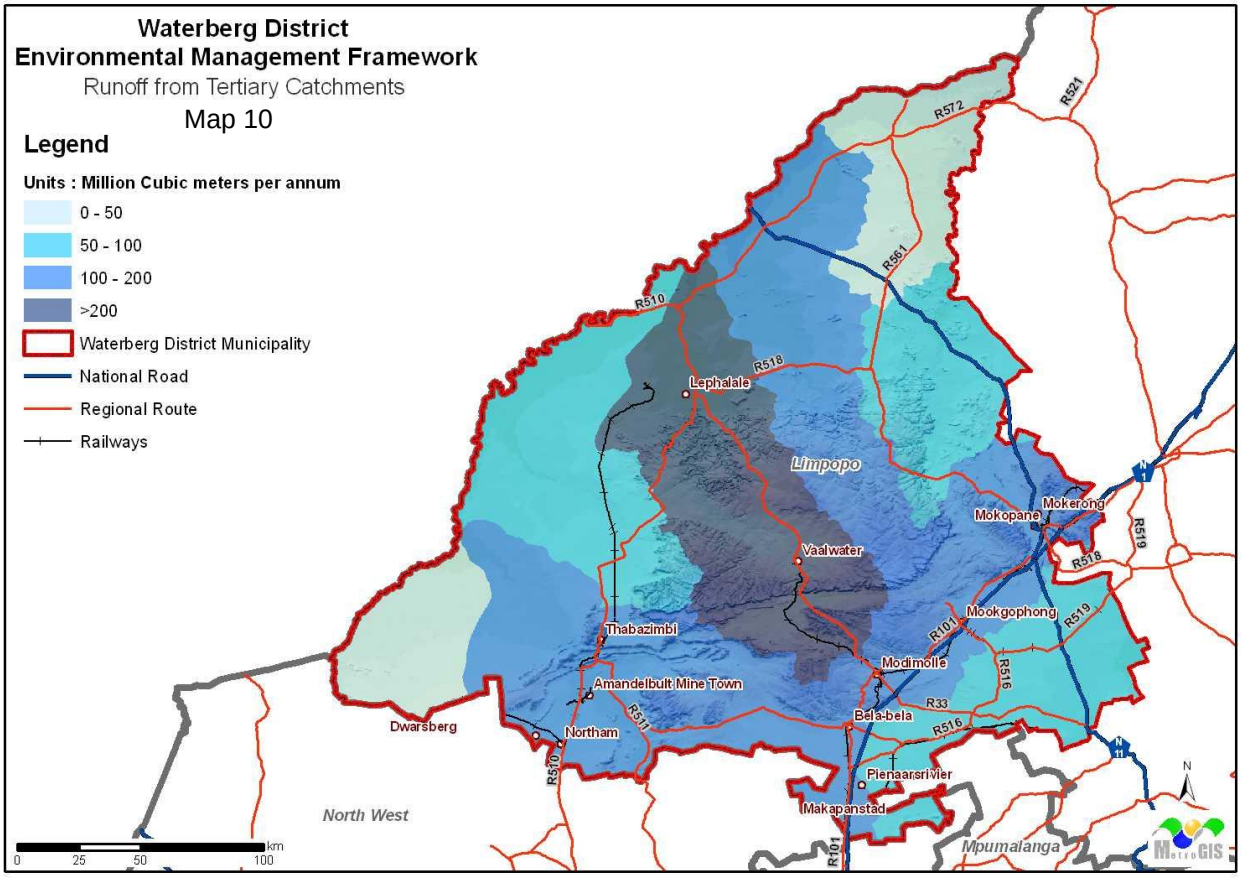
2.3.2. Water availability

The Waterberg District Municipality has the following river catchments within its boundaries:

- Lower Crocodile River sub-catchment, Crocodile River downstream of the Vaalkop, Rooikoppies and Klipvoor dams including the Matlabas River;
- the Mokolo (or Mogol) River Catchment;
- the Lapalala River Catchment;
- the Mogalakwena River Catchment; and
- a portion of the Olifants River Catchment.

The rivers flowing in the Study Area drain in a north-westerly direction to the Limpopo River.

Map 10: Runoff from tertiary catchments



2.3.2.1. Lower Crocodile River sub-catchment

The Lower Crocodile River sub-catchment generates around 100 cubic m/annum of runoff. The Vaalkop, Roodekopjes, (Hartebeespoort), Klipvoor and Bierspruit Dams are water sources, which directly feed the Lower Crocodile River area. A mine near Northam receives its water from a Rand Water pipeline running from the Vaal Dam. The entire catchment areas of the Matlabas River is situated in the Waterberg District Municipality and has an estimated MAR of 37 million cubic metres, of which only 9 million cubic metres can be considered available on a 70% assurance base. This river has an inconsistent runoff.

2.3.2.2. Mokolo (or Mogol) River catchment

The upper reaches of this catchment receives a fair amount of water from the Waterberg mountain range. The Mokolo River and its tributaries form a considerable river system that drains 8 450 km^2 with an estimated MAR of 272 million cubic metres of which 98 million cubic metres can be utilised economically. Halfway down the catchment the Mokolo Dam (formerly known as the Hans Strydom Dam) can be found. It supplies water to Matimba Power Station, the Grootegeluk Coal Mine and the greater Ellisras area. Downstream of the dam, farmers make use of the irrigation allocation.

2.3.2.3. Lephalala River catchment

The drainage area of the Lephalala River catchment is around 4866 km^2 with a MAR of about 135 million cubic m/annum. There is no major dam in this catchment area and irrigation is limited.

2.3.2.4. Mogalakwena River catchment

The Mogalakwena River catchment covers an area of 19 327 km^2 and the MAR is around 140 million cubic m/annum. Two major dams, the Glen Alphine Dam and the Doringdraai Dam are located in the catchment. The Doringdraai Dam supplies water to Mokopane (Potgietersrus), whilst the Glen Alphine Dam provides the immediate and downstream area with water for both primary use and irrigation. Modimolle (Nylstroom) also receives its water from small local dams such as the Donkerpoort Dam and the Welgevonden Dam as well as via a pipeline from the Roodeplaat Dam, near Pretoria.

Nylsvley is a major feature in the southern Nyl catchment between Modimolle (Nylstroom) and Mokopane (Potgietersrus).

2.3.3. Major dams in the EMF area

2.3.3.1. The Mokolo Dam

The Mokolo Dam is the largest in the EMF area. The dam was constructed in the late 1970's primarily to supply water to the Matimba power station but the dam also supplies water to the town of Lephalale. The dam also supplies water for irrigation purposes downstream. After the construction of the Mokolo Dam, rapid and extensive irrigation development took place upstream. This resulted in a large reduction of the dam's yield from an estimated 39 million m^3/a (RSA, 1970) to 23 million m^3/a (DWAF, 1992). This figure has since been updated by DWA to 29 million m^3/a. The dam's water is currently fully allocated.

The allocations for the Mokolo Dam are as follows (DWAF, 2001b):

- Matimba power station: 7,3 million m^3/a;
- Iscor coal mine: 9,9 million m^3/a;
- Lephalale: 1,0 million m^3/a; and
- irrigation (downstream of dam) 10,4 million m^3/a

Total 28,6 million m^3/a.

2.3.3.2. The Doorndraai Dam

The Doorndraai Dam is situated on the Sterk River near Mokopane and supplies water to Mokopane and to irrigators along the Sterk River. Construction of the dam was completed in 1953 and it was raised in 1975. The yield of the raised Doorndraai Dam is estimated at 8,6 million m^3/a (DWAF, 2001b).

The allocations for the Doorndraai Dam are as follows (DWAF, 2001b):

- Mokopane: 4,4 million m^3/a; and
- Irrigation (downstream of dam) 3,7 million m^3/a

Total 8,1 million m^3/a

2.3.3.3. The Glen Alpine Dam

The Glen Alpine Dam is situated on the Mogalakwena River. The yield of this dam is limited due to its small size, the ephemeral nature of the runoff into the dam, and the high evaporation rates in this area. The dam was completed in 1967 and supplies water to irrigators downstream. The allocation to irrigators was 5,9 million m^3/a, but of this 1,6 million m^3/a was to irrigators in

Lebowa who never took up the allocation. However, 6,9 million m^3/a has been registered by water users as water use sourced from the Glen Alpine Dam, so it will be necessary to verify the lawfullness of these registered water users before reallocating Lebowa's allocation to other users.

2.3.3.4. Other dams

There are many other smaller dams found within the study area. Their main use appears to be for irrigation. These dams do however have impact on the water systems by reducing the overall water yield of various rivers.

2.3.4. Groundwater

Groundwater is available and widely used throughout the area, but in varying quantities depending upon the hydrogeological characteristics of the underlying aquifer. Groundwater is usually the main source of water supply to rural communities although surface water is also used conjunctively where this is available. Groundwater is also used widely for irrigation. Groundwater is used to supply the platinum mines west of Mokopane.

2.3.5. Water schemes

Water is a scarce resource in the Waterberg District. In order to support the new developments taking place in the Lephalale area, the Mokolo Crocodile Water Augmentation Project (MCWAP) has been proposed. This is fully discussed in the planning section of this report.

2.4. RIVER HEALTH[5]

2.4.1. General introduction

The sections below were adapted from the State of the Rivers Reports for the Crocodile West Marico Water Management Area, the Mokolo River Catchment and the Phalala (Lephalala) River Catchment. The State of the Rivers Reports was completed in 2005 and 2006 and they are the most recent available information on these river systems.

[5] River Health Programme (2007) *A Biomonitoring Survey of the Lephalala River Catchment Limpopo Province Field Survey of 2005*. M.K. Angliss. Specialist Scientist. Limpopo Environmental Affairs.
River Health Programme (2005). *State-of-Rivers Report: Monitoring and Managing the Ecological State of Rivers in the Crocodile (West) Marico Water Management Area*. Department of Environmental Affairs and Tourism. Pretoria. ISBN NO: 0-620-34054-1
River Health Programme (2006) *State-of-Rivers Report The Mokolo River System*. Department of Environmental Affairs and Tourism. Pretoria. ISBN No. 978-0-620-38215-1.

Map 11: Rivers and dams

2.4.2. Crocodile (West) and Marico WMA

2.4.2.1. Lower Crocodile River

Ecological status

The overall ecological status of the Lower Crocodile River is poor. The instream habitat integrity is poor, extensive irrigation and multiple abstraction points along this river have an impact on river functioning. Flows are regulated through a series of weirs and dams resulting in unseasonal releases to maintain irrigation. This leads to undercutting of riverbanks and increased sedimentation.

The riparian vegetation integrity is poor. In many areas the riparian vegetation has been cleared for agriculture and pumps that use water from the river. Large numbers of alien species are found along this section of river, including castor-oil plants and Syringa. High levels of agriculture near the confluence of the Crocodile River and Klipspruit has degraded the riparian zone. Large number of dams in this region and upstream is causing a loss in flow variability. Low flows are depositing fine sediments in pools and on bends. A lack of high flow events is resulting in reed encroachment and the encroachment of terrestrial vegetation on flood benches.

Only hardy species remain within this river indicating a poor fish assemblage index. The loss of habitat and connectivity of the river has resulted in conditions too stressful for most fish species.

The water quality is poor. Sites indicated a low flow with intermediate levels of nutrients. The water contained severe organic pollution. The reduced water quality can be attributed to high agricultural return flows.

The diminished flows are leading to dry sections and isolated pools. This in conjunction with reduced water quality affects the habitat suitability and therefore impacts invertebrate diversity negatively.

Drivers of ecological change

The major drivers of change in this section of the Crocodile River can be attributed to the extensive abstraction of water for irrigation purposes, which impacts on the natural flow regime of the river. The agricultural return flows negatively impact on the water quality. The dams and weirs act as barriers to both the flow of the river and the natural migration patterns of fauna.

Management responses

The water use and water abstraction for irrigation purposes should be better controlled. The environmental flow requirements should be determined and an ecological reserve should be strictly implemented. Agricultural return flows should be monitored and controlled. Where possible, bank erosion should be stabilised. Alien invasive species should be cleared, especially from the riparian zone.

2.4.2.2. Sundays River

Ecological status

The overall ecological status of this river is fair to good. The instream habitat integrity is fair to good. Water abstraction is limited to a few irrigation areas. There were a large number of weirs prior to the 2000 floods, but most of these were destroyed. The existing weirs have limited take-off. Some overgrazing combined with Sandveld has led to considerable deposition of sand in pools and on bends. Flow variability is still good.

The riparian zone habitat integrity is poor. This is as a result of bank erosion that was caused by damaged weirs and overgrazing. The encroachment of terrestrial species into the riparian zone may be an indication of some flow modification. Agriculture, stock farming and resorts have the greatest impact on the riparian vegetation. Some invasive alien species do occur, however vegetation is largely natural and bank structure is generally intact.

The fish assemblage integrity is fair as moderately sensitive fish species still occur in the river. The lower sections of the river are impacted by water abstraction during flow periods. The upper sections of this river are generally in good condition. It is the lower reaches where reduced water quality and habitat alteration impact on invertebrate diversity.

The water quality is fair. The flows have been low, and contained intermediate levels of nutrients. The water is free from any significant organic pollution. Impacts are primarily due to agricultural return flows.

Drivers of ecological change

The damaged weirs have an impact by modifying the flow of the river. Alien vegetation encroaching on the riparian zone also has a negative impact.

Management responses

An EIA should be undertaken if the repair of any of the damaged weirs is being considered. Alien vegetation should be cleared from the riparian zone. Overgrazing should be kept to a minimum to reduce sediment input into the river. Agricultural return flows should be monitored. It is important to determine the natural flow regime of the river and to ensure that the ecological reserve is always maintained.

2.4.2.3. Lower Marico River

Ecological status

The overall ecological status for this section of the Marico River is fair. The instream habitat integrity is poor. The primary cause is the flow releases from the Molatedi Dam. Water is released every 4 to 6 weeks into some weirs for irrigation and supply to Botswana. The surrounding area is quite flat and this results in the inundation of large areas covering shallow instream habitats. Although the releases are beneficial to riparian vegetation, they are having a detrimental effect on aquatic biota.

The riparian zone habitat integrity is fair. There is a large variety of vegetation at Molatedi Dam, which is abundant due to the mixed bedrock streambed. Downstream of the dam however, vegetation is negatively impacted by the lack of water. The extent of riparian vegetation cover is low, ground cover and indigenous riparian tree species recruitment is low. Some alien species are found in this area. In general the riparian vegetation integrity is good. Cultivation adjacent the river is limited due to the steep riverbanks. The border fence also assists in protecting the riparian zone.

The fish assemblage integrity is poor. The frequency of occurrence of species is low due to reduced flows. There are mostly only hardy species present. There are no SASS scores for this reach of river because no water quality score is available. However, water quality is viewed as reduced because of irrigation return flows.

Drivers of ecological change

The main driver of ecological change is irrigated commercial agriculture. Farmers request water from dams when levels in weirs are low.

Management responses

The riverbed downstream of the Molatedi Dam is dry and the rapid release of water would lead to erosion. Natural flow should be simulated by regulated releases.

2.4.2.4. Plat River

Ecological status

The overall ecological status of this river is poor. The instream habitat integrity is poor. A number of agricultural dams and weirs as well as the Bela-Bela Municipality have a serious impact on the aquatic biota and connectivity of this river reach because large volumes of water are being abstracted. The flows in the middle sections of this river reach are also being choked by debris from alien vegetation, mainly Eucalyptus species.

The riparian zone habitat is poor. Water abstraction has a large impact. The presence of alien vegetation is causing a reduction in the undergrowth, leading to bank instability. Banks on river bends are badly eroded, leading to a change in terrace structure.

The riparian vegetation integrity is poor. Alien vegetation has largely replaced indigenous vegetation. Blue gum, lantana, poplar, seringa, prickly pear, bramble and sesbania grow in the area extensively.

The fish assemble integrity is fair to poor. Only hardy species are found, usually limited to isolated pools in the lower sections. Upper sections are in fair condition with snake catfish (*Clarias theodorae*) still present.

The invertebrate integrity is fair to poor. The largest impact on the invertebrates is the abstraction of water and subsequent riparian habitat alteration. The upper sections are still in a reasonably fair condition.

The water quality is fair. The river has between low and intermediate levels of nutrients and is free from significant organic pollution. Although some localised urban runoff and sewage outflow contribute to moderate water quality scores.

Drivers of ecological change

The main driver of ecological change is the demand for irrigation water, which has resulted in reduced flows and an altered natural habitat. Flow is blocked in some areas by encroachment of alien vegetation on the riparian zone.

Management responses

Water use should be controlled and managed, especially for irrigation purposes. An ecological reserve should be determined and implemented. Alien invasive plants should be removed and

riparian habitats rehabilitated. Urban pollution, especially sewage spills should be identified and controlled.

2.4.3. The Mokolo River catchment

2.4.3.1. The Sand tributaries

Ecological status

This is ecoregions 7.02 & 7.03, and the main tributaries of the Mokolo River include the Sand River, Klein Sand River, Sandspruit, Loubadspruit and Grootspruit. The overall ecological status for this unit is fair.

The instream habitat integrity and riparian vegetation integrity is fair. Habitat diversity is moderate and marginal vegetation cover is good. Alien vegetation is present and is contributing to bank instability.

The invertebrate community is in a moderate condition, given the seasonal nature of these small streams. Invertebrates normally associated with marginal vegetation appear to be in abundance.

The fish assemblage integrity is fair, with most of the expected species being found in the river. Both flow dependant species, the common mountain catfish (*Amphilius uranoscopus)* and the shortspine suckermouth (*Chiloglanis pretoriae),* were also recorded. In the smaller streams, catches were dominated by small barbs (*Barbus spp.).*

Alien vegetation is contributing to bank instability. Many of the streams in this area are considered to be seasonal under present flow conditions.

Given the seasonal nature of these small streams, the SASS survey revealed that the invertebrate community was in a moderate condition. Mayflies and dragonflies abounded in these clear water streams while very few caddis flies were recorded. Invertebrates normally associated with marginal vegetation were in abundance although few molluscs were recorded. Most of the fish species expected in the main stem of the river were recorded

Drivers of ecological change

Land use in the area is dominated by mixed agricultural lands and some informal settlements. Throughout this area there are a large number of bridges, weirs, dams, pumps and off-channel storage reservoirs. In many areas the riverbanks are impacted by vegetation removal and cattle tracks.

There are a large number of bridges, weirs, dams, pumps and off-channel storage reservoirs throughout this area.

Management responses

Alien vegetation should be removed and riparian vegetation should be rehabilitated as much as possible.

2.4.3.2. The Sterkstroom catchment

Ecological status

This area falls in ecoregions 6.01, 7.02, and 7.03. The main rivers include the Sterkstroom, Taaibosspruit, and Frikkie-se-loop. The area falls entirely within the protected areas of Welgevonden, Marakele and neighbouring private nature reserves. Only the extreme upper catchments of the Frikkie-se-loop and the Sterkstroom are located on private farms. The overall ecological status for this unit is fair.

Many dams, weirs, bridges and crossing points are located in the catchment despite the protection afforded by the conservation areas. These barriers contribute to the fragmentation of fish populations in this ecologically important area. The instream habitat integrity is fair. While bank stability is poor, showing the impact of the 2000 floods.

The fish assemblage integrity is fair. Flow-dependant fish species still survive, largely due to the presence of deep, well-oxygenated pools that remain available when the streams have stopped flowing during severe droughts. Two species of alien fish occur namely the largemouth bass *(Micropterus salmoides)* and the common carp (*Cyprinus carpio)*. The largemouth bass are especially a threat to indigenous fish species.

The aquatic invertebrate populations are in a fair condition. The SASS results yielded high scores that reflect the good diversity of aquatic habitats and the high proportion of sensitive invertebrate families present.

The riparian vegetation is in a fair condition. Some flood damage was observed. A limited amount of terrestrial vegetation was observed to be encroaching at all survey sites. The two main alien plant species recorded were the rattlebox (*Sesbania punicea),* and syringa (*Melia azedarach)*.

Drivers of ecological change

Droughts and flooding appear to have had a large impact on this area's rivers. Also the large amount of infrastructure found along the rivers may have an impact.

Management responses

Alien fish species and vegetation should be removed and controlled as much as possible. Bank stability should be maintained or improved.

2.4.3.3. The Rietspruit catchment

Ecological status

This area falls in ecoregions 1.03, and 6.01. The area has one main river, the Rietspruit River flowing through it. The stream rises and flows along the Waterberg before cascading over a waterfall, which acts as a natural break. The river subsequently opens out into a large wetland lying on the Mokolo floodplain. Overall the ecological status of the area is considered fair.

The instream habitat integrity is fair to good. Bank stability is good, with only slight erosion. Habitat diversity and habitat cover are both considered to be high. A number of farm dams and a fishing resort are located upstream of the survey sites, causing this isolated reach of river to be even more fragmented.

The fish assemblage integrity is fair. Most of the expected fish species were found in this ecological unit. While the species recorded reflected the diverse in-stream and marginal habitats, no flow-dependant species were recorded. Alien species of fish are thought to have been introduced into upstream farm dams, but none were recorded during the survey.

The aquatic invertebrate populations are in a fair condition. Good SASS scores were recorded. A high diversity of mayflies, dragonflies and caddis flies were noted. No molluscs were recorded.

The riparian vegetation is in a fair condition. Only a few alien plants are present. Some terrestrial trees encroached into the riparian zone, but the riparian vegetation is recorded as being largely intact.

Drivers of ecological change

Limited bush clearing and cattle tracks were considered to be the major impacts on the riparian vegetation. The dams and fishing resorts appear to be having an impact on the flow of the river.

Management responses

The riparian vegetation should be protected, and not be allowed to be cleared. Dams should be carefully considered before permission is given for construction and they should be built in such a way that they do not affect the downstream habitat.

2.4.3.4. The Upper Mokolo region

Ecological status

This area falls in ecoregions 6.01, and 6.02. It has around five main rivers falling within this unit, including Sterkstroom, Dwars River and its lesser tributary the Jim-se-loop, Brakspruit and the Mokolo itself. Overall the ecological status of the upper Mokolo River, as well as the Dwars River and its lesser tributary the Jim-se-loop is fair.

The instream habitat integrity is fair to good for the Moloko River and fair for the Dwars River and Jim-se-loop River. The Mokolo has a mixed channel section with bed material consisting predominantly of large, moderately embedded cobbles. This reach is classified as pool-riffle and numerous sand or gravel bars are present. Flood plains are often present. Bank stability is considered to be moderate. The Dwars River and Jim-se-loop have lower gradient mixed bed alluvial channels with sand and gravel dominating the bed. For the most part, the river in this study unit is protected by private land owners.

The fish assemblage integrity is good for the upper Mokolo River and fair for the Dwars and Jim-se-loop Rivers. The fish community of the Mokolo River main stem was largely intact with all the expected species recorded. Flow dependent species of fish were recorded in abundance. The alien largemouth bass (*Micropterus salmoides*) was recorded in the Mokolo River near Vaalwater. The absence of flow dependent species confirms the fact that the Dwars River and Jim-se-loop River have become seasonal rivers. A large number of dams in the extreme upper catchments, together with loss of wetlands, are thought to have contributed to this reduction in flow.

The invertebrate populations of the Mokolo River were extremely diverse and reflected the good quality benthic and marginal habitats. The Dwars River community, although diverse, was indicative of the seasonal flows and poorer quality benthic habitats.

The riparian vegetation is fair for both the Mokolo River and the Dwars and Jim-se-loop Rivers. There are heavy infestations of alien vegetation such as eucalyptus (*Eucalyptus sp.)*, syringa (*Melia azedarach)* and poplars (*Populus sp.).* Reed encroachment is a growing concern in the

Mokolo River Catchment. The discharges from the Vaalwater sewage works into the Mokolo River must be closely monitored.

Drivers of ecological change

Impacts from bridges, dams and weirs are common. Invasive alien vegetation is destabilising the riverbanks. Heavy alien infestations and reed encroachment is of concern.

Management responses

Alien vegetation should be removed and controlled as much as possible. Any further construction of infrastructure needs to be carefully considered in terms of what impact it may have on the rivers.

2.4.3.5. The Middle Mokolo region

Ecological status

This area falls in ecoregions 1.03, 6.01, and 6.02. The main river is the Mokolo River. The Mokolo River's tributaries include the Poer-se-loop, Tambotie, Bulspruit and Malmanies Rivers. The upstream section of the Mokolo River passes through some irrigated farmlands, but mostly through private game reserves. The river is impounded by the Mokolo Dam, which lies within the provincial Mokolo Dam Nature Reserve. The dam supplies water to downstream irrigation farms, the town of Lephalale, Matimba power station and Kumba colliery, which are all located in the Lower Mokolo Region study unit.

Overall the ecological status of the Mokolo River upstream of the Mokolo Dam is good, while the overall the ecological status of the Mokolo River downstream of the dam is fair.

The instream habitat integrity upstream of the dam is good, while below the dam it is fair to good. Bank stability is good. Habitat diversity is high, with the dominant bed material being cobble and boulders.

The fish assemblage integrity was recorded as good upstream of the dam, and as fair downstream of the dam. Upstream a high percentage of the expected fish species were found, including all the flow-dependent species, confirming the near perennial status of the river in this section. Downstream of the dam, benthic habitat conditions were degraded and all flow dependent species were absent. The Mokolo Dam itself has a substantial population of the two alien species of fish, the largemouth bass (*Micropterus salmoides*), and the common carp (*Cyprinus carpio*). Crocodiles are also present in the dam. Hippopotamus are present in the catchment, but occur mostly downstream of the Mokolo Dam.

The invertebrate populations are recorded as being in a good condition upstream of the dam, and in a fair condition downstream of the dam. Upstream of the dam, very good SASS scores were recorded, with the sensitive stoneflies, mayflies and caddis flies in high abundance, while many families were absent downstream of the dam.

The riparian vegetation was largely intact and recorded as being in a fair condition both upstream and downstream of the dam. The only alien species recorded included the rattlebox (*Sesbania punicea),* and the syringa (*Melia azedarach)*. A limited amount of terrestrial vegetation encroachment was observed at all sites. Small populations of the highly invasive alien weed parrots feather (*Myriophyllum aquaticum*), were noticed in pools below Mokolo Dam, as well as within the dam itself.

Drivers of ecological change

Impacts within this study unit are dominated by irregular water releases from the Mokolo Dam to the lower section of the river. Causeways, a road bridge and an assortment of riparian impacts also occur. Reed encroachment and cattle tracks through the riparian zone are also noticeable negative impacts. As well as the alien species present in the area.

Management responses

The releases from the Mokolo Dam need to be handled in such a way that they do not have a negative impact on the river downstream. Alien vegetation should be removed and controlled. Overgrazing of cattle in the riparian zone should be limited as much as possible.

2.4.3.6. The Lower Mokolo region: The Limpopo plain

Ecological status

This area falls in ecoregions 1.02, 1.03, and 6.01. The main river is the Mokolo River. This section of river has several oxbows and isolated off-channel pools. A wide floodplain borders the river for much of this section. There are two seasonal tributaries, the Sandloop and the Tambotie Rivers. Overall the ecological status is fair.

The instream habitat integrity is in a fair condition. The river channel is dominated by sandy runs and pools, but is heavily infested with reedbeds (*Phragmites mauritianus*).

The fish assemblage integrity is fair. Hardy, pool dwelling species of fish dominate. No fish species requiring permanent flow were recorded, but several species that require flowing water for breeding purposes still remain. No alien fish species were recorded.

The invertebrate populations are recorded as being in a fair condition. Poor habitat diversity accounts for an invertebrate assemblage that is dominated by hardy families associated with marginal vegetation and sand. The moderately scoring SASS assessments are likely to be as a result of the irregular flow regime.

The riparian vegetation is in a fair condition, with reed encroachment considered the main vegetation impact. Alien vegetation is sparse. Downstream from Lephalale, disturbance to the riparian zone was limited to bridges, sand mining and agricultural practices.

Drivers of ecological change

The main impact on this section of the river is from the regulated flow regime created by the Mokolo Dam. Sporadic flows are also being released for the farming community. This creates a large problem as reed beds and reed encroachment impact on the river negatively. There are five major road bridges in this area. A number of farm dams are located in the Mokolo River close to the Limpopo confluence. Sand mining is widespread.

Management responses

The ecological impacts should be taken into account in the management of the Mokolo Dam and its water releases. The impact of farm dams and sand mining should be kept at a minimum.

2.4.4. The Lephalala (Phalala) River catchment

The Lephalala River catchement report format was largely different from the other two. Thus no definite drivers of ecological change and management responses will be discussed.

The Macro Invertebrate Response Assessment Index (MIRAI) was used to determine the ecological state for the invertebrate populations in the Lephalala River catchment. No define indication of the state of the riparian vegetation could be discerned from the report.

2.4.4.1. Lephalala upper tributaries

Ecological status

The Lephalala's upper tributaries fall within ecoregion 6.01. The upper tributaries lie entirely on private farmlands, which are dominated by expansive grasslands. The overall ecological status of this section is fair.

The grasslands and wetlands are heavily overgrazed and infested by Bankrupt Bush (*Stoebe vulgaris*). There are also large stands of wattle along the watercourse. A number of dams and pumps can also be found.

The fish assemblage integrity is fair. Two of the more sensitive fish species the snake catfish (*Clarias theodorae*) and the orangefin barb (*Barbus eutaenia*) were absent. Most of these upper catchment dams have been stocked with Black Bass (*Micropterus salmoides*) for angling purposes.

The invertebrate populations are in a good condition. During the assessment, 18 out of a reference of 27 families were recorded.

Drivers of ecological change

Not defined.

Management responses

Not defined.

2.4.4.2. Lephalala Waterberg

Ecological status

This section of the Lephalala River falling in ecoregion 6.01 flows mostly through game farms, including the Lephalala Wilderness Area and Biosphere. River habitat is dominated by steep, "pool – rapid" sequences with the river substrate consisting mostly of bedrock and large boulders. The overall ecological status of this section is fair.

The strongly perennial Lephalala River stopped flowing in 2004. Drought combined with upper catchment degradation and the large numbers of recently built farm dams in the upper reaches of the river are thought to have contributed to this. The large number of farm dams is thought to be contributing to the fragmentation of the system.

The fish assemblage integrity is fair. Only 16 of the expected 30 fish species were recorded, and of these, many were recorded in low numbers. Pool dwelling species may have been missed, due to the presence of crocodiles preventing proper surveying. No truly migratory species (eels) were recorded. Low conductivity combined with fast deep water and difficult sampling habitat may have contributed to an artificially low assessment of this area.

The invertebrate populations are in a good condition. During the assessment, 39 out of a reference of 47 families were recorded.

Drivers of ecological change

Not defined.

Management responses

Not defined.

2.4.4.3. Lephalala

Ecological status

This section of the Lephalala River falling in ecoregion 1.02 is dominated by low gradient sand and gravel runs with reed fringed pools and bedrock outcrops. The river passes through agricultural areas and rural settlements before joining the Limpopo River. Many farm dams and pumps can be found. The river is historically perennial, but this lower reach is now seasonal. The overall ecological status of this section is fair.

The fish assemblage integrity is fair. Out of an expected 30 fish species, only 17 were recorded. Dams and deep pools provide refuge for hardy pool dwelling fish species. None are equipped with fishways and the river has become both fragmented and isolated from the broader Limpopo catchment as a result.

The invertebrate populations are in a good condition. During the assessment, 40 out of a reference of 46 families were recorded.

Drivers of ecological change

Not defined.

Management responses

Not defined.

2.4.4.4. Blocklandspruit

Ecological status

This tributary of the Lephalala River falls within ecoregion 6.01. The sites that were surveyed fell within the Lephalala Wilderness Area. The stream habitat appears largely natural, with the habitat being dominated by bedrock and sandy pools with reed fringed, cobble and gravel riffles. There are however a number of small dams and one large dam in the river which are reported to house both bass and carp. The overall ecological status of this section is fair.

The fish assemblage integrity is fair to good. Some 20 out of an expected 27 fish species were recorded. Barbs were abundant and the flow dependent Swafin Suckermouth or Rock Catlet (*Chiloglanis pretoriae*) was recorded. However, neither of the other highly sensitive flow

dependent Orangefin Barb (*Barbus eutaenia*) nor the Southern Barred Minnow (*Opsaridium peringueyi*) were recorded.

The invertebrate populations are in a good condition. During the assessment, 26 out of a reference of 34 families were recorded.

Drivers of ecological change

Not defined.

Management responses

Not defined.

2.4.4.5. Daggakraal

Ecological status

This tributary of the Lephalala River falls within ecoregion 6.01. This stream has a “floodplain – wetland habitat”. Very low flow was encountered and a number of shallow pools were observed to have fish a considerable distance away from the Lephalala main stem. The overall ecological status of this section is fair.

The fish assemblage integrity is fair. Out of a potential of 13 fish species, 7 were recorded.

The invertebrate populations are in a good condition. During the assessment, 10 out of a reference of 17 families were recorded.

Drivers of ecological change

Not defined.

Management responses

Not defined.

Table 4: Summary of the State of the Rivers					
	Fish Assemblage Integrity Index (FAII)	Riparian Vegetation Index (RVI)	South African Scoring System (SASS) / Macro Invertebrate Response Assessment Index (MIRAI)	Overall Ecological Status	Ecological Importance and Sensitivity (EIS)
Lower Crocodile River	Poor	Poor	Poor	Poor	Moderate
Sundays River	Fair	Poor	Poor	Fair	Moderate
Lower Marico	Poor	Good	No Data	Fair	Moderate
The Sand Tributaries	Fair	Fair	Fair	Fair	Moderate
The Sterkstroom Catchment	Fair	Fair	Fair	Fair	High
The Rietspruit Catchment	Fair	Good	Fair	Fair	Moderate
The Upper Mokolo River	Good	Fair	Good	Fair	Moderate
Dwars River & Jim-se-loop River	Fair	Fair	Good	Fair	Moderate
The Middle Mokolo River Upstream of the Mokolo Dam	Good	Fair	Good	Good	Moderate
The Middle Mokolo River Downstream of the Mokolo Dam	Fair	Fair	Fair	Fair	Moderate
The Lower Mokolo Region: The Limpopo Plain	Fair	Fair	Fair	Fair	Moderate
Lephalala upper tributaries	Fair	No Data	Good	Fair	High
Lephalala Waterberg	Fair	No Data	Good	Fair	High
Lephalala	Fair	No Data	Good	Fair	Moderate
Blocklandspruit	Fair	No Data	Good	Fair	High
Daggakraal	Fair	No Data	Good	Fair	Low / Marginal

FAII: Fish Assemblage Integrity Index	Fish are good indicators of long-term influences on general habitat conditions within a river reach. The FAII is an expression of the degree to which a fish population differs from its expected undisturbed condition.
RVI: Riparian Vegetation Index	Healthy riparian zones help to maintain the form of the river channel and act as filters for sediment, nutrients and light. Plant material from this zone is an important source of food for aquatic fauna. RVI is a measure of the degree of modification of the riparian zone from its natural state.
SASS: South African Scoring System (macro-*invertebrates*)	Aquatic invertebrates require specific habitats and water quality conditions. They are good indicators of recent localised conditions in a river. SASS is an index, based on invertebrate families found at a site.
Ecological Status:	All the features and characteristics of the river and its riparian areas that influence its ability to support the natural flora and fauna, and its capacity to provide a variety of goods and services.
EIS: Ecological Importance and Sensitivity	An indication of whether a river should receive a high level of protection or not: high meaning it should be protected in a natural or good state, and low meaning it has less conservation value or is already impacted, and may be more suitable for development, etc. (Importance refers to the diversity and rarity of habitats and biota; and sensitivity to the ability to tolerate and recover from disturbances and impacts).

2.5. BIOLOGY

2.5.1. Biomes and bioregions of the study area

There are two major biome units occurring within the EMF area, namely Savanna and Grassland. Other biome units may also occur in isolated areas. Savanna can be generally described as having a herbaceous layer usually dominated by grass species and a discontinuous to sometimes very open tree layer. The soil variation can sometimes be quite large. There is often a good correlation between vegetation patterns and soil types. The term grassland refers to herbaceous vegetation of relatively short and simple structure that is dominated by graminoids[6]. Woody plants are rare or absent or are confined to specific habitats, such as smaller escarpments or koppies.

The biomes of South Africa have been divided up into bioregions, which are the intermediate level of vegetation organisation between that of vegetation type and biome. Bioregions are defined on the basis of similar biotic and physical features and processes at the regional scale. Most of the study area is within the Central Bushveld Bioregion, which falls within the Savanna Biome. There are also small patches of vegetation that fall within the Mesic Highveld Grassland

[6] **Graminoid** means grasses and grasslike plants, such as sedges.

Bioregion, which falls within the Grassland Biome. These bioregions and biomes are zonal vegetation types, which is vegetation typical of particular climatic zones. Azonal vegetation, in contrast, occurs under special substrate and/or hydrogeological conditions, which exert an over-riding influence on floristic composition, structure and dynamics over macroclimate. There are various azonal vegetation types occurring in the study area, including azonal forest, alluvial vegetation and inland saline vegetation.

Descriptions of the major vegetation types occurring within the study area are given below.

Map 12: Vegetation

2.5.2. Central bushveld bioregion

2.5.2.1. SVcb 1 Dwaalboom Thornveld

The vegetation of the Dwaalboom Thornveld is usually characterised by plains. A layer of scattered, low to medium high, deciduous[7] mircophyllous trees and shrubs with a few broad-leaved tree species occurs. There is an almost continuous herbaceous layer dominated by grass species. Different trees and shrubs dominate in a particular area, depending on the type of soil and clay content. The alternation of soil types creates a mosaic of patches typically 1-5 km across. The main transformation is by cultivation, and the main use is cattle grazing. In conservation it is classified as least threatened.

Important taxa include:

- Tall tree: Acacia erioloba;
- small trees: *Acacia erubescens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *A. fleckii, A. mellifera subsp detinens, Combretum imberbe, Rhus lancea, Ziziphus mucronata;*
- tall shrubs: *Acacia hebeclada* subsp. *hebeclada, Combretum hereroense, Diospyros lycioides* subsp*. lyciodes, Eulea undulata, Grewia flava, Tarchonanthus camphorates*;
- low shrubs: *Acacia tenuispina* (d), *Abutilon austro-africanum, Aptosimum elongatum, Hirpicium bechuanense, Pavoniaa burchellii, Solanum delagoense;*
- succulent shrubs: *Kalanchoe rotundifolia, Talinum caffrum;*
- herbaceous climber: *Rhynchosia minima*;
- graminoids: *Aristida bipartite* (d), *Bothriochloa insculpta* (d), *Diditaria eriantha* subsp. *eriantha* (d), *Ischaemum afrum* (d), *Panicum maximum* (d*), Cymbopogon pospischillii*, *Eragrostis curvula, Sehima galpinii, Setaria incrassata*; and
- herbs: *Heliotropium ciliatum, Kohautia caespitosa* subsp. *brachyloba, Nidorella hottentotica*.

2.5.2.2. SVcb 2 Madikwe Dolomite Bushveld

Madikwe Dolomite Bushveld has gentle ridges and low hills. The tree and shrub layers are often not clearly distinct, especially on steeper slopes. The herbaceous layer is continuous and

[7] **Deciduous** means a plant, which sheds its leaves each year.

dominated by grasses. Some species distributions are associated with the east-west climatic gradient. In conservation it is classified as least threatened.

Important taxa include:

- Tall tree: *Sclerocarya birrea* subsp. *caffra*;
- small trees: *Combretum apiculatum* (d), *Kirkia wilmsii* (d), *Ozoroa paniculosa* (d)*, Rhus lancea* (d), *Combretum imberbe, Rhus leptodictya, Ximenia americana, Ziziphus mucronata*;
- tall shrubs: *Grewia flava* (d), *Tarchonanthus camphorates* (d), *Vitex zeyheri* (d), *Clerodendrum glabrum, Grewia bicolour, G. monticola*; and
- graminoids: *Enneapogon scoparius* (d), *Heteropogon contortus* (d), *Aristida congesta, Panicum coloratum, P. maximum*.

2.5.2.3. SVcb 12 Central Sandy Bushveld

The Central Sandy Bushveld vegetation occurs in low areas. These low areas are sometimes found between mountains and sandy plains and catena. This vegetation unit supports tall deciduous woodlands, with different species dominating a particular point depending on the soil type occurring there. The herbaceous layer is dominated my grass species. The vegetation unit contains two endemic species. Several alien plants are found, at low densities, and widely scattered. In conservation it is classified as Vulnerable.

Important taxa include:

- Tall trees: *Acacia Burkei* (d), *A. Robusta, Sclerocarya birreas* subsp. *Caffra*;
- small trees: *Burkea Africana* (d) *Combretum apiculatum (d), C zeyher, Terminalia serica* (d)*, Ochna pulchra, Peltophorum africanum, Rhus leptodictya*;
- tall shrubs: *Combretum hereoense, Grewia bicolor, G. Monticola, Strychnos pungens*;
- low shrubs: *Agathisanthemum Bojeri* (d)*, Indigofera filipes* (d)*, E. Rigigdior* (d)*, Hyperthelia dissolute* (d)*, Panicum maximum* (d)*, Perotis patens* (d), *Anthephora pubescens, Aristida acabrivals subsp. abrivalvis, Brachiaria serta, Elionurus muticus, Eragrostis nindensis, Loudetia simplex, Schmidtia papophoroides, Themeda triandra, Trachypogon spicatus;*

- herbs: *Dicerocaryum seneiodes* (d)*, Baleria macrostegia, Blephars integrifolia, Crabbea angustifolia, Evolvulus alsinoides, Geigeria burkei, Hermannia lancifolia, Indigofera daleoides, Justicia anagalloides, Kyphocarpa angustifolia, Lophiocarpus tenuissimus, Waltheria indica, Xerophyta humilis.*;
- geophytic[8] herb: *Hypoxis hemerocallidea;* and
- succulent[9] herb: *Aloe greatheadii* var. *davyana;*

Biogeographically Important Taxa (Central Bushveld endemics)

- Graminiod: *Mosdenia leptostachys;* and
- herb: *Oxygonum dregeanum* subsp. *canescens* var. *dissectum.*

2.5.2.4. SVcb 13 Loskop Mountain Bushveld

The vegetation occurs on low mountains and ridges with open tree Savanna on lower-lying areas dominated by *Burkea africana* and a denser broad-leaved tree Savanna on lower slopes and midslopes with prominent *Diplorhynchus condylocarpon*, *Combretum apiculatum* and *Acacia caffra*. The herbaceous layer is dominated by grasses. A small percentage is transformed by cultivation and urban and built-up areas. Erosion is mostly very low to low.

Important taxa include:

- Tall tree: *Acacia burke;*
- small trees: *Acacia caffra* (d), *Burkea africana* (d), *Combertum apiculatum* (d), *C. zeyheri* (d), *Croton gratissimus* (d), *Faurea saligna* (d), *Heteropyxis natalensis* (d), *Ochna pulchra* (d), *Protea caffra* (d), *Pseudolachnostylis maprouifolia* (d), *Terminalia sericea* (d), *Brachylaena rotundata, Combretum molle, Englerophytum magalismontanum, Ozoroa sphaerocarpa, Pappea capensis, Rhus leptodictya, Strychnos cocculoides, Vangueria parvifolia;*
- tall shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Combretum moggii, Grewia flava, Mundulea sericea, Pavetta zeyheri, Psydrax livida, Vitex rehmanni;*

[8] ***Geophytic plant*** means a land plant that survives an unfavourable period by means of underground food-storage organs (e.g. rhizomes, tubers, and bulbs). Buds arise from these to produce new aerial shoots when favourable growth conditions return.

[9] ***Succulent*** means any plant that possesses a succulent tissue, and further specified a succulent tissue is a living tissue that serves and guarantees a temporary storage of utilizable water, which makes the plant temporarily independent from external water supply.

- low shrub: *Rhus zeyheri* (d);
- succulent shrub: *Aloe castanea;*
- graminoids: *Aristida transvaalensis* (d), *Loudetia simplex* (d), *Trachypogon spicatus* (d), *Digitaria eriantha* subsp. *eriantha, Enneapogon pretoriensis, Heteropogon contortus, Setaria sphacelata, Themeda triandra, Tristachya biseriata;* and
- herb: *Xerophyta retinervis.*

Endemic taxa include:

- Geophytic herb: *Gladiolus pole-evansii;* and
- succulent herb: *Haworthia koelmaniorum.*

2.5.2.5. SVcb 15 Springbokvlakte Thornveld

The Springbokvlakte Thornveld occurs on a flat to slightly undulation plains. The vegetation is an open to dense, low thorn Savanna dominated be *Acacia* species or shrubby grassland. The shrub layer is very low. Around half of this vegetation type has been transformed, mainly by cultivation. Alien plants occur scattered over wide areas. In conservation it is classified as endangered.

Important taxa include:

- Small trees: *Acacia karoo* (d), *A. luederitzii* var. *retinens* (d), *A. mellifera* subsp. *detinens* (d), *A nilotica* (d), *Ziziphus mucronata* (d), *Acacia tortilis* subsp. *heteracantha*, *Boscia foetida* subsp. *rehmanniana*;
- tall shrubs: *Euclea undulata* (d), *Rhus engleri* (d), *Dichrostachys cinerea, Diospytos lycioides subsp. lycioides, Grewia flava, Tarchonanthus camphortus*;
- low shrubs: *Acacia tenuispina* (d), *Ptycholobium plicantum*;
- succulent shrub: *Kleinia longiflora*;
- herbaceous climbers: *Momordica balsamina, Rhynchosia minima*;
- graminoids: *Aristida bipartite* (d), *Dichanthium annulatum* var. *papillosum* (d), *Ishaemum afrum* (d), *Setaria incrassata* (d), *Aristidia canescens*, *Brachiaria erucifromis*; and
- herbs: *Aspilla mossambicensis, Indigastrum parviflorum, Nidorella hottentotica, Orthosiphon suffrutescens, Senecio apiifolius*.

2.5.2.6. SVcb 16 Western Sandy Bushveld

Western Sandy Bushveld occurs on slightly undulating plains. The vegetation varies from tall open woodland to low woodland, broad-leaved as well as microphyllous tree species prominent. In conservation it is classified as least threatened.

Important taxa include:

- Tall trees*: Acacia erioloba, A. nigrescens, Sclerocarya birrea* subsp. *caffra*;
- small trees: *Acacia erubescens* (d), *A. mellifera* subsp. *detinens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Combretum apiculatum* (d), *C. imberbe* (d), *Combretum apiculatum* (d), *C. imberbe* (d), *Terminalia sericea* (d), *Combertum zeyheri, lannea discolor, Ochna pulchra, Peltophorum africanum*;
- tall shrubs: *Combretum hereroense* (d), *Euclea undulata* (d), *Coptosperma supra-axillare, Dichrostachys cinerea, Grewia bicolour, G. flava, G. monticola*;
- low shrubs: *Clerodendrum ternatum, Indigofera filipes, Justica flava*;
- graminoids: *Anthrephora pubescens* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis pallens* (d), *E. rigidior* (d), *Schmidtia pappophroides* (d), *Aristida congesta, A. diffusa, A. stipitata* subsp*. graciliflora, Eragrostis superba, Panicum maximum, Perotis patens*; and
- herbs: *Blepharis integrifolia, Chamaecrista absus, Evolvulus alsinoides, Geigeria burkei, Kyphocarpa angustifolia, Limeum fenestratum, L. viscosum, Lophiocarpus tenuissimus, Monsonia angustifolia*.

2.5.2.7. SVcb 17 Waterberg Mountain Bushveld

Waterberg Mountain Bushveld has rugged mountains with vegetation grading through differing kinds of bushveld depending on the kind of soil and slope on which it occurs. The grass layer is moderately developed or well developed. Carrying capacity of the vegetation for domestic stock animals is low, especially during the dry season. In conservation it is classified as least threatened.

Important taxa include:

- Tall tree: *Acacia robusta*;
- small trees: *Acacia caffra* (d), *Burkea africana* (d), *Combretum apiculatum* (d*), Croton grastissimus* (d), *Cussonia transvaalensis* (d), *Faurea saligna* (d), *Heteropyxis natalensis*

(d), *Ochna pulchra* (d), *Protea caffra* (d), *Albizia tanganyicensis, Combretum molle, Englerophytum magalismontanum, Ficus burkei, F. glumosa, Ochna pretoriensis, Pseudolachnostylis ,aprouneifolia, Rhus lancea, Terminalia sericea, Vangueria infuasta, V. parvifolia*;

- tall shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Combretum moggii, C. nelsonii, Dichrostachys cinerea, Euclea crispa subsp. crispa, Gnidia Kraussiana, Olea capensis subsp. enervis, O. europaea* subsp. *africana, Rhus pyroides* var. *pyroides, Strychnos pungens, Vitex rehmannii*;
- low shrubs: *Anthospermum rigidum* subsp. r*igidum, Barleria affinis, Felicia muricata, Helichrysum kraussii, Protea welwitschii* subsp. *welwitshii, Rhus rigida* var. *dentate*;
- geoxylic suffrutices*: Dichapetalum cymosum, Parinari capensis* subsp. *capensis*;
- succulent shrubs: *Aloe chabaubii, Lopholaena coriifolia*;
- woody climbers*: Ancylobotrys capensis* (d), *Rhoicissus revoilii*;
- graminoids: *Loudetia simplex* (d), *Schizachyrium sanguineum* (d), *Trachypogon spicatus* (d), *Barchiaria serrata, Digitaria eriantha* subsp. *eriantha, Elionurus muticus, Enneapogon scoparius, Setaria sphecelata, Themeda triandra, Tristachya leucothrix*;
- herbs: *Berkheya insignis, Chamaecrista mimosoides, Geigeria elongata, Hibiscus meyeri* subsp. *transvaalensis, Xerophyta retinervis*; and
- geophytic herbs: *Haemanthus humillis* subsp*. humillis, Hypoxis rigidula*.

Biogeographically important taxa include:

([CB]Central Bushveld endemic, [N]Nothern Sourveld endemic)

- Small tree: *Encephalartos Eugene-maraisii*[N];
- tall shrub: *Erythrophysa transvaalensis*[CB];
- soft shrub: *Chorisochora transvaalensis*[N]; and
- graminoid: *Mosdenia leptostachys*[CB];

Endemic taxa include:

- Tall shrubs: *Grewia rogersii*, *Pachystigma triflorum*; and
- herb: *Oxygonum dregeanum* subsp. *canescens* var. *pilosum*

2.5.2.8. SVcb 18 Roodeberg Bushveld

Roodeberg Bushveld consists of plains and slightly undulating plains, including some low hills. The vegetation is short closed woodland to tall open woodland and has a poorly developed grass layer. The area is mostly used for game ranching. Transformation is caused mainly be cultivation. In conservation it is classified as least threatened.

Important taxa include:

- Tall trees*: Acacia burkei* (d), *A. nigrescens* (d), *A. robusta* (d*), A. erioloba, Sclerocarya birrea* subsp *caffra*;
- small trees*: Acacia erubescens* (d)*, A. mellifera* subsp. *detinens* (d), *A. nilotica* (d*), A. tortilis* subsp. *heteracanta* (d), *Combretum apiculatum* (d)*, Kirkia acuminata* (d), *Acacia grandicornuta, A. luederitzii* var. *retinens, A. senegal* var. *leiorhachis, Albizia harveyi, Combretum imberbe, Commiphora mollis, Rhus lancea, Terminalia sericea, Ziziphus murconata*;
- tall shrubs: *Dichrostachys cinerea* (d), *Grewia flava* (d), *Euclea crispa* subsp*. crispa, E. undulata, Grewia monticola, Hibiscus micranthus*;
- low shrubs*: Commiphora africana, Melhania acuminata, Sida cordifolia, Solanum delagoense*;
- gramminoids: *Aristida canescens* (d), *Chloris virgata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon cenchroides* (d), *Eragrostis rigidior* (d), *Panicum maximum* (d), *Urochloa mosambicensis* (d), *Aristida congesta*, *Barchiaria deflexa, Cymbopogon pospischilii, Cynodon dactylon, Eragrostis rotifer*; and
- herbs: *Achyranthes aspera, Corbichinia decumbens, Hemizygia elliotii, Kyphocarpa angustifolia, Seddera capensis, Tephrosia purpea* subsp. *leptostachya, Waltheria indica*.

2.5.2.9. SVcb 19 Limpopo Sweet Bushveld

Limpopo Sweet Bushveld occurs on plains that may sometimes be undulating or irregular. These plains are often traversed by several tributaries of the Limpopo River. The vegetation is short open woodland. In disturbed areas dense impenetrable thickets of trees may form. Though limited by low rainfall, this is a good area for game and cattle farming due to the high grazing capacity of the sweet veld. In conservation it is classified as least threatened.

Important taxa include:

- Tall trees: *Acacia robusta* (d), *A. burkei*;
- small trees: *Acacia erubescens* (d), *A. fleckii* (d), *A. nilotica* (d), *A. trunca* (d), *Combretum alexandi* (d), *Dichrostachys cinerea* (d), *Phaeoptilum spinosum* (d), *Rhigozum obovatum* (d), *Cadaba aphylla*, *Combretum hereroense, Commiphora pyracanthoides, Ehretia rigida* subsp. *rigida, Euclea undulata, Grewia flava, Gymnosporia senegalensis*;
- low shrubs: *Acacia tenuispina* (d), *Commiphora africana, Felicia muricata, Gossypium herbaceum* subsp. *africanum, Leucosphaera bainesii*;
- graminoids: *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon cenchroides* (d), *Eragrostis lehmanniana* (d), *Panicum coloratum* (d), *Schmidtia pappophorodies* (d), *Aristida congesta, Cymbopogon nardus, Eragrostis pallens, E. rigidior, E. trichophora, Ischaemum afrum, Panicum maximum, Setaria verticillata, Stipagrostis uniplumis, Urochloa mosambicensis*;
- herbs: *Acanthosicyos naudinianus, Commelina benghalensis, Harpagophytum procumbens* subsp. *transvaalense, Hemizygia elliotii, Hermbstaedtia odorata, Indigofera daleoides*; and
- succulent herbs: *Kleinia fulgens, Plectranthus neochilus*.

2.5.2.10. SVcb 20 Makhado Sweet Bushveld

The vegetation type occurs on slightly to moderately undulating plains sloping generally down to the north with some hills in the southwest. It is a short and shrubby bushveld with a poorly developed grass layer. Part of the area has densly populated rural communities. Erosion is low to high.

Important taxa include:

- Small trees: *Acacia erubescense* (d), *A. gerrardii* (d), *A. mellifera* subsp. *detinens* (d), *A. rehmanniana* (d), *Boscia albitrunca* (d), *Combertum apiculatum* (d), *Acacia tortillis* subsp. *heteracantha, Terminalia sericea;*
- tall shrubs: *Commiphora pyracanthoides, Dichrostachys cinerea, Grewia flava, Hibiscus calyphyllus, Lycium shawii, Rhigozum obovatum;*
- low shrubs: *Baleria lancifolia, Hirpicium bechuanense, Indigofera poliotes, Melhania rehmannii, Pechuel-Loeschea leubnitziae;*

- graminoids: *Anthephora pubescens* (d), *Aristida stipitata* subsp. *graciliflora* (d), *Cenchrus ciliaris* (d), *Enneapogon scoparius* (d), *Brachiaria nigropedata, Eragrostis trichophora, Panicum coloratum, P. maximum, Schmidtia pappophoroides, Urochloa mosambicensis;* and
- herbs: *Chamaecrista absus, Corbichonia decumbens, Geigeria acaulis, Harpagophytum procumbens* subsp. *transcaalense, Heliotropium steudneri, Hemizygia elliotii, Hermbstaedtia odorata, Lecas sexdentata, Osteospermum muricatum, Tephrosia purpurea* subsp. *leptostachya.*
- Endemic taxon;
- Herb: *Dicliptera minor* subsp. *pratis-manna.*

2.5.2.11. SVcb 23 Polokwane Plateau Bushveld

It occurs on moderately undulating plains with a short open tree layer and with a well-developed grass layer to grass plains with occasional trees at higher altitudes. Hills and low mountains of Mamabolo Mountain Bushveld are embedded within this unit. Dense concentration of rural human settlements is found. In some regions populations of alien *Agave, Jacaranda mimosfolia, Melia azedarach, Opuntia ficus-indica* and *Ricinus communis* are of concern.

Important taxa include:

- Small trees: *Acacia caffra* (d), *A. permixta* (d), *A. rehmanniana* (d), *A. karroo, A. tortilis* subsp. *heteracantha, Combretum molle, Ormocarpum kirkii, Ziziphus mucronata;*
- succulent tree: *Aloe marlothii* subsp. *marlothii;*
- tall shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Gymnosporia senegalensis* (d), *Combretum hereroense, Diospyros lycioides* subsp. *sericea, Euclea crispa* subsp. *crispa, Heteromorpha arborescens* var. a*byssinica*, *Lippia javanica, Rhus pyroides* var, *pyroides, Tephrosia rhodesica, Triumfetta pilosa* var. *tomentosa;*
- low shrubs: *Anthospermum rigidum* subsp. *rigidum, Gymnosporia glaucophylla, Hirpicium bechuanense, Lantana rugosa, Senecio burchellii, Sida rhombifolia, Solanum panduriforme;*
- succulent shrub: *Aloe cryptopoda;*
- woody climber: *Asparagus africanus;*

- herbaceous climbers: *Momordica balsamina, Rubia petiolaris;*
- graminoids: *Aristida diffusa* (d), *Brachiaria nigropedata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis curvula* (d), *Themeda triandra* (d), *Aristida congesta, Cymbopogon caesius, Cynodon dactylon, Digitaria diagonalis, Diheteropogon amplectens, Elionurus muticus, Eragrostis gummiflua, E. racemosa, E. superba, Eustachys paspaloides, Panicum maximum, Pogonarthria squarrosa, Sporobolus africanus;*
- herbs: *Felicia mossamedensis, Hermbstaedtia odorata, Pollichia campestris;*
- geophytic herbs: *Eulophia petersii, Hypoxis hemerocallidea;* and
- succulent herb: *Aloe greatheadii* var. *greatheadii.*

Biogeographically important taxa (central bushveld endemics) include:

- Graminoid: *Mosdenia leptostachys;*
- herb: *Oxygonum dregeanum* subsp. *canescens* var. *dissecturn;* and
- geophytic herb: *Ledebouria crispa.*

2.5.2.12. SVcb 24 Mambolo Mountain Bushveld

Mambolo Mountain Bushveld occurs on low mountains, the lower slopes of Strydpoort and Makapan ranges and on rocky hills. These slopes are moderate to steep and very rocky. They are covered by small trees and shrubs. Rock slabs or domes are sparsely vegetated, and then mostly with a mixture of xerophytic[10] or resurrection plants, with several succulents. Two endemic succulent shrubs can be found in this vegetation unit. Alien plants also occur. Land uses include grazing wood harvesting and medicinal plant collecting. In conservation it is classified as least threatened.

Important taxa include:

- Tall tree: *Sclerocarya birrea* subsp. *caffra;*
- small trees: *Combretum molle* (d), *Croton gratissimus* (d), *Heteropyxis natalensis* (d), *Acacia caffra*, *A. davyi*, *A. gerrardii*, *A. nilotica*, *Berchemia zeyheri, Cussonia natalensis, C. transvaalensis, Dombeya rotundifolia, Erythrina Iysistemon, Lannea discolor, May tenus undata, Pappea capensis, Rhus leptodictya, Schotia brachypetala;*

[10] **Xerophytic** means a plant adapted to living in a dry arid habitat.

- succulent trees: *Euphorbia cooperi* (d), *Aloe marlothii* subsp. *marlothii, Euphorbia ingens;*
- tall shrubs: *Clerodendrum glabrum* (d), *Elephantorrhiza burkei* (d), *Acokanthera oppositifolia, A. rotundata*, *Buddleja saligna, Canthium mundianum, Carissa edulis, Ehretia obtusifolia, Euclea crispa* subsp. *crispa* (short, small-leaved form), *Grewia occidentalis, Hibiscus calyphyllus, Olea europaea* subsp. *africana*, *Pouzolzia mixta, Rhus pentheri, R. rehmanniana, Scutia myrtina, Tarchonanthus parvicapitulatus;*
- low shrubs: *Diospyros lycioides* subsp. *nitens* (d), *Grewia vernicosa* (d), *Barleria rotundifolia, Gossypium herbaceum* subsp. *africanum, Gymnosporia glaucophylla, Hermannia floribunda, Heteromorpha stenophylla* var. *transvaalensis, Lantana rugosa, Myrothamnus flabellifolius, Plinthus rehmannii;*
- succulent shrubs: *Kalanchoe sexangularis* (d), *Kleinia longiflora* (d), *Aloe arborescens, Cotyledon barbeyi, C. orbiculata* var. *orbiculata, Kalanchoe paniculata, K. rotundifolia, Senecio berbertonkus, Tetradenia riparia;*
- woody climbers: *Asparagus buchananii* (d), *Jasminum multipartitum* (d), *Acacia ataxacantha, Cryptolepis cryptolepidioides;*
- herbaceous climber: *Pentarrhinum insipidum;*
- graminoids: *Cymbopogon caesius* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Heteropogon contortus* (d), *Aristida congesta, A. diffusa, Enneapogon scoparius, Eragrostis rigidior, Tricholaena monachne, Triraphis andropogonoides;*
- herb: *Vahlia capensis* subsp. *vulgaris;*
- geophytic herbs: *Boophone disticha, Drimia altissima, D. robusta, Eulophia petersii;* and
- succulent herbs: *Aloe greatheadii* var. *greatheadii* (d), *Aeollanthus rehmannii, Avonia rhodesica, Crassula swaziensis, Plectranthus grandidentatus, P. hadiensis.*

Endemic taxon:

- Succulent shrubs: *Euphorbia clivicola, Khadia media.*

2.5.2.13. SVcb 25 Poung Dolomite Mountain Bushveld

It is open to closed woodland with well-developed shrub layers and occurs on low to high mountain slopes on various slope angles, aspects and altitude, especially along the western extension.

Important taxa include:

- Small trees: *Hippobromus pauciflorus* (d), *Kirkia wilmsii* (d), *Seemannaralia gerrardii* (d), *Boscia albitrunca, Combretum hereroense, Croton gratissimus, Dombeya autumnalis, Vitex obovata* subsp. *wilmsi;*
- succulent tree: *Euphorbia tirucalli* (d);
- tall shrubs: *Pouzolzia mixta, Senna petersiana;*
- low shrubs: *Asparagus intricatus* (d), *Barleria rotundifolia, Euchaetis schlechteri, Rhynchosia nitens;*
- geoxylic suffrutex: *Ozoroa albicans;*
- succulent shrub: *Plectranthus xerophilus* (d);
- woody climbers: *Pristimera longipetiolata, Tecoma capensis;*
- graminoids: *Bewsia biflora* (d), *Brachiaria serrata* (d), *Eragrostis lehmanniana* (d), *Loudetia simplex* (d), *Melinis repens* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Enneapogon scoparius, Heteropogon contortus, Melinis nerviglumis, Panicum deustum, Tragus berteronianus;*
- herb: *Stylochaeton natalensis;*
- geophytic herbs: *Cheilanthes dolomiticola* (d), *Sansevieria hyacinthoides;* and
- succulent Herb: *Plectranthus neochilus.*

Biogeographically important taxa:

([N]Northern Sourveld endemic, [SK]Sekhukhune endemic)

- Small shrub: *Lynburgia cassinoides*[SK] (d);
- low shrub: *Asparagus fourei*[N];
- soft shrub: *Chorisochora transvaalensis*[N]*;*
- megaherb: *Dracaena transvaalensis*[N] (d)*;* and
- geophytic herb: *Haemanthus pauculifolius*[N]*.*

Endemic taxa:

- Small trees: *Encephalartos dolomiticus, E. inopinus;*

- low shrub: *Melhania integra;*
- succulent shrubs: *Delosperma vandermerwei, Euphorbia grandialata;*
- herbs: *Barleria dolomiticola, Lotononis pariflora;*
- geophytic herbs: *Brachystelma minor, B. parvulum, Gladiolus dolomiticus,* G. *pavonia, Ledebouria dolomiticola;* and
- succulent herbs: *Aloe branddraaiensis, A. monotropa, Gasteria batesiana* var. *dolomitica, Huernia blyderiverensis, Plectranthus dolomiticus.*

2.5.2.14. SVmp 1 Musina Mopane Bushveld

This vegetation type occurs on undulating to very irregular plains, with some hills. The dominating species is largey dependent on the type of soil underlying the vegetation. The field layer is well developed and open during the dry season. The herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs.

Important taxa include:

- Tall trees: *Acacia nigrescens, Adansonia digitata, Sclerocarya birrea* subsp. *caffra*;
- small trees: *Colophospermum mopane* (d), *Combretum apiculatum* (d), *Acacia Senegal* var. *leiorhachis, A. tortilis subsp. heteracantha, Boscia albitrunca, B. foetida* subsp. *rehmanniana, Commiphora glandulosa, C. tenuipetiolata, C. viminea, Sterculia rogersii, Terminalia prunioides, T. sericea, Ximenia americana*;
- tall shrubs: *Grewia flava* (d), *Sesamothamnus lugardii* (d), *Commiphora pyracanthoides, Gardenia volkensii, Grewia bicolor, Maerua parvifolia, Rhigozum zambesiacum, Tephrosia polystachya*;
- low shrubs: *Acalypha indica, Aptosimum lineare, Barleria sensnsis, Dicoma tomentosa, Felicia clavipilosa* subsp. *transvaalensis, Gossypium herbaceum* subsp. *africanum, Hermannia glanduligera, Neuracanthus africanus, Pechuel-Loeschea leubnitziae, Ptycholobium contortum, Seddera suffruticosa*;
- succulent shrub: *Hoodia currorii* subsp. *lugardii*;
- herbaceous climber: *Momordica balsamina*;
- graminoids: *Schmidtia pappophroides* (d), *Aristida adscensionis, A. congesta, Bothriochloa insculpta, Brachiaria deflexa, Cenchrus cillaris, Digitaria eriantha subsp.*

eriantha, Enneapogon cenchroides, Eragrostis lehmanniana, E. pallens, Fingerhuthia africana, Heteropogon contortus, Sporobolus nitens, Stipagrostis hirtigluma subsp. *patula, S. uniplumis, Tetrapogon tenellus, Urochloa mosambicensis*;

- herbs: *Acrotome inflata, Becium filamentosum, Harpagophytum procumbens* subsp. *transvaalense, Heliotropium steudneri, Hermbstaedtia odorata, Oxygonum delagoense*; and
- succulent herbs: *Stapelia gettliffei, S. kwebensis*.

2.5.3. Mesic Highveld Grassland Bioregion

2.5.3.1. Gm 27 Strydpoort Summit Sourveld

Strydpoort Summit Sourveld vegetation can be characterised by short to tall grassland along rocky summits and mountain slopes. The landscape has a broken topography. There are many deeply incised valleys. The sparsely wooded slopes are steep and rocky. Transformation levels are very low. In conservation it is classified as least threatened.

Important taxa include:

- Small trees: *Acacia caffra* (d), *Combretum molle* (d), *Cussonia paniculata* (d), *Englerophytum magalismontanum* (d), *Protea caffra* subsp. *caffra* (d), *Cussonia transvaalensis, Faurea saligna, Mundulea sericea, Protea roupelliae* subsp. *roupelliae, P. rubropilosa, Vanqueria infausta*;
- tall shrub: *Rhus dentate*;
- woody climbers: *Ancylobotrys capensis, Rhoicissus tridentate*;
- low shrubs: *Rhus magalismontana* (d), *Aeschynomene rehmannii, Anthospermum hispidulum, Chrysanthemoides monilifera* subsp. *septentrionalis, Justicia betonica, Leonotis ocymifolia, Polygala hottentotta*;
- graminiods: *Aristida transvaalensis* (d), *Loudetia simplex* (d), *Monocymbium ceresiiforme* (d), *Schizachyrium sanguineum* (d), *Themeda triandra* (d), *Trachypogon spicatus* (d), *Tristachya leucothrix* (d), *Alloteropsis semialata* subsp. *eckloniana*, *Andropogon chinensis, Bulbostylis burchellii, Diheteropogon amplectens, D. filifolius, Elionurus muticus, Eragrostis racemosa, Sporobolus pectinatus*;

- herbs: *Acalypha angustata, Helichrysum nudifolium* var. *nudifolium, Monsonia attenuata, Pearsonia sessilifolia* subsp. *sessifolia, Rhynchosia monophylla, Selanginella dregei, Vernonia galapinii, V. natalensis, Xerophyta retinervis*;
- herbaceous climber: *Rhynchosia totta*; and
- succulent herbs: *Aloe fosteri, Crassula swaziensis, Kleinia stapeliiformis*.

Biogeographically important taxa include:

([N]Northern sourveld endemic, [W]Wolkberg endemic)

- Small trees: *Encephalartos Eugene-maraisii*[N], *Protea rubropilosa*[W];
- tall shrub: *Vitex obovata* subsp. *wilmsii*[N],
- low shrubs: *Berkheya carlinopsis* subsp. *magalismontana*[N], *Helichrysum uninervium*[N]; and
- succulent herbs: *Aloe affinis*[N], *A. thompsoniae*[W].

Endemic taxa include:

- Succulent shrub: *Thorncroftia media*;
- semiparasitic shrub: *Thesium gracilentum*; and
- herb: *Aster nubimontis*.

2.5.3.2. Gm 29 Waterberg-Magaliesberg Summit Sourveld

The Waterberg-Magaliesberg Summit Sourveld has rugged summit crests and adjacent steep rocky slopes supporting a mosaic of low, wiry, closed grasslands and scattered closed-canopy bush clumps. The extent of the rock outcrops, rock boulders and local soil depth plays a determining role in the extent to which bush clumps occur within the grasslands. The rocks and woody vegetation are able support rich epilithic and epiphytic lichen and bryophyte flora due to the frequent mist. In conservation it is classified as least threatened.

Important taxa include:

([B]Also Blouberg)

- Small trees: *Acacia caffra* (d), *Combretum molle* (d), *Englerophytum magalismontanum* (d), *Protea caffra* subsp. *caffra* (d), *Cussonia natalensis*, *Faurea saligna*[B], *Mundulea sericea, Protea roupelliae* subsp. *roupelliae, Vangueria infausta*;

- tall shrubs: *Euryops brevipapposus*[B], *Hyperacanthus amoenus, Rhus dentate*;
- woody climber: *Ancylobotrys capensis*;
- low shrubs: *Aeschynomene rehmannii, Anthospermum hispidulum, Erica woodii*[B], *Justicia betonica, Leonotis ocymifolia, Myrsine africana, Passerina Montana, Polygala hottentotta*;
- succulent shrub: *Cotyledon barbeyi*;
- graminoids: *Aristida transvaalensis* (d), *Monocymbium ceresiiforne* (d), *Schizachyrium sanguineum* (d), *Themeda triandra* (d), *Trachypogon spicatus* (d), *Andropogon chinensis, Blubostylis burchellii, Diheteropogon amplectens, Eragrostis racemosa, Ischyrolepis schoenoides*[B], *Panicum maximum, Pentaschistis natalensis*[B], Tristachya rehmanii;
- herbs: *Acalypha angustata*, *Helichrysum nudifolium* var. *nudifolium*, *H. subglomeratum*[B], Rhyncho*sia monophylla, Selaginella dregei, Tephrosia purpurea* subsp. *leptostachya, Vernonia galpinii, Waltheria indica, Xerophyta retinervis*;
- herbaceous climber: Rhynchosia totta;
- geophytic herb*: Agapanthus inapertus* subsp. *intermedius*[B]; and
- succulent herb: *Crassula swaziensis.*

Biogeographically important taxa include:

([B]also on Bloubreg, [N]Northern sourveld endemic, [S]Soutpansberg endemic)

- Low shrubs: *Berkheya carlinopsis* subsp. *magalismontana*[N], *Eriocephalus longifolius*[N];
- herbs: Teraselago wilmsiiN;
- geophytic herbs: *Agapanthus dyeri*[N,B], *Cyrtanthus thorncroftii*[N]; and
- succulent herbs: *Aloe vossii*.

2.5.4. Zonal and Intrazonal Forest

2.5.4.1. FOz 2 Northern Afrotemperate Forest

The Northern Afrotemperate Forest vegetation is a low, relatively species-poor forest of afromontane[11] origin. Some of the forests still clearly show afromontane character. The major threats to this type of vegetation are uncontrolled timber extraction, medicinal-plant harvesting, grazing and the occasional hot fires encroaching from the surrounding Savanna woodlands. There are a few endemic species within this vegetation unit. In conservation it is classified as least threatened.

Important taxa include:

- Tall trees: *Celtis africana* (d), *Halleria lucida* (d), *Olinia emarginata* (d), *Pittosporum viridiflorum* (d), *Podocarpus latitolius* (d), *Rothmannia capensis* (d), *Scolopia mundii* (d), *Afrocarpus falcatus, Buddleja saligna, Dais* co*tinifolia*, *Ilex mitis;*
- small trees: *Acalypha glabrata* (d), *Buddleja salvidolia* (d), *Calpurnia aurea* (d), *Combretum erythrophy/lum* (d), *Diospyros lycioides* subsp *guerkei* (d), *D. whyteana* (d), *Euclea crispa* subsp. *crispa* (d), *Widdringtonia nodiflora* (d), *Bowkeria verticillata, Canthium ciliatum, Leucosidea sericea, Scolopia flanaganii.* woody climber: *Cassinopsis ilicdolia* (d);
- tall shrubs: *Myrsine africana* (d), *Cliffortia nitidula;*
- soft shrubs: *Isoglossa grantii* (d), *Hypoestes aristata, Plectranthus fruticosus.* herbs: *Plectranthus grallatus* (d), *P hereroensis* (d), *Peperomia retusa, Streptocarpus haygarthii,* S. *pusillus;*
- geophytic herbs: *Blechnum attenuatum (d), Asplenium aethiopicum, Polystichum luctuosum;* and
- graminoids: *Carex spicato-paniculata (d), Oplismenus hirtellus (d), Cyperus albostriatus, Schoenoxiphium lehmannii, Thamnocalamus tessellatus.*

Endemic taxa include:

- Tall tree: *Scolopia oreophila;*
- small tree: *Maytenus albata;*

[11] **Afromontane** means the plant and animal species common to the mountains of Africa.

- tall shrub: *Sparrmannia ricinocarpa;* and
- herb: *Streptocarpus polyanthus* subsp. *dracomontanus.*

2.5.5. Azonal Forest

2.5.5.1. FOa 1 Lowveld Riverine Forest

The Lowveld Riverine Forests are tall forests fringing larger rivers (gallery forests) and water pans. These forests are dense and tall, structured into several tree layers and with a well-developed dense shrub layer. Clearing for cultivation has transformed an unknown portion. Agricultural malpractices upstream, building of dams and excessive water extraction for agriculture and mining as well as local exploitation for timber and non-timber forest products are serious threats to this vegetation. In conservation it is classified as critically endangered.

Important taxa include:

- Tall trees: *Acacia robusta* subsp. *calvigera* (d), *Breonadia salicina* (d), *Diospyros mespiliformis* (d), *Faidherbia albida* (d), *Ficus sycomorus* (d), *Kigelia africana* (d), *Berchemia discolor, Combretum erythropyllum, C. imberbe, Ekebergia capensis, Philenoptera violacea, Rauvolfia caffra, Spirostachys africana, Syzygium guineense, Trichilia emetica, Xanthocercis zambesiaca;*
- small trees: *Combertum hereroense, Corton megalobotrys, Hyphaene coriacea, Nuxia oppositifolia, Phoenix reclinata, Vernonia colorata;*
- tall shrubs: *Abutilon angulatum, Acacias schweinfurthii, Ficus carprefolia;*
- soft shrub: *Hypoestes aristata;*
- herb: *Achyranthes aspera* (d); and
- graminoids: *Digitaria eriantha* (d), *Panicum maximum* (d), *Echinochloa pyramidalis, Eriochloa meyeriana, Panicum coloratum, Phragmites mauritianus, Seraria incrassata, S. sphacelata, Sporobolus consimillis.*

2.5.6. Alluvial Vegetation

2.5.6.1. AZa 7 Subtropical Alluvial Vegetation

Subtropical Alluvial Vegetation occurs on flat flat alluvial[12] riverine terraces supporting and intricate complex of large vegetation (channel of flowing rivers and river-fed pans), marginal reed belts (in sheltered oxbows and along very slow-flowing water courses) as well as extensive flooded grasslands, short lived herblands and riverine thickets. Much of this vegetation has been transformed for cultivation, urban development and road building. Alien woody species commonly occur in this vegetation. In conservation there is currently a lack of data concerning this vegetation type.

Important taxa include:

(Riparian thickets)

- Small trees: *Acacia natalitia* (d), *A. robusta* (d), *Boscia foetida* subsp. *rehmanniana* (d), *Combretum erythrophyllum* (d), *Phoenix reclinata* (d), *Salix mucronata* subsp. *woodii* (d), *Ziziphus mucronata* (d), *Acacia luederitzii, A. nebrownii, A. nigrescens, A. tortllls, A. xanthophloea, Colophospermum mopane, Combretum hereroense, Philenoptera violacea, Pseudoscolopia polyantha* (Pondoland, sharing with Capensis).
- tall shrubs: *Salvadora angustifolia* (d), *Commiphora glandulosa, C. pyracanthoides, Euclea divinorum, Grewia bicolor, Gymnosporia senegalensis;*
- low shrubs: *Justicia flava, Ocimum canum;*
- graminoids: *Eragrostis trichophora* (d), *Panicum maximum* (d), *Setaria incrassata* (d), *Sporobolus ioclados* (d), *Chloris virgata, Dactyloctenium aegyptium, Enneapogon cenchroides, Urochloa mosambicensis;*
- herbs: *Commelina benghalensis* (d), *Abutilon austro-africanum, Acalypha indica, Achyranthes aspera, Boerhavia erecta, Commicarpus fallacissirnus, Cucumis zeyheri, Heliotropium ovalifolium, Lobelia angolensis, Oxygonum sinuatum, Pupalia lappacea, Ruellia patula;*
- geophytic herb: *Crinum moorei;* and
- succulent herb: *Portulaca quadrifida.*

(Reed beds)

[12] **Alluvial** means made of clay, sand, or dirt washed by flowing water.

- Megagraminoids: *Phragmites australis* (d), *P. mauritianus* (d), *Prionium serratum* (only along few rapids in Pondoland).

(Flooded grasslands and herb lands)

- Megagraminoid: *Cyperus immensus;*
- graminoids: *Cynodon dactylon* (d), *Cyperus articulatus* (d), *Echinochloa pyramidalis* (d), *Urochloa mosambicensis* (d), *Bolboschoenus glaucus, Chloris mossambicensis, C. virgata, Cyperus corymbosus, C. difformis, C. distans, C. fastigiatus, C. sexangularis, Dactyloctenium aegyptium, Hemarthria altissima, Ischaemum afrum, Paspalidium obtusifolium, Setaria sphacelata, Sporobolus consimilis, S. fimbriatus;*
- herbs: *Alternanthera sessilis, Amaranthus praetermissus, Grammatotheca bergiana* (Pondoland), *Marsilea ephippiocarpa, Scutellaria racemosa;*
- geophytic herb: *Trachyandra selti;* and
- aquatic herbs: *Ceratophyllum muricatum, Ottelia exserta.*

Endemic Taxon:

(Flooded grasslands and herblands)

- Herb: *Crotalaria mollii.*

2.5.7. Freshwater Wetlands

2.5.7.1. AZf 6 Subtropical Freshwater Wetlands

It occurs on flat topography supporting low beds dominated by reeds, sedges and rushes, waterlogged meadows dominated by grasses. Found typically along edges of often seasonal pools in Aeolian depressions as well as fringing alluvial backwater pans or artificial dams. So far only about 4% has been transform (largely for cultivation), but the pressure of local grazing a urban sprawl will result in the demise of many subtropical fresh water habitats. Disturbance leads to invasion by alien plants such as *Lantana camara, Chromolaena discolor* and *Melia darach* (on the edges of wetlands) and aquatic weeds such *Eichhornia crassipes, Pistia stratiotes* and *Salvinia molesta* (in water bodies).

Important taxa include:

a) Marshes

- Small trees: *Hyphaene coriacea* (d), *Phoenix reelinata* (d);

- graminoids: *Chloris virgata* (d), *Cynodon dactylon* (d), *Cyperus articulatus* (d), *Dactyloctenium aegyptium* (d), *Diplachne fusca* (d), *Echinochloa pyramidalis* (d), *Fimbristylis obtusifolia* (d), *Hemarthria altissima* (d), *Imperata cylindrica* (d), *Ischaemum arcuatum* (d), *Leersia hexandra* (d), *Pycreus mundii* (d), *Sporobolus nitens* (d), *S. smutsii* (d), *Urochloa stolonifera* (d), *Bolboschoenus glaucus, Courtoisia cyperoides, Cyperus alopecuroides, C. pectinatus, Oigitaria natalensis, Echinochloa stagnina, Eragrostis chapelieri, E. lappula, Eriochloa meyeriana, Fimbristylis bisumbellata, Fuirena ecklonii, Oxycaryum cubense, Paspalidium obtusifolium, Paspalum commersonii, Pycteus pelophilus, P. polystachyos, Selena poiformis, Sporobolus consimiles;*
- herbs: *Pentodon pentandrus* (d), *Persicaria senegalensis* (d), *Burmannia madagascariensis, Centella coriacea, Commelina dittuse, Convolvulus mauritanicus, Desmodium dregeanum, Eelipta prostrata, Epaltes gariepina, Eriocaulon abyssinicum, Ethulia conyzoides, Glinus lotoides, Hydrocotyle ranunculoides, Ludwigia adscendens* subsp. *ditfusa, L. leptocarpa, L. octovalvis, L. palustris, Neptunia oleracea, Persicaria attenuata* subsp. *africana, P. hystricula, Rorippa madagascariensis, Sium repandum, Vahlia capensi;*
- geophytic herbs: *Eulophia angolensis, Zeuxine africana;*
- succulent herb: *Salicornia pachystachya;*
- semiparasitic herb: *Buchnera longespicata;* and
- aquatic herbs: *Bergia salaria, Lagarosiphon crispus.*

b) Lakes and ponds

- Graminoid: *Eleocharis dulcis* (forming rafts);
- aquatic herbs: *Azolla pinnata* var. *africana* (d), *Ceratophyllum demersum* (d), *Lemna minor* (d), *Nymphaea nouchali* var. *caerulea* (d), *Pistia stratiotes* (d), *Wolffia arrhiza* (d), *Aponogeton desertorum, A. natalensis, A. rehma Ceratophyllum muricatum, Marsilea macrocarpa, Najas marl* subsp. *delilei, N. pectinata, Nymphoides indica* subsp. *occidentalis, N. rautanenii, Ottelia exserta, Potamageton crispus, P. tinatus, P. schweinfurthii, Spirodela polyrhiza, S. punctata, Trapanatans* var. *bispinosa.*
- carnivorous herbs: *Utricularia* subsp. *exoleta, U. inflexa, U. subulata;* and
- geophytic herb: *Crinum paludosum.*

c) Reed and sedge beds

- Megagraminoids: *Cladium mariscus* subsp. *jamaicense* (d), *Cyperus papyrus* (d), *Phragmi australis* (d), *P. mauritianus* (d), *Schoenoplectus corymbosus, S. scirpoideus* (d), *Typha capensis* (d); and
- graminoids: *Cyperus tigiatus* (d), C. *difformis, C. digitatus, C. latifolius, C. sexangularis, Fuirena ciliaris.*

Biogeographically mportant taxa (all southernmost distribution limit):

a) Stream banks

- Herb: *Floscopa glomerata, Ipomoea aquatica;* and
- geophytic herb: *Bolbitis heudelotii.*

b) Lakes and ponds

- Aquatic herbs: *Brasenia schreberi, Ceratopteris comuta, Wolffia globosa, Wolffiella welwitschii;* and
- herbs: *Hygrophila schulii, Limnophyton obtusifolius, Marsilea apposita, M. coromandeline. M. minuta, M. villifolia.*

c) Reed and sedge beds

- Graminoids: *Cyperus dives, C. procerus, C. proliter.*

2.5.7.2. AZf 6 Albany Alluvial Vegetation

Subtropical freshwater wetlands occur on flat topography supporting low beds dominated by reeds, sedges and rushes, waterlogged meadows dominated by grasses. This vegetation type is found typically along edges of often seasonal pools in Aeolian depressions as well as fringing alluvial backwater pans or artificial dams. Pressure of local grazing and urban sprawl will result in the demise of many subtropical fresh water habitats. Disturbance leads to invasion by alien plants. In conservation it is classified as least threatened.

Important taxa include:

(Marshes)

- Small trees: *Hyphaene coriacea* (d), *Phoenix reelinata* (d);

- graminoids: *Chloris virgata* (d), *Cynodon dactylon* (d), *Cyperus articulatus* (d), *Dactyloctenium aegyptium* (d), *Diplachne fusca* (d), *Echinochloa pyramidalis* (d), *Fimbristylis obtusifolia* (d), *Hemarthria altissima* (d), *Imperata cylindrica* (d), *Ischaemum arcuatum* (d), *Leersia hexandra* (d), *Pycreus mundii* (d), *Sporobolus nitens* (d), *S. smutsii* (d), *Urochloa stolonifera* (d), *Bolboschoenus glaucus, Courtoisia cyperoides, Cyperus alopecuroides, C. pectinatus, Oigitaria natalensis, Echinochloa stagnina, Eragrostis chapelieri, E. lappula, Eriochloa meyeriana, Fimbristylis bisumbellata, Fuirena ecklonii, Oxycaryum cubense, Paspalidium obtusifolium, Paspalum commersonii, Pycteus pelophilus, P. polystachyos, Selena poiformis, Sporobolus consimiles;*
- herbs: *Pentodon pentandrus* (d), *Persicaria senegalensis* (d), *Burmannia madagascariensis, Centella coriacea, Commelina dittuse, Convolvulus mauritanicus, Desmodium dregeanum, Eelipta prostrata, Epaltes gariepina, Eriocaulon abyssinicum, Ethulia conyzoides, Glinus lotoides, Hydrocotyle ranunculoides, Ludwigia adscendens* subsp. *ditfusa, L. leptocarpa, L. octovalvis, L. palustris, Neptunia oleracea, Persicaria attenuata* subsp. *africana, P. hystricula, Rorippa madagascariensis, Sium repandum, Vahlia capensi;*
- geophytic herbs: *Eulophia angolensis, Zeuxine africana;*
- succulent herb: *Salicornia pachystachya;*
- semiparasitic herb: *Buchnera longespicata;* and
- aquatic herbs: *Bergia salaria, Lagarosiphon crispus.*

(Lakes and ponds**)**

- Graminoid: *Eleocharis dulcis* (forming rafts);
- aquatic herbs: *Azolla pinnata* var. *africana* (d), *Ceratophyllum demersum* (d), *Lemna minor* (d), *Nymphaea nouchali* var. *caerulea* (d), *Pistia stratiotes* (d), *Wolffia arrhiza* (d), *Aponogeton desertorum, A. natalensis, A. rehma Ceratophyllum muricatum, Marsilea macrocarpa, Najas marl* subsp. *delilei, N. pectinata, Nymphoides indica* subsp. *occidentalis, N. rautanenii, Ottelia exserta, Potamageton crispus, P. tinatus, P. schweinfurthii, Spirodela polyrhiza, S. punctata, Trapanatans* var. *bispinosa.*
- carnivorous herbs: *Utricularia* subsp. *exoleta, U. inflexa, U. subulata;* and
- geophytic herb: *Crinum paludosum.*

(Reed and sedge beds)

- Megagraminoids: *Cladium mariscus* subsp. *jamaicense* (d), *Cyperus papyrus* (d), *Phragmi australis* (d), *P. mauritianus* (d), *Schoenoplectus corymbosus, S. scirpoideus* (d), *Typha capensis* (d); and
- graminoids: *Cyperus tigiatus* (d), C. *difformis, C. digitatus, C. latifolius, C. sexangularis, Fuirena ciliaris.*

Biogeographically important taxa (all southernmost distribution limit):

(Stream banks)

- Herb: *Floscopa glomerata, Ipomoea aquatica;* and
- geophytic herb: *Bolbitis heudelotii.*

(Lakes and ponds)

- Aquatic herbs: *Brasenia schreberi, Ceratopteris comuta, Wolffia globosa, Wolffiella welwitschii;* and
- herbs: *Hygrophila schulii, Limnophyton obtusifolius, Marsilea apposita, M. coromandeline. M. minuta, M. villifolia.*

(Reed & sedge beds)

Graminoids: *Cyperus dives, C. procerus, C. proliter.*

2.5.8. Inland Saline Vegetation

2.5.8.1. AZi 11 Subtropical Salt Pans

Subtropical salt pans occur in shallow depressions, often found on old alluvial terraces of rivers. They are surrounded by zones of bank reeds or low herblands and in more perennial pans also filled with a dense carpet of macrphytic floating vegetation. The edges of some pans may have an alien plant infestation. Alien species are dominant in some Lowveld pans when filled with water. . In conservation it is classified as least threatened.

Important taxa include:

(Drained pan bottoms)

- Graminoids: *Cynodon dactylon* (d), *Diplachne eleusine* (d), *Eragrostis rotifer* (d), *Cloris virgata, Cyperus indecorus;* and

- herbs: *Isoetes schweinfurthii, Persicaria senegalensis.*

(Pan edges)

- Megagraminoid*: Phragmites mauritianus* (d);
- graminoids: *Digitaria didactyla, Echinochloa pyramidalis, Paspalum vaginatum, Sporobolus smutsii;* and
- herbs: *Eclipta prostrata, Marsilea ephippiocarpa, Pericaria hystricula, Syngonanthus wahlbergii.*

(Pan lakes)

- Herb*: Ludwigia stolonifera* (d);
- aquatic herbs: *Azolla pinnata* var. *caerulea* (d), *Potamogeton crispus* (d), *Trapa natans* var. *bispinosa* (d), *Wolffia arrhiza* (d), *Monochoria africana, Najas pectinata, Nymphaea lotus;* and
- carnivorous herb: *Utricularia inflexa* (d).

2.5.9. Conservation and protection status of broad vegetation types

On the basis of a recently established approach used at national level by SANBI (Driver et al. 2005), vegetation types can be categorised according to their conservation status which is, in turn, assessed according to the degree of transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the recent national vegetation map (Mucina, Rutherford & Powrie 2005) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 5, as determined by best available scientific approaches (Driver et al. 2005).

The level at which an ecosystem becomes critically endangered differs from one ecosystem to another and varies from 16% to 36% (Driver et al. 2005). There are a number of different vegetation units that occur in the EMF area. The details of which, including the conservation target and ecosystem status is summarised in the table below:

Table 5: Conservation status of different vegetation types occurring in the EMF study area, according to Driver et al. 2005 and Mucina et al. 2006

Vegetation type	Biome	Cons. target	Protected	Remain	Conservation status
Dwaalboom Thornveld	Savanna	19%	6%	86%	Least Threatened
Madikwe Dolomite Bushveld	Savanna	19%	18%	99%	Least Threatened
Central Sandy Bushveld	Savanna	19%	3%	76%	**Vulnerable**
Loskop Mountain Bushveld	Savanna	24%	14%	98%	Least Threatened
Springbokvlakte Thornveld	Savanna	19%	1%	51%	**Endangered**
Western Sandy Bushveld	Savanna	19%	6%	96%	Least Threatened
Waterberg Mountain Bushveld	Savanna	24%	9%	97%	Least Threatened
Roodeberg Bushveld	Savanna	19%	6%	82%	Least Threatened
Limpopo Sweet Bushveld	Savanna	19%	1%	95%	Least Threatened
Makhado Sweet Bushveld	Savanna	19%	1%	73%	**Vulnerable**
Mamabolo Mountain Bushveld	Savanna	24%	8%	24%	Least Threatened
Polokwane Plateau Bushveld	Savanna	19%	1%	83%	Least Threatened
Poung Dolomite Mountain Bushveld	Savanna	24%	10%	94%	Least Threatened
Musina Mopane Bushveld	Savanna	19%	2%	97%	Least Threatened
Strydpoort Summit Sourveld	Grassland	24%	17%	99%	Least Threatened
Waterberg-Magaliesberg Summit Sourveld	Grassland	24%	26%	100%	Least Threatened
Northern Afrotemperate Forest	Forest	31%	37%	99%	Least Threatened
Lowveld Riverine Forest	Forest	100%	100%	97%	**Critically Endangered**
Subtropical Freshwater Wetlands	**Wetlands**	24%	40%	94%	Least Threatened
Subtropical Salt Pans	**Wetlands**	24%	20%	69%	**Vulnerable**
Subtropical Alluvial Vegetation	**Wetlands**	31%	71%	84%	Least Threatened

There are five vegetation types in the study area for which there is serious conservation concern (Table 5), namely Lowveld Riverine Forest, Springbokvlakte Thornveld, Central Sandy Bushveld, Makhado Sweet Bushveld and Subtropical Salt Pans. Of these, two are listed in the Draft National List of Threatened Ecosystems (GN 1477 of 2009, published under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)), where Lowveld Riverine Forest and Springbokvlakte Thornveld are both listed as vulnerable. This implies that these two vegetation types (Lowveld Riverine Forest and Springbokvlakte Thornveld) are accorded protection under Act No. 10 of 2004. Wetlands are protected under the National Water Act (1998), which covers the vegetation types, subtropical freshwater wetlands, subtropical salt pans and subtropical alluvial vegetation.

The distribution of vegetation types in different conservation categories is shown in Map 13. The small patches of the critically endangered Lowveld Riverine Forest is situated in the north near the border, between Tom Burke and Zwartwater**.**

Map 13: Conservation status of vegetation in the study area

Lists of plant species previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute. These are listed in section 3.4.15. Additional species that could occur in similar habitats, as determined from database searches and literature sources, but have not been recorded in these grids are also listed.

Of the species that are considered to occur within the geographical area under consideration, there were 64 species recorded in the quarter degree grids that constitute the study area. According to IUCN Ver. 3.1 (IUCN, 2001) three of these are listed as critically endangered, three as endangered, 15 as vulnerable, 12 as near threatened, one as critically rare, 14 as declining and 16 as rare (see Table 6 for explanation of categories).

Table 6: Explanation of IUCN Ver. 3.1 categories (IUCN, 2001), and Orange List categories (Victor & Keith, 2004)

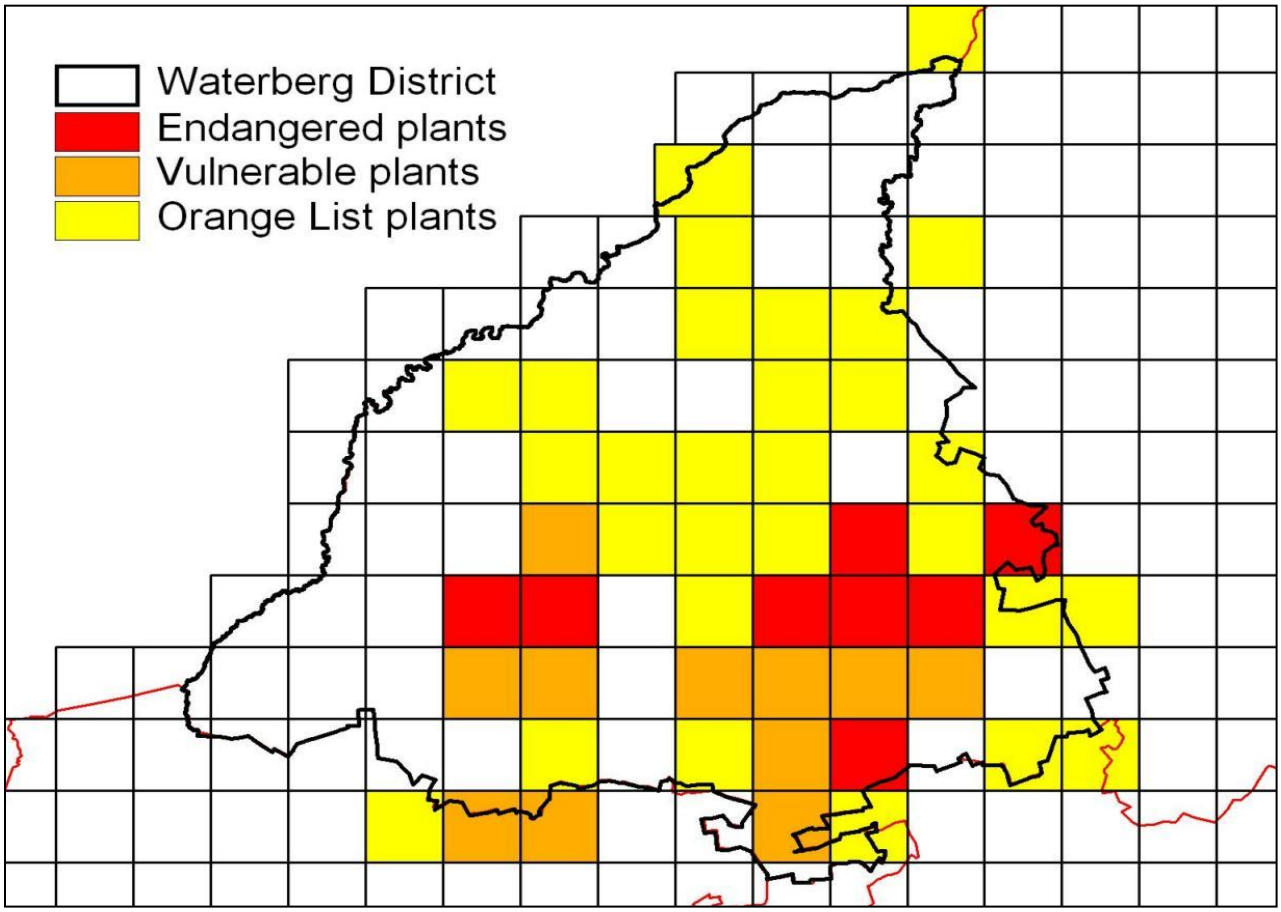
IUCN / Orange List category	Definition	Class
EX	Extinct	Extinct
CR	Critically Endangered	Red List
EN	Endangered	Red List
VU	Vulnerable	Red List
NT	Near Threatened	Orange List
LC (Declining)	Least Concern, declining taxa	Orange List
LC (Rare)	Least Concern, rare	Orange List
LC (Critically Rare)	Least Concern, rare: only one subpopulation	Orange List
LC (Rare-Sparse)	Least Concern, rare: widely distributed but rare	Orange List

An indication of the distribution of Red and Orange List plant species is given in Map 14. This shows grids in which these species are found with critically endangered and endangered species grids shown in red, vulnerable species grids shown in orange and remaining species grids shown in yellow. The most important areas in terms of containing the most threatened species are as follows (in order of importance):

1. Potgietersrus 2429AA (Buffelshoekberge): 4 Red and 13 Orange List species
2. Kransberg 2427BC (SW part of Waterberg): 4 Red and 4 Orange List species
3. Naboomspruit 2428DA (SE of Waterberg): 3 Red and 7 Orange List species
4. Lekkerrus 2428BC (central part of Waterberg): 3 Red and 2 Orange List species
5. Haakdoring 2428BD (SE part of Waterberg): 2 Red and 4 Orange List species
6. Crecy 2428DB (SE of Waterberg): 2 Red and 3 Orange List species

7. Warmbad 2428CD (S of Waterberg):1 Red and 8 Orange List species
8. Pienaarsrivier 2528AB (near Gauteng): 1 Red and 5 Orange List species
9. Sterkrivier 2428BA (central part of Waterberg): 1 Red and 4 Orange List species
10. Nylstroom 2428 CB (S part of Waterberg):1 Red and 4 Orange List species
11. Heiningsfontein 2428AD (central part of Waterberg): 1 Red and 2 Orange List species
12. Settlers 2428DC (S of Waterberg): 1 Red and 1 Orange List species
13. Sentrum 2427AD (just north of Thabazimbi): 1 Red List species

Map 14: Distribution of Red and Orange List plant species in the study area



2.5.10. Red List animal species of the study area

All Red List vertebrates (mammals, birds, reptiles, amphibians) that could occur in the study area are listed in Appendix 1. Those vertebrate species with a geographical distribution that includes the study area are discussed further.

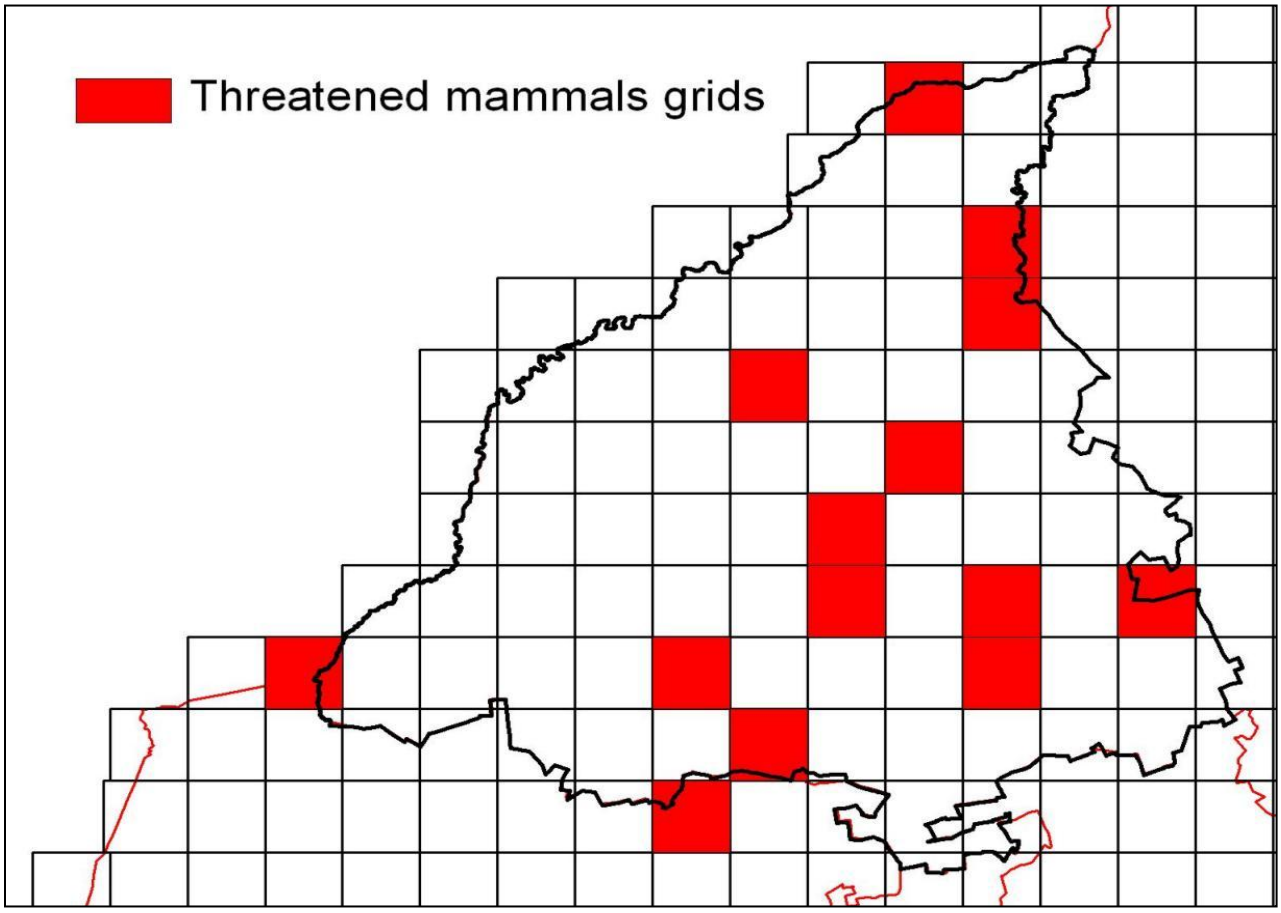
There are 43 mammal species of conservation concern that occur in the study area. Thirteen of these species are threatened with extinction and are on the Red List (classified as CR, EN or VU). Seven of these species are only found in protected areas, game reserves or in private breeding programmes. These are the Tsessebe, Black Rhino, Roan Antelope, Sable Antelope, Cheetah, African Wild Dog and Lion. There are six mammal species on the Red List that have a restricted distribution in the study area and which survive independently of conservation efforts, i.e. are dependent on maintenance of natural habitat outside of protected areas. These are the Short-eared Trident Bat, Botswana Long-eared Bat, Peak-saddle Horseshoe Bat, Juliana's Golden Mole, the Giant Rat and the Pangolin. The grids where theswe species have been previously recorded is shown in Map 15.

There are 21 threatened bird species (CR, EN or VU) that are found in the study area. They are found in a variety of habitats, although some patterns are evident. Large rivers, streams and wetlands provide important habitat for a number of species. Cliffs and mountainous areas are important for many species, including a number of vulture species. Woodlands and Savanna vegetation provide foraging habitat for many of the species found in the area.

There is one frog species of conservation concern, the Giant Bullfrog, previously recorded in the grids in which the study area is located and which could occur there.

There are two vulnerable and one near-threatened reptile species that have a distribution that includes the study area. The near threatened species occurs only peripherally in the study area. The other two species are the Nile crocodile and the African Rock Python.

Map 15: Distribution of Red List mammal species in the study area



2.5.11. Protected trees

Tree species protected under the National Forest Act are listed below. Those that have a geographical distribution that includes the study area are *Acacia erioloba*, *Adansonia digitata*, *Afzelia quanzensis* (marginal), *Boscia albitrunca*, *Brachystegia spiciformis* (marginal), *Breonadia salicina, Combretum imberbe*, *Curtisia dentata, Elaedendron transvaalensis*, *Erythrophysa transvaalensis*, *Lonchocarpus capassa* (marginal), *Pittosporum viridiflorum, Podocarpus latifolius* , *Prunus africana Sclerocarya birrea* subsp. *caffra* and *Securidaca longependunculata*.

The tree *Acacia erioloba* occurs in dry woodland along watercourses in arid areas where underground water is present as well as on deep Kalahari sands. *Adansonia digitata* occurs in hot, dry bushveld at low altitudes. *Afzelia quanzensis* occurs in hot, arid bushveld and sand forest, usually on deep sand. *Boscia albitrunca* occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils. *Brachystegia*

spiciformis occurs in woodland and is usually the dominant tree over large parts of its range. *Breonadia salicina* occurs in riverine fringe forest and along the banks of permanent rivers and streams. *Combretum imberbe* occurs in bushveld, often on alluvial soils along rivers or dry watercourses. *Curtisia dentata* occurs in coastal and montane forest. *Elaedendron transvaalensis* occurs in bushveld, occasionally on termitaria. *Erythrophysa transvaalensis* occurs on rocky ridges in bushveld, often associated with outcrops of red syenite. *Lonchocarpus capassa* occurs in bushveld and woodland, often at low altitude along rivers. *Pittosporum viridiflorum* occurs along forest margins, in bush-clumps and in bushveld, often in rocky outcrops. *Podocarpus latifolius* is found in coastal and Afromontane forest. *Prunus africana* occurs in montane forest, usually in mistbelt areas. *Sclerocarya birrea* subsp. *caffra* occurs in a wide variety of bushveld and woodland. *Securidaca longependuncula*ta occurs in bushveld.

2.5.12. Other features of conservation importance

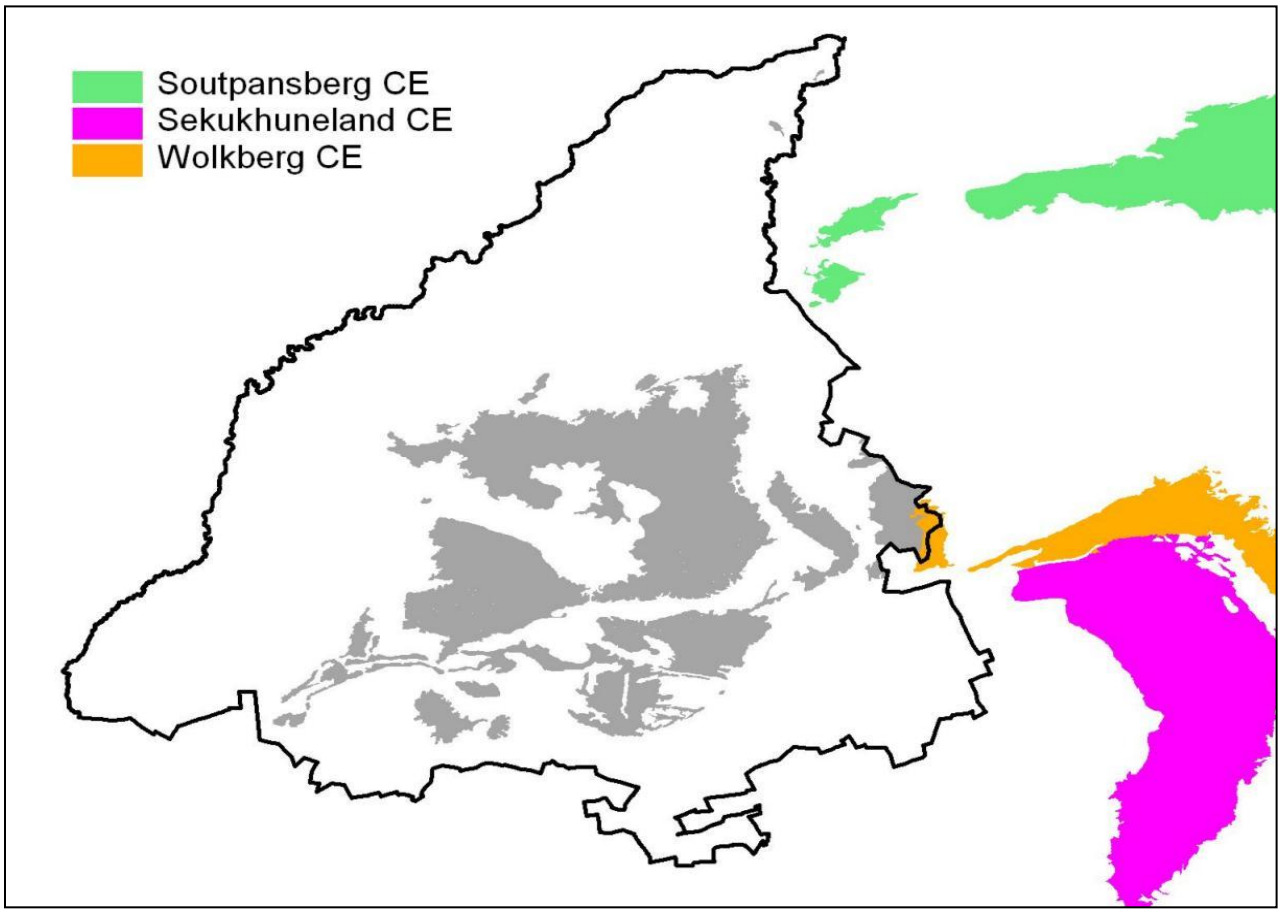
2.5.12.1. Centres of endemism

South Africa contains a number of areas where there are high levels of endemism amongst plant species. This means that high proportions of the species are restricted to that area and occur nowhere else.

There are three centres of endemism that occur near to the eastern boundary of the study area, the Soutpansberg Centre, the Sekhukhuneland Centre and the Wolkberg Centre (van Wyk & Smith 2001). A small piece of the Wolkberg Centre of Endemism occurs within the EMF study area (Map 16).

The relationship between the centres of endemism and the mountainous parts of the study area (shown in grey in Map 16) are of interest from a biological point of view. The vegetation within the mountains of the study area is similar to or shows floristic gradients linking them with the centres of endemism, especially the Wolkberg Centre of Endemism. This suggests that the flora of the mountains of the study area also has high levels of uniqueness, but not necessarily sufficient to warrant the classification of the Waterberg as a separate centre. From the point of view of locating unique areas of biodiversity within the study area, the relationship suggests that the mountains of the study area should be regarded as of particular value within the study area.

Map 16: Centres of Endemism in and nearby the study area



2.5.12.2. Conservation areas

From a biodiversity management and conservation planning perspective, protected areas are key for meeting a number of objectives, including conservation targets for protecting representative portions of vegetation and habitats, linking landscapes, providing economic benefits, ensuring a continued supply of ecosystem goods and services and providing refugia for threatened organisms. According to the Convention on Biodiversity, “they constitute an important stock of natural, cultural and social capital, yielding flows of economically valuable goods and services that benefit society, secure livelihoods, and contribute to the achievement of Millennium Development Goals. Moreover, protected areas are the key to buffering unpredictable impacts of impending climate change.”

There are a number of statutarily protected areas within the Waterberg District Municipality. These are shown in Map 17. The largest of these include Atherstone Nature Reserve, Marakele

National Park, Moepel Nature Reserve, Wonderkop Nature Reserve, Masebe Nature Reserve, Entabeni Nature Reserve and Doorndraai Dam Nature Reserve (Table 7). Some of these protected areas provide the core areas that have been incorporated into the Waterberg Biosphere Reserve (see next section).

An important fact to note is that the protected area network in the study area provides protection for some of the more unique landscapes and biodiversity features in the study area, including parts of the Waterberg as well as some large wetland systems.

Map 17: Protected areas within the study area

Table 7: Protected areas in the study area

NAME	HECTARES
Marakele National Park	65907.924
Moepel Nature Reserve	26927.335
No Name 2	26501.097
Atherstone Nature Reserve	23606.854
Wonderkop Nature Reserve	18018.835
No Name 14	16849.374
Entabeni Nature Reserve	12054.259
Doorndraai Dam Nature Reserve	8699.061
No Name 13	8070.219
Masebe Nature Reserve	7749.428
D'Nyala Nature Reserve	7265.833
Sabie Sabie Game Reserve	5891.646
No Name 20	5762.553
Bellevue Nature Reserve	5616.241
Witvinger Nature Reserve	5305.635
Hans Strijdom Nature Reserve	4992.203
No Name 15	3532.563
Nylsvley Nature Reserve	3101.335
Ben Alberts Nature Reserve	2957.942
Percy Fyfe Nature Reserve	2472.183
Madikwe Nature Reserve	2177.302
Rust De Winter Nature Reserve	1910.815
No Name 16	1863.973
Madeleine Robinson Nature Reserve	1378.508
Saanf Sanf Propety	1307.310
No Name 12	740.329
Hetbad Nature Reserve	700.054
Schuinsdraai Nature Reserve	548.037
Willem Prinsloo Private Nature Reserve	44.159
Sandf Property	27.191
Scuinsdraai Nature Reserve	24.724

2.5.12.3. Waterberg Biosphere Reserve

The Waterberg is the first region in the northern part of South Africa to be named as a Biosphere Reserve by UNESCO. An approximate boundary of the Biosphere Reserve is given in Map 17 (conservation areas), as sourced from http://www.waterbergbiosphere.org. Tourism is the major source of income for the people living within the Biosphere Reserve. However, people also practice cattle ranching, crop production and are increasingly switching over to game farming for eco-tourism. The biosphere reserve concept is considered to be

important for helping to find a balance between the pressures of the tourist industry, the need to generate direct benefits to the local communities and the conservation of the natural assets. Attaining this balance is the goal of the Waterberg Biosphere Reserve Committee which was set up after a five year consultation process with all stakeholders concerned.

The presence of the Biosphere Reserve in the study area provides an opportunity to promote biodiversity conservation at the same time as advancing eco-tourism in the study area. The scenic splendour of the Waterberg is associated with high diversity and relatively high levels of biological uniqueness. At the same time, the Waterberg area within which the Biosphere Reserve is situated is an important and valuable water catchment area in the study area. The conservation of this part of the landscape therefore serves multiple purposes and can provide ecological benefits to an array of landscapes outside the Biosphere Reserve area.

2.5.12.4. Wetlands, riparian areas

There are a number of rivers, streams, drainage lines and wetlands in the study area. Major rivers and drainage lines in the study area are shown in Map 11. It is clear from this figure that parts of the landscape contain a high frequency of small drainage lines whereas other parts of the landscape only form the setting for larger rivers and streams to pass through.

Some of the larger perennial streams and small rivers in the study area are the Crocodile River, the Matlabas River, the Mokolo River, the Lephalala River and the Mogalakwena River, all of which drain into the Limpopo River that runs along the north-western boundary of the study area. All of these originate within the Waterberg area. The Nyl River, which feeds one of the most important wetland systems in the Limpopo Province, is one of the upper reaches of the Mogalakwena River. Nylsvley is a RAMSAR site and contains unique biodiversity and ecosystem processes. The entire catchment of Nylsvley is within the south-eastern part of the study area, originating within parts of the Waterberg. There are some small tributaries of the Olifants River draining the south-eastern part of the study area.

Perennial and non-perennial rivers and streams represent a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal. They are also an important and variable habitat for a variety of organisms. They provide a connecting network through the landscape that provides a unique feature for linking dispersed patches of natural habitat, especially in landscapes that have undergone high levels of transformation. Wetlands, rivers and streams are protected under the National Water Act.

2.5.12.5. Habitat transformation in the study area

There are significant parts of the study area that have been transformed by urbanisation, cultivation or mining. The natural habitat in these areas is lost. There are also areas that still contain natural habitat, but it is degraded, usually by severe over-grazing. An indication of areas that have been transformed or degraded is provided in Map 18.

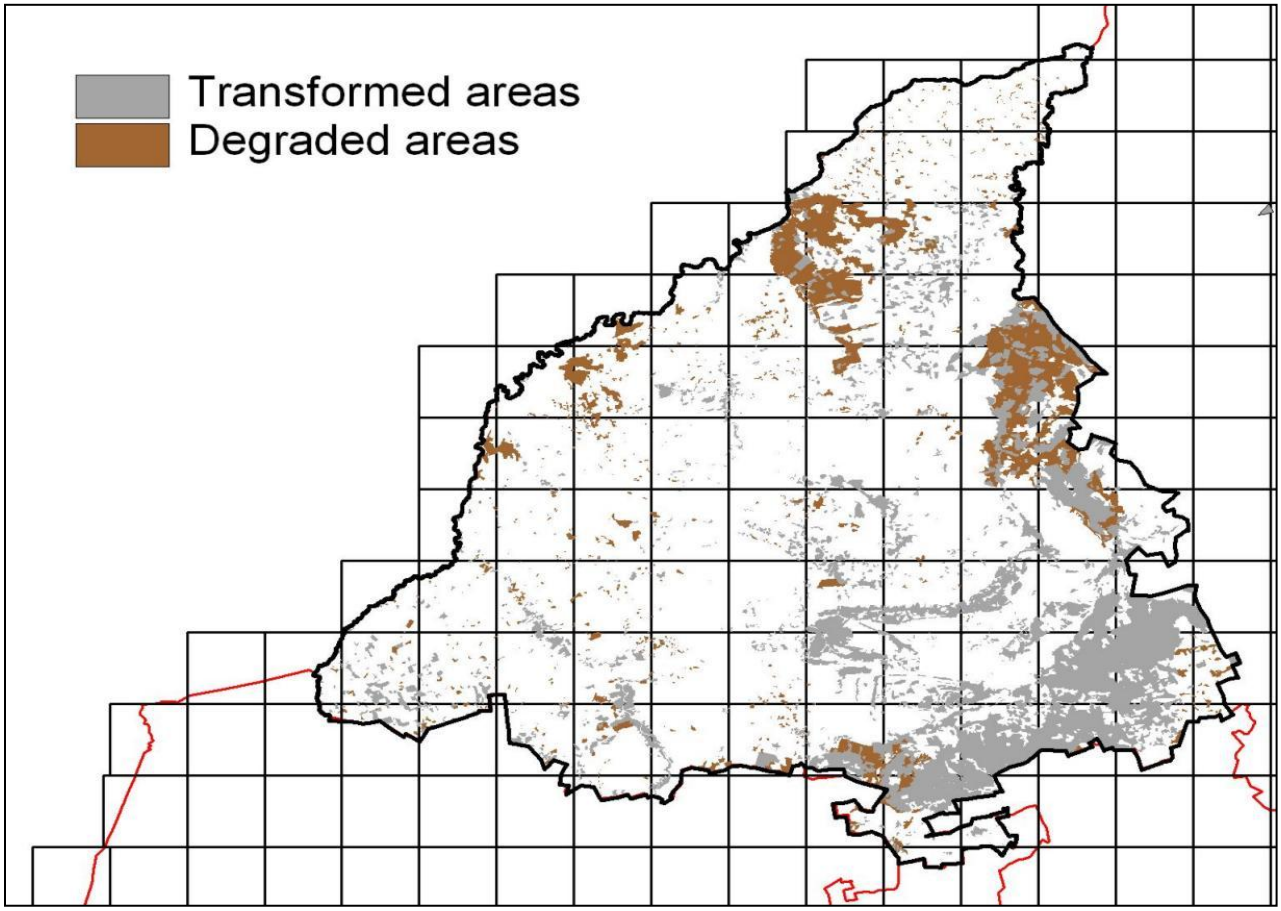
The conservation status of the vegetation types is determined by assessing the degree of transformation relative to the overall extent of a vegetation type. The vegetation types with the highest conservation status (see Map 13) are found in those areas where the greatest amount of transformation has taken place. A contradiction thus arises that the areas with the highest degree of degradation and transformation are often also the areas where conservation efforts are focused as a priority. This should not detract from the natural value of the untransformed areas, which are often given a low conservation status due to low levels of transformation. Sometimes the areas with little evidence of human impact have a natural sense of place which also has a high value.

This ecological assessment identifies those parts of the study area that have high conservation value or contain threatened organisms. Areas containing untransformed natural vegetation, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity. The information provided in the preceding sections was used to compile a map of remaining natural habitats and areas important for maintaining ecological processes in the study area as well as areas containing unique biodiversity. These include the following:

- Vegetation of conservation importance. This is based primarily on a national assessment (see Map 13);
- potential occurrence of populations of Red List organisms, including flora and fauna that occur within remaining natural habitats in the study area (see Map 14 and 15);
- centres of endemism, areas that contain high numbers of species with very restricted distribution (see Map 16);
- protected areas, which are areas that already have statutory protection (see Map 17);
- The Waterberg Biosphere Reserve, an area managed for biodiversity and eco-tourism (see Map 17);

- perennial and non-perennial rivers and streams. This represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal (see Map 11); and
- areas classified as ridges, steep slopes or mountain ranges: these mountain areas, consisting mostly of the Waterberg and satellite hills, are an important biogeographical corridor and contain unique biodiversity.

Map 18: Habitat transformation and degradation in the study area



These factors have all been taken into account in evaluating biological importance within the study area. A summary of these features is shown in Map 19.

Map 19: Rating of ecological value in the study area

2.5.13. Discussion and conclusions

The purpose of this study was to provide an indication of what is in the study area and also which of those features in the study area have high value, from an ecological perspective. There are many vegetation types that occur in the study area, most of which are part of the Savanna Biome. These vegetation types are classified into different conservation categories based on the degree or transformation and conservation. A small number of these were identified as having high conservation status. Any remaining untransformed areas within these vegetation types are considered to be ecologically sensitive.

Other factors that may lead to parts of the study area having high ecological sensitivity are the presence of rivers, streams, drainage lines and wetlands, presence of steep slopes or mountains and the potential presence of various plant and animal species of conservation concern.

Mountains and ridges are considered to have high ecological value due to the ecological processes that they support. Mountains and drainage lines (wetlands) represent particularly vital natural corridors as they function both as wildlife habitat, providing resources needed for survival, reproduction and movement and as biological corridors, providing for movement between habitat patches. Both functions are potentially critical to conservation of biological diversity as the landscape becomes increasingly fragmented into smaller, more isolated patches (Rosenberg *et al.*, 1997).

Other than protected ecosystems and threatened plant and animal species, forests and wetlands are both protected under national legislation (National Forests Act and National Wetlands Act respectively). Any impacts on these features would require a permit from the relevant National Department. There are various tree species that are protected under the National Forests Act that have a geographic distribution that includes this area. Any impacts on individuals of any of these species require a permit from the National Department.

An assessment of Red List and Orange List plant and animal species that could occur in the study area indicates that only a small number of these are in high conservation categories (CR, EN or VU). The distribution of these species in the landscape provides additional support for classifying certain parts of the landscape into higher conservation categories.

Most of the study area appears to still be in natural condition, although significant parts may be degraded due to commercial livestock farming, cultivation and alien plant invasions.

Taking all these factors into consideration, it was possible to identify those parts of the study area that have a high ecological value. A summary of the most important of these is as follows:

1. The Waterberg: this area is identified as being of elevated biodiversity value. It also contains a number of protected areas and the important Waterberg Biosphere Reserve. In addition, the Waterberg constitutes a vital water catchment area within the study area, the function of which is critical to maintain for ecological and other reasons.
2. Springbokvlakte: this area contains a vegetation type of elevated conservation value. The area has been transformed to a high degree and remaining natural habitat needs to be conserved in order to retain components of this ecosystem and its biodiversity in the landscape. There are some threatened organisms that occur within this area which also require protection. The Nyl River is situated within this area.
3. Perennial rivers: the main perennial rivers draining the study area as well as the Limpopo River are vital hydrological features in the landscape and also provide vital ecological corridors through the landscape.

There are other natural features in the landscape that do not emerge as having high conservation status, but they do nevertheless have high ecological value. The Limpopo River valley and the bushveld on the low-lying plains to the north-west of the Waterberg are relatively intact. Components of this landscape should be preserved before transformation leads to the loss of the entire area. The area is a vital ecological link between the Limpopo River and the Waterberg. Significant parts of this landscape need to be retained to avoid degradation of the entire Waterberg area.

2.5.14. Species of conservation importance

Table 8: Plant species of conservation importance (Threatened, Near Threatened and Declining) that have historically been recorded in the study area

Sources: South African National Biodiversity Institute in Pretoria.

Taxon	Family	Status*
Euphorbia clivicola R.A.Dyer	Euphorbiaceae	Critically Endangered
Gasteria disticha (L.) Haw.	Asphodelaceae	Critically Endangered
Orbea elegans Plowes	Apocynaceae	Critically Endangered, Possibly Extinct
Brachystelma gerrardii Harv.	Apocynaceae	Endangered
Delosperma macellum (N.E.Br.) N.E.Br.	Mesembryanthemaceae	Endangered

Encephalartos eugene-maraisii I.Verd.	Zamiaceae	Endangered
Bowiea volubilis Harv. ex Hook.f. subsp. volubilis	Hyacinthaceae	Vulnerable
Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.	Orchidaceae	Vulnerable
Ceropegia stentiae E.A.Bruce	Apocynaceae	Vulnerable
Cucumis humifructus Stent	Cucurbitaceae	Vulnerable
Cullen holubii (Burtt Davy) C.H.Stirt.	Fabaceae	Vulnerable
Cyphostemma hardyi Retief	Vitaceae	Vulnerable
Elytrophorus globularis Hack.	Poaceae	Vulnerable
Eulophia coddii A.V.Hall	Orchidaceae	Vulnerable
Jamesbrittenia bergae P.Lemmer	Scrophulariaceae	Vulnerable
Ledebouria atrobrunnea S.Venter	Hyacinthaceae	Vulnerable
Marsilea farinosa Launert subsp. arrecta J.E.Burrows	Marsileaceae	Vulnerable
Oryza longistaminata A.Chev. & Roehr.	Poaceae	Vulnerable
Prunus africana (Hook.f.) Kalkman	Rosaceae	Vulnerable
Sartidia jucunda (Schweick.) De Winter	Poaceae	Vulnerable
Corchorus psammophilus Codd	Malvaceae	Threatened
Eulalia aurea (Bory) Kunth	Poaceae	Near Threatened
Adenia fruticosa Burtt Davy subsp. fruticosa	Passifloraceae	Near Threatened
Argyrolobium campicola Harms	Fabaceae	Near Threatened
Brachystelma hirtellum Weim.	Apocynaceae	Near Threatened
Ceropegia turricula E.A.Bruce	Apocynaceae	Near Threatened
Curtisia dentata (Burm.f.) C.A.Sm.	Cornaceae	Near Threatened
Drimia sanguinea (Schinz) Jessop	Hyacinthaceae	Near Threatened
Elaeodendron transvaalense (Burtt Davy) R.H.Archer	Celastraceae	Near Threatened
Holothrix randii Rendle	Orchidaceae	Near Threatened
Isoetes transvaalensis Jermy & Schelpe	Isoetaceae	Near Threatened
Panicum dewinteri J.G.Anderson	Poaceae	Near Threatened
Searsia gracillima (Engl.) Moffett var. gracillima	Anacardiaceae	Near Threatened
Crassula cymbiformis Toelken	Crassulaceae	Critically Rare
Adenia gummifera (Harv.) Harms var. gummifera	Passifloraceae	Rare
Agapanthus coddii F.M.Leight.	Agapanthaceae	Rare
Berkheya radyeri Roessler	Asteraceae	Rare
Blepharis uniflora C.B.Clarke	Acanthaceae	Rare
Brachystelma inconspicuum S.Venter	Apocynaceae	Rare
Combretum petrophilum Retief	Combretaceae	Rare
Dicoma montana Schweick.	Asteraceae	Rare
Euphorbia louwii L.C.Leach	Euphorbiaceae	Rare
Euphorbia waterbergensis R.A.Dyer	Euphorbiaceae	Rare
Freylinia tropica S.Moore	Scrophulariaceae	Rare
Gladiolus dolomiticus Oberm.	Iridaceae	Rare

Gladiolus pardalinus Goldblatt & J.C.Manning	Iridaceae	Rare
Justicia minima A.Meeuse	Acanthaceae	Rare
Justicia montis-salinarum A.Meeuse	Acanthaceae	Rare
Tylophora coddii Bullock	Apocynaceae	Rare
Warburgia salutaris (G.Bertol.) Chiov.	Canellaceae	Rare
Acacia erioloba E.Mey.	Fabaceae	Declining
Ansellia africana Lindl.	Orchidaceae	Declining
Boophone disticha (L.f.) Herb.	Amaryllidaceae	Declining
Callilepis leptophylla Harv.	Asteraceae	Declining
Cassipourea malosana (Baker) Alston	Rhizophoraceae	Declining
Crinum macowanii Baker	Amaryllidaceae	Declining
Crinum stuhlmannii Baker	Amaryllidaceae	Declining
Drimia altissima (L.f.) Ker Gawl.	Hyacinthaceae	Declining
Eulophia speciosa (R.Br. ex Lindl.) Bolus	Orchidaceae	Declining
Gunnera perpensa L.	Gunneraceae	Declining
Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.	Hypoxidaceae	Declining
Ilex mitis (L.) Radlk. var. mitis	Aquifoliaceae	Declining
Pterocelastrus rostratus (Thunb.) Walp.	Celastraceae	Declining
Rapanea melanophloeos (L.) Mez	Myrsinaceae	Declining

* Conservation Status Category assessment according to IUCN Ver. 3.1 (IUCN, 2001), as evaluated by the Threatened Species Programme of the South African National Biodiversity Institute in Pretoria. *IUCN (3.1) Categories: VU = Vulnerable, EN = Endangered, CR = Critically Endangered, NT = Near Threatened.

Table 9: Threatened vertebrate species with a geographical distribution that includes the current study area

MAMMALS

Common name	Order/ Family	Taxon	Habitat	Status[1]	Importance of study area for species
ARTIODACTYLA / PERISSODACTYLA					
Tsessebe	Artiodactyla / Bovidae	*Damaliscus lunatus lunatus*	Grassland and grassland / woodland ecotones.	EN	**HIGH**, occurs throughout study area
Black rhinoceros	Perissodactyla / Rhinocerotidae	*Diceros bicornis minor*	Browser, occurring in bushveld/savanna habitats, requires dense cover, sufficient browse and permanent water	VU	**HIGH**, but only occurs in game reserves
Roan antelope	Artiodactyla / Bovidae	*Hippotragus equinus*	Open savanna woodlands, requires medium-tall grasses and permanent water.	VU	**HIGH**, occurs widely in study area
Sable antelope	Artiodactyla / Bovidae	*Hippotragus niger niger*	Savanna, requires permanent water.	VU	**HIGH**, occurs throughout study area
Sharp's grysbok	Artiodactyla / Bovidae	*Raphicerus sharpei*	Shrublands and savanna woodlands, prefer low growing shrub and grass of medium height, avoid tall grass	NT	**MEDIUM**, peripheral occurrence in north-eastern part of study area

CARNIVORA					
Cheetah	Carnivora / felidae	*Acinonyx jubatus*	Open plains, savanna woodland, desert fringes.	VU	**HIGH**, occurs widely in study area
Spotted hyena	Carnivora / Hyaenidae	*Crocuta crocuta*	Savanna, predator / scavenger	NT	**HIGH**, occurs widely in study area
Brown hyena	Carnivora / Hyaenidae	*Hyena brunnea*	Savanna, urban areas, scavenger	NT	**HIGH**, occurs throughout study area
Serval	Carnivora / Felidae	*Leptailurus serval*	Moist savanna, tall grass, eating small mammals (espec. Otomys), birds, reptiles, fruits, invertebrates, amphibia, fish.	NT	**HIGH**, occurs throughout study area
Spotted-necked otter	Carnivora / Mustelidae	*Lutra maculicollis*	Permanent, unsilted, unpolluted rivers, streams and freshwater lakes where sufficient numbers of its prey occur.	NT	**HIGH**, occurs in southern third of study area.
African wild dog	Carnivora / Canidae	*Lycaon pictus*	Savanna woodland, broken, hilly country, open plains, arid areas	EN	**HIGH**, occurs widely in study area
Honey badger	Carnivora / Mustelidae	*Mellivora capensis*	Wide variety of habitats. Probably only in natural habitats.	NT	**HIGH**, occurs throughout study area
Lion	Carnivora / Felidae	*Panthera leo*	Savanna, shrubland, grassland, desert, predator of mammals, scavenger	VU	**HIGH,** occurs in significant prt of study area, mostly in Limpopo Valley.
African weasel	Carnivora / Mustelidae	*Poecilogale albinucha*	Moist grassland or woodland with more than 700 mm rainfall per year and where flourishing populations of small rodents occur. Grassland, scrub woodland. The distribution range of this animal covers the west coast of South Africa from Garies southward into the western Cape coastal belt, east and north-east Northern Cape, and all other provinces	DD	**HIGH**, occurs throughout study area
CHIROPTERA					
Short-eared trident bat	Chiroptera / Hipposideridae	*Cloeotis percivali*	Caves and subterranean habitats in mixed woodland savanna; aerial insectivore.	CR	**HIGH**, distribution includes most of study area
Gambian epauletted fruit bat	Chiroptera / Pteropodidae	*Epomophorus gambianus crypturus*	Savanna, urban areas; frugivore, rossting in trees	DD	**HIGH**, eastern half of study area
Sundevall's leaf-nosed bat	Chiroptera / Hipposideridae	*Hipposideros caffer*	Caves and subterranean habitats; aerial insectivore	DD	**MEDIUM**, southern part of study area
Botswana long-eared bat	Chiroptera / Vespertilionidae	*Laephotis botswanae*	Savanna and riparian woodland, often associated with rocky outcrops; insectivore	VU	**HIGH**, two of three recorded sightings are in study area
Schreiber's long-fingered bat	Chiroptera / Vespertilionidae	*Miniopterus schreibersii*	Caves and sub-terranean habitats in Fynbos, savanna, woodland, succulent and	NT	**HIGH**, occurs throughout study area

			Nama Karoo, grassland; cave-dwelling aerial insectivore.		
Temminck's hairy bat	Chiroptera / Vespertilionidae	*Myotis tricolor*	Caves in forests, shrubland, savanna, grassland, mountains; cave-dwelling aerial insectivore.	NT	**HIGH**, distribution includes most of study area
Welwitsch's hairy bat	Chiroptera / Vespertilionidae	*Myotis welwitschii*	Savanna, roosts in shrubs and trees	NT	**MEDIUM**, eastern half of study area
Anchieta's pipistrelle	Chiroptera / Vespertilionidae	*Pipistrellus anchietae*	Savanna, riparian, coastal and scrub forests, as well as bushveld, often in the vicinity of open water, possibly roosting in trees; aerial insectivore	NT	**MEDIUM**, low reporting rate in study area, but includes distribution range
Rusty bat	Chiroptera / Vespertilionidae	*Pipistrellus rusticus*	Savanna, riparian forests, roosts in crevices in trees; aerial insectivore.	NT	**HIGH**, occurs throughout study area
Peak-saddle horseshoe bat	Chiroptera / Rhinolophidae	*Rhinolophus blasii*	Caves and sub-terranean habitats	VU	**MEDIUM**, low reporting rate in study area, but includes significant part of distribution range
Geoffroy's horseshoe bat	Chiroptera / Rhinolophidae	*Rhinolophus clivosus*	Caves and subterranean habitats; fynbos, shrubland, grassland, succulent and Nama-karoo; insectivore	NT	**HIGH**, occurs throughout study area
Darling's horseshoe bat	Chiroptera / Rhinolophidae	*Rhinolophus darlingii*	Savanna, rossting in caves and sub-terranean habitats	NT	**HIGH**, occurs throughout study area
Hildebrandt's horseshoe bat				NT	**HIGH**, occurs throughout study area
INSECTIVORA					
South African hedgehog	Insectivora / Erinaceidae	*Atelerix frontalis*	Wide variety of habitats where there is ample ground cover. Avoids mesic habitats.	NT	**HIGH**, occurs throughout study area
Reddish-grey musk shrew	Insectivora / Soricidae	*Crocidura cyanea*	Wide variety of habitats. Nocturnal, terrestrial.	DD	**HIGH**, occurs throughout study area
Tiny musk shrew	Insectivora / Soricidae	*Crocidura fuscomurina*	Terrestrial habitats, wide tolerance	DD	**LOW**, peripheral distribution in southern part of study area
Lesser red musk shrew	Insectivora / Soricidae	*Crocidura hirta*	Wide range of habitats from moist savanna and wetlands to Kalahari thornveld. Terrestrial, nocturnal.	DD	**HIGH**, occurs throughout study area
Swamp musk shrew	Insectivora / Soricidae	*Crocidura mariquensis*	Marshy conditions in the savanna biome and highveld grasslands	DD	**HIGH**, distribution includes most of study area
Forest shrew	Insectivora / Soricidae	*Myosorex varius*	Wide variety of vegetation types, usually primary. Terrestrial habitats adjacent to wetlands; forest	DD	**LOW**, not previously recorded in grids, but overall geographical distribution includes this

					area.
Juliana's golden mole	Insectivora / Chrysochloridae	*Neamblysomus julianae*		VU	**HIGH**, few known sites of which two occur in study area
Greater dwarf shrew	Insectivora / Soricidae	*Suncus lixus*		DD	**LOW**, peripheral distribution in southern part of study area
RODENTIA					
Giant rat	Rodentia / Muridae	*Cricetomys gambianus*		VU	**MEDIUM**, mostly Soutpansberg Mountains, but isolated population in study area.
Water rat	Rodentia / Muridae	*Dasymus incomtus*	Semi-aquatic, occurring in various wetland types	NT	**MEDIUM**, eastern half of study area
Rock dormouse	Rodentia / Myoxidae	*Graphiurus platyops*	Rocky terrain, also been found in camelthorn trees. Eats insects and seeds. Nocturnal.	DD	**MEDIUM**, eastern half of study area
Single-striped mouse	Rodentia / Muridae	*Lemniscomys rosalia*		DD	**HIGH**, occurs throughout study area
Bushveld gerbil	Rodentia / Muridae	*Tatera leucogaster*	Terrestrial, sandy soils. Excavates burrows in sandy soils, usually at the base of small shrubs, but also in the open. Granivorous, insectivorous and herbivorous.	DD	**HIGH**, occurs throughout study area
MACROSCELIDAE / PHOLIDOTA / TUBULIDENTATA					
Short-snouted elephant shrew	Macroscelidea / Macroscelididae	*Elephantulus brachyrhynchus*		DD	**HIGH**, occurs throughout study area
Bushveld elephant shrew	Macroscelidea / Macroscelididae	*Elephantulus intufi*	Savanna, grassland, shrubland. Sandy soils with sparse grass cover.	DD	**HIGH**, northern to north-western half of study area constitutes main distribution
Pangolin	Pholidota / Manidae	*Manis temminckii*		VU	**HIGH**, occurs throughout most of study area

[1]Status according to Friedmann & Daly 2004.

AMPHIBIANS

Common name	Species	Habitat	Status[2]	Likelihood of occurrence
Giant Bullfrog	*Pyxicephalus adspersus*	Widely distributed in southern Africa, mainly at higher elevations. Inhabits a variety of vegetation types where it breeds in seasonal, shallow, grassy pans in flat, open areas; also utilises non-permanent vleis and shallow water on margins of waterholes and dams. Prefer sandy substrates although they sometimes inhabit clay soils. Recorded from the grid 3127CB.	NT	**HIGH**, recorded throughout study area

[2]Status according to Minter et al. 2004.

REPTILES

Common name	Species	Habitat	Status[3]	Likelihood of occurrence
African rock python	*Python sebae natalensis*	Wide range of habitats, but mostly moist, rocky well-wooded valleys. Frequently found in and around water. Prefer open savanna type habitat but have been found in forest areas	VU	**HIGH**, recorded throughout study area. Species seldom found very close to human habitation.
Nile crocodile	*Crocodylus niloticus*	Rivers in more tropical areas of the country. May also occur in farm dams. Restricted largely to game and nature reserves.	VU	**HIGH**, recorded in many parts of study area, especially Limpopo River.
Muller's Velvet Gecko	*Homopholis mulleri*	Under bark and in holes of marula and knob-thorn trees in open mopane veld.	Restricted, NT[4]	**MEDIUM**, previously recorded in 2328BD - distribution only just enters study area

[3]Status according to Branch 1988.
[4]Status according to Groombridge 1994.

BIRDS

Common name	Species	Habitat	Status[3]	Importance of study area for species
Bittern	*Botaurus stellaris*	Lowland swamps and densely vegetated wetlands with extensive stands of tall vegetation. Previously recorded in 2428DB (probably in wetlands along Nyl River east of Naboomspruit).	CR	MEDIUM
Saddle-billed stork	*Ephippiorhynchus senegalensis*	Aquatic habitats in open country, favouring large rivers, freshwater wetlands and floodplains. Large trees are required for roosting and nesting.	EN	HIGH
White-backed Night Heron	*Gorsachius leuconatus*	Swift and slow-flowing rivers and streams with heavily wooded margins or overhanging vegetation.	VU	MEDIUM
Hooded Vulture	*Necrosyrtes monachus*	Well-developed woodland. Attracted to large, well-foliaged deciduous trees, such as Diospyros mespilliformis and Xanthocercis zambesiaca, particularly in riparian habitats.	VU	LOW
Cape Vulture	*Gyps coprotheres*	The Cape Vulture is concentrated in the Lesotho Highlands and the northern provinces of South Africa. It has been reported from areas in the study site, and in adjacent grids. It forages over open grassland and woodland. It is dependent on tall cliffs for roosting and breeding but also roosts on trees and pylons. It has declined dramatically due to threats such as food shortages, electrocutions, poisonings, drownings and disturbance at breeding and roosting sites.	VU	HIGH
African White-backed Vulture	*Gyps africanus*	Woodland, nests in large trees in loose colonies. Known from Madikwe NR.	VU	HIGH
Lappetfaced Vulture	*Torgos tracheliotos*	Favours semi-arid areas with rainfall <400 mm	VU	MEDIUM
White-headed Vulture	*Trigonoceps occipitalis*	Mixed, deciduous and broad-leaved woodland.	VU	LOW
Tawny Eagle	*Aquila rapax*	Mainly in woodlands, including lightly wooded areas.	VU	MEDIUM
Martial Eagle	*Polemaetus bellicosus*	The Martial Eagle is widespread but uncommon throughout South Africa and neighbouring countries. It tolerates a wide range of vegetation	VU	HIGH

		types, being found in open grassland, scrub, Karoo and woodland. It relies on large trees (and electricity pylons) to provide nest sites. It is found typically in flat country and is rarer in mountains and forests. One of the main reason it is declining is because of persecution on private land. This species has been recorded from the study area and many surrounding areas.		
Bataleur	*Terathopius ecaudatus*	Wide variety of woodland types, from open semi-arid Kalahari to well developed, relatively mesic broadleaved woodland.	VU	MEDIUM
African marsh harrier	*Circus ranivorus*	Dependent on wetlands, particularly permanent wetlands. Nests usually in reedbeds over water, although they are also occasionally situated in adjacent sedges and scrub. Foraging activity is concentrated in the local wetlands, but birds occasionally range into adjacent grasslands and cultivated areas.	VU	MEDIUM
Lesser Kestrel	*Falco naumannii*	This species is widespread in South Africa except for most of the Northern Cape, and occurs in other countries. This species occurs in open country and roosts communally in tall trees (mainly *Eucalyptus*), in urban areas. They prefer to forage in pristine grassland, which is scarce since few areas are not transformed by agriculture. Most of the threats, however, exist in the Palearctic part of its range, and conservation is therefore complex as it only occurs in South Africa for part of its cycle. They forage on insect swarms and are beneficial to agriculture in this way. They have been sited within the study area and surrounding areas.	VU	MEDIUM
Blue Crane	*Anthropoides paradiseus*	This species is a near-endemic to South Africa, occurring in every province. It is locally abundant in parts of its range. It has experienced substantial decline due to poisoning of birds and indirect loss of grassland breeding habitat. It occupies dry short grassland, being more abundant in the eastern sour grasslands where natural grazing of livestock is the predominant land use. Not dependent on wetland habitats for breeding. They have been recorded in the study area and surrounding areas. Nesting sites are secluded open grasslands with full view around the nest for predator evasion.	VU	MEDIUM
African Finfoot	*Podica senegalensis*	Clear, perennial rivers and streams, lined with reeds, overhanging trees and shrubs. Avoids stagnant and fast-flowing waters.	VU	MEDIUM
Kori Bustard	*Ardeotis kori*	Woodland and arid scrub. Usually occurs in dry savanna, but in South Africa it is also found in moist woodlands.	VU	HIGH
Stanley's Bustard	*Neotis denhami*	This is an Afrotropical endemic that occurs through the central parts of South Africa, and Limpopo Province and Mpumalanga. It occurs in the southern part of the study area.	VU	MEDIUM
Whitebellied Korhaan	*Eupodotis cafra*	This species is found in eastern South Africa. Most abundant in hilly areas at the interface between grassland and savanna biomes. Habitat loss through crop farming, overgrazing, burning and high human densities have lead to its decline.	VU	MEDIUM
Grass Owl			VU	

Pel's Fishing Owl				
Southern Ground Hornbill	*Bucorvus leadbeateri*	A widespread but sparse breeding resident, extending from the Northern Province down the eastern side of South Africa to the Eastern Cape. It nests in holes in rock faces or trees, and is impacted on by removal of trees and disturbance of cliff faces. It is also threatened by transformation of its grassland foraging habitat.	VU	MEDIUM

Table 10: List of protected tree species (National Forests Act)

Acacia erioloba	*Acacia haematoxylon*
Adansonia digitata	*Afzelia quanzensis*
Balanites subsp. *maughamii*	*Barringtonia racemosa*
Boscia albitrunca	*Brachystegia spiciformis*
Breonadia salicina	*Bruguiera gymnhorrhiza*
Cassipourea swaziensis	*Catha edulis*
Ceriops tagal	*Cleistanthus schlectheri* var. *schlechteri*
Colubrina nicholsonii	*Combretum imberbe*
Curtisia dentata	*Elaedendron (Cassine) transvaalensis*
Erythrophysa transvaalensis	*Euclea pseudebenus*
Ficus trichopoda	*Leucadendron argenteum*
Lumnitzera racemosa var. *racemosa*	*Lydenburgia abottii*
Lydenburgia cassinoides	*Mimusops caffra*
Newtonia hildebrandtii var. *hildebrandtii*	*Ocotea bullata*
Ozoroa namaensis	*Philenoptera violacea* (*Lonchocarpus capassa*)
Pittosporum viridiflorum	*Podocarpus elongatus*
Podocarpus falcatus	*Podocarpus henkelii*
Podocarpus latifolius	*Protea comptonii*
Protea curvata	*Prunus africana*
Pterocarpus angolensis	*Rhizophora mucronata*
Sclerocarya birrea subsp. *caffra*	*Securidaca longependunculata*
Sideroxylon inerme subsp. *inerme*	*Tephrosia pondoensis*
Warburgia salutaris	*Widdringtonia cedarbergensis*
Widdringtonia schwarzii	

Acacia erioloba, *Adansonia digitata*, *Afzelia quanzensis* (marginal), *Boscia albitrunca*, *Brachystegia spiciformis* (marginal), *Breonadia salicina, Combretum imberbe*, *Curtisia dentata, Elaedendron transvaalensis*, *Erythrophysa transvaalensis*, *Lonchocarpus capassa* (marginal), *Pittosporum viridiflorum, Podocarpus latifolius* , *Prunus africana Sclerocarya birrea* subsp. *caffra* and *Securidaca longependunculata* have a geographical distribution that coincides with the study area.

3. CULTURAL AND HISTORICAL FEATURES

3.1. INTRODUCTION

It becomes apparent from the study that the Waterberg District has a rich and varied history. This history extends back as far as the Stone Age, and was greatly influenced by natural phenomena and features of the area. Important cultural and historical features of the area include rock paintings, clay pottery and ruins such as that of the Langa Ndebele. Aspects of the heritage legislation were reviewed in the study.

3.2. HERITAGE LEGISLATION

In the developed world heritage resources are protected by international, national and regional legislation providing regulations, policies and guidelines for the protection, management, promotion and utilisation of heritage resources. This approach also applies in South Africa, which is internationally known for its remarkable heritage. It boasts seven World Heritage Sites, with the Makapan Valley near Mokopane in the Waterberg as part of the Cradle of Humankind, as its crown jewel. Many of the international guidelines for the development of cultural heritage management policies therefore may be applicable in South African circumstances.

The Makapan's Valley and the Taung site were declared World Heritage Sites in 2005. The United Nations Educational and Cultural Organisation (UNESCO) declare sites as world heritage sites with the aim to recognise and preserve outstanding places of cultural and natural heritage

At a national level heritage resources in South Africa are dealt with by the National Heritage Council Act (Act 11 of 1999) and the National Heritage Resources Act (Act 25 of 1999). Other national legislation relevant to heritage resources includes the Environmental Management Act (Act 107 of 1999) and the Mineral Petroleum Resources Development Act (Act 28 of 2002).

South Africa's 'national estate' includes a wide range of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999) (see Table 11). The Act also categorises heritage resources in a three-tier system, namely Grade I (national), Grade II (provincial) and Grade III (local) heritage resources.

At provincial level, heritage legislation in South Africa is implemented by Provincial Heritage Resources Agencies (PHRAs) which apply the National Heritage Resources Act (Act 25 of 1999) together with provincial government guidelines and strategic frameworks.

Metropolitan/Municipal (local) policy regarding the protection of cultural heritage resources is also linked to national acts and is implemented by the South African Heritage Resources Agency (SAHRA) and the Provincial Heritage Resources Agencies.

A policy and guidelines for the management of cultural heritage resources in the Waterberg District Municipality still has to be developed.

Table 11: Types and ranges of heritage resources (the national estate) as outlined in Section 3 of the National Heritage Resources Act, 1999 (Act 25 of 1999)

The National Heritage Resources Act (Act 25 of 1999, Art 3) outlines the following types and ranges of heritage resources that qualify as part of the National Estate, namely:

(a) places, buildings structures and equipment of cultural significance;
(b) places to which oral traditions are attached or which are associated with living heritage;
(c) historical settlements and townscapes;
(d) landscapes and natural features of cultural significance;
(e) geological sites of scientific or cultural importance;
(f) archaeological and palaeontological sites;
(g) graves and burial grounds including-
  (i) ancestral graves;
  (ii) royal graves and graves of traditional leaders;
  (iii) graves of victims of conflict;(iv) graves of individuals designated by the Minister by notice in the Gazette;
  (v) historical graves and cemeteries; and
  (vi) other human remains which are not covered in terms of the Human Tissues Act, 1983 (Act 65 of 1983);
(h) sites of significance relating to the history of slavery in South Africa;
(i) movable objects, including -
  (i) objects recovered from the soil or waters of South Africa, including archaeological and paleontological objects and material, meteorites and rare geological specimens;
  (ii) objects to which oral traditions are attached or which are associated with living heritage;
  (iii) ethnographic art and objects;
  (iv) military objects;
  (v) objects of decorative or fine art;
  (vi) objects of scientific or technological interest; and
  (vii) books, records, documents, photographs, positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act (Act 43 of 1996).

The National Heritage Resources Act (Act 25 of 1999, Art 3) also distinguishes nine criteria for places and objects to qualify as 'part of the national estate if they have cultural significance or other special value…'. These criteria are the following:

(a) its importance in the community, or pattern of South Africa's history;
(b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(d) its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
(e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa;
(i) sites of significance relating to the history of slavery in South Africa.

3.3. TYPES AND RANGES OF HERITAGE RESOURCES

The 'national estate' as outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999) is well represented in the Waterberg District. The heritage of the Waterberg refers to all sites of geological, zoological, botanical and historical importance, national monuments, historic buildings and structures, works of art, literature and music, oral traditions and museum collections and their documentation, which provides the basis for a shared culture and creativity. Heritage does not stand alone but forms an integral and indispensable part of the environment. These assets are also known as cultural and natural resources.

Cultural heritage resources can be defined as buildings, structures, objects, sites and landscapes. They may include natural properties such as plantations, gardens or parks on heritage sites or domesticated animals (sheep, cattle, dogs, etc.) and plants (maize, millet, etc.). Heritage resources can be tangible (sites, buildings, structures, etc.) or intangible (oral histories, legends, myths, etc.), as well as movable (objects) or immovable (buildings, structures, sites, precincts). Cultural landscapes involve pre-historic and historical settlements and their interrelationship with particular environments whilst historical townscapes reflect past architectural styles and social networks in semi-urban and urban environs. Living heritage incorporates customs, behaviour and traditions that have continued since times immemorial or that are re-enacted as ways of the past.

Heritage resources are unique and precious and they can never be renewed once they have been destroyed. Human interventions by means of various development activities continuously endanger the wide range of heritage resources that occur all-around. (Interventions in the past, of course, have contributed to the *status quo* or the way heritage stands today.) Good heritage management therefore is essential if we wish to bequeath the national estate to future generations.

The cultural heritage of the Waterberg District is primarily the result of human interventions and creations from the earliest times until the present. This cultural heritage is non-renewable and is therefore vulnerable to environmental, economic and social pressures.

3.4. THE HERITAGE CHARACTER OF THE WATERBERG DISTRICT

Human history in the Waterberg District is closely linked to the natural phenomena and features such as the mountains, plains, minerals, grassvelds and water resources in the district. Rainfall, seasonal fluctuations in temperatures and general climatic conditions were not constant and many of these fluctuations challenged human adaptation as it offered opportunities and

constraints to bands of hunter-gatherers, complex farming communities, specialists such as metal workers or entrepreneurial traders in the past. Considering the depth of time associated with human occupation of the district, namely three million years in the Makapan Valley, it can be accepted that fluctuations over this time span were many, different in various eco-zones and probably eventful, if not disastrous, to human groups in this vast region.

The heritage character of the Waterberg District is discussed according to heritage resources that are known to exist in different areas (zones) in the district. In some instances areas equal eco-zones with distinct ecological features such as the Waterberg Mountains which was home to the Late Stone Age San hunters and Khoe Khoe herders and the numerous rock paintings and stone tools they left in rock shelters and in caves in the mountains. Mostly, however, these areas collate with the presence of historically known human groups such as the eighteenth century Bakwena Bamôgôpa who settled at clusters of 'kopjes' near Northam, the farms and towns which colonial farmers occupied along the eastern fringes of the Waterberg during the 19th century or the plains studded with mountains and hills to the north-west of Mokopane which served as the Langa Ndebele sphere of influence from the eighteenth century onwards.

When referring to the human past in archaeological (heritage) terms, the following time periods are usually distinguished, namely:

- The Stone Age (SA) is divided into the Early Stone Age (ESA) (covers the period from 2.5 million years ago to 250 000 years ago), the Middle Stone Age (MSA) (refers to the period from 250 000 years ago to 22 000 years ago) and the Late Stone Age (LSA) (the period from 22 000 years ago to 200 years ago). Stone Age hunter-gathers seasonally moved around in small bands and lived in temporary settlements such as open sites or caves and mainly lived by means of hunting and gathering. LSA hunter-gathers and Khoekhoe herders are also associated with rock art.
- The Iron Age (IA) is usually divided into the Early Iron Age (EIA) (covers the 1st millennium AD) and the Later Iron Age (LIA) (covers the first 880 years of the 2nd millennium AD). The Iron Age (IA) is associated with the first agro-pastoralists (farming) communities who lived in semi-permanent villages, manufactured pottery and in some instances practised specialised activities such as mining, metal working and trading.
- The Historical (Colonial) Period refers to the appearance of the first written records provided by hunters, traders, adventures and missionaries who moved into the interior from the 1830's onwards. Their diaries, memoirs and journals contains amongst others

descriptions of the indigenous peoples, places, fauna and flora, minerals and (now historical) events that occurred in this part of the country.

3.4.1. Plains with mountains and 'kopjes'

The vast open plain between Mokopane and the Bakenberg, before one enters the Waterberg, is characterised by mountains, smaller 'kopjes' and knolls which are scattered over this level area. Many of these mountains and hills bear historical names such as Mapela, Fonthane (Moordkopje) and Thutlwane. Still further north of Bakenberg (Mapela) is Magagamatala. Together with Mabyanamatshwaana, Tsotsodi, Segodini and Sefakaulo these mountains and hills served as historical settlements, battlefields and as graveyards for the Langa Ndebele and some of their chiefs. This cultural landscape therefore represented the 19th century sphere of influence of the Langa Ndebele.

The Langa Ndebele can be divided into the Langa of Mapela and a younger junior section, namely the Langa of Bakenberg. The Langa Ndebele is a Nguni (Hlubi) group who moved from KwaZulu-Natal through the Limpopo Province during the 17th century. They settled at mountains and on the plains where they subjugated a number of smaller Sotho clans whilst others voluntarily joined the Langa Ndebele to become part of the Langa Ndebele sphere of influence.

During the Langa Ndebele's sojourn through the Limpopo Province they remained at Leysdorp, Bosega and Thaba Tšweu. They adopted the Sotho language and culture and acknowledge the seniority of the Ndebele of Kekana (near Zebediela) who also had moved from KwaZulu/-Natal to their present abode near Zebediela. The Ndebele of Langa and Kekana, together with the Voortrekkers, were involved with the siege of the Makapans Caves during 1854.

The Ledwaba/Maune Ndebele clans, who are related to the Langa-Ndebele, live in the Bergzicht-Kalkspruit and Mašašane townships. Thaba Tšweu, also known as Witkop were occupied by clans of the Langa Ndebele during the 17th century to the 19th century. According to oral tradition they lived at Thaba Tšweu for four successive generations under the leadership of Masebe I, Mapuso, Podile and Masebe II. Concentration of stone walled sites in defiles and along the base of Thaba Tšweu today attests to the presence of these early Langa Ndebele clans.

Early exploration for platinum on the Platreef was done by the Northern Platinums Ltd Company's during the 1920's. (The Platreef is part of the Merensky Reef that curves 20 km south of Mokopane northwards for approximately 100 km). Potgietersrust Platinum Mine's firts pilot plant was built on Zwartfontein 818LR in 1927. The world's consumption of platinum and its price became extremely depressed by 1930. This led to the collapse of all the platinum mines in the 1930's. Evidence for early exploration and mining still exist on the vast plain north-west of Mokopane and mining heritage remains include trenches, shafts and old mine infrastructure some of which still survives.

Photo 1: A Langa Ndebele settlement

A Langa Ndebele settlement on the plains to the north-west of Mokopane, probably Thutlwane.
Note the extensive remains of stone walled sites on two levels of the mountain. The Voortrekkers attacked Mankopane on 12 June 1868 at Thutlwane and raided large numbers of cattle and small stock, but they could not take the highest part of the mountain where Mankopane's headquarters were. Mankopane died on 30 May 1877 and was buried in his cattle kraal on the mountain (above).

3.4.5 The Waterberg

The central part of the project area covers the extensive Waterberg mountain mass. This mountainous terrain is divided by the Mogol, Lephalale and Magalakwena Rivers whose catchments are on the mountains and run northwards through the mountain range. This region has a slightly higher rainfall than the flat bushveld to the north and west, abundant surface water supplies in the summer, edible plants and fruits and animals and insects that can be used as food.

Settlements dating from the Stone Age (SA) and the Iron Age (IA) occur in this area as well as rock art sites associated with the Late Stone Age (LSA). Concentrations of these heritage sites have been recorded on farms such as New Belgium 608LR, Kirstenbosch 497LR, Buffelskraal 486LR, Haakdoringdraai 711LR and many other farms across the Waterberg. Some of the best preserved rock art sites in the Waterberg occur in rock shelters, shallow overhangs and in caves while open sites with evidence of stone tool knapping and manufacturing activities have also been recorded. The Department of Anthropology and Archaeology at the University of South Africa (UNISA) has mapped at least sixty archaeological sites incorporating SA, IA and rock art sites in an area which is covered by the 1: 50 000 topographical map of Melkrivier 2328CD.

The rock art tradition of the Waterberg comprises of the following:

- Classical San rock paintings, which is typical to those that also occur on the flat areas of the Limpopo Province;
- Khoekhoe (herder) rock paintings are strikingly different as they comprise of geometric finger paintings in a colour spectrum that ranges from red and orange to white. (Some temporally overlaps with that of the San). Non-representative motiffs in early herder art include ‘karosse’, lioncloths, aprons and handprints in red and yellow; and
- The late rock art of the Waterberg mainly consist of finger paintings which were done by African farmer communities. It co-occurs with classic San art (at most of the painted sites in the Waterberg). This art is linked to the rituals of the North-Sotho speakers of the region and were painted on the completion of initiation ceremonies.

Although South African rock art in all regions share fundamental commonalities, differences in regions illustrate distinct meanings to specific and also temporal themes, e.g. specific animals, postures or handprints. The central motif for rock art in the Waterberg is handprints while paintings of sheep are also general (but uncommon elsewhere in the Limpopo Province).

Stylistic attributes specific to the Waterberg include the so-called Waterberg posture, the spread eagled or saurian motif and the emphasis on animals such as the red hartebees. The 'Waterberg posture' usually depicts a male in profile with only one leg and one arm, short, and angled out and upwards. The individual's penis also protrudes upwards and outwards like its arm.

Photo 2: Rock paintings on New Belgium 608LR

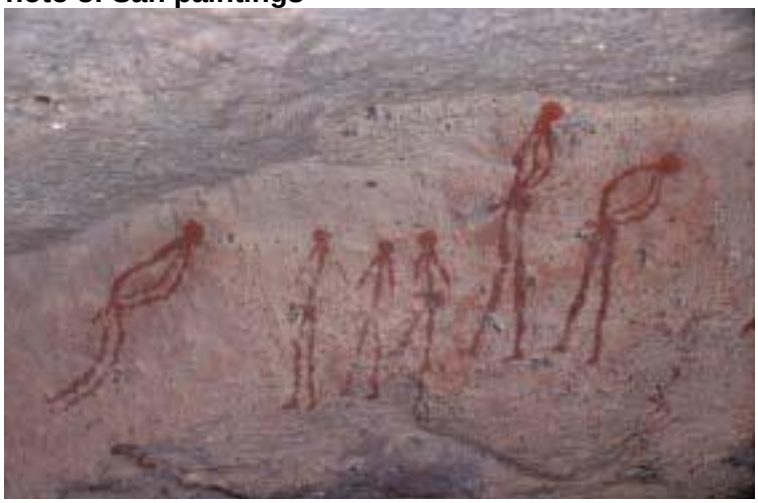
Animal and human figures on a rock face on New Belgium 608LR in the Waterberg. Note that the animal in the foreground is a red hartebeest, one of the most common depicted animal figures in this part of the Waterberg (above).

These human figures are usually found in association with stylised hartebeest antelope images. The hartebeest, like the human figures, are also viewed in profile with only one front and back leg. These uncommon hartebeest forms a category of subtle therianthropes (part-human, part-animal) figures.

Most of the Waterberg rock art is associated with the LSA which implies that most of the rock art in the Waterberg may have been done within the last millennium AD. There is evidence that some San rock painting sites were used as ritual sites, such as for rain making by later farming communities.

MSA and LSA (last millennium AD) hunter-gatherers settlements are associated with the mountainous and flatter areas of the Waterberg. Many of these sites are associated with rock shelters and overhangs. The Olieboompoort rock shelter with MSA and LSA assemblages on Waterval 601, next to the Rietspruit in the Waterberg, serves as a chronological marker for the SA in the Waterberg. This site also holds rock paintings. The end of the MSA in the Waterberg is probably close to 35 000 years BP (before present). The Waterberg may have remained unoccupied for a long period between the MSA and the LSA. Later Iron Age activities in the Waterberg only started with the arrival of the first farming communities who settled on the plains around the Waterberg in AD570.

Photo 3: San paintings



San paintings of human figures on a rock face on Grootdenteren 533LR in the Waterberg (above).

The first African farmers in the Waterberg settled towards the more open parts of the Waterberg plateau. They were the people of the Eiland Tradition (so-called according to their pottery's decoration and style). Eialnd settlements date from the first centuries of the second millennium AD, namely 1100AD to 1300AD, and are usually characterised by the absence of stone walls and the presence of a distinct decorated pottery. One of the largest and best preserved EIA Eiland sites, which are located on a hilltop with terraces along the hillside, occurs on Kirstenbosch 497LR.

No stone walls are associated with this site which dates from the middle to the late 13th century AD. Clusters of LSA tools occur near a rock shelter on the perimeter of the Eiland site. This spatial association between LSA tools and Iron Age villagers reflect aspects of interaction between these groups.

The appearance of Moloko pottery towards the middle of the second millennium AD in the Waterberg is associated with the arrival of the ancestors of the Sotho. A number of settlements dating from AD1600 were recorded near the Motlhabatsi River. From this time a number of stone walled sites appear in the Waterberg itself. Some seems to be defensive in nature as they

occur along cliff edges and are surrounded with perimeter walls such as Bobididi, Buffelsfontein and Malore Hill. Some of the sites may be associated with the arrival of the ancestors of the Nguni-derived Ndebele and with the Batlhalerwa who originated from Zimbabwe.

Bambata pottery, which is associated with Khoekhoe herders are found at Ongelukskraal and at Olieboompoort. The Khoekhoe were herders who moved southwards from Angola/Botswana through South Africa during the early first millennium AD and therefore may have had a temporary presence in the Waterberg.

The Waterberg was one of the last areas to be settled by the colonial Voortrekkers. Colonial families established themselves in the Waterberg where they practised a mixed farming existence during the latter part of the nineteenth century. The colonists also hunted antelope and big game in order to supplement their food resources and to barter products from the hunt for other commodities.

Colonial presence in the Waterberg only became more marked from AD1870 onwards although it is estimated that there were less than two hundred white residents in the Waterberg by AD1900. First generation homesteads, or ‘hartbeeshuise’ constructed with clay or clay bricks and thatched roofs, have all disappeared by now and have been replaced with second and third generation farm residences. Colonial family graveyards as well as informal graveyards for labourers are scattered throughout the area.

Photo 4: Clay bins

Clay bins used for grain storing in a rock shelter on a flat-topped sandstone hill to the north of the Waterberg. These LIA sites are associated with Sotho and Ndebele communities and date from AD1500 to 1880 (above).

3.4.2. The northern and western savannah Bushveld

In the far north and west, after passing the last foothills of the Waterberg Mountains, a homogenous area covered with sand veld and thorn trees marks the Waterberg District. The Matlabas and Crocodile Rivers are the main drainage courses in the west with the Mokol and Magalakwena Rivers further towards the east all meandering northwards to join the Limpopo River. The far northern part of this zone is an unknown entity with regard to the existence of any heritage resources. No detailed archaeological survey or any other significant heritage investigation has yet been conducted in this area. This lack of research or absence of any dedicated heritage survey can be attributed to the fact that no historical communities occur here and that no development projects have taken place in this area. The Blouberg Mountains to the east has been researched as this is the home of the Gananwa who settled here during the 18th century.

Human occupation further to the south and west, closer to the Waterberg, started at an early period. MSA artefacts have been observed along the banks of the Mokol, Phalala and Limpopo Rivers as well as at Nelsonskop where cupules and potsherds were noted. Most of the Stone

Age sites can be classified as open (surface) sites which imply that the artefacts from these sites occur 'out of context'. Such assemblages have less significance than artefacts which occur in closed stratigraphic layers. Although rock paintings mainly occur in the Waterberg, some rock paintings were recorded in outlier foothills of the Waterberg on Rhebokshoek 638 and Bulsfontein 639 in the Kurumakatiti Nature Reserve.

Numbers of ephemeral EIA and LIA settlements which date from the first millennium AD were recorded north of the Limpopo River in Botswana. Although not recorded as yet, it is highly likely that similar sites may occur in older floodplains along the southern banks of the Limpopo River. A number of small IA sites have been recorded along tributaries of the Matlabas River on Rhebokshoek 638, Haarlem Oost 51, Springbokvlei 55, Turfpan 54, Leamington 20, Somerset Noord 21, Elysium 395. No detailed investigations of these sites have yet been undertaken.

Evidence for more substantial farming and metal working in this area occur at the base of the Waterberg, on the farm Diamand 228 which date from AD570 and on farms near the Bulge and Mamba Rivers. These farming communities herded with cattle and sheep, planted crops such as sorghum and millet and smelted iron on a substantial scale.

It is clear that EIA as well as LIA communities did not prefer this flat outstretched sand veld for habitation and for farming. The scarcity of drinkable surface water for humans and animal, low annual summer rainfalls, high temperatures with accompanying high evaporation rates and soils which lacked nutrients were not conducive to crop planting. The absence of all year round grazing also did not encourage mixed farming in this part of the project area.

At least one of the mystical places associated with the origings of some of the indigenous peoples of South Africa occur in this area, namely Rathateng which is a low hill near the juncture between the Crocodile and Marico Rivers on the farm London. Oral tradition claims that the Sotho-Tswana originates from this settlement before they dispersed in many clans over large areas of the North-West Province from the 17th century onwards.

Another small group of people who occupied this area from as early as 1875 were the Vaalpense (also known as Kattea, Malesa, Masarwa, etc.), who were a mixture of Negroied and San people. The Vaalpense were impoverished nomadic hunters and herders who did not occupy permanent settlements that have left traces on the landscape. They became subordinate to the Seleka, Langa Ndebele and colonial farmers who employed some of them as labourers.

The Historical Period commenced with the arrival of the first colonial hunters, traders and farmers during the first half of the nineteenth century. Lephalale served as a nexus for hunting parties operating from Vaalwater and the Waterberg in the east, Thabazimbi in the south and Botswana in the north-east. A few historical houses with graveyards, including informal graveyards, occur but are widely scattered across the area. Most of these houses date from the 1930/40's and are of a similar architectural style. Many of these farmsteads and associated infrastructure have been altered or are renovated. Cultural landscapes, such as those in the older Waterberg region to the east, therfore do not exist.

Ellisras originates from a combination of the surnames of Patric Ellis and Piet Erasmus who settled on the farm Waterkloof 502LQ in the 1930's. After the main route between Vaalwater and Stockpoort was established, facilities such as schools, churches and shops arose on the farm. During the 1920's the exploration for water lead to the discovery of massive coal fields. Geological Survey launched an exploration programme in 1941 in which Iscor partook. Drilling was completed in 1952. In 1957 Iscor obtained the surface rights to six farms, including Grootegeluk. Work on the Grootegeluk Coal Mine commenced in December 1974. Municipal status was granted to Ellisras on 1 July 1986. The name Ellisras was changed to Lephalale in 2002.

Vaalwater is situated in a transitional zone between the drier western part and the wetter eastern part of the country. A branch railway line from Modimolle to Vaalwater was opened in 1925. The town houses the charming Church of St. John the Baptist which was built by the local Anglican community and consecrated on 15 July 1914.

3.4.3. Thabazimbi and Northam

Thabazimbi is the Tswana word for 'mountain of iron'. The exceptionally rich iron deposits at the Vlieggepoort defile was discovered by J.H. Williams in 1939. The government bought the ore body and Iscor started with production in 1931. The township of Thabazimbi was mainly established for the employers of Iscor. It was laid out on the farm Kwaggashoek and officially proclaimed on 4 May 1953.

The Thabazimbi-Rooiberg area is known for the prehistoric mining of tin which occured during the last few centuries in Rooiberg, near the contemporary village with the same name. This knowledge on pre-historic mining and smelting was compiled by curious miners, geologists and metallurgists during the early part of the 20th century and is largely technical as it provides no insight into the chronology, settlements or the identity of the miners. More detailled scientific

research is required as evidence for the prehistoric working of iron, copper and lead also has been reported from the area.

Two archaeological surveys were conducted in the Thabazimbi area, namely in the west where Kumba's iron ore mine is located and towards the Rooiberg Mountains in the east. Evidence for pre-historic iron smelting and habitation was recorded at more than ten settlements in the Ben Alberts Nature Reserve and in the Kumba mining area, south of Thabazimbi. In a survey along the southern fringes of the Boschoffsberge and along the Rooiberg and Sandrivier Valleys, south and east of Thabazimbi, sixty three sites were recorded. These setllements represent four classes (units), namely Rooiberg Units 01 and 02 which belong to the EIA (AD900 and AD1200), Rooiberg Unit 03 which belongs to the LIA (AD1500) and Rooiberg Unit 04 which is attached to a LIA phase which is associated with stone walled settlements (AD1700-1800).

The area stretching north and north-westwards from Thabazimbi towards Sentrum may have been scarcely occupied during the LIA and Historical Period, and possibility at times during the pre-historical period as well. The defile known as 'vlieggepoort' in the Vlieëberg Mountains, which today serves as entrance to Thabazimbi from the south, accommodates the northwards flowing Crocodile River whose densely vegetated banks was probably infested with the tsetse fly (thus the reference to 'vlieë') in the past. The tsetse fly prevented farmers to herd with livestock and subsequently the establishment of permanent settlements with large communities.

The tsetse fly was only eradicated after the runderpest of 1894 which also opened opportunities for livestock herding. This initial economic backdraw in the face of an abundance of minerals (such as iron, tin, copper and lead) probably promoted the mining, working and trading of minerals. Large amounts of tin were mined at Rooiberg whilst iron ore was smelted on several sites to the south of Thabazimbi. Mining of minerals was also sighted near the banks of the Crocodile River on the farm Sweet Home 233 and on Zandfontein 394 near the Matlabas River. Extensive copper mining occurred in the Dwarsberge which is located in the far south-western corner of the Waterberg District during the LIA.

Northam is situated on the railway line running from Pretoria to Thabazimbi. The village was laid out on the farm Leeuwfontein by E.H.J. Fulls and formally proclaimed in 1946. Leeuwfontein and surrounding farms belonged to H. Herd who bought the properties from British soldiers who received these farms as compensation after the Anglo Transvaal War (1899-1902). He named the village Northam in honour of Northam in Devonshire, England. The area is known for its rich deposits of chrome and platinum.

The Bafokeng, Bakwêna Bamôgôpa and Bakwêna Baphalane may have been one clan living in the Northam area during the LIA. Today, the Bafokeng occupy the Rustenburg area, the Baphalane lives in Ramakoka and the Bamôgôpa occupy an area between Madibeng (Brits) in the south-east and Northam in the north-west. It seems as if a cluster of 'kopjes' north of Northam, including Spitskop (Sefikwe) west of the town, served as a sphere of influence for the Bakwêna Bamôgôpa from the seventeenth century onwards. Clusters of stone walled sites along the base lines of these kopjes were probably occupied by these clans who had the *kwena* (crocodile) as their totem.

Photo 5: Mining heritage remains

Mining heritage remains on the Platreef north-west of Mokopane where the first Potgietersrus Platinum Mine was established in the 1920's. The Platreef was mined until the collapse of the platinum industry in the 1930's. The platinum industry only boomed again during the last decades of the 20th century (above).

3.4.4. The northern foothills and flats of the Waterberg

Isolated flat-top sandstone hills (mesa) and kopjes on sandveld that is covered with thorn trees occur directly to the north of the Waterberg. These topographical features correspond with the

spheres of influence of the Seleka-Ndebele and the Batlhalerwa (Shongwane) clans who have their origins in the LIA and historical period. These flat-topped mountains, which also occur elsewhere in the Waterberg, also hold rock art sites in shelters, overhangs or caves.

Rock art sites are also associated with rituals such as rain ceremonies. Rain control ceremonies conducted by LIA farmer communities in the Waterberg are associated with rock art sites as it was believed that the potency of rock art contributed to the influence ('power') of such places.

Stone cairns, grindstones and clay pots, which were manufactured and used by LIA communities, frequently occur in rock shelters and overhangs where there are no or little occupational debris.

The Berlin missionary Schlömann observed ritual practices by a group of Vaalpense in 1888. This group took him to the prominent Tafelkoppe Mountain who commands a prominent view on a stretch of the Lephalale River where they described their ritualised behaviour and explained in what way the painted shelter at this mountain features in their rituals.

The Ndebele of Seleka is a remnant of the Southern Ndebele people who moved from the Pretoria area into their present homeland during the 18th century.

The Batlhalerwa, also known as the Shongwane, lives in the Rustenburg (Bafokeng) District in the North-West Province. The clan is also known as the Babididi, a name which is derived from their former settlement Bobididi Hill on the banks of the Lephalale River where they lived under a chief named Shongwane. Their totem is the Tlhalerwa or wild dog.

It is said that the Batlhalerwa originally were Karanga and that they arrived from Bokgalaka (Zimbabwe) north of the Limpopo River. Their first settlement took place at Haernertsburg (Tzaneen) and it is said that the group, at this time, served as a section of the Batlou tribe of Makgoba. Ramoitoi ruled during the 18th century, *prior* to the Ndebele invasion. His eldest son Ranare was taken prisoner by the Mapela Ndebele and his brother left the tribe with his followers in AD1860 and joined the Bakgatla Bagakgafela under chief Kgamanyane who recognised him as headman of the village Mamatwantwa on the Mothlabe River near Rustenburg.

These two clans are historically associated with flat-topped hills such as Bobididi, Magagamatala, Tafelkoppe and others. Both Bobididi and Magagamatala hold remains that may be associated with these clans as well as with the Langa Ndebele. These LIA and historical communities probably practised a mixed farming existence as well as metal working in a harsh

environment as remains of these activities were found at some of the sandstone hills in the area.

3.4.5. The Makapans Valley

The Makapans Valley to the north of Mokopane, one of South Africa's world heritage sites, incorporates an extensive cave complex which holds paleontological, archaeological and historical remains. Makapans Caves is situated fifteen kilometer to the north of the town of Mokopane in the Makapan Valley which is a broad, shallow valley which is bounded on the east and south-east by the dolomitic Maribashoek Mountains, Buffelshoek Mountains and Highveld mountain ranges. East of the Highland Mountains the land drops away to the Pietersburg plateau. The Dorps River, which flows through the valley, originates on the high altitudes of the Highland Mountains in the east. A continuation of these dolomitic ranges executes a sharp westwards turn to form the Makapan's Vally northern slopes.

The Makapansgat Valley holds a complex of caves of which the Makapans limeworks is the oldest, spanning an age of greater than 4 million years until perhaps 1.6 million years ago. Thousands of fossil bones have been excavated from the site, amonst others those of Australopethicus Africanus which are between 3.03 and 2.58 million years old based on paleomagnetism dating techniques. Caves in the Makapans Valley include amongst others Ficus Cave, Buffalo Cave, Historic Cave or Makapansgat and others.

The Ficus Cave's name is derived from a fig tree (Ficus Ingens) which curtains its entrance. This cave has yielded IA and 19th century Colonial relics, a large bat colony and an underground lake.

Dr. Robert Broom collected a small sample of fossils from Buffalo Cave including the remains of the extinct buffalo, Bos Makapania. More recent excavations bought to light an extensive Cornelian Land Mammal Age fauna including antelopes, horses, monkeys and carnivores. The fauna along with palaeomagnetic age estimates suggests an age of between 780 000 and 1,07 million years for the fossil bearing deposits.

The Cave of Hearths is part of the Historic Cave complex and is one of two sites in the world which holds a complete record of human occupation from the earliest period of human existence, from the ESA (with remains of Australopethicus Africanus) through the MSA, the LSA up to the IA. The Historic Cave or Makapansgat lies adjacent to the Cave of Hearths. It is most famous for the clash between the Voortrekkers and the Ndebele during the siege of the cave

which lasted from 25 October to 21 November 1854. The cave was proclaimed a National Mounument in 1936.

At least fifty settlements dating from the LIA and Historical period were recorded during an archaeological survey in the Makapan Valley. The identity of the valley's previous inhabitants is unknown although the Cave of Hearth's complex can historically be linked to the Ndebele of Makapan. After the massacre of Voortrekker families at Moorddrift and Pruissen, including members of Hermanus Potgieter's party at Fonthane Hill (Moordkopje) in 1854, Commandant General Piet Potgieter assembled a commando of 500 men who took siege of the huge cavern into which the Ndebele had withdrawn. The Ndebele was finally overtaken on 21 December 1854 having lost more than 2 000 members of the clan. Piet Potgieter was killed during the siege. Makapan (Mokopane) escaped with other members and retrieved to his capital where he took poison and died shortly afterwards.

After the runderpest which lasted in the 1890's impoverished Tsonga, and Shangaan from the Lowveld moved into the Makapan Valley joining the local Pedi and Ndebele. In 1905 the Ndebele chief Johannes Kekane and his followers moved into the valley from Zebediela. In 1926 the first white farmers began work in the Makapan Valley which was subsequently divided four farms.

Excavations of three of the fifty sites revealed an Iron Age sequence (primarily derived from the Ficus Cave deposists) stretching from the EIA (AD500-600), an Eiland phase (AD900-1000), an ambiguous 15th century cultural entity and a superficial early 20th century Ndebele occupation.

Photo 6: Mapela's memorial

Mapela, one of the great Langa Ndebele chiefs, moved his village to Fothane Hill (Moordkopje) where Hermanus Potgieter and his party were massacred in 1854. Mapela died here in 1825. A memorial indicates his grave on top of the mountain (above).

3.4.6. Colonial towns along the eastern perimeter of the Waterberg

A number of towns along the eastern perimeter of the Waterberg have their origins in colonial history, namely Bela-Bela, Modimolle, Mookgophong and Mokopane. A hot spring serves as the reason for Bela-Bela's existence. Tswana who lived in the area in the 19th century knew the spring and called it Bela-Bela ('he who boils on his own'). The first whites who saw the spring were the hunters Jan Grobler and Carl van Heerden in the 1860's. Van Heerden later built his farm around the spring and drained the swamp that formed over the centuries. The healing properties of the spring spread and people from far and wide visited the spring. President T.F. Burgers visited 'Het Bad' himself in 1873 and in the same year the ZAR bought the spring which was developed into a public spa. Gradually a settlement known as Warmbad grew around the spring. The settlement was proclaimed a town on 14 December 1882. The name Hartingsburg for the town never gained currency and the name Warmbad was official bestowed on the town when it recieved municipal status in 1932. The Limpopo Government changed the name to Bela-Bela.

Historical beacons in the area include a blockhouse which served in the line of blockhouses which stretched from Naauwpoort in the Magaliesberg to Pietersburg during the Anglo Transvaal War (1899-1902). A Voortrekker cemetery lies along the Thabazimbi road.

From the eastern fringes of Bela-Bela and Modimolle, where the Waterberg is known as Rooiberg, the Springbokflats stretches eastwards towards Roedan, Settlers and Tuinplaas. Kranskop (Modimolle) and the Nylsvley Nature Reserve are located on this outstertched piece of grass land. Many thousands of springbok and other antelope roamed these plains before they were wiped out by hunters during the 18th and 19th centuries. Stone Age sites were recorded on Vellefontein, Blaauwbank and Hartebeesfontein near the Rooiberg. MSA artefacts are probably widespread across the Springbokflats, mainly manufacured from dolerite, felsite and quartzite derived from the Rooiberg. At Tuinplaas, part of the skeleton of a Homo Neanderthalenis was found decades ago.

Known historical beacons in the Rooiberg close to Bela-Bela and Modimolle includes Buyskop and Kranskop (Modimolle). Buyskop, a foothills of the Rooiberg on the outskirts of Bela-Bela served as home for Coenraad De Buys, notorious nineteenth century traveller, hunter and adventurer who disappeared during one of his sojourns in the Limpopo Valley and whose descendants today live in Buysdorp in the Soutpansberg. Kranskop (Modimolle), a chunk of the Rooiberg who shifted far to the east now sitting on the eastern shoulder of the N1, is the place from where the town of Nylstroom derives its name. This mountain is considered a holy place by some of the local people.

The village of Nylstroom was laid out on the farm Rietvlei in 1866. Nylstroom is also known by some of the locals as Mogalakwena (‘fierce crocodile’). A group of Voortrekkers known as the ‘Jerusalemgangers’ who arrived in the area in 1886 named the north-flowing river – the headwaters of the Magalakwena flowing to the Limpopo River – the Nile River believing that following its course and after crossing Africa and Egypt it will bring them to the holy land. The name of Nylstroom was changed to Modimolle.

Historical beacons in town include the residence of Advocate J.G. Strydom the Prime Minister from 1954 to 1958 who lived in this Cape Dutch house which was designed by Gerard Moerdijk. The historic Waterberg Reform Church was built in 1889 and constitutes a historical townscape together with a number of other historical residences that reflects the heritage character of Nylstroom.

Naboomspruit north of Modimolle had its beginnings when J.K.G van Zyl settled on the farm Vischgat which became known as Kaufmanns Place – so-called after a trader who put up a store, an inn and stables for the horses of the mail coach service that travelled between Pretoria and Pietersburg. The town dates back to 1907. Its original name is derived from the numerous Naboom (Euphorbia) trees which grow in the area and the new name, Mookgophong is the Tswana word for the same plant.

Mokopane in the defile between the Waterberg and the Strydpoortberge traces its name to the Voortrekker leader Hendrik Potgieter who established a settlement in the poort in 1852 which he called Vredenburg. In 1858 the ZAR renamed the village in honour of Commandant-General Piet Potgieter who was killed during the siege of Makapansgat in 1854. Uninterrupted attacks by black groups and the effect of malaria lead to the abandonment of the town which was only re-established in 1890 and the name changed from Potgieterust to Potgietersrus. In 2002 the name was changed to Mokopane, an alternative name for Makapan the Ndebele chief who sought refuge in the Makapanas Valley during the Ndebele's clash with the Voortrekkers in 1854.

Historical beacons in the area include a cluster of Ana Trees north-west of Mokopane where the explorer and missionary Dr. D. Livingstone once camped under the canopy of these trees. Commandant-General Piet Potgieter who was killed at Makapansgat was buried in the municipal grounds. A monument commemorating the Ndebele's murder of Voortrekker families was erected along the R101 near the entrance to Mokopane. The Percy Five, Ntabeni and Welgevonden Nature Reserves occur in the general area. The Arend Dieperink Museum houses an extensive collection of Voortrekker memorabilia and an aloe garden with 4 000 specimens representing more than 200 species.

Photo 7: Stone walls on top of Magagamatala

Stone walls on top of Magagamatala, one of the previous capitals of the Langa Ndebele. Magagamatlala was attacked on 14 April 1858 by a punitive Voortrekker expedition and 800 of Mankopane's subjects were killed. This is known as the war of 'Nterekane' or the 'War of Maruputlase' (above).

3.4.7. Pressures and impacts on cultural resources in the Waterberg District

Natural and heritage resources are generally better protected in conservation areas such as nature reserves. A limited number of nature conservancy's exist in the Waterberg District where heritage resources are protected from human interventions and development. The absence of an awareness of the significance, importance and protected status of heritage resources outside these protected areas therefore causes an unnecessary pressure on heritage resources which may not be treated with the same caution as natural and cultural resources in protected areas.

A general ignorance about the conservation value of heritage resources amongst developers, lay men and the public may cause an impact (damage, alteration, removal) on heritage

resources which again creates legal liabilities to these institutions and people as they are not aware of the penalties associated with damaging heritage sites and removing artefacts from heritage sites.

All kinds of development activities can affect (damage, destroy, alter, remove) heritage resources. These development activities can only follow after the necessary environmental impact assessment studies have been conducted. Large scale development activities such as mining operations and power generation projects (with numerous spin-offs etc., town development projects, roads, railway and power lines construction, etc.) near Mokopane, Lephalale, Thabazimbi and Northam are not always accompanied with compulsory Phase I Heritage Impact Assessment (HIA) studies.

Uncontrolled and unplanned development such as the establishment of informal settlements or squatter camps on the outskirts of large towns such as Modimolle, Bela-Bela, Mokopane, Northam and Lephalale can cause the destruction of heritage resources and cultural landscapes.

The development of an increasing number of 'ecological friendly' residential areas in the Waterberg is threatening the unspoilt nature of the mountain where large numbers of undiscovered heritage resources still exist. An increase in these types of development projects with associated recreational facilities, such as roads and footpaths, provides greater access to unspoilt areas and heritage sites.

Uncontrolled recreational activities such as the absence of professional guides on walking trails in the Waterberg may lead to acts of vandalism (damage to rock art paintings) or the illegal removal of artefacts from cave sites and from rock painting sites.

Population pressure, caused amongst other by the influx of people to new work opportunities, causes homelessness and unemployment. This lead to the vandalism of cultural resources such as memorials, graves and graveyards, archaeological sites and buildings as these sites, structures and features are mostly unprotected and may be defaced, robbed and stripped from valuables.

Natural processes such as soil erosion, weathering and flooding expose heritage sites and their contents from time to time. This causes irreversible damage or the destruction of heritage resources.

Increased air pollution from mining and industry may eventually cause damage to rock paintings and engraving sites.

Due to a lack of heritage research (including dedicated heritage surveys) the bulk of the Waterberg District's heritage resources have not been discovered, geo-referenced or recorded in heritage registers (kept at municipalities, museums, SAHRA's offices). The absence of a comprehensive knowledge regarding the cultural heritage of the Waterberg District inhibits utilising these heritage resources for the improvement of mankind.

Map 20: Heritage sites

4. AIR POLLUTION POTENTIAL[13]

4.1. AIR POLLUTION SOURCES

In the Waterberg District Municipality Air Quality Management Plan, completed in June 2009, an emissions inventory for the Waterberg District was compiled for air pollution sources where information was available or where emission factors could be applied to quantify emissions.

Potential air pollution sources in the Waterberg District have been identified as:

- Power generation – Matimba Power Station is the main source of SO_2 emissions in Lephalale. The new Medupi Power Station will also be a significant source of SO_2 emissions.
- Mining – mainly fugitive dust emissions from mining activities.
- Industrial emissions – mainly emissions from small boiler sources and brickworks in the District. These sources contribute to PM10 and SO_2 concentrations.
- Domestic fuel burning – mainly coal and paraffin burning in informal settlements such as Mahwelereng (Mogalakwena), Marapong (Lephalale) and Regorogile and Lpeleng (Thabazimbi).
- Vehicle emissions – from petrol and diesel vehicles along major roads and the N1 highway in the District. Vehicles are not considered to be a significant air pollution source in the District.
- Agricultural activities – although not quantified, agricultural activities are considered to be an important source of ambient particulate concentrations. Thabazimbi Local Municipality is the main contributor to agricultural activities in the District, contributing to almost 40% of the District's GDP.
- Biomass burning – also not quantified due to the irregular and seasonal nature of this source, are also considered to be an important contributor to ambient particulate concentrations, particularly during the fire-burning season.
- Waste Treatment and Disposal - there are seven licenced disposal facilities (landfills) in the Waterberg District for the disposal of general waste. Incineration occurs on a small

[13] **Main source:** The Waterberg District Municipality Air Quality Management Plan completed in June 2009.

scale in the District with medical waste from hospitals and clinics outsourced to Tshumisano Waste Management.

- Vehicle entrainment of dust from paved and unpaved roads.
- Other fugitive dust sources such as wind erosion of exposed areas.

Particulate and gaseous emissions from industrial operations, domestic fuel burning and vehicle tailpipe emissions were quantified for this assessment, due to the availability of data for these sources. Power generation was identified to be the main contributing source to PM10 emissions (68%) in the District, although this is likely to have been overestimated as many mines did not provide their emissions data, and therefore, were not possible to quantify. With the quantification of all mines in the District, mining sources are likely to be the main contributor to PM10 emissions in the District. Power generation is the main contributing source to SO_2 and NO_2 emissions in the District, contributing to 95% and 93% respectively.

Table 12: Industrial sources and polluting factors in the Waterberg District

Municipality	Source	Process Description	Longitude (°E)	Latitude (°S)
Bela-Bela	Bela-Bela Hospital	Hospital	28.28758	-24.88542
Lephalale	Eskom Matimba Power Station	Power Generation	27.61122	-23.66995
	Ellisras Suiwel (EDMS) Bpk	Dairy Products Processing		
	Grootegeluk Coal Mine	Opencast Coal Mining	27.56064	-23.66275
	Hanglip Brickworks	Brick Making	27.59123	-23.68231
	Veterinary Laboratory	Veterinary Services	27.70547	-23.67536
	Witpoort Hospital	Hospital		
Modimolle	FH Odendaal Hospital	Hospital	28.42217	-24.70142
	Limpopo MDR TB Unit	Hospital	28.39458	-24.70772
	Meat Rite	Meat Processing	28.42050	-24.71575
	Nylstene (Edms) Bpk	Brick Making	28.24633	-24.59661
Mogalakwena	African Red Granite	Opencast Mining	28.70548	-23.92026
	George Masebe Hospital	Hospital		
	Midway Brick	Brick Making	29.13451	-24.13029
	Mokopane Hospital	Hospital	28.98863	-24.15351
	Nedan Oil Mills	Oil Processing	29.00811	-24.16100
	Potgietersrus Abattoir (Edms) Bpk	Abbatoir	28.99808	-24.16328
	Poitgietersrus Citrus	Citrus Manufacturing	29.02222	-24.20639
	PPL Anglo Platinum	Platinum Mining	28.92422	-24.01069
	Van Erkoms Tobacco	Tobacco Manufacturing	28.98025	-24.21006
	Veterinary Laboratory (Dept of Agriculture)	Veterinary Services	29.01617	-24.20819
Mookgopong	Inca Lime	Limestone and Dolomite	29.22580	-24.48158
Thabazimbi	Amandebult Platinum Mine (Anglo American)	Platinum Mining	27.29139	-24.82581
	Northam Platinum	Platinum Mining	27.33496	-24.80659
	Pretoria Portland Cement	Cement Making	26.83104	-24.81358
	Thabazimbi Mine	Iron Ore Mining	27.38567	-24.60608
	WES Enterprises	Animal Feeds Manufacturing	27.39806	-24.59200

4.2. ESTIMATED TOTAL EMISSIONS FOR LOCAL MUNICIPALITIES

Estimated total emissions for each Municipality in the Waterberg District indicate that for:

- Industrial and mining emissions - Lephalale Local Municipality is the major source of industrial emissions, contributing to approximately 96% of emissions in the District. Matimba Power Station and Grootegeluk Coal Mine are the main contributing sources in this Municipality.

- Domestic fuel burning emissions – Mogalakwena is the largest contributor to domestic fuel burning emissions in the District, contributing to approximately 52% of emissions.

- Vehicle emissions – Thabazimbi and Lephalale are the main contributors to vehicle emissions, contributing 28% and 24% respectively. However, the contribution of Bela-Bela, Modimolle, Mogalakwena and Mookgophong to vehicle emissions may have been under-estimated as vehicle volumes on the N1 highway could not be obtained.

The National Framework for Air Quality Management in South Africa rates the Waterberg District as having potentially poor air quality mainly due to emissions from industries. As a whole, the Waterberg District is, however, not considered to be an industrialised area as predominant activities in the area are agriculture, game farming and eco-tourism. Proposed future industrial developments will, however, make the Waterberg, in particular, the Lephalale region an important role player in air quality in upcoming years. The construction of Eskom's Medupi Power Station has already begun with an additional two Power Stations (Coal 3 and 4) proposed in the Waterberg. Sasol has also proposed the development of a coal-to-liquids (CTL) plant in north-western part of the Waterberg District.

Within the District, most industries are located in the major towns, and along major roads connecting these towns. Mogalakwena has the highest industrial activity in the District with industries located predominantly in the town of Mokopane. Within Lephalale, Matimba Power Station is one of the major industries within Lephalale and the Waterberg District as a whole. Mining is the predominant activity in Thabazimbi while Bela-Bela, Modimolle and Mookgophong have very few industries.

Based on information obtained from the Limpopo Province, the APPA Registration Certificate Review Database and an area wide site visit, the main industrial sources within each Local Municipality have been identified to be:

- Bela-Bela – There are no industrial sources in this town. Bela-Bela hospital has a boiler, which is in the process of being decommissioned.
- Lephalale – Exxaro Grootegeluk Mine, Ellisras Suiwel and Witpoort Hospital. Scheduled processes include the Veterinary Laboratory (Department of Agriculture) and Matimba Power Station.
- Modimolle – FH Odendaal Hospital and Meat Rite. Nylstene brickworks is the only scheduled process in Modimolle.
- Mogalakwena –Van Erkoms Tobacco, Nedan Oil Mills, Potgeitersrus Citrus, African Red Granite, PPL Anglo Platinum, George Masebe Hospital and Mokopane Hospital. Scheduled processes include the Potgeitersrus Abbatoir (boiler decommissioned), Veterinary Laboratory (Department of Agriculture) and Midway Bricks.
- Mookgophong – The only mine in this Municipality is Inca Lime Mine.
- Thabazimbi – Thabazimbi Mine and Amandelbult Platinum Mine. Scheduled processes include Northam Platinum, WES Enterprises and PPC Cement.

4.3. POTENTIAL HOTSPOTS

Potential key 'hotspot' areas were identified within the Waterberg District. These areas are based on the available ambient air quality monitoring data and emissions inventory compiled for the district. Emphasis was placed on areas with high population densities and the spatial distribution of sources in relation to residential areas.

The target areas include:

- Clean areas where it is important for the current land uses and future land use potential to have the best possible air quality and where no change from current air quality should be allowed;
- Local industrial control areas where there are concentrations of local industries that may in future have unacceptable cumulative impacts on air quality where moderated change could be allowed but where stringent air quality constraints are nevertheless desired;
- Industrial areas (hotspots) where substantial industrial or other growth should be allowed with increases in concentrations up to the national standard;
- Areas with high residential concentrations (current and potential future) where no change from current air quality should be allowed; and

- Transition areas and areas in which corridors connect major future industrial areas where moderated change could be allowed but where stringent air quality constraints are nevertheless desired.

5. ECONOMIC CHARACTERISTICS AND DRIVERS

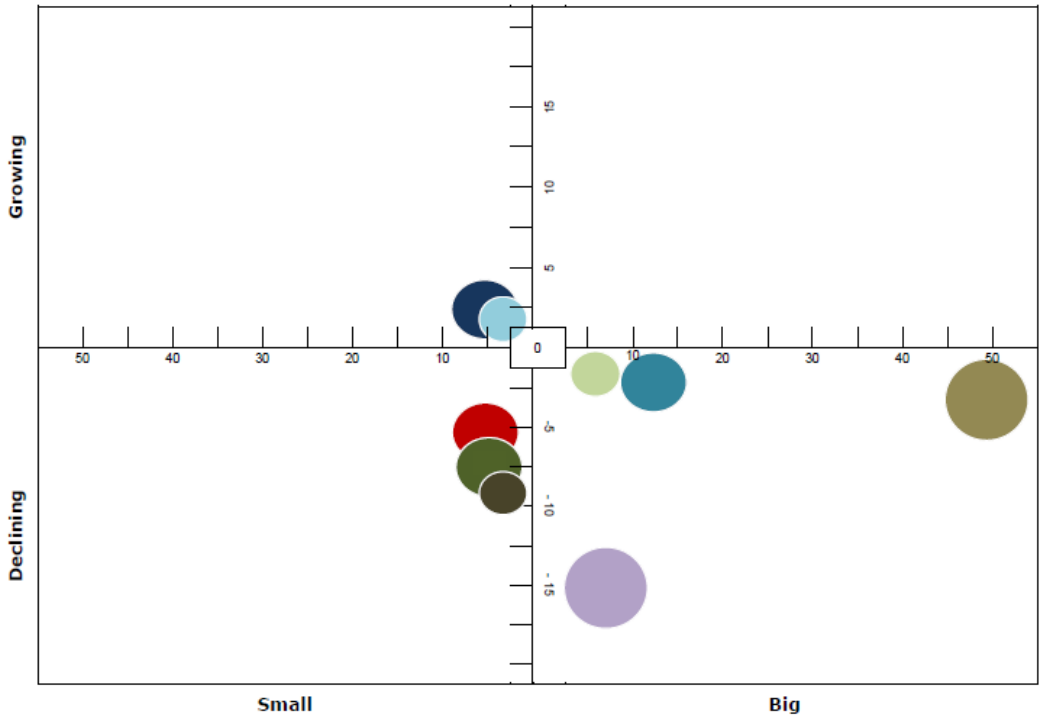
5.1. ECONOMIC PROFILE OF THE WATERBERG DISTRICT MUNICIPALITY

Compared with other districts in Limpopo, the Waterberg District Municipality presents greater prospects for growth in all sectors in terms of GDP, employment and population. Mining, agriculture, and tourism sectors serve as a backbone for growth and have a potential of triggering growth of other sectors such as transport, construction and trade.

5.1.1. GDP and Formal employment outlook

Waterberg's main GDP contribution, by far, comes from the mining sector with a share of almost half (49%) of the GDP in the District, followed by finance sector (11%).

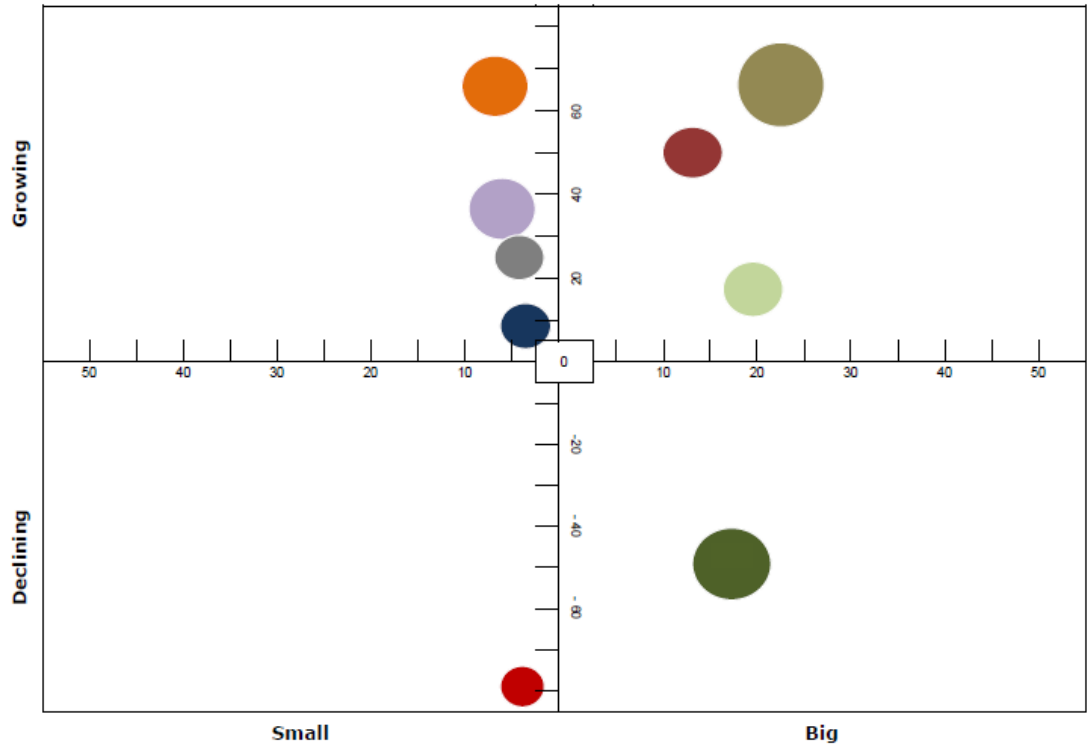
Figure 8: GDP Contribution per sector



Color code	Sector	Share %	% change
	Agriculture	3.17	-7.89
	Community Services	3.73	-5.63
	Construction	1.25	-8
	Electricity	4.48	0.67
	Finance	11.44	-0.17
	Government Services	6.05	-9.59
	Manufacturing	3.72	0.54
	Mining	49.03	-0.35
	Transport	9.7	-15.36
	Wholesale	7.42	-2.96

Only two (electricity and manufacturing sectors) showed insignificant (0.67% and 0.54%, respectively) GDP growth in 2005. While mining is the largest GDP contributor, it was in negative growth for the year 2005. Transport registered the largest decline in GDP growth (-15.36%). None of the biggest GDP contributors registered positive growth during the same period under review.

Figure 9: Employment contribution per sector



Color code	Sector	Share %	% change
	Agriculture	17%	-54%
	Community Services	2%	-90%
	Construction	9%	24%
	Electricity	1%	11%
	Finance	9%	63%
	Manufacturing	13%	51%
	Mining	23%	69%
	Transport	5%	38%
	Wholesale	20%	11%

5.1.2. Growth, development and economic character

The Waterberg experienced steady but relatively modest growth between 2001 and 2007 in terms of employment, with the exception of agriculture and community services which respectively shed 54% and 90% jobs during the same period. Figure 9 above presents an interesting observation that the majority of sectors both small and big registered negative GDP growth between 2003 and 2005.

Although mining is by far the biggest contributor to the GDP, it comes second (16%) in terms of employment after the agriculture sector (26.98%). Even though agriculture creates more jobs it is one of the smallest contributors to the total GDP with a share of approximately 3%. The rate (69%) in which mining created employment between 2001 and 2007 signals a trend that mining will become the biggest employer in the near future, whereas agriculture registered negative growth of 54%. This phenomenon is best explained by the ability of mining and related sectors such as manufacturing, transport and construction which registered 51%, 38% and 24%, respectively, to attract skilled labour and compensate them better than agricultural sector.

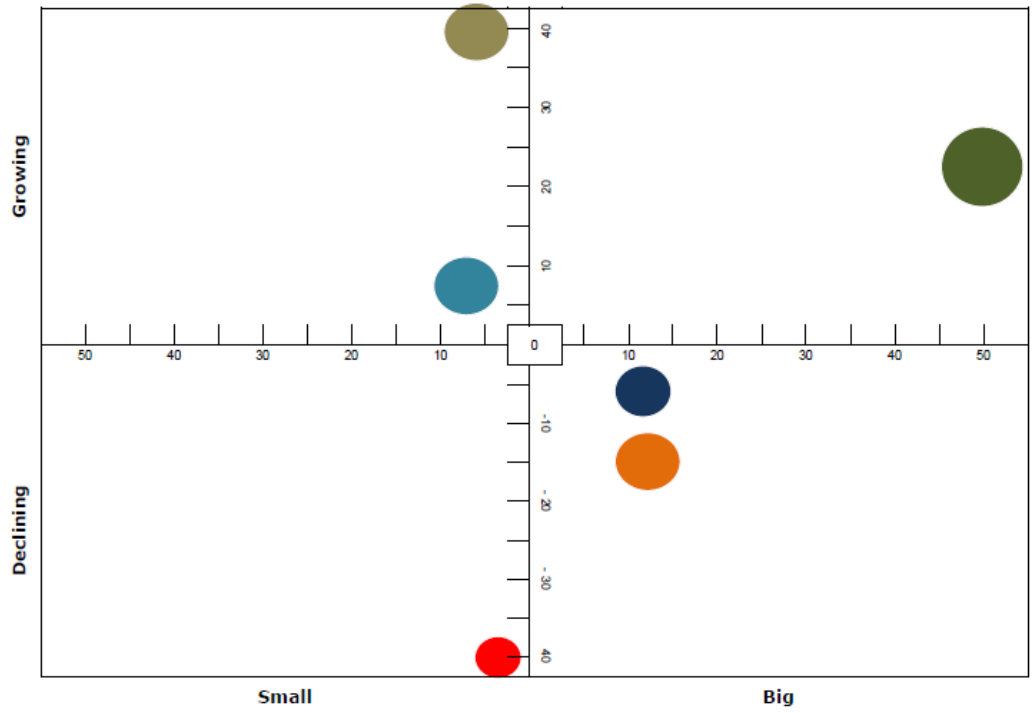
For agriculture to survive the threat of losing skilled labour and possibly cease to exist, it is has to compete and offer better incentives. Investments in the agricultural sector must be encouraged and grow with investments in other sectors in order to keep it competitive in the market.

5.1.3. Population

In terms of the population outlook (Figure 10), three local municipalities registered positive growth with Modimolle registering the biggest growth of 70% followed by Mogalakwena at 27%. The latter Municipality has the biggest population (55%) in the District and contributes the third largest (16%) GDP. Thabazimbi contributes the largest GDP (36%) whereas the size of its population is the third largest in Waterberg. Mookgophong has the smallest population (2.88%),

and equally the smallest GDP contribution. Mookgophong registered the biggest (-44%) negative population growth. The change of municipal demarcation may have impacted largely in these anomaly population growth trends.

Figure 10: Population per local municipality



Color code	Municipality	Share %	% change
	Mogalakwena	55.47	27.08
	Lephalale	13.44	-16.61
	Thabazimbi	10.02	-6.55
	Bela Bela	9.37	7.13
	Modimolle	8.82	70.95
	Mookgopong	2.88	-44.23

5.1.4. Municipalities

5.1.4.1. Bela-Bela

Bela-Bela local municipality's leading GDP contributor is the transport sector (36%). However, the sector employs the third smallest number of employees, compared to other sectors. The highest formal employer is the agriculture sector, even though it is the fifth smallest contributors to the total GDP of the municipality. The finance sector is the second largest contributor to the GDP (22%). Mining is the smallest sector both in GDP and formal employment numbers.

5.1.4.2. Modimolle

The agriculture sector is predominantly the main employer in numbers (28%) in Modimolle local municipality, although the sector contributes the fifth largest GDP (8%) in the Municipality. Transport and finance are first and second, respectively, in the GDP contribution while they employ the third and fifth smallest number of employees.

5.1.4.3. Mogalakwena

Mogalakwena local municipality has a relatively evenly distributed contribution by most sectors, both in GDP and formal employment numbers. Although mining is the highest GDP contributor (19.8%), it is not as predominant as in other municipalities. Government services employs the most people (18%), but is closely followed by wholesale and community services. Agriculture has the least GDP contribution while the electricity sector employs the least number of people.

5.1.4.4. Thabazimbi

Thabazimbi local municipality has the most unevenly distributed contribution by sectors, both in GDP and formal employment numbers. Mining accounts for (80%) of the GDP in the Municipality, and 50% of formal employment is in the mining sector. Agriculture employs the second largest at 19%.

5.1.4.5. Lephalale

Lephalale local municipality also has a relatively unevenly distributed contribution by sectors, both in GDP and formal employment numbers. Most formally employed people work in the agriculture sector (39%) while most GDP comes from mining (59%). Other sectors are very small in comparison to the mining sector, both in GDP size and employment numbers.

5.1.4.6. Mookgophong

In Mookgophong most employment (57%) is in agriculture, while most GDP comes from finance, transport and wholesale sectors. The least contributor in both categories is the construction sector.

5.2. MINING AND MINERAL DEVELOPMENT

The Waterberg District currently has several mines in operation. The major minerals being mined include platinum, iron-ore and coal.

A large coalfield housing a good portion of South Africa's remaining coal reserves is found near Lephalale. There is currently one mine operational there, namely Grootegeluk. Part of the coal mined is used at the Matimba Power Station to generate electricity. Exxaro Resources Ltd. owns the Grootegeluk coal mine. Kumba Resources own the Iron Ore mine at Thabazimbi.

Platinum is mined at Mokopane, Amendelbult and Northam. Anglo Platinum Ltd. owns the mines at Mokopane and Amendelbult, while Northam Platinum Ltd owns the mine at Northam.

The important mining activities in the region include:

- Granite operations in Bakenberg;
- a number of tin fields in the Waterberg;
- tin field deposits in Bakenberg and Rooiberg near the Marakele National Park. These deposits will have an influence on the future zoning of the Waterberg Biosphere Nature Reserve;
- the Waterberg coal field which has 45% of South Africa reserves;
- platinum mining in the western sector. This complex has significant reserves and is being exploited by three mining companies, namely Northam Platinum (Goldfields), Amandelbult (AMPLATS) and the Union section (AMPLATS); and
- iron mining in Thabazimbi. The mine has been in operation since 1936 and is believed to have the remaining life span estimated at about 5-8 years.

5.3. MINERAL PROCESSING

Platinum mining takes place in the District at Thabazimbi, Mokopane, Northam and Amandelbult. Platinum processing requires large amounts of water, although the quality of water need not be very high. Platinum processing also requires a lot of electricity.

Iron ore mining takes place at Thabazimbi. The processing of iron ore requires smelting. This involves the iron ore being powdered and mixed with coke[14], to be burnt. The burning process needs to take place in a very controlled manner. The smelting process removes the oxygen atoms bonded to the iron atoms in the form of carbon monoxide. Further processing turns the carbon monoxide into carbon dioxide.

5.4. LIQUID FUEL FROM COAL

With the development of the new Medupi Power Station and the expansion of the Grootegeluk Coal Mine, the Waterberg begins to appeal to other options and development possibilities in the area, one of them being Sasol's project, Mafutha.

Sasol are keen to build Sasol Four, referred to as project Mafutha (meaning "the big one in isiZulu"). The abundance of coal feedstock in the Waterberg District makes it a prime area for a coal-to-liquids (CTL) project. The plant could produce 80 000 barrels a day in addition to Sasol's current 150 000 barrels a day being produced at Secunda. This would result in Sasol's synthetic fuel output increasing by more than 50 percent.

South Africa is currently importing refined liquid fuel in order to meet the demands of the country. Project Mafutha would produce enough refined liquid fuel to fill the current gap in the market. However, such a CTL plant has serious implications in terms of South Africa's carbon footprint.

5.5. TOURISM

The tourism sector in the Waterberg District is concentrated around the N1 area and the Biosphere. Areas of high intensity of tourism are focused around:

- The Nyslvley Reserve;
- Modimolle;
- Bela-Bela extending along the Rooiberg road;
- Thabazimbi;
- Lephalale; and
- the mountainous area south west of Marken.

[14] **Coke** means a solid-fuel product containing about 80 per cent of carbon produced by distillation of coal to drive off its volatile constituents: used as a fuel and in metallurgy as a reducing agent for converting metal oxides into metals.

Other tourism activity also takes place bordering the southern escarpment of the Waterberg. Very little tourism activity takes place in the Limpopo Valley.

Some of the important tourism features include sites such as the Makapan's Caves and Valley. The caves, which are formed within a limestone strata, have been excavated for many years as layer upon layer revealed evidence of hominid occupation of great African and international importance. The Makapan Valley has been declared a World Heritage Site. Visits to the Makapan's Valley must be arranged in advance by contacting the Mogalakwena Bushveld Community Tourism Association.

The Waterberg Biosphere Reserve is a declared UNESO site. It is an important eco-tourism attraction in the Waterberg District. There are many existing reserves that fall within the area.

Another important tourism feature is the Marakele Park northeast of Thabazimbi. It is home to a number of fauna and flora species including Cape vultures and rare indigenous species such as Yellowwood trees (*Podocarpus latifolius*).

A number of private game reserves offering various experiences can also be found around the Waterberg area.

The Waterberg area is seen as an ideal place for most tourism operators. It is a malaria free region and is only two-three hours drive away from the economical hub of Gauteng. This aspect and its rich tourism nature resources have given it an added advantage to be a favourable tourism destination and attraction for both local and international tourists.

5.6. AGRICULTURE

The Waterberg District has a relatively low agricultural potential on the whole. Agriculture will, however, remain an important economic activity. The Sprinkbok Flats area of the Waterberg District is where a large portion of the agriculture takes place. Irrigated agriculture is also found along the rivers through the region. Towns, around which extensive agriculture takes place includes, Lephalale, Thabazimbi and Mookgophong.

The agriculture around Thabazimbi is known for cash crop production and horticulture. Cash crops include crops such as cotton, sunflower, tobacco and soya beans as well as fruit and vegetables. Lephalale has a variety of agricultural activities taking place around it including game farming, livestock farming and irrigated agriculture. Mookgophong also has a variety of agricultural activities, including game farming, citrus fruit and spice (paprika) production.

Agricultural activities in areas such as Modimole, Mogalakwena and Bela-Bela are practiced on a small scale.

5.7. ECONOMIC CENTRES/NODES

The notable economic nodes found within the EMF area include Lephalale, Thabazimbi and Mokopane.

Lephalale is considered an economic node. It is one of the fastest growing centres in South Africa. The main economic drivers of this node include:

- the Grootegeluk coal mine;
- the Matimba power station;
- agriculture;
- livestock farming;
- the D'Nyala Nature Reserve; and
- hunting and eco-tourism.

Thabazimbi is dominated by the mining and agriculture sectors. The economic drives for Thabazimbi include:

- Platinum mining;
- iron ore mining;
- agriculture in the form of cattle, dryland and irrigated farming;
- the Marakele National park; and
- hunting and eco-tourism.

Mokopane's economic drivers include:

- Makapan World Heritage Site;
- retail node;
- industrial development;
- agricultural production; and
- the platinum mine.

5.8. ECONOMIC POTENTIAL

The Waterberg District's rich natural resources provide great opportunities for future economic expansion and development in the province. Its rich mineral resources have not been fully explored in order to maximise its benefits. There are still some rich mineral deposits yet to be explored and mined in most parts of the mineral rich areas of the Waterberg District. Various potential agricultural opportunities that can boost the economy have also been identified in the area.

The economic opportunities in the area have been identified at both local and district levels. The different local municipalities in the Waterberg District provide various economic opportunities. The local municipalities and their economic potential opportunities are as follows:

5.8.1. Bela-Bela Local Municipality Area

The Bela-Bela Local Municipality area's local economy accounts for 7% of the District's economy and its economy is predominately attributed to its tourism sector. Bela-Bela area has a number of nature conservation areas. These include the Rust De Winter Nature Reserve located in the southern boarder of the municipality area, the Enkeldoornspoort Nature Conservation Area in the south-eastern corner of the municipality area, Mabula Game Reserve, Bonwa Phala Game Reserve and Mabilingwe Game Reserve as well as the Bothasvley Nature Conservation Area and the Sondela Nature Reserve. The nature conservation areas and the hot springs found in the area have made Bela-Bela ultimately one of the remarkable tourism destinations. The tourism sector has added to the municipality area's economic boost.

The agricultural sector in Bela-Bela plays a significant role towards the area's economy. Vegetable production is predominately practiced in the municipality area. The vegetables grown in the area are squash butternut, squash hubbarb, onions, watermelons, cabbage assorted, sweet-corn, pumpkin grey, pumpkin white, beetroot, carrots, and peppers. Fruits are also grown in the area and include grapes, citrus, and peaches. Cash crops are also produced in Bela-Bela and include maize, cotton, millet, tobacco, lucerne, cowpeas, groundnuts, wheat, jug beans, China beans and sunflower.

The mining sector in Bela-Bela is practiced at a small scale. The known mining activity in the area is the small-scale mining of industrial diamonds found in the southern parts of Bela-Bela.

The Bela-Bela Municipality has embarked on development projects that will help boost the local economy. Some of the projects include:

- Day-old chick production;
- broiler rearing;
- crocodile breeding; and
- turning the Rust De Winter Nature Reserve into an agri-tourism destination.

Some of the aforementioned projects where established a few years ago and are already beginning to make a considerable contribution towards the local economy. There are also some proposed projects in the tourism sector that will be implemented in the near future. Future potential in the mining sector also exists in the area. There is an occurrence of precious metals in the area that are not economically viable to mine at present. It is hoped that with continuous technological improvements in the mining sector, these deposits will prove to be profitable in future.

5.8.2. Mookgophong Local Municipality Area

The Mookgophong Area has a considerable bigger economy compared to the Bela-Bela area. It accounts for over 18% of the District's economy. A number of economic opportunities have been identified in the Mookgophong area. These opportunities are predominately agricultural projects and include:

- Paprika production under the irrigation schemes;
- expansion of citrus production in Nyl/Mokgalakwena;
- spices and granadilla production in Nyl/Mokgalakwena;
- meat processing in Naboom;
- hydroponics in the Springbok flats; and
- game farming in the Tambotie floodlands.

The Mookgophong Municipality area also has a growing tourism sector. Proposed development plans towards the sector are being looked into and these will help boost the local tourism sector and the economy.

5.8.3. Modimolle Local Municipality Area

The Modimolle Local Municipality Area has both active agricultural and tourism sectors. Like the Mookgophong Local Municipality Area, the agricultural sector in the Modimolle area is strong. Several development projects and opportunities have been identified in the area, which include:

- Alma hydroponics;
- Meropa vegetables;
- Waterberg Agriculture training project;
- Limpopo Dipudi project, which is a goat abattoir;
- LDA Leseding poultry project in Vaalwater;
- the Busy Bee aquaculture project;
- community game farm projects;
- organic vegetable projects; and
- venison processing project.

The Modimolle local economy has gone through changes over the last decade. Most of the area's primary and secondary sectors have experienced a decline with an exception of the agricultural sector. The tertiary sectors have been exceptional.

5.8.4. Mokgalakwena Local Municipality Area

The Mokgalakwena local economy is driven by the primary, secondary and tertiary sectors. Over the decade, all sectors in the area have experienced considerable growth with the agricultural sector recording the most growth rate. Compared to other local municipality areas in the District, Mokgalakwena has been performing considerably well.

The Mokgalakwena area boasts a number of minerals occurring in its vicinity. The minerals mined in the area include clay which is mined on the Weenen farm, granite, limestone, fluorspar and tin.

The Mokgalakwena area is well known for its agricultural production in the District. The agricultural activities practiced in the area are game farming which is mainly practiced in the western part of the Municipal area, cattle farming, and land farming (cotton and sunflower) as well as intensive tobacco, sorghum and maize farming.

In terms of tourism, the Mookgalakwena area has a number of tourism resources. These include the Makapan World Heritage Site, Entabeni Game Reserve, George Masebe Nature Reserve. Doorndraaidam Nature Reserve and Percy Fyfe Nature Reserve. Other facilities found in the area include a number of game farms, game lodges as well as a sacred site.

The industrial and commercial sectors in the Mokgalakwena Municipality area are reasonably well established. Mokopane is the major retail node of the Municipality and industrial development mainly occurs in Mokopane.

The Mokgalakwena has identified a number of potential projects and economic opportunities across all sectors of the local economy in the area. Some of these include:

- Establishment of another platinum mine by Pan Palladium in joint venture with Impala Platinum;
- proposed venture to develop a conservancy in the Makapan's valley area;
- chicken abattoir;
- Makomole agricultural farm;
- the provincial ITC hub,
- the Mokgalakwena I- Community Project; and
- the expansion of capital projects at Potgietersrus platinum Mine in Mokopane.

Mokgalekwena's economy is exceptional in the Waterberg area, owing to its broad diversity of the economic sectors. The area presents many development options and economical potential for future development and expansion.

5.8.5. Thabazimbi Local Municipality Area

The agricultural and the mining sectors are the most dominate economic sectors in the Thabazimbi Local Municipality area. Eco-tourism and hunting are also an exception.

Several mineral resources are mined in Thambazimbi. It has some platinum deposits which are mined by Anglo Platinum and Northam Platinum, iron ore mined by Kumba Resources, and limestone as well as andulisite which are mined by Pretoria Portland Cement and Trollope Mining services respectively.

The agricultural sector in the Thabazimbi area can be categorised as irrigation, dry land crop production and cattle and game farming. The main crops grown in the area are wheat, which is mostly grown in winter, soya, maize, cotton, red peppers, sunflower, sorghum as well as other fruits and vegetables.

The Thabazimbi Local Municipality area still presents development potential. It still has a number of unexploited mineral deposits in the area, and the international status of the

Waterberg Biosphere Reserve which includes the Marakele National park also creates additional economic opportunity in the District.

5.8.6. Lephalale Local Municipality Area

The Lephalale Local Municipality area is seen as an area with high agricultural potential in the District. The area has extensive livestock production as well as hunting and eco-tourism. The other major activities in the area besides cattle farming and eco-tourism are tobacco and coal mining. Table grapes are also produced in the Lephalale area and these grapes have a two-week lead-time over other grapes grown in the country.

The biggest part of the Waterberg Biosphere Reserve is located in Lephalale and the major attractions in the area include game watching, D'Nyala Nature Reserve, Ferroland Private Game Reserve, Lephalale Wilderness, Marakele National Park, Welgevonded Game Reserve and Wonderkop Reserve as well as all areas along the Limpopo River.

The Lephalale Local Municipality area is also home to the Matimba Power Station, which is one of the world biggest dry cooled power stations.

The Lephalale Local Municipality area is set to undergo major expansion projects in all the major economic sectors. The main identified economical potentials in Lephalale include:

- The construction of the Madupe Power Plant station;
- projected Sasol Plant;
- the expansion of coal mining in the area to the north;
- upgrading of the Matimba Power Station;
- further exploration of the other mineral rich areas such as the south of Marnitz, east of Tom Burke and north of Baltimore;
- proposed privatisation of the D'Nyala and the Mokolo Dam Nature Reserve - in order to utilise the reserves more economically and to be able to provide better services to the tourists.
- Marula project at Steenbokpan;
- Maropong Paprika project;
- Rooigrond commonage at Rifilwe (cattle and goats);
- a seed nursery at Madibaneng; and

- the expansion of the integrated Godisa projects.

The Lephalale area shows great potential for future economical developments. It has promising mining and agricultural sectors. The advantageous location of the Waterberg Biosphere Reserve in Lephalale has made the area a hunting paradise and amongst the favoured tourists attraction.

5.8.7. Alternative sustainable development plans for the Waterberg District

The Waterberg District Municipality has experienced considerable economic growth over the years. This has created expectations that the District's economy is good and performing. The positive economic reviews have attributed to the major economic response from several potential investors. The economic plans in the Waterberg District have been set to benefit both the Local Municipalities and District as a whole.

Besides the potential projects that have been put in place to help boosts the local economy on local and district levels, recommendations on future projects have also been made. These projects will be viable and sustainable for the whole district in future and not just selected Local Municipality areas. The projects will serve as potential sustainable economic drivers. The recommended projects include:

- Bio fuel

The biofuel industry involves the production of fuel by using biomass as the raw material. This industry has grown over the past years in South Africa, with bio diesel production taking the lead followed by the production of ethanol. This industry has a significant potential in the District due to the areas' abundant production of sunflower, soya beans and maize, as these happen to be the main raw materials for the production of biofuel. The biofuel industry has several advantages, which include low prices of biofuel compared to crude oil, higher employment opportunities, and it is environmentally friendly.

- The introduction of Horticulture cluster

The Waterberg area has a large number of small-scale farmers. These can be grouped and integrated to a cluster. The formation of the cluster could increase local opportunities in the community and lead to job creation as well as make service provision viable.

- The introduction of meat processing factory

The introduction of a meat-processing factory could add value to the already existing cattle farming. If these value-adding processes could be retained in the District, it can create various employment and development opportunities in the area.

- The promotion of a manufacturing industry

The manufacturing potential in the Waterberg area is mainly related to the processing of primary products. This industry could flourish in the agricultural sector (especially the processing of leather), food products and mineral beneficiation. The mineral beneficiation although might not be long term, it still should be regarded as a potential project.

- Game farming

The policies in the Waterberg area should encourage the development of game farming at an eco-friendly manner. Private game owners should be encouraged to also introduce eco-friendly tourism as well as encourage them to expand their operations.

- The promotion of fruit and vegetable clusters

This can be achieved through the identification of local farmers and what products are produced in the area.

The Waterberg District Municipality has the responsibility to provide a strategic framework for development to take place in its respective local municipalities. For this reason, the Waterberg District Municipality has embarked on projects that will entail that all the people have a better life and development programmes that can sustain the economy for a long period of time. This will be achieved through the continuous support from major investors.

5.9. ECONOMIC TABLES AND GDP CONTRIBUTIONS

5.9.1. Contribution % to gross value added (GVA) 2004

Table 13: Contribution % to gross value added (GVA) 2004

	Agriculture hunting forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Construction	Wholesale and retail trade	Transport, storage and accommodation	Financial, insurance, real estates and business	Community, social and personal services	**Total**
Waterberg	0.51	3.80	4.77	- 0.83	7.58	9.80	12.17	6.70	0.99	3.76%
Thabazimbi	0.51	2.88	7.58	- 0.36	12.33	15.86	13.31	10.34	0.99	3.75
Lephalale	0.51	5.71	3.55	- 0.98	7.37	11.47	13.20	7.71	0.99	3.21
Mookgophong	0.52	40.54	4.53	1.18	7.42	11.69	10.23	5.38	0.99	4.66
Modimolle	0.52	42.58	7.57	3.83	12.81	15.96	20.48	5.54	0.99	6.04
Bela-Bela	0.52	43.01	8.21	5.47	13.28	16.73	22.19	5.55	0.99	5.94
Mogalakwena	0.51	41.89	1.40	2.39	2.43	3.60	5.33	0.64	0.99	3.64

5.9.2. Growth per sector of the Waterberg District (2002-2004)

The sectors that experienced significant growth during 2002-2004 include the electricity and water, transport and communication, finance and trade and mining. The agricultural sector also showed significant growth in 2004.

Table 14: Growth per sector of the Waterberg District (2002-2004)

Sector	**2002**	**2003**	**2004**
Agriculture, forestry and fishing	2.0%	- 4.9%	8.9%
Mining	3.9%	2.4%	9.0%
Manufacturing	0.2%	5.7%	6.5%
Electricity and water	18.8%	7.3%	5.0%
Construction	- 16.1%	6.0%	-2.2%
Wholesale and retail; catering and accommodation	1.0%	3.1%	5.4%
Transport and communication	7.2%	5.9%	25.0%
Finance and business services	5.9%	7.7%	3.8%
Community, social and other personal services	5.3%	2.6%	3.4%
General government services	0.8%	1.3%	0.8%

Chart 23: Waterberg Sectoral GDP % contribution - LED Data 2005

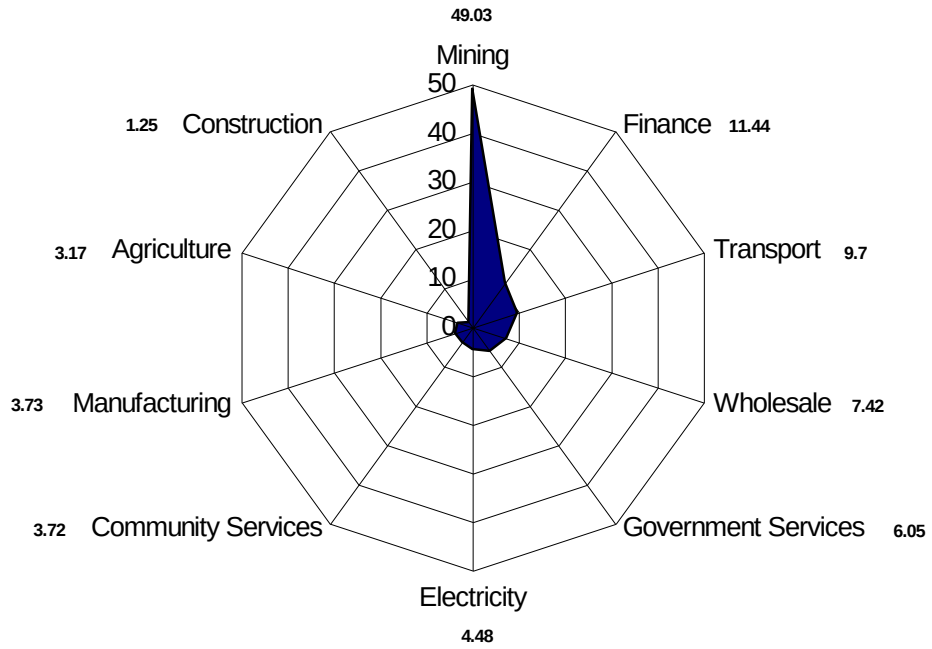


Chart 24: Waterberg Local Municipalities GDP % contribution - LED Data 2005

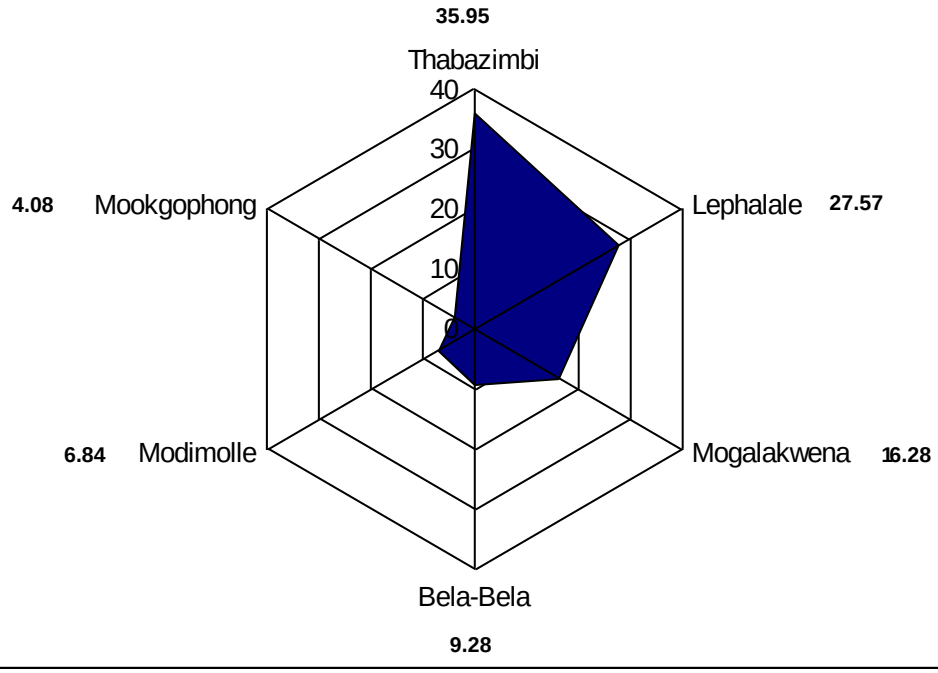


Chart 25: Waterberg Sectoral GDP Growth % - LED Data 2005

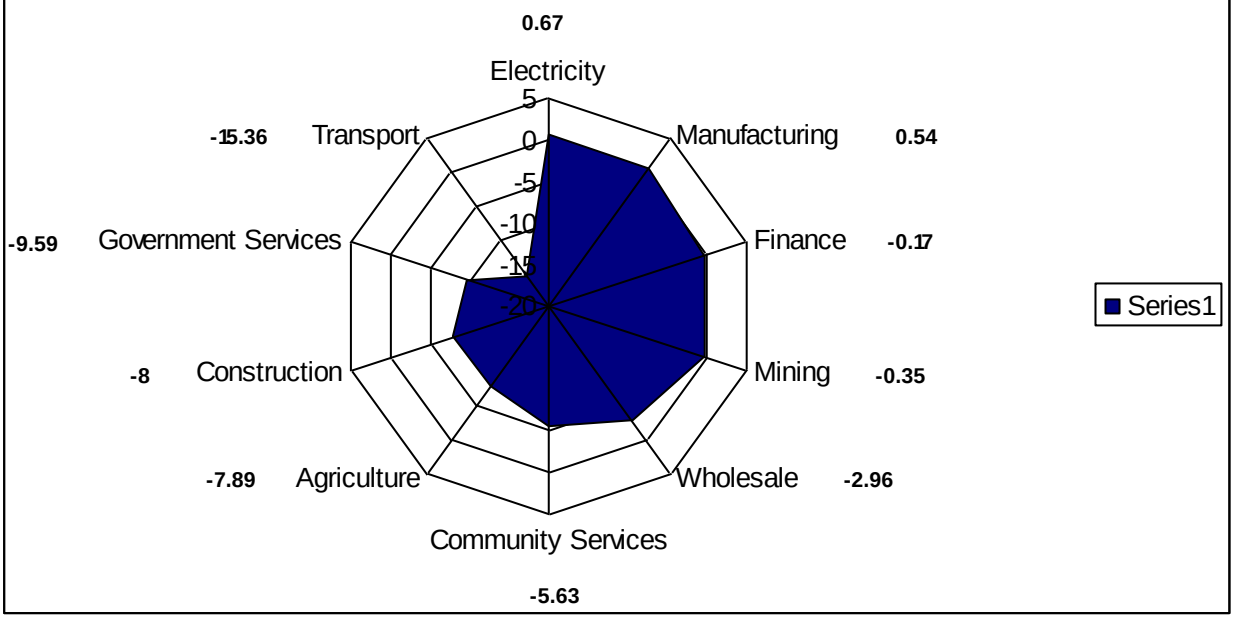
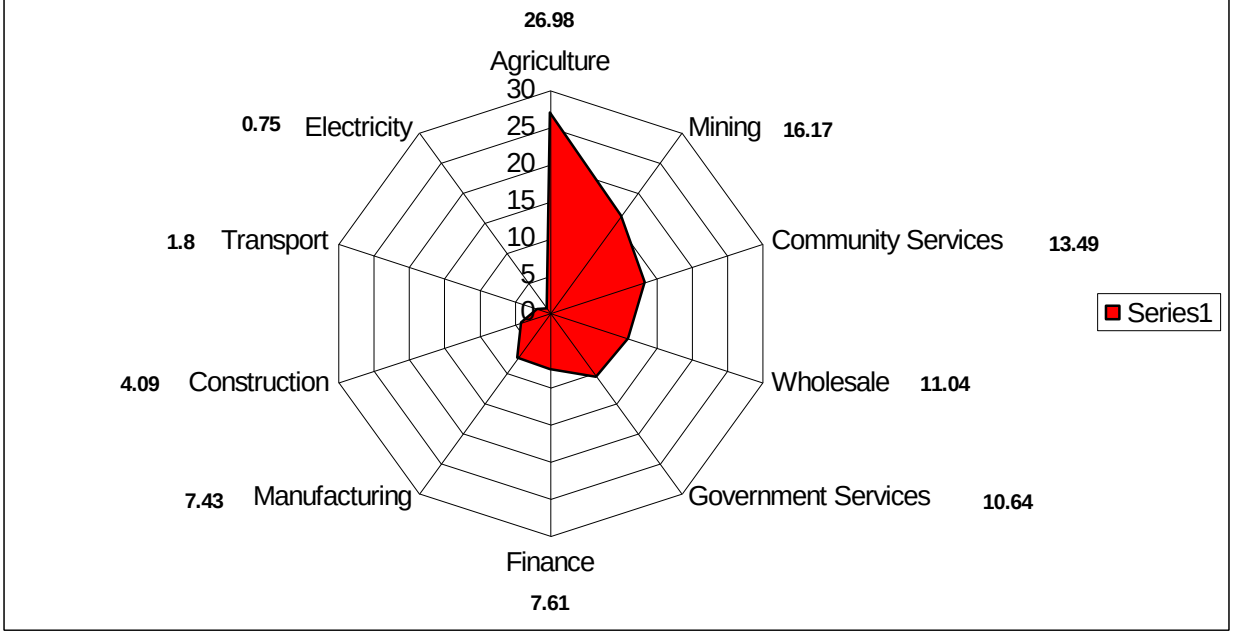


Chart 26: Waterberg Sectoral Formal Employment % contribution - LED Data 2005



5.9.3. GDP contribution per sector of Bela-Bela, 2005

The transport sector in the Bela-Bela area is the largest contributor to the area's economy. This is followed by the finance and the wholesale sectors. The construction sector also makes a considerable contribution towards the Waterberg area's economy. The agricultural sector is the largest contributor to employment in the area in comparison to the other sectors.

The tourism sector in the Waterberg area is not indicated individually. It falls within the wholesale sector.

Table 15: GDP contribution per sector of Bela-Bela, 2005

Sectors	GDP%	GDP% Bela-Bela / Waterberg	Sectoral Employment %
Agriculture	5.12	**15.01**	24.18
Mining	2.05	**0.39**	0.86
Manufacturing	3.70	**9.22**	7.92
Electricity	3.13	**6.48**	0.83
Construction	2.78	**20.72**	4.16
Wholesale	13.79	**17.24**	19.19
Transport	36.15	**34.57**	2.21
Finance	22.11	**17.92**	9.07
Community services	4.89	**12.14**	18.36
Government services	6.28	**9.64**	13.21
Total	100	**9.28**	100

Chart 27: Bela-Bela Sectoral GDP % contribution - LED Data 2005

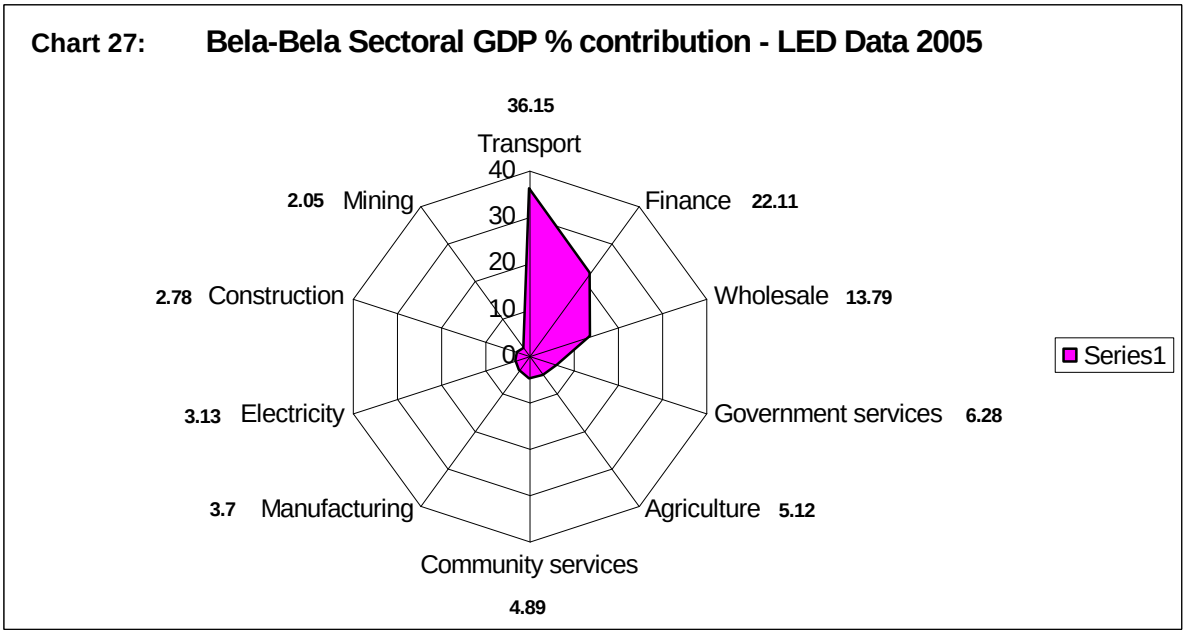
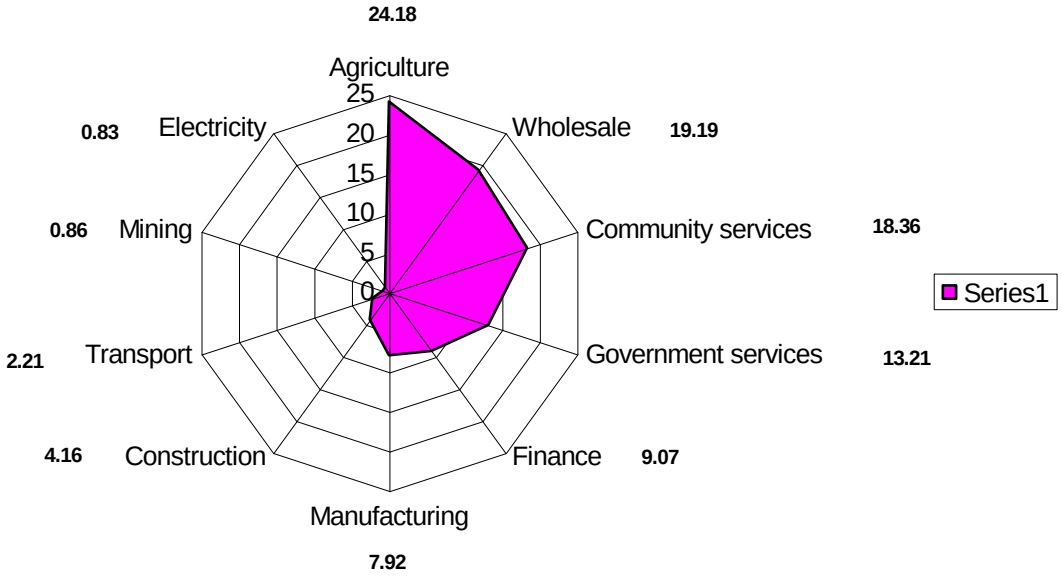


Chart 28: Bela-Bela Sectoral Formal Employment % contribution - LED Data 2005



5.9.4. GDP contribution per sector of Modimolle, 2005

The major economic sectors in the Modimolle local area are government services, agricultural, transport and finance respectively. The agricultural sector is the largest contributor towards the local area's workforce.

Table 16: GDP contribution per sector of Modimolle, 2005			
Sectors	**GDP%**	**GDP% Modimolle / Waterberg**	**Sectoral Employment %**
Agriculture	7.72	**16.67**	28.30
Mining	1.40	**0.19**	1.07
Manufacturing	4.74	**8.79**	10.66
Electricity	1.15	**1.75**	0.31
Construction	3.04	**16.69**	5.47
Wholesale	13.35	**12.30**	13.86
Transport	23.54	**16.58**	1.85
Finance	20.36	**12.16**	8.46
Community services	6.63	**12.14**	15.54
Government services	18.02	**20.37**	14.49
Total	100	**6.86**	100

Chart 29: Modimolle Sectoral GDP % contribution - LED Data 2005

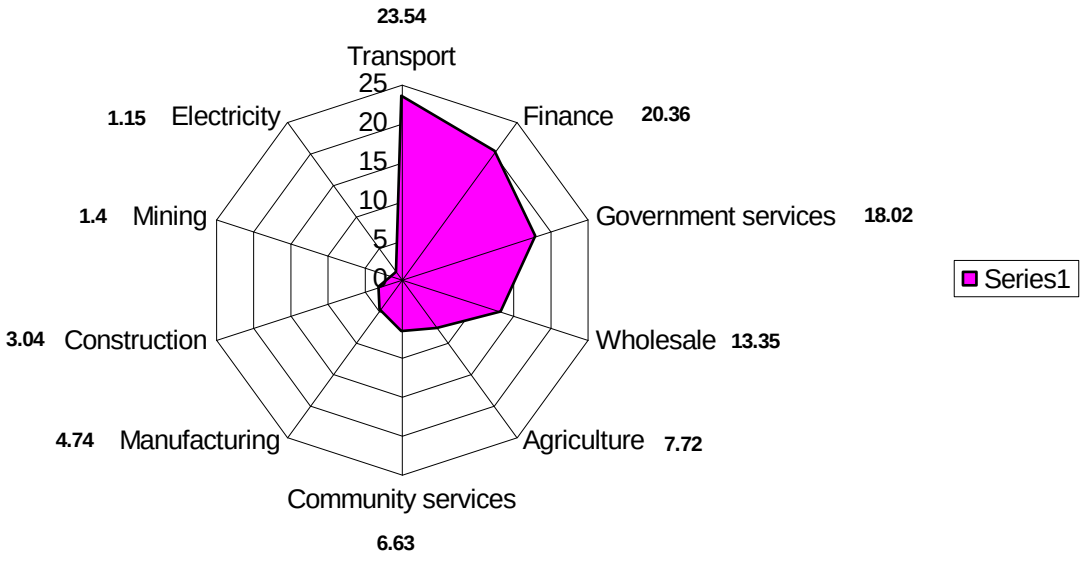
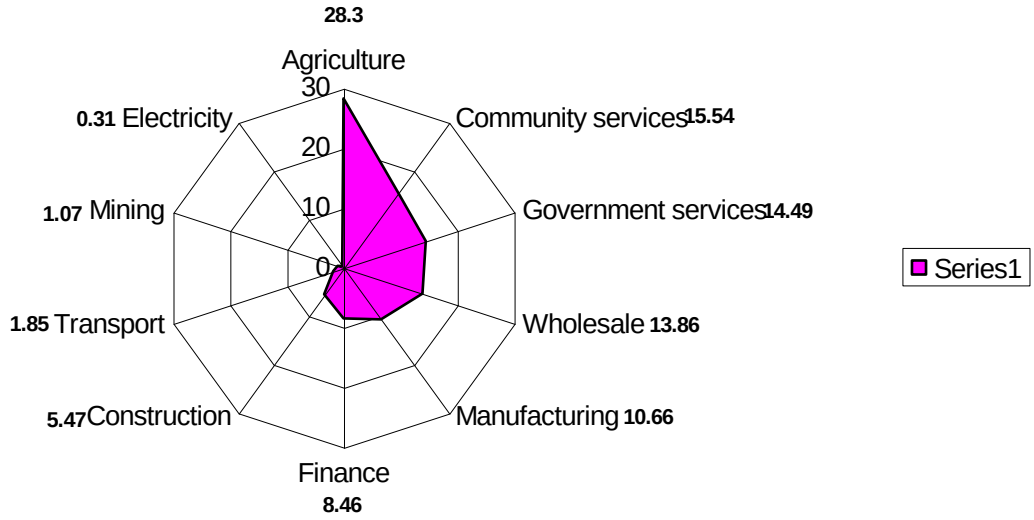


Chart 30: Modimolle Sectoral Formal Employment % contribution - LED Data 2005



5.9.5. GDP contribution per sector of Mogalakwena, 2005

The mining sector is the largest contributor towards the Mogalakwena's local economy. Other sectors that significantly contribute towards the Mogalakwene's economy include finance, wholesale and government services sectors respectively. The Mogalakwena's local economy makes a significant contribution towards the Waterberg area's GDP contribution. The government services sector is the dominant contributor towards Mogalakwena's local employment. The wholesale and the agricultural sectors also make significant contributions towards the workforce in the area.

Table 17: GDP contribution per sector of Mogalakwena, 2005

Sectors	GDP%	GDP% Mogalakwena / Waterberg	Sectoral Employment %
Agriculture	1.21	**6.21**	14.05
Mining	19.84	**6.57**	5.76
Manufacturing	5.02	**21.94**	8.06
Electricity	5.29	**19.20**	0.74
Construction	2.31	**30.17**	5.84
Wholesale	17.25	**37.82**	16.58
Transport	9.98	**16.74**	2.80
Finance	18.17	**25.84**	11.85
Community services	6.17	**26.93**	16.18
Government services	14.76	**39.73**	18.14
Total	100	**16.28**	100

Chart 31: Mogalakwena Sectoral GDP % contribution - LED Data 2005

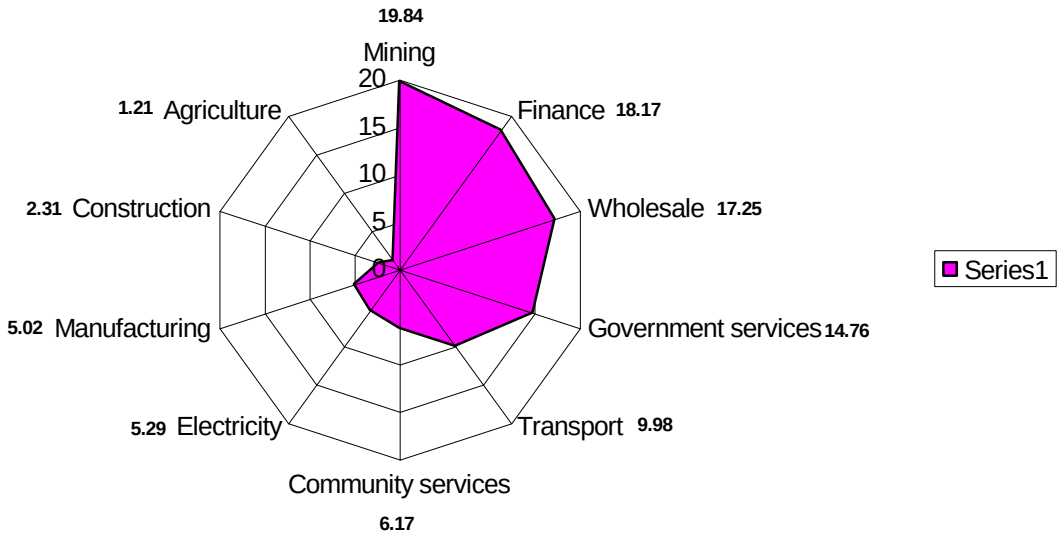
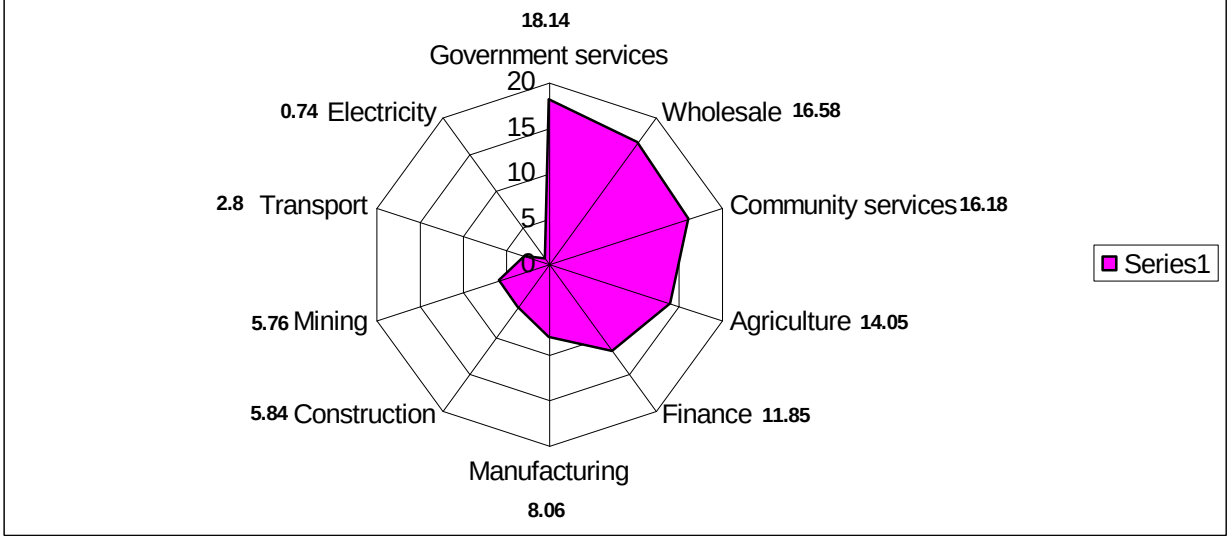


Chart 32: Mogalakwena Sectoral Formal Employment % contribution - LED Data 2005



5.9.6. GDP contribution per sector of Thabazimbi, 2005

The Thabazimbi local mining sector is the major economic sector in the local area. It is also the major employer in the area, the sector employees nearly half of the Thabazimbi local workforce. The Thabazimbi local mining sector is the dominant contributor towards the Waterberg district area's mining GDP contribution.

The other significant sectors in the local area include community services, agricultural and manufacturing respectively.

Table 18: GDP contribution per sector of Thabazimbi, 2005

Sectors	GDP%	GDP% Thabazimbi / Waterberg	Sectoral Employment %
Agriculture	1.75	**19.84**	19.10
Mining	79.91	**58.60**	49.14
Manufacturing	2.02	**19.54**	5.42
Electricity	0.36	**2.92**	0.25
Construction	0.62	**17.82**	3.62
Wholesale	3.59	**17.40**	4.81
Transport	1.26	**4.67**	0.78
Finance	5.63	**17.68**	4.49
Community services	3.08	**29.63**	8.51
Government services	1.78	**10.58**	3.87
Total	100	**35.95**	100

Chart 33: Thabazimbi Sectoral GDP % contribution - LED Data 2005

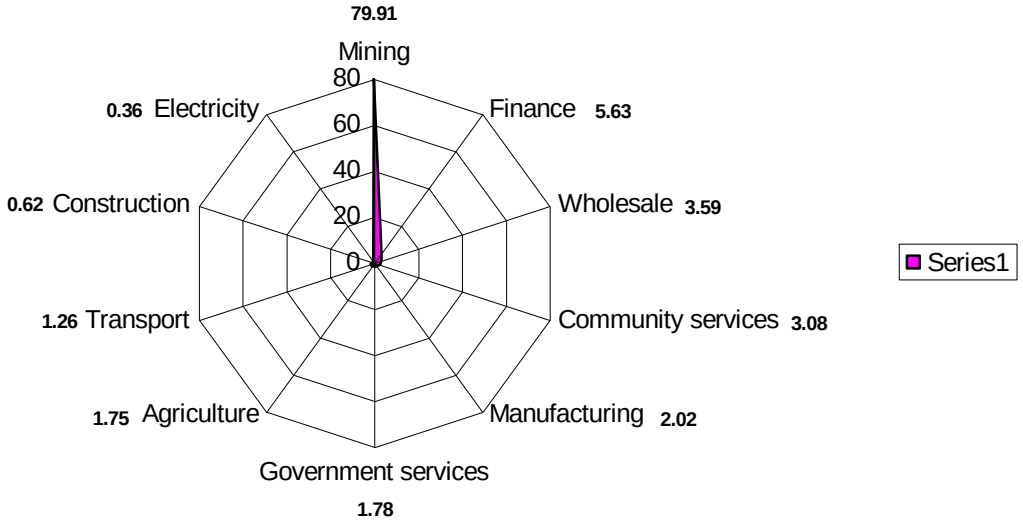
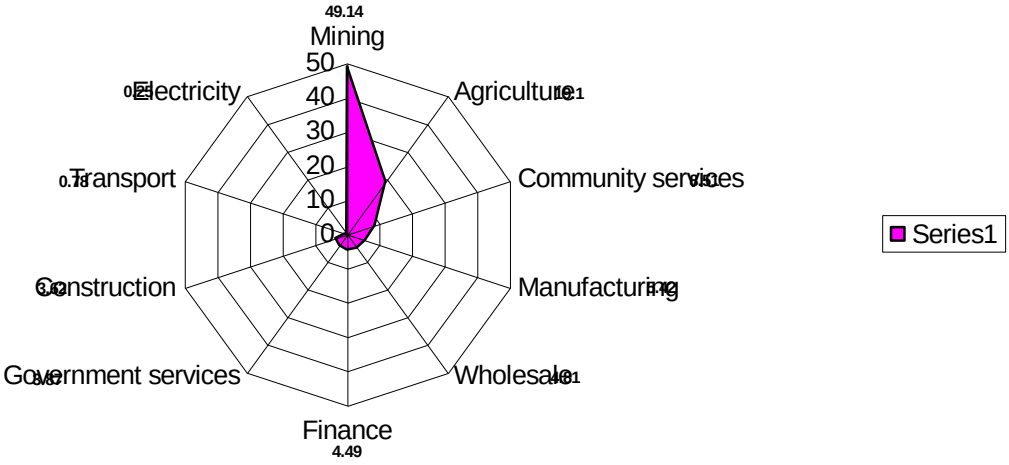


Chart 34: Thabazimbi Sectoral Formal Employment % contribution - LED Data 2005



5.9.7. GDP contribution per sector of Lephalale, 2005

The mining sector in the Lephalale local area is the dominate contributor to the area's local economy. It also makes a significant contribution towards the Waterberg area's mining GDP contribution.

Other significant sectors in the local area include electricity, transport and finance. The agricultural sector in the Lephalale area is not strong in comparison to the aforementioned sectors. It however, makes the most significant contribution towards the local area's workforce.

Table 19: GDP contribution per sector of Lephalale, 2005

Sectors	GDP%	GDP% Lephalale / Waterberg	Sectoral Employment %
Agriculture	3.33	**28.98**	38.85
Mining	59.21	**33.29**	7.89
Manufacturing	4.08	**30.18**	6.75
Electricity	11.33	**69.65**	2.14
Construction	0.54	**12.02**	2.94
Wholesale	2.09	**7.76**	7.76
Transport	7.36	**20.92**	2.08
Finance	6.80	**16.38**	6.60
Community services	2.04	**15.03**	15.71
Government services	3.23	**14.73**	9.29
Total	100	**27.57**	100

Chart 35: Lephalale Sectoral GDP % contribution - LED Data 2005

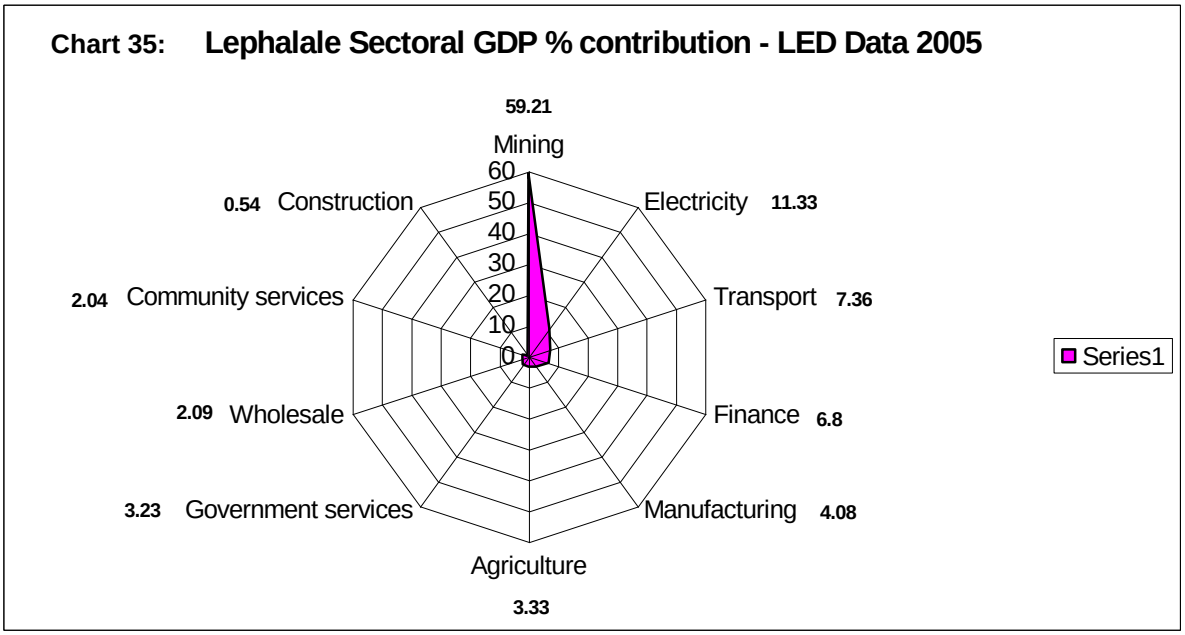
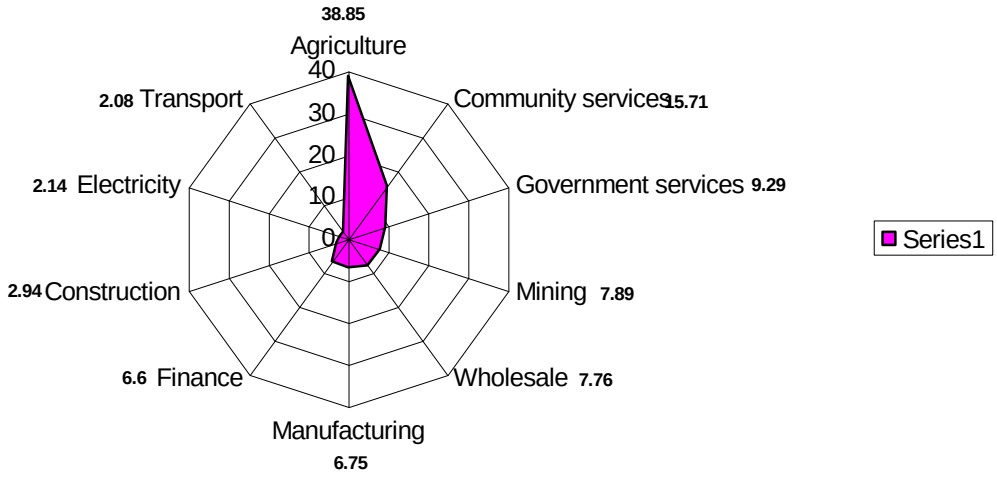


Chart 36: Lephalale Sectoral Formal Employment % contribution - LED Data 2005



5.9.8. GDP contribution per sector of Mookgophong, 2005

The significant economic sectors in the Mookgophong area include finance, transport, wholesale and mining respectively.

Other sectors in the local area include the agricultural, manufacturing as well as the government services. The agricultural sector is the major contributor to the Mookgophong local employment with more than half of the local workforce being employed in the sector.

Table 20: GDP contribution per sector of Mookgophong, 2005

Sectors	GDP%	GDP% Mookgophong / Waterberg	Sectoral Employment %
Agriculture	10.34	**13.33**	56.80
Mining	11.25	**0.94**	1.79
Manufacturing	9.41	**10.33**	7.63
Electricity	0.00	**0.00**	0.04
Construction	0.79	**2.58**	1.53
Wholesale	13.60	**7.48**	9.70
Transport	15.50	**6.52**	1.27
Finance	28.04	**10.01**	5.76
Community services	3.77	**4.12**	8.94
Government services	7.31	**4.94**	6.53
Total	100	**4.08**	100

Chart 37: Mookgophong Sectoral GDP % contribution - LED Data 2005

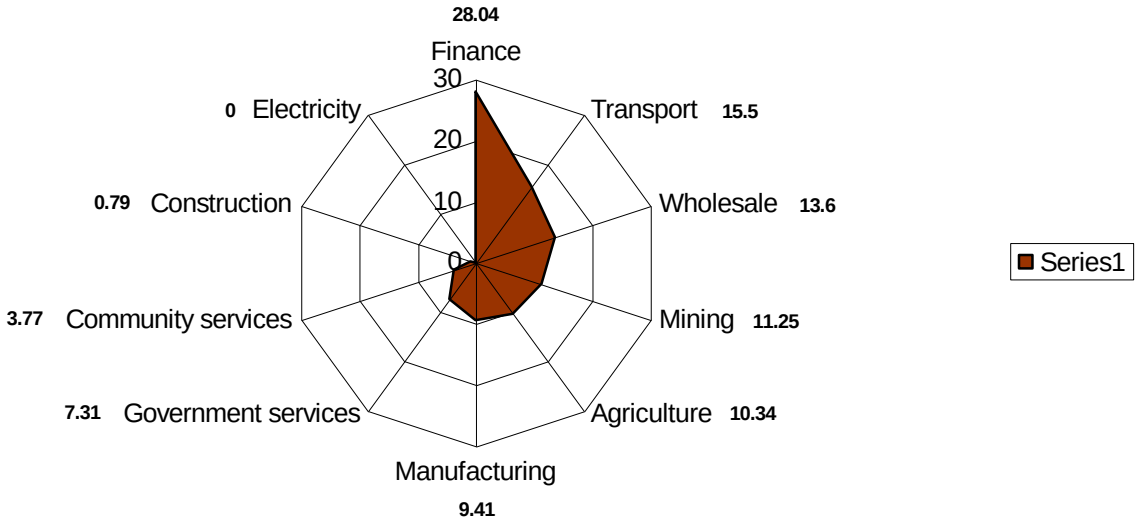
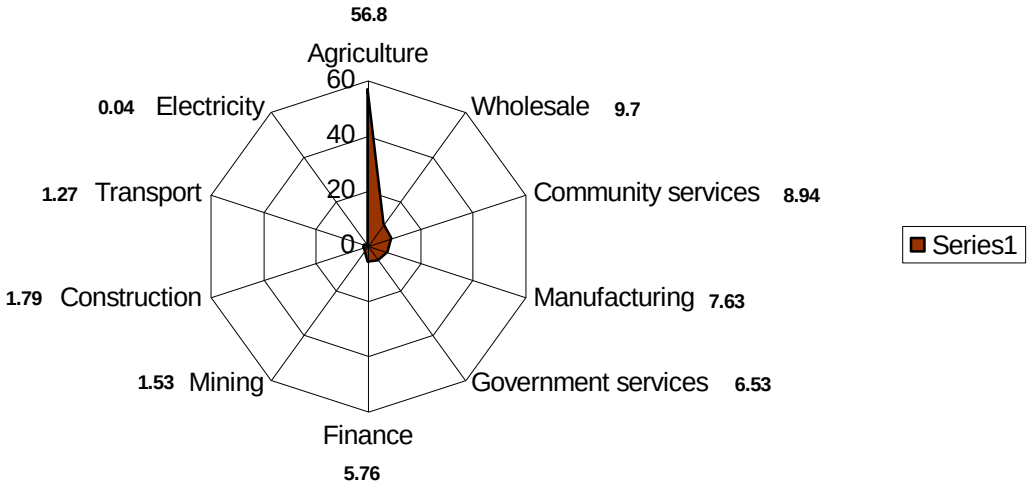


Chart 38: Mookgophong Sectoral Formal Employment % contribution - LED Data 2005



6. POPULATION CHARACTERISTICS

6.1. INTRODUCTION

According to the 2007 population data the Waterberg District Municipality area has an estimated total population of 572 625. This is a drop compared to the 2001 population data which indicated an estimated population of 614 157. Most of the people in the District are distributed around Mogalakwena, Lephalale, as well as the Thabazimbi local municipality areas respectively. The local municipalities located on the south-eastern part of the District are the least populated. Bela-Bela, Modimolle and the Mookgophong local municipalities are located in the south-eastern part of the district. The Mogalakwena Local Municipality is the most populated area with an estimated total population of 330 742 whilst the Mookgophong local municipality area is the least populated area with an estimated total population of 17 183.

The education levels in the Waterberg area dropped in 2007 compared to the 2001 data. This can be attributed to the drop of the population in the area. The majority of the area's population has primary to secondary education with most of the working population earning between R1 to R400 and R6401 to R12 800 per month.

6.2. WATERBERG DISTRICT MUNICIPALITY

Table 21: Population - age and gender WD

	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	33088	33264	66352	31239	33406	64645
5-9	37088	36281	73369	33671	32207	65878
10-14	37261	37372	74633	32924	33317	66241
15-19	35635	36176	71811	32537	32459	64996
20-24	26399	28488	54887	28132	25298	53430
25-29	23286	26763	50049	25484	21947	47431
30-34	19499	21553	41052	23069	21450	44519
35-39	18104	20469	38573	17396	17105	34501
40-44	15685	16355	32040	14817	16296	31113
45-49	12324	14074	26398	13508	3183	16691
50-54	9751	10526	20277	9899	1196	11095
55-59	7141	7807	14948	9193	9553	18746
60-64	6571	8944	15515	6644	7196	13840
65-69	4423	6893	11316	4840	9724	14564
70-74	3850	6186	10036	3539	5684	9223
75-79	2221	3240	5461	2505	5389	7894
80-84	1653	2903	4556	909	2462	3371
85+	962	1922	2884	1283	3164	4447
Sub-total	**294941**	**319216**	**614157**	**291589**	**281036**	**572625**

The biggest contributors to employment in the Waterberg District are mining and quarrying, wholesale and retail trade, agriculture, hunting and fishing, as well as the manufacturing sectors, with the percentage representation of the different sectors being 6.5%, 5.5%, 4.6%, and 3.7%. In the context of the EMF mining, agriculture and the manufacturing sectors play an important role in the economy of the region, in improving livelihoods and sustaining the regional economy. Even more important is the contribution of these sectors to the Gross Geographic Production (GGP) of the region, which have been highlighted as important growth sectors in the Limpopo Growth and Development Strategy 2004.

Table 22: Population - Income distribution

	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1380	1433	2813	107380	137008	244388
R 1- R 400	19849	22158	42007	66845	70755	137600
R 401- R 800	19873	12193	32066	18399	22267	40666
R 801- R 1600	15451	6156	21607	18193	42962	61875
R 1601- R 3200	14584	5601	20185	12869	6474	19243
R 3201- R 6400	8838	4880	13718	14334	7720	22054
R 6401- R12800	4325	1207	5532	9244	7162	16406
R 12801- R 25600	1276	212	1488	4141	1659	5800
R 25601- R 51200	392	125	517	1634	461	2095
R 51201- R 102400	203	65	268	532	319	851
R 102401- R 204800	93	27	120	445	62	507
R 204801 or more	38	19	57	247	85	332
Sub-total	**86302**	**54076**	**140378**	**254983**	**296834**	**551817**

Table 23: Population – Institutions attended

2001			
	M	**F**	**Total**
No schooling	33940	50556	84496
Some primary	31512	31456	62968
Complete primary	10737	11445	22182
Some secondary	42957	47193	90150
Grade 12/	23120	24560	47680
Higher	9607	10910	29517
Sub-total	**151873**	**176120**	**327993**

2007			
	M	**F**	**Total**
Pre- school	4778	3563	8341
Primary	45038	45285	90323
Secondary	42411	43184	85595
College	1159	1192	2351
University /Tech	619	879	1498
Adult basic	0	0	0
Other	474	293	727
Not applicable	29389	27501	56890
Unspecified	1210	1535	2745
Institutions	1850	1750	3600
Sub-total	**126928**	**125142**	**252070**

The 2007 Community Survey shows a decrease in education levels in the Waterberg compared to the 2001 census data (Table 24). This can be to attributed to the lower population recorded in the community survey for the area. The majority of the population have primary to secondary education, with the majority of the working population in the income categories R1 to R400 and R6401 to R12 800 per month.

Table 24: Population - Employment Industries

	2001			**2007**		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	22659	11141	33800	11194	4490	15684
Mining and quarrying	12492	586	13078	20216	1887	22103
Manufacturing	5972	2378	8350	8970	3600	12570
Electricity; gas and water supply	1066	165	1231	1013	315	1364
Construction	6318	680	6998	7641	1002	8643
Wholesale and retail trade	9266	7499	16765	10974	7641	18615
Transport; storage and communication	2777	551	3328	3071	1510	4581
Financial; insurance; real estate and business services	3360	1988	5348	5598	3118	8716
Community; social and personal services	10720	10421	21141	9161	12967	2212
Other and not adequately defined	0	0	0	4601	10321	14922
Private households/ not applicable	6259	14709	20968	89794	126649	216443
Undermined	4353	3963	8316	6154	5694	11848
Sub- total	**85242**	**54081**	**139323**	**178387**	**179230**	**337701**

Chart 39: Waterberg Local Municipalities Population contribution - Stats SA 2007

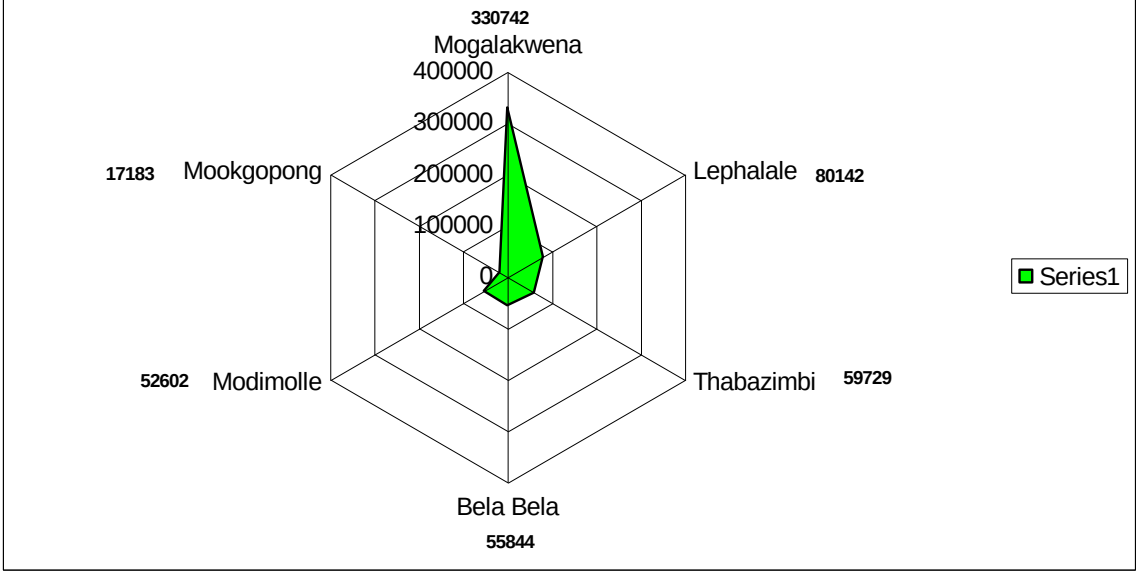
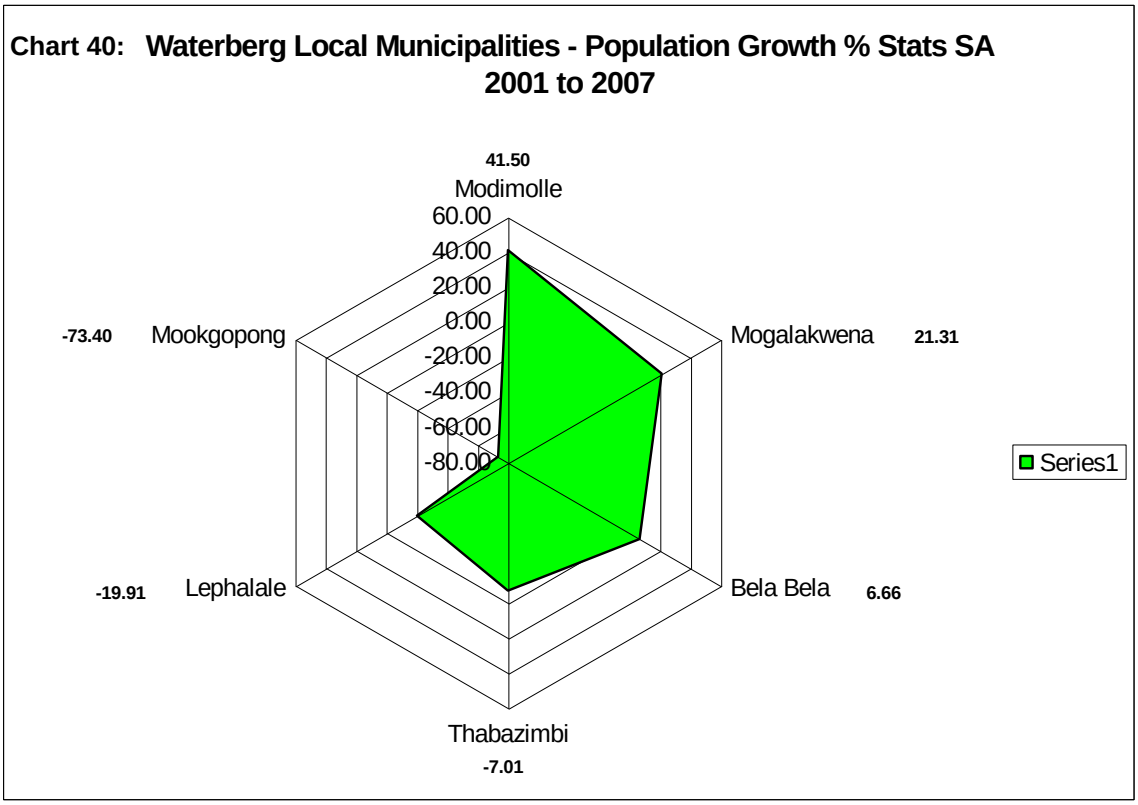


Chart 40: Waterberg Local Municipalities - Population Growth % Stats SA 2001 to 2007

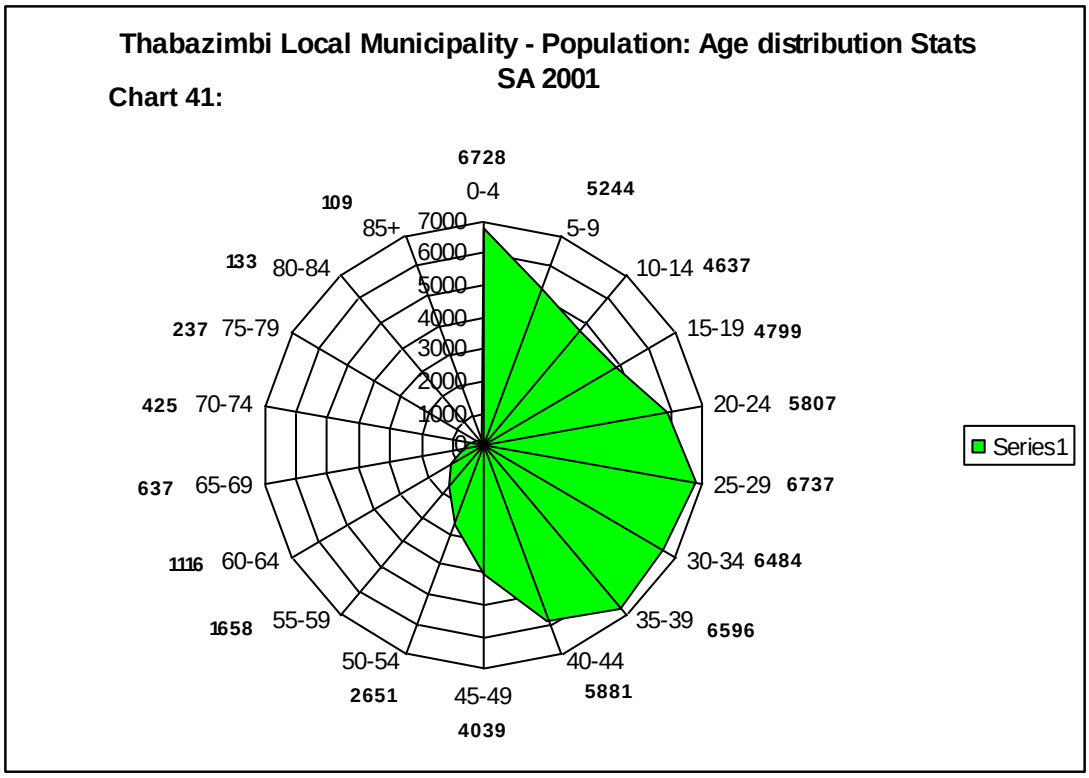


6.3. LOCAL MUNICIPALITIES

6.3.1. Thabazimbi Local Municipality

Thabazimbi Local Municipality - Population: Age distribution Stats SA 2001

Chart 41:



Thabazimbi Local Municipality - Population: Age distribution Stats SA 2007

Chart 42:

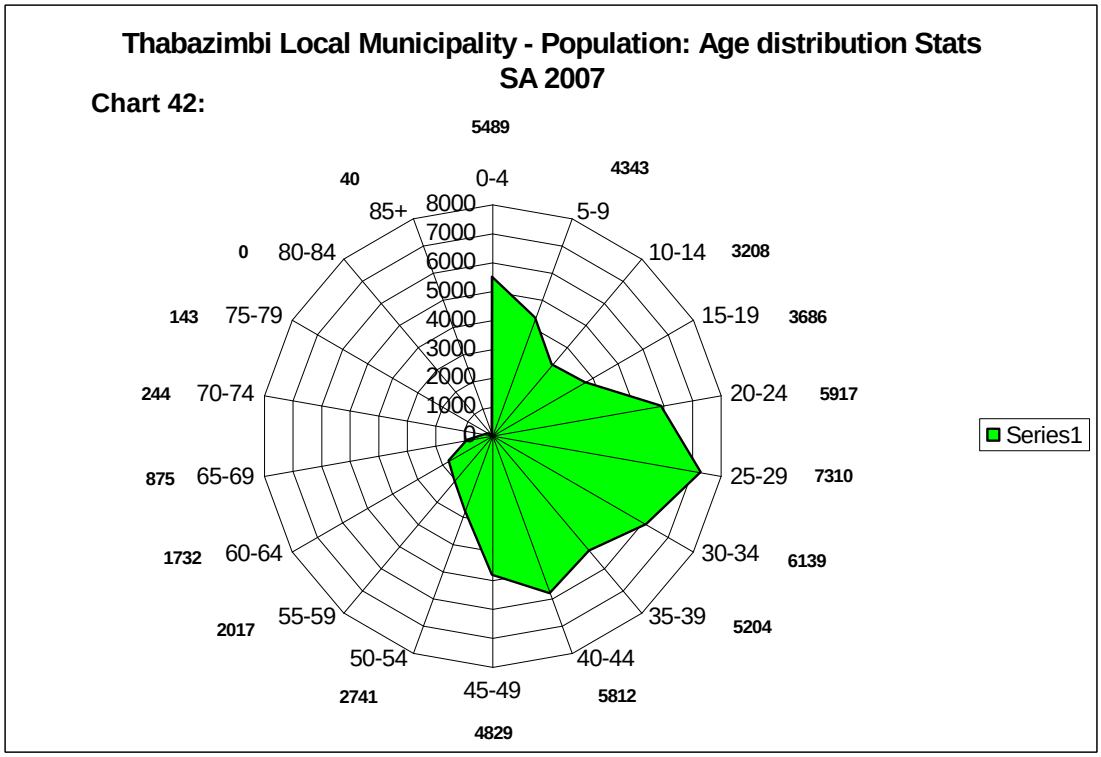
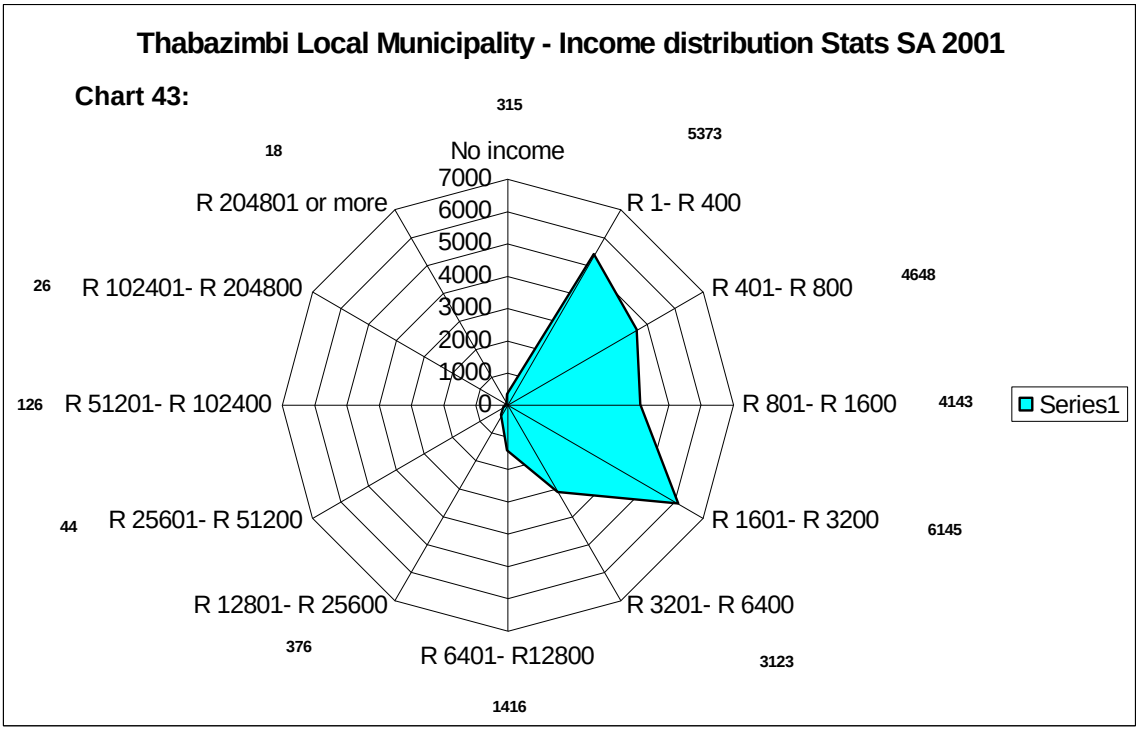


Table 25: Thabazimbi Local Municipality Population - Age and gender						
	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	3286	3442	6728	2658	2831	5489
5-9	2635	2609	5244	1988	2355	4343
10-14	2383	2254	4637	1358	1850	3208
15-19	2343	2456	4799	1716	1970	3686
20-24	2867	2940	5807	3653	2264	5917
25-29	3256	3481	6737	4309	2991	7310
30-34	3269	3215	6484	3520	2619	6139
35-39	3634	2962	6596	3014	2190	5204
40-44	3643	2238	5881	3907	1905	5812
45-49	2462	1577	4039	3304	1525	4829
50-54	1724	927	2651	2201	540	2741
55-59	1014	644	1658	1244	773	2017
60-64	672	444	1116	1121	611	1732
65-69	385	252	637	279	596	875
70-74	234	191	425	150	94	244
75-79	123	114	237	91	52	143
80-84	60	73	133	0	0	0
85+	47	62	109	3	35	40
Sub-total	**34037**	**29881**	**63918**	**34526**	**25203**	**59729**

Table 26: Thabazimbi Local Municipality Population - Income distribution						
	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	169	146	315	8727	14564	23291
R 1- R 400	2274	3099	5373	2286	2436	4722
R 401- R 800	3440	1208	4648	941	1250	2191
R 801- R 1600	3485	658	4143	4207	1872	6079
R 1601- R 3200	5425	720	6145	5598	1134	6732
R 3201- R 6400	2583	540	3123	6193	1964	8157
R 6401- R12800	1264	152	1416	2753	885	3638
R 12801- R 25600	346	30	376	1428	473	1901
R 25601- R 51200	105	21	126	955	93	1048
R 51201- R 102400	35	9	44	196	42	238
R 102401- R 204800	18	8	26	210	0	210
R 204801 or more	15	3	18	0	0	0
Sub-total	**19159**	**6594**	**25753**	**33494**	**24713**	**58207**


Thabazimbi Local Municipality - Income distribution Stats SA 2001
Chart 43:
315
5373
4648
4143
6145
3123
1416
376
44
126
26
18
No income
R 1- R 400
R 401- R 800
R 801- R 1600
R 1601- R 3200
R 3201- R 6400
R 6401- R12800
R 12801- R 25600
R 25601- R 51200
R 51201- R 102400
R 102401- R 204800
R 204801 or more
7000
6000
5000
4000
3000
2000
1000
0
Series1

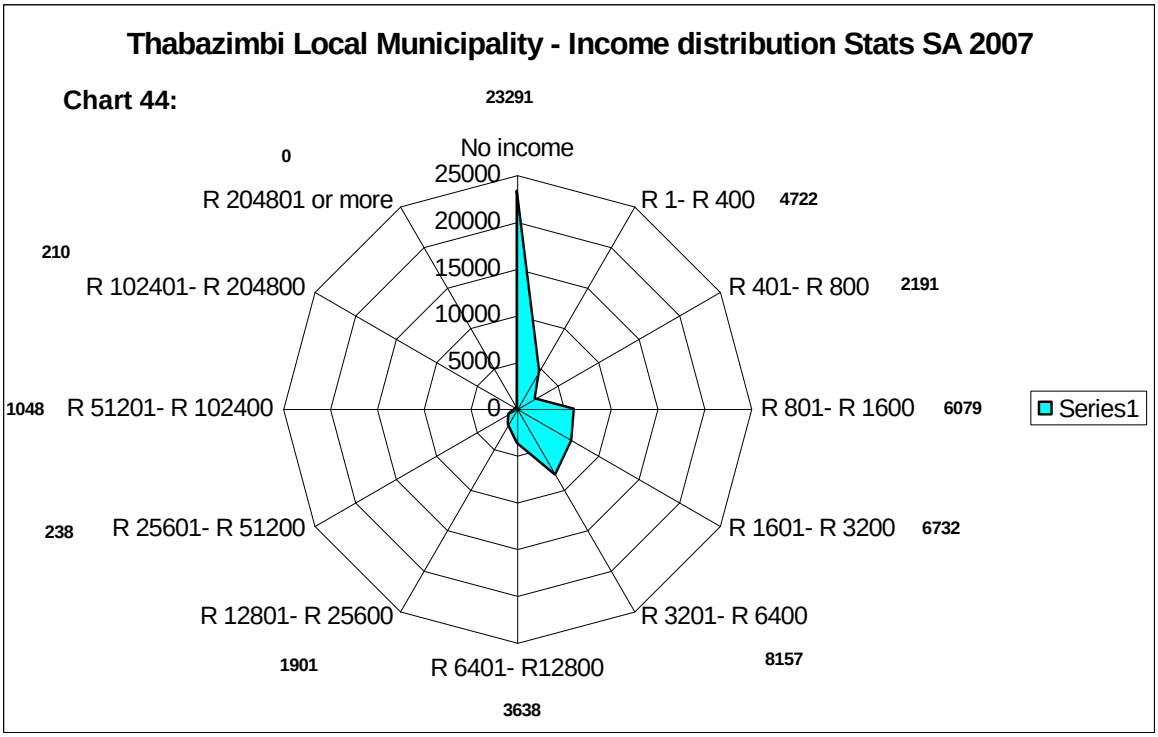

Thabazimbi Local Municipality - Income distribution Stats SA 2007
Chart 44:
23291
4722
2191
6079
6732
8157
3638
1901
238
1048
210
0
No income
R 1- R 400
R 401- R 800
R 801- R 1600
R 1601- R 3200
R 3201- R 6400
R 6401- R12800
R 12801- R 25600
R 25601- R 51200
R 51201- R 102400
R 102401- R 204800
R 204801 or more
25000
20000
15000
10000
5000
0
Series1

Table 27: Thabazimbi Local Municipality Population - Institution attended

2001			
Schooling	**M**	**F**	**Total**
No schooling	3904	3436	7340
Some primary	5568	3878	9446
Complete primary	2047	1693	3740
Some secondary	5654	6278	11932
Grade 12/	3912	2991	6903
Higher	991	846	1837
Sub-total	**22076**	**19122**	**41198**

2007			
Schooling	**M**	**F**	**Total**
Pre- school	320	341	661
Primary	2281	2694	4975
Secondary	1598	1941	3534
College	117	90	207
University /Tech	45	45	90
Adult basic	0	0	0
Other	0	44	44
Not applicable	4001	2935	6936
Unspecified	139	173	312
Institutions	221	173	394
Sub-total	**8717**	**8436**	**17153**

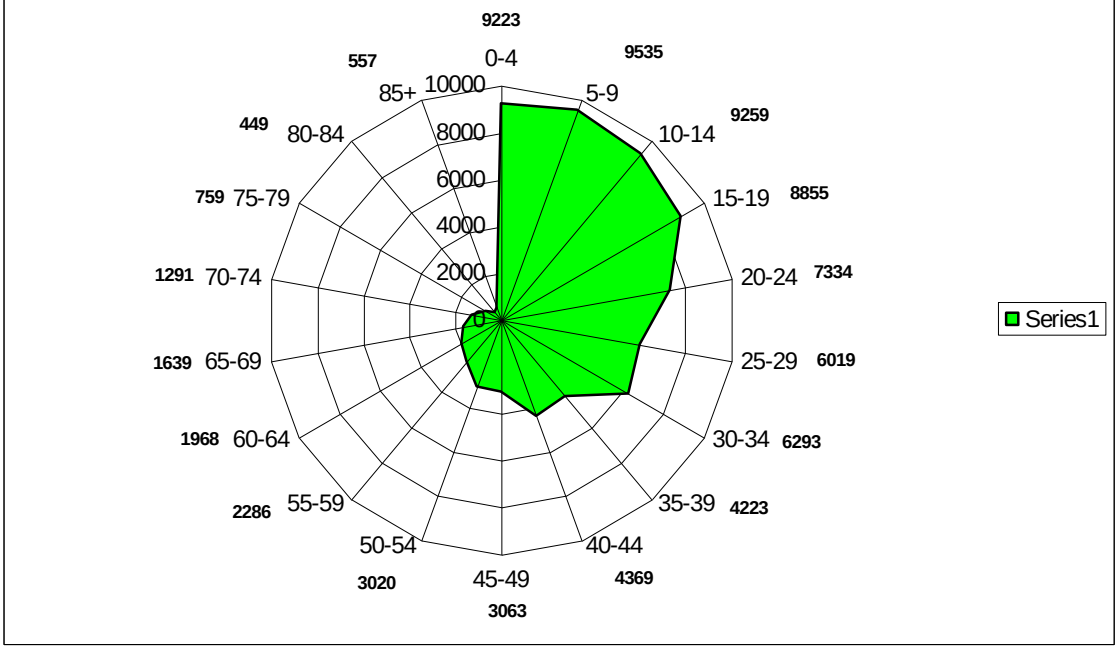
Table 28: Thabazimbi Local Municipality Population - Employment Industries

	2001			2007		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	4323	1364	5687	1489	775	2264
Mining and quarrying	9221	311	9532	14930	1271	16201
Manufacturing	1154	180	1334	641	43	684
Electricity; gas and water supply	66	12	78	52	47	99
Construction	979	73	1052	836	135	971
Wholesale and retail trade	837	652	1489	1289	1408	2697
Transport; storage and communication	305	58	363	706	141	847
Financial; insurance; real estate and business services	353	263	616	542	334	876
Community; social and personal services	819	963	1782	734	1435	2169
Other and not adequately defined	0	0	0	829	811	1640
Private households/ not applicable	779	2222	3001	5098	11180	16278
Undermined	822	483	1305	372	216	588
Sub- total	**19658**	**6581**	**26239**	**27518**	**17796**	**45314**

6.3.2. Lephalale Local Municipality

Lephalale Local Municipality - Population: Age distribution Stats SA 2007

Chart 45:



Lephalale Local Municipality - Population: Age distribution Stats SA 2001

Chart 46:

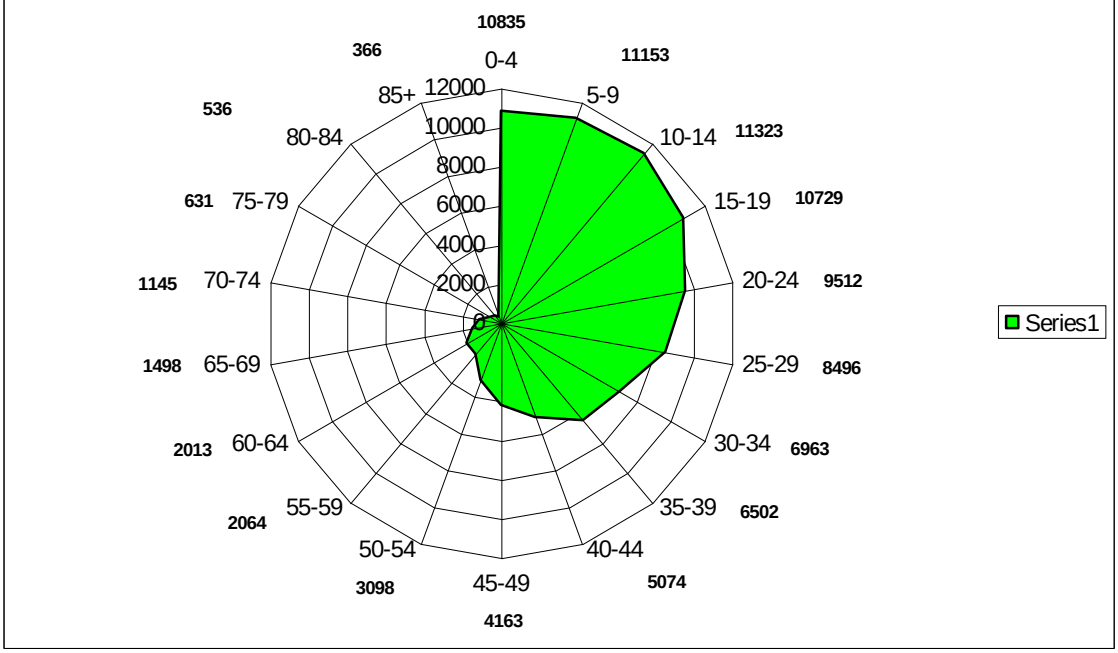
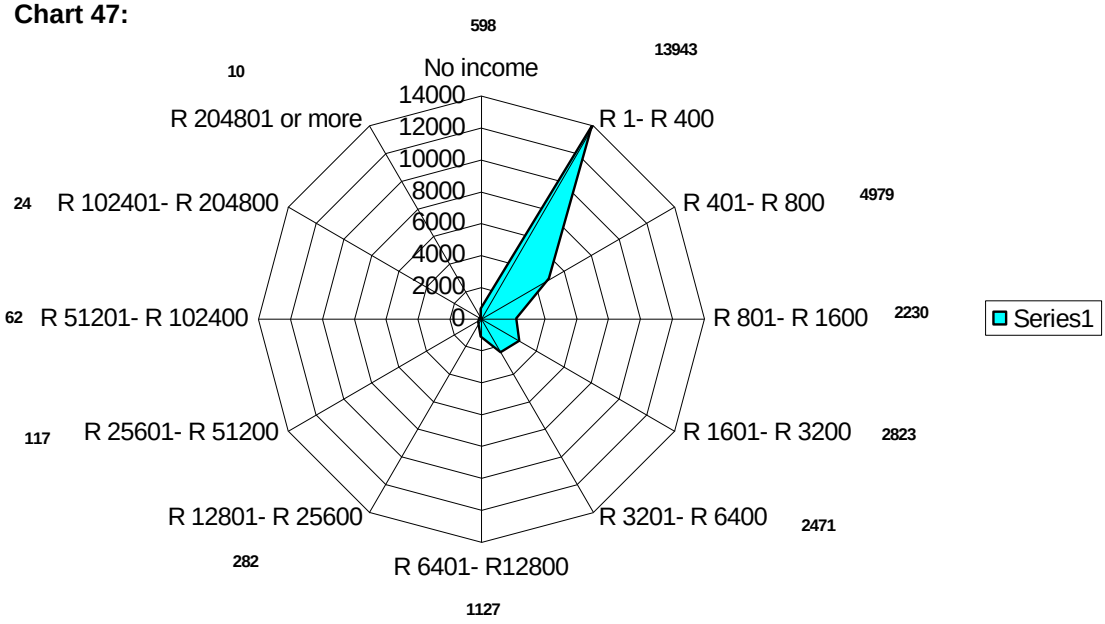


Table 29: Lephalale Local Municipality Population - Age and gender						
	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	5490	5345	10835	4535	4688	9223
5-9	5638	5520	11153	4809	4726	9535
10-14	5679	5644	11323	4512	4747	9259
15-19	5302	5427	10729	4138	4717	8855
20-24	4631	4881	9512	3873	3461	7334
25-29	4106	4390	8496	3222	2797	6019
30-34	3445	3518	6963	3529	2764	6293
35-39	3099	3403	6502	2260	1963	4223
40-44	2579	2495	5074	1895	2474	4369
45-49	1918	2245	4163	1639	1424	3063
50-54	1461	1637	3098	1298	1722	3020
55-59	1012	1052	2064	1135	1149	2286
60-64	923	1090	2013	665	1303	1968
65-69	568	930	1498	388	1251	1639
70-74	495	650	1145	384	907	1291
75-79	266	365	631	272	487	759
80-84	220	316	536	84	365	449
85+	150	216	366	217	340	557
Sub-total	**46982**	**49124**	**96106**	**38857**	**41285**	**80142**

Table 30: Lephalale Local Municipality Population table - Income distribution						
	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	283	315	598	13009	17675	30684
R 1- R 400	6966	6977	13943	10381	10478	20859
R 401- R 800	3288	1691	4979	3329	2995	6324
R 801- R 1600	1576	654	2230	6074	6815	12889
R 1601- R 3200	2048	775	2823	872	550	1422
R 3201- R 6400	1765	706	2471	1536	875	2411
R 6401- R12800	907	220	1127	1352	784	2136
R 12801- R 25600	254	28	282	456	181	637
R 25601- R 51200	81	36	117	157	63	220
R 51201- R 102400	49	13	62	65	0	65
R 102401- R 204800	21	3	24	0	0	0
R 204801 or more	10	0	10	0	0	0
Sub-total	**17248**	**11418**	**28666**	**37231**	**40416**	**77647**

Lephalale Local Municipality - Income distribution Stats SA 2001

Chart 47:



Lephalale Local Municipality - Income distribution Stats SA 2001

Chart 48:

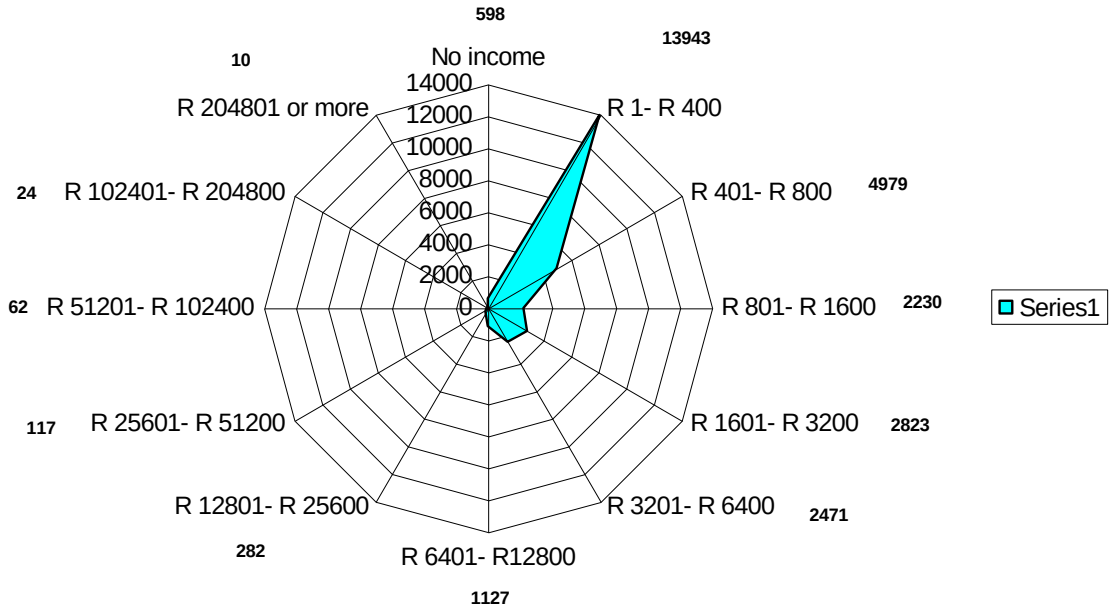


Table 31: Lephalale Local Municipality Population - Institution attended

2001				2007			
Schooling	**M**	**F**	**Total**	**Schooling**	**M**	**F**	**Total**
No schooling	5878	7560	13438	Pre- school	1018	424	1442
Some primary	5695	5770	11465	Primary	6059	6574	12633
Complete primary	1867	1926	3793	Secondary	6100	5415	11515
Some secondary	6418	7148	13566	College	517	0	517
Grade 12/	3464	3304	6768	University /Tech	0	185	185
Higher	1551	1476	3027	Adult basic	0	0	0
Sub-total	**24873**	**27184**	**52057**	Other	74	0	74
				Not applicable	3245	4610	7855
				Unspecified	97	257	354
				Institutions	222	186	408
				Sub-total	**17332**	**17651**	**34983**

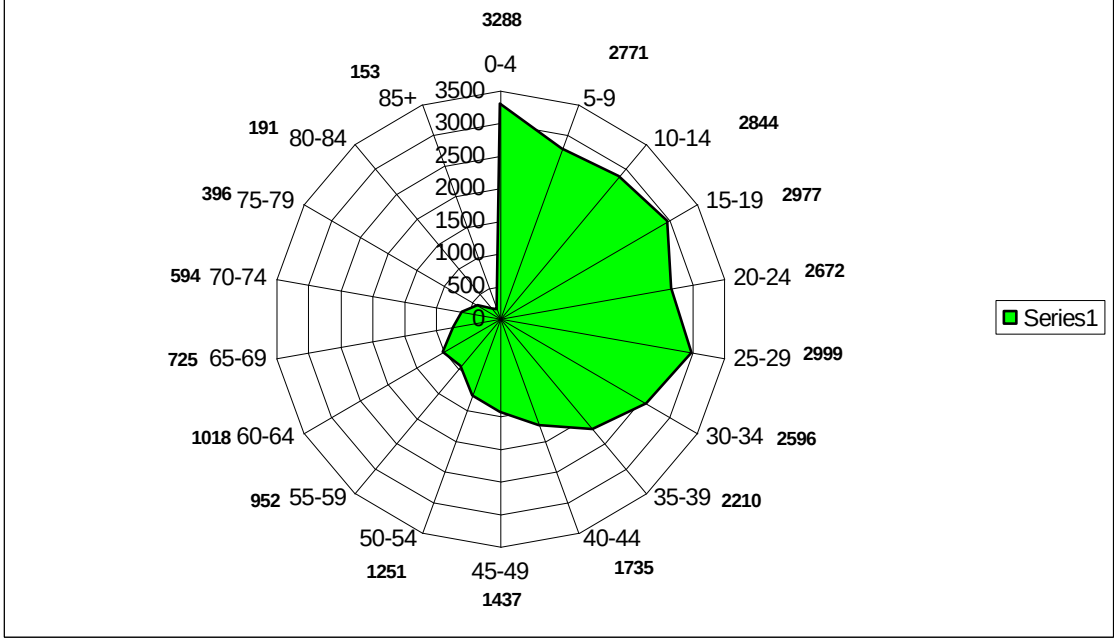
Table 32: Lephalale Local Municipality Population - Employment Industries

	2001			2007		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	6097	3391	9488	2989	870	3859
Mining and quarrying	1609	117	1726	2427	151	2578
Manufacturing	740	438	1178	696	222	918
Electricity; gas and water supply	649	90	739	86	124	210
Construction	907	108	1015	493	60	533
Wholesale and retail trade	1174	1191	2365	700	910	1610
Transport; storage and communication	514	97	611	307	232	539
Financial; insurance; real estate and business services	536	370	906	121	409	530
Community; social and personal services	1786	1463	3249	831	1054	1885
Other and not adequately defined	0	0	0	734	1667	2401
Private households/ not applicable	2320	3390	5710	13195	17502	30697
Undermined	912	764	1676	613	577	1190
Sub- total	**17244**	**11419**	**28663**	**23192**	**23778**	**46970**

6.3.3. Mookgophong Local Municipality

Mookgophong Local Municipality - Population: Age distribution
Stats SA 2001

Chart 49:



Mookgophong Local Municipality - Population: Age distribution
Stats SA 2007

Chart 50:

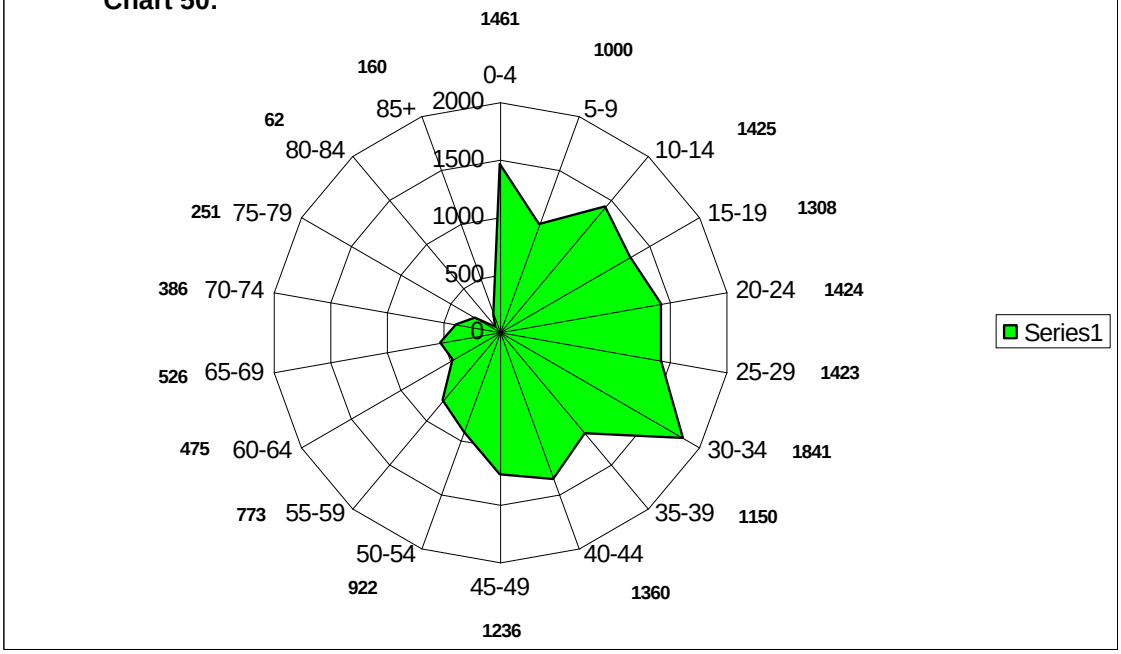
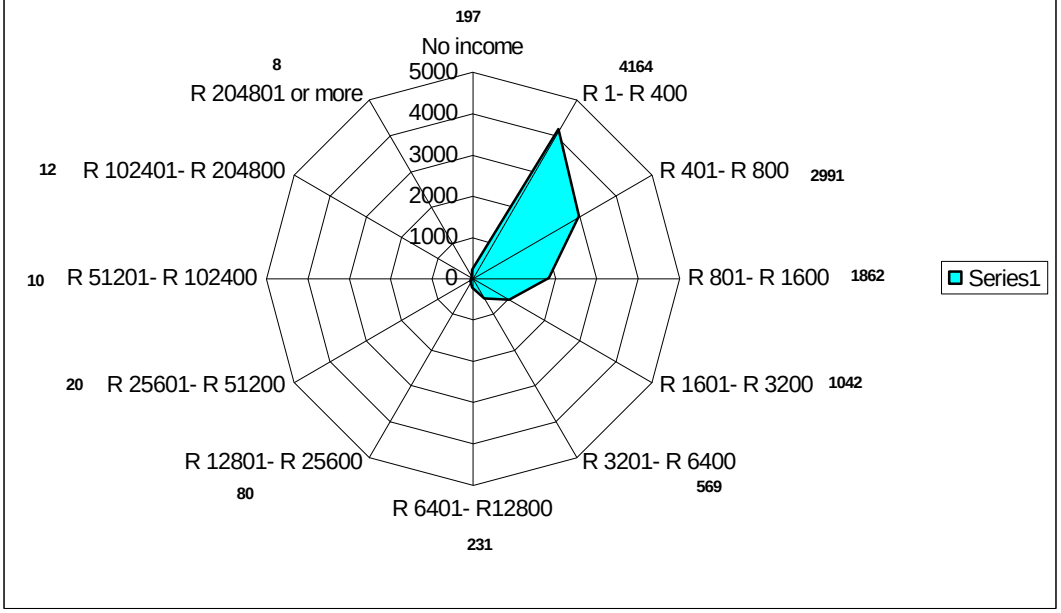


Table 33: Mookgophong Local Municipality Population - Age and gender						
	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	1611	1677	3288	856	605	1461
5-9	1417	1354	2771	506	494	1000
10-14	1467	1377	2844	683	742	1425
15-19	1490	1487	2977	739	569	1308
20-24	1371	1301	2672	846	578	1424
25-29	1516	1483	2999	671	752	1423
30-34	1339	1257	2596	1034	807	1841
35-39	1049	1161	2210	598	552	1150
40-44	862	873	1735	724	636	1360
45-49	684	753	1437	823	413	1236
50-54	670	581	1251	401	521	922
55-59	510	462	952	409	364	773
60-64	506	512	1018	277	198	475
65-69	357	368	725	205	321	526
70-74	280	314	594	197	189	386
75-79	209	187	396	177	74	251
80-84	74	117	191	6	56	62
85+	40	113	153	45	115	160
Sub-total	**15452**	**15377**	**30829**	**9197**	**7986**	**17183**

Table 34: Mookgophong Local Municipality Population table: Income distribution						
	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	87	110	197	2678	3428	6106
R 1- R 400	2039	2125	4164	783	865	1648
R 401- R 800	1915	1076	2991	622	732	1354
R 801- R 1600	1206	656	1862	853	1310	2163
R 1601- R 3200	762	280	1042	909	360	1269
R 3201- R 6400	348	221	569	2687	436	3123
R 6401- R12800	198	33	231	422	159	581
R 12801- R 25600	65	15	80	257	100	357
R 25601- R 51200	17	3	20	55	68	123
R 51201- R 102400	10	0	10	63	61	124
R 102401- R 204800	9	3	12	24	0	24
R 204801 or more	5	3	8	4	0	4
Sub-total	**6661**	**4527**	**11188**	**9357**	**7519**	**16876**

Mookgophong Local Municipality - Income distribution Stats SA 2001

Chart 51:



Mookgophong Local Municipality - Income distribution Stats SA 2007

Chart 52:

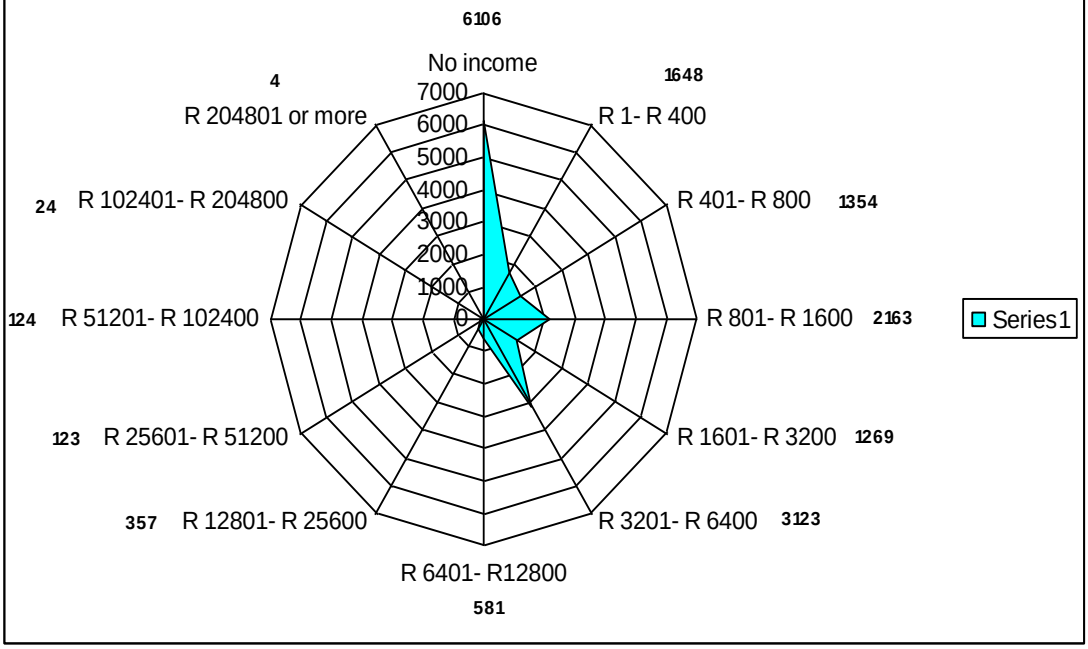


Table 35: Mookgophong Local Municipality Population - Institution attended							
2001					**2007**		
Schooling	**M**	**F**	**Total**		**Schooling**	**M**	**F**	**Total**
No schooling	2242	2506	4748		Pre- school	45	42	87
Some primary	2002	1801	3803		Primary	778	839	1617
Complete primary	674	585	1259		Secondary	836	841	1677
Some secondary	2562	2613	5175		College	68	20	88
Grade 12/	1381	1471	2852		University /Tech	63	20	83
Higher	536	502	1038		Adult basic	0	0	0
Sub-total	**9397**	**9478**	**18875**		Other	0	19	19
					Not applicable	852	565	1417
					Unspecified	22	0	22
					Institutions	110	37	147
					Sub-total	**2774**	**2383**	**5157**

Table 36: Mookgophong Local Municipality Population - Employment Industries						
	2001			**2007**		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	2783	1575	4358	1045	475	1520
Mining and quarrying	74	5	79	30	0	30
Manufacturing	519	149	668	736	339	1075
Electricity; gas and water supply	15	3	18	42	0	42
Construction	418	52	470	272	64	336
Wholesale and retail trade	748	663	1411	466	2437	2903
Transport; storage and communication	235	32	267	232	36	268
Financial; insurance; real estate and business services	225	127	352	605	280	885
Community; social and personal services	694	528	1222	383	731	1114
Other and not adequately defined	0	0	0	163	343	506
Private households/ not applicable	503	1070	1573	1643	2437	4080
Undermined	441	329	770	402	301	703
Sub- total	**6655**	**4533**	**11188**	**6019**	**7443**	**13462**

6.3.4. Modimolle Local Municipality

Chart 53:

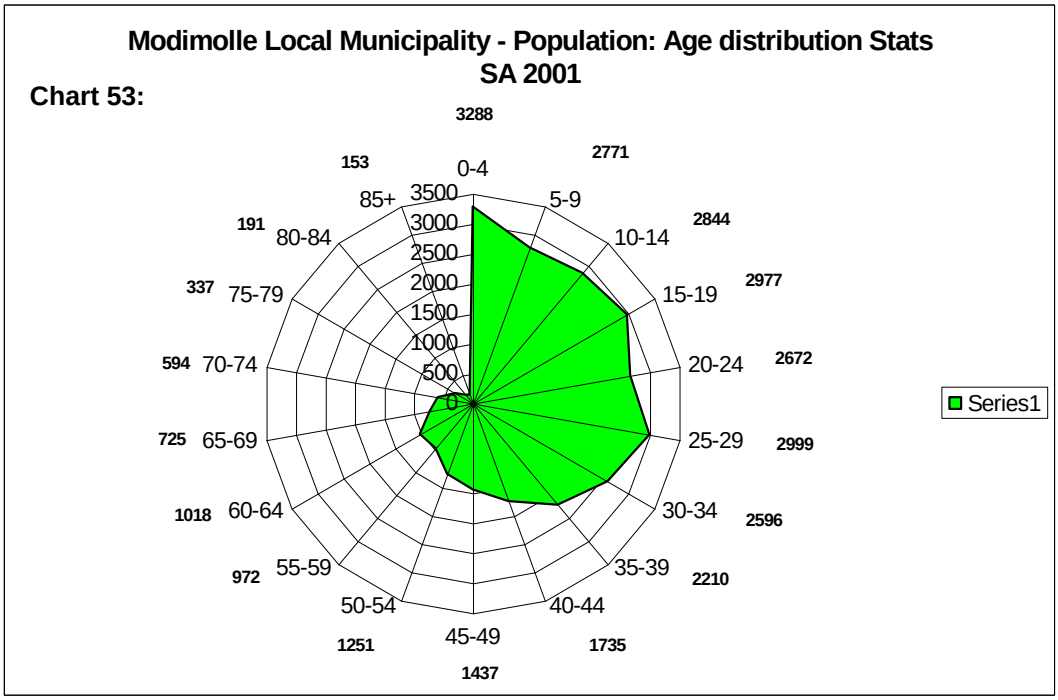


Chart 54:

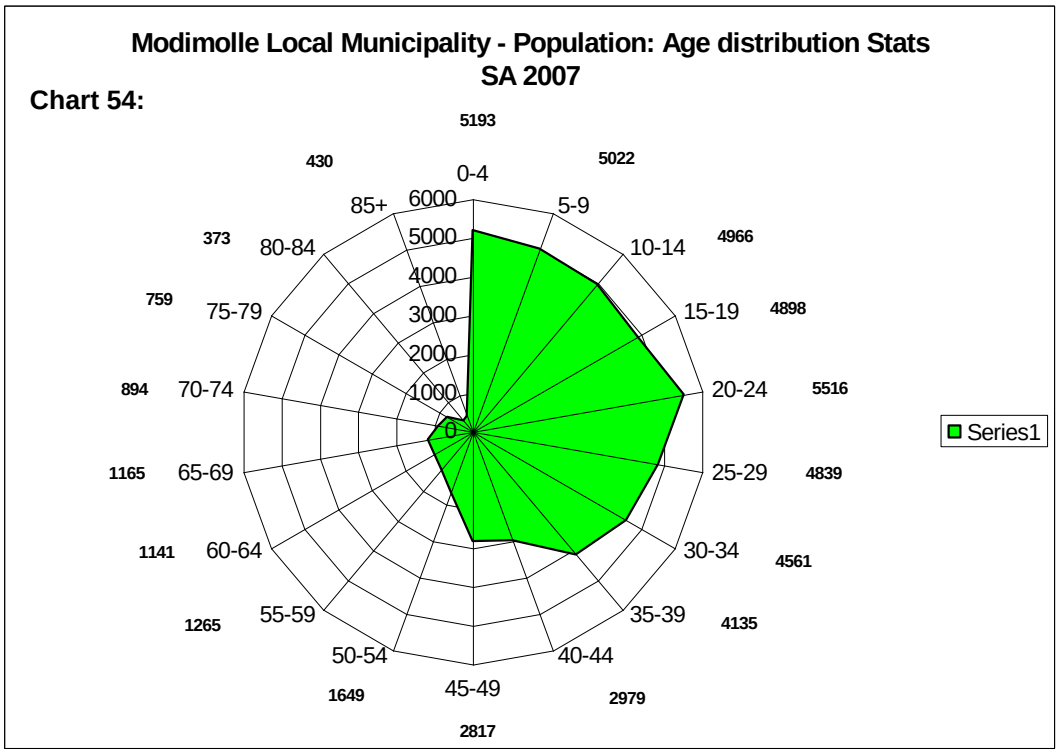
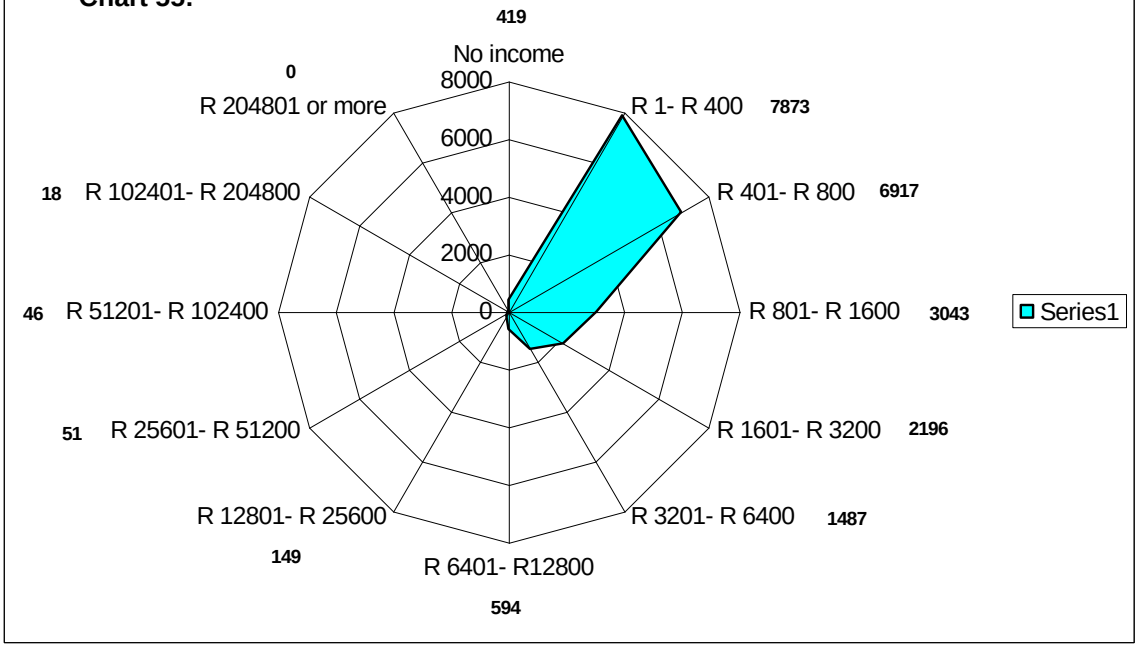


Table 37: Modimolle Local Municipality Population - Age and gender						
	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	1611	1677	3288	2532	2661	5193
5-9	1417	1354	2771	2887	2135	5022
10-14	1467	1377	2844	2468	2498	4966
15-19	1490	1487	2977	2016	2882	4898
20-24	1371	1301	2672	3029	2487	5516
25-29	1516	1483	2999	2606	2233	4839
30-34	1339	1257	2596	2607	1954	4561
35-39	1049	1161	2210	2398	1737	4135
40-44	862	873	1735	1346	1633	2979
45-49	684	753	1437	1308	1509	2817
50-54	670	581	1251	824	825	1649
55-59	510	462	972	754	511	1265
60-64	506	512	1018	545	596	1141
65-69	357	368	725	457	708	1165
70-74	280	314	594	366	528	894
75-79	150	187	337	212	547	759
80-84	74	117	191	262	111	373
85+	40	113	153	121	309	430
Sub-total	**15393**	**15377**	**30770**	**26738**	**25864**	**52602**

Table 38: Modimolle Local Municipality Population - Income distribution						
	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	238	181	419	6739	9380	16119
R 1- R 400	4010	3863	7873	4863	4728	9591
R 401- R 800	4338	2579	6917	2895	2497	5392
R 801- R 1600	2144	899	3043	4993	3923	8916
R 1601- R 3200	1382	814	2196	1738	808	2546
R 3201- R 6400	830	657	1487	1142	1022	2164
R 6401- R12800	411	183	594	938	839	1777
R 12801- R 25600	119	30	149	406	239	645
R 25601- R 51200	40	11	51	235	158	393
R 51201- R 102400	32	14	46	180	73	253
R 102401- R 204800	12	6	18	83	33	116
R 204801 or more	0	0	0	0	0	0
Sub-total	**13556**	**9237**	**22793**	**24212**	**23700**	**47912**

Modimolle Local Municipality - Income distribution Stats SA 2001

Chart 55:



Modimolle Local Municipality - Income distribution Stats SA 2007

Chart 56:

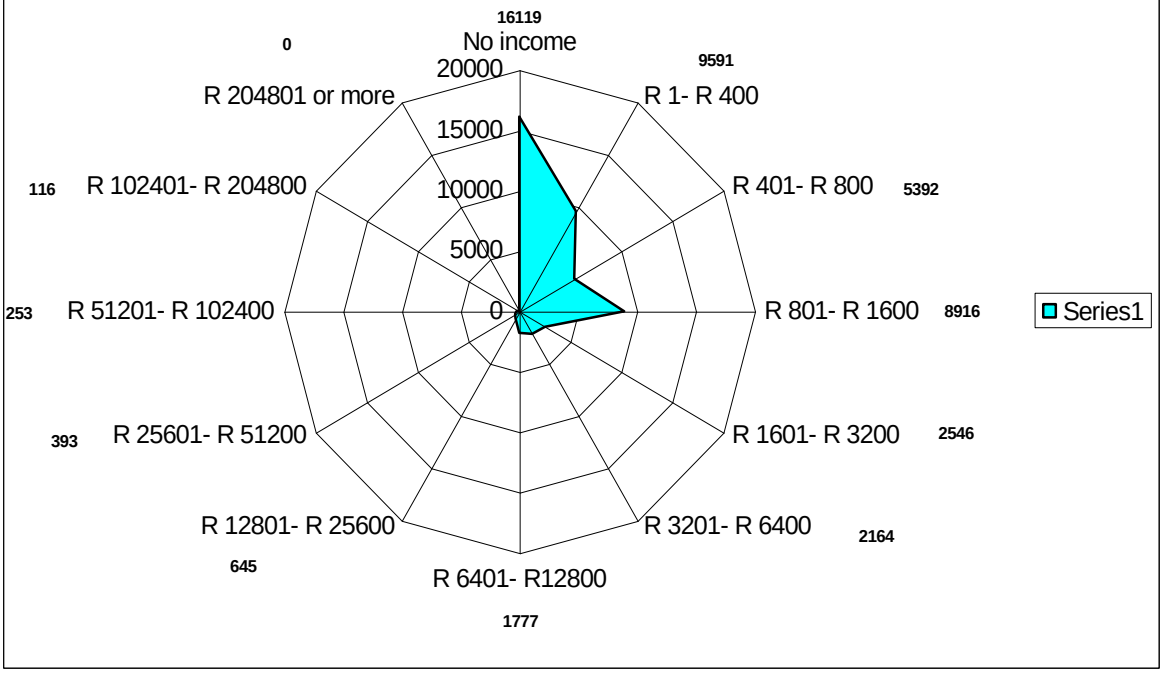
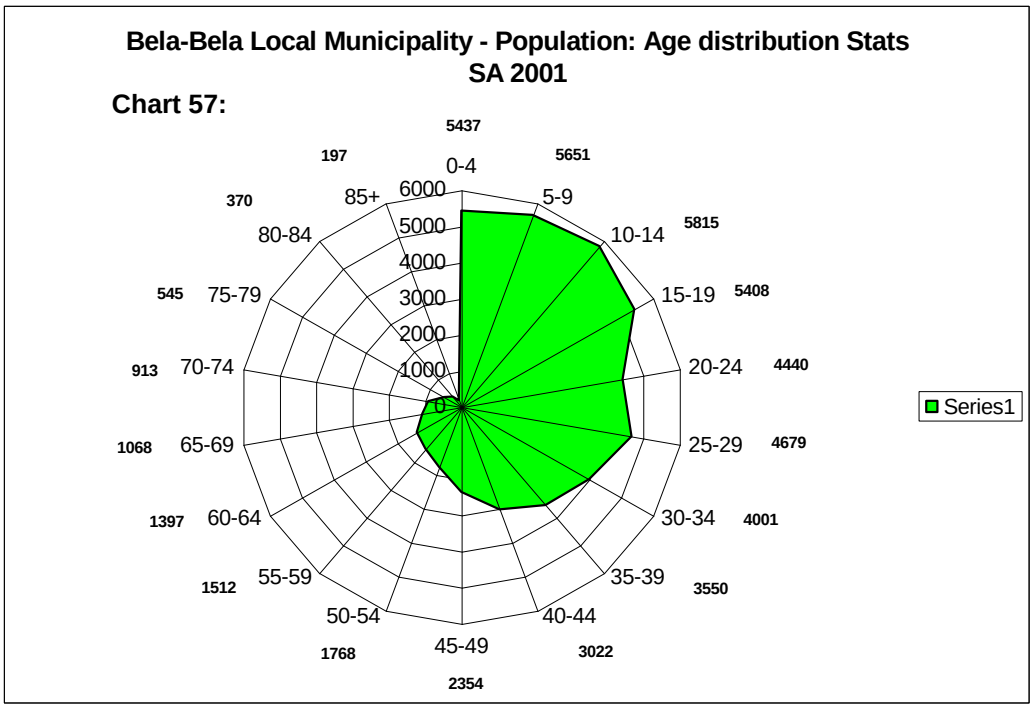


Table 39: Modimolle Local Municipality Population - Institution attended							
2001					**2007**		
Schooling	**M**	**F**	**Total**		**Schooling**	**M**	**F**	**Total**
No schooling	4448	4904	9352		Pre- school	417	291	708
Some primary	5028	4857	9885		Primary	3485	3248	6733
Complete primary	1578	1666	3244		Secondary	2223	2660	4883
Some secondary	5444	5390	10834		College	41	28	69
Grade 12/	3182	2900	6082		University /Tech	35	0	35
Higher	1307	1381	2688		Adult basic	0	0	0
Sub-total	**20987**	**21098**	**42085**		Other	31	25	56
					Not applicable	3402	3288	6690
					Unspecified	0	35	35
					Institutions	766	428	1194
					Sub-total	**10400**	**10003**	**20403**

Table 40: Modimolle Local Municipality Population - Employment Industries						
	2001			**2007**		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	4713	2464	7177	1908	751	2659
Mining and quarrying	65	28	93	31	0	31
Manufacturing	1150	459	1609	1503	737	2240
Electricity; gas and water supply	84	29	113	170	33	203
Construction	1375	160	1535	1189	60	1249
Wholesale and retail trade	1517	1172	2689	1867	1121	2988
Transport; storage and communication	322	78	400	465	186	651
Financial; insurance; real estate and business services	455	264	719	701	775	1476
Community; social and personal services	2058	1708	3766	1680	1065	2745
Other and not adequately defined	0	0	0	1005	1650	2655
Private households/ not applicable	1138	2414	3548	4800	8219	13019
Undermined	679	462	1141	1000	846	1846
Sub- total	**13552**	**9238**	**22790**	**16319**	**15443**	**31762**

6.3.5. Bela-Bela Local Municipality



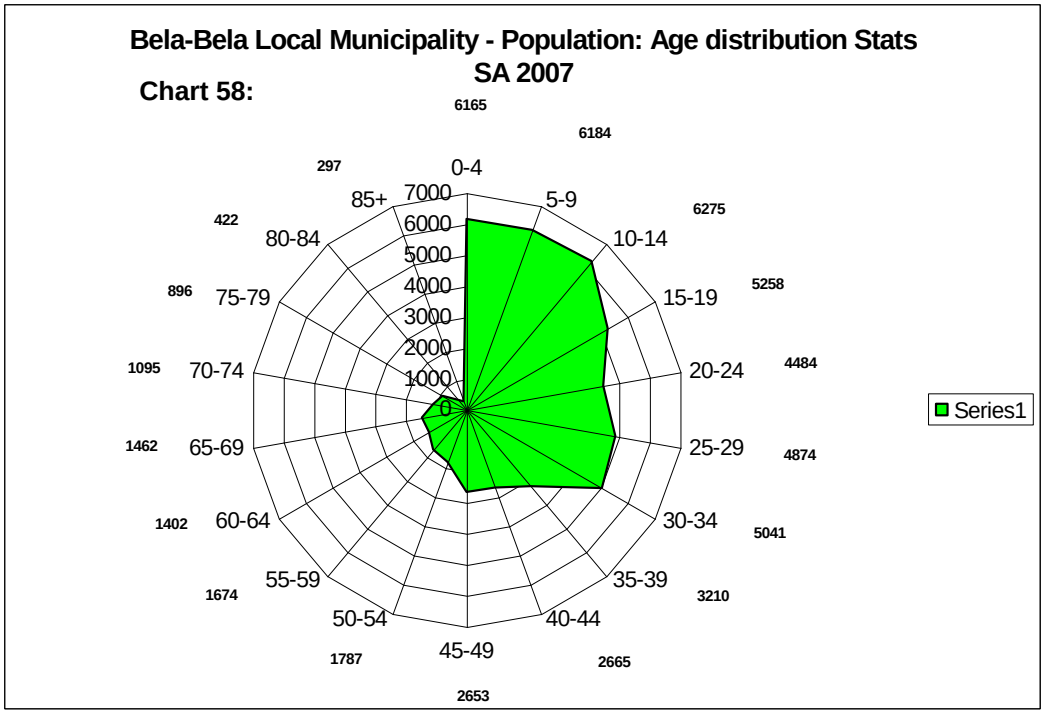
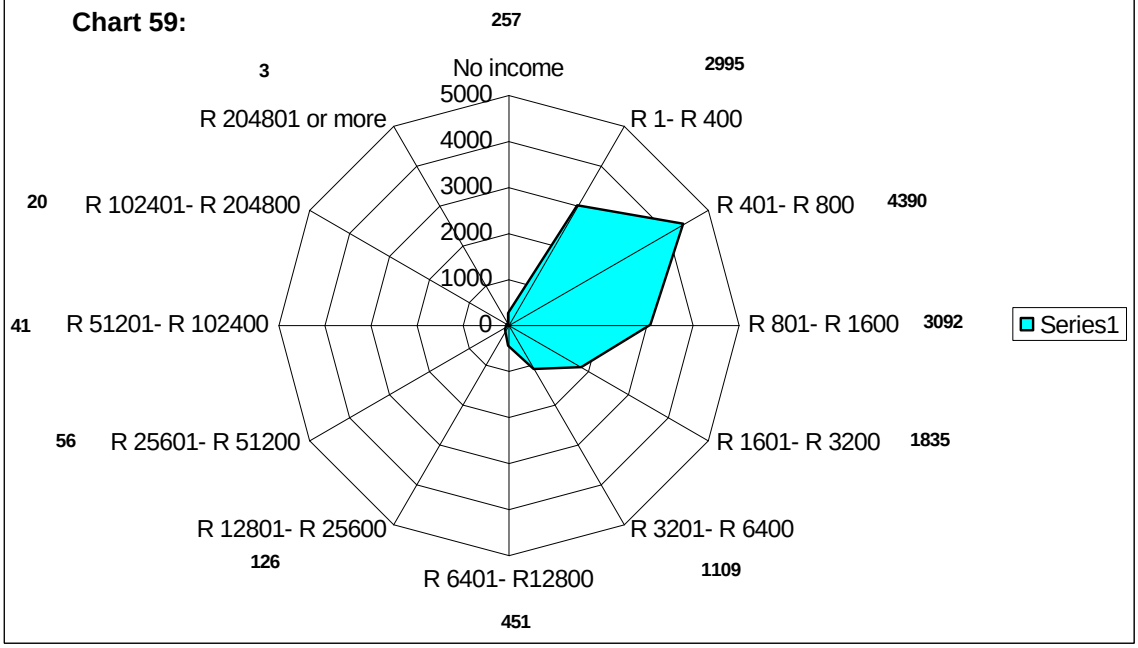


Table 41: Bela-Bela Local Municipality Population - Age and gender						
	2001			2007		
Age	M	F	Total	M	F	Total
0-4	2702	2735	5437	3101	3064	6165
5-9	2851	2800	5651	2958	3226	6184
10-14	2852	2963	5815	2928	3347	6275
15-19	2574	2834	5408	2567	2691	5258
20-24	2166	2274	4440	2264	2220	4484
25-29	2210	2469	4679	2704	2170	4874
30-34	1956	2045	4001	2815	2226	5041
35-39	1698	1852	3550	1667	1543	3210
40-44	1448	1574	3022	1261	1404	2665
45-49	1092	1262	2354	1208	1445	2653
50-54	871	897	1768	872	915	1787
55-59	736	776	1512	787	887	1674
60-64	645	752	1397	638	764	1402
65-69	493	575	1068	551	911	1462
70-74	397	516	913	512	583	1095
75-79	251	294	545	433	463	896
80-84	166	204	370	170	252	422
85+	72	125	197	105	192	297
Sub-total	**25180**	**26947**	**52127**	**27541**	**28303**	**55844**

Table 42: Bela-Bela Local Municipality Population - Income distribution						
	2001			2007		
Income	M	F	Total	M	F	Total
No income	122	135	257	8673	12835	21508
R 1- R 400	1361	1634	2995	5607	5793	11400
R 401- R 800	2728	1662	4390	1878	2233	4111
R 801- R 1600	1999	1093	3092	5047	3628	8675
R 1601- R 3200	1155	680	1835	2728	1019	3747
R 3201- R 6400	568	541	1109	917	665	1582
R 6401- R12800	320	131	451	840	896	1736
R 12801- R 25600	87	39	126	251	239	490
R 25601- R 51200	46	10	56	58	0	58
R 51201- R 102400	30	11	41	0	25	25
R 102401- R 204800	16	4	20	44	25	69
R 204801 or more	3	0	3	0	30	30
Sub-total	**8435**	**5940**	**14375**	**26043**	**27388**	**53431**

Bela-Bela Local Municipality - Income distribution Stats SA 2001

Chart 59:



Bela-Bela Local Municipality - Income distribution Stats SA 2007

Chart 60:

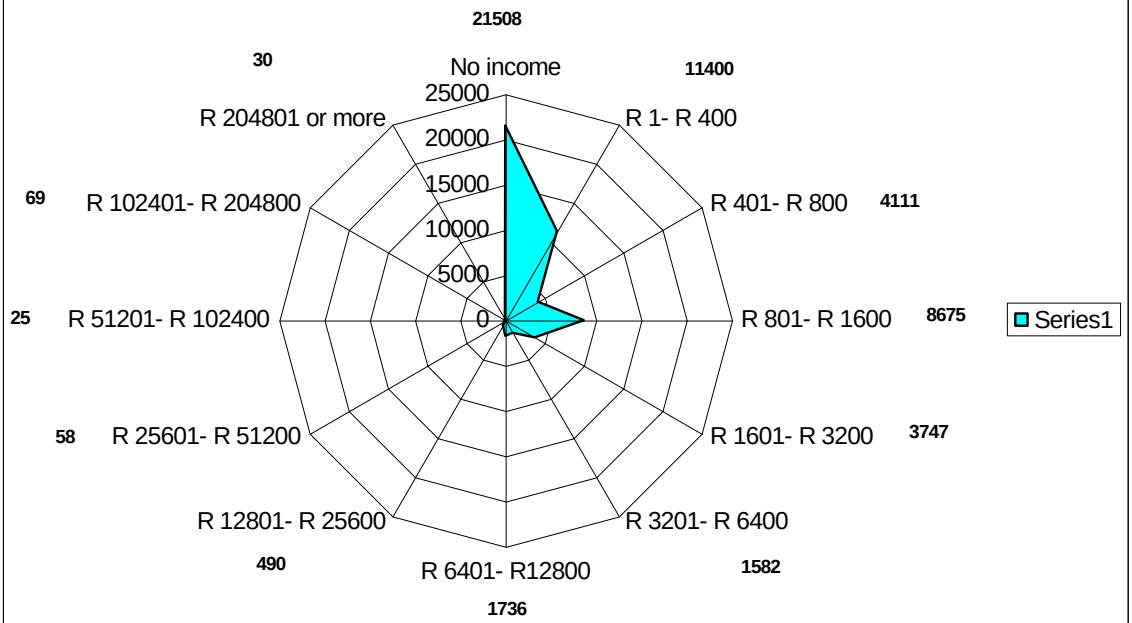


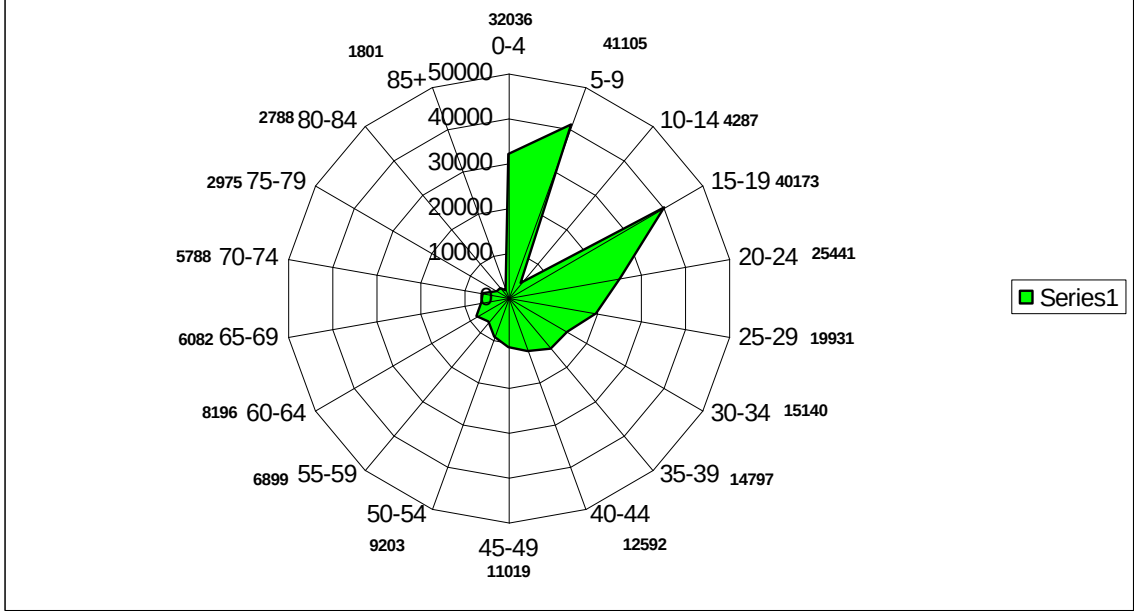
Table 43: Bela-Bela Local Municipality Population - Institution attended							
2001					**2007**		
Schooling	**M**	**F**	**Total**		**Schooling**	**M**	**F**	**Total**
No schooling	2149	2629	4778		Pre- school	432	569	1001
Some primary	3476	3580	7056		Primary	3838	4580	8418
Complete primary	1018	1213	2231		Secondary	2974	2858	5832
Some secondary	4076	4333	8409		College	24	0	24
Grade 12/	2371	2612	4983		University /Tech	55	54	109
Higher	1112	1244	2356		Adult basic	0	0	0
Sub-total	**14202**	**15611**	**29813**		Other	0	54	54
					Not applicable	2963	2895	5858
					Unspecified	143	160	303
					Institutions	287	246	533
					Sub-total	**10716**	**11416**	**22132**

Table 44: Bela-Bela Local Municipality Population - Employment Industries						
	2001			**2007**		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	2393	950	3343	5121	465	1986
Mining and quarrying	45	6	51	227	26	253
Manufacturing	404	138	542	498	369	867
Electricity; gas and water supply	65	16	81	137	54	191
Construction	767	52	819	2458	30	2488
Wholesale and retail trade	1475	1180	2655	1415	1308	2723
Transport; storage and communication	289	92	381	292	92	384
Financial; insurance; real estate and business services	424	218	642	1000	381	1381
Community; social and personal services	1371	1343	2714	1300	1315	2615
Other and not adequately defined	0	0	0	801	1458	2259
Private households/ not applicable	493	1445	1938	6423	9963	16386
Undermined	698	504	1202	510	755	1265
Sub- total	**8424**	**5944**	**14368**	**16582**	**16216**	**32798**

6.3.6. Mogalakwena Local Municipality

Mogalakwena Municipality - Population: Age distribution Stats SA 2001

Chart 61:



Mogalakwena Municipality - Population: Age distribution Stats SA 2007

Chart 62:

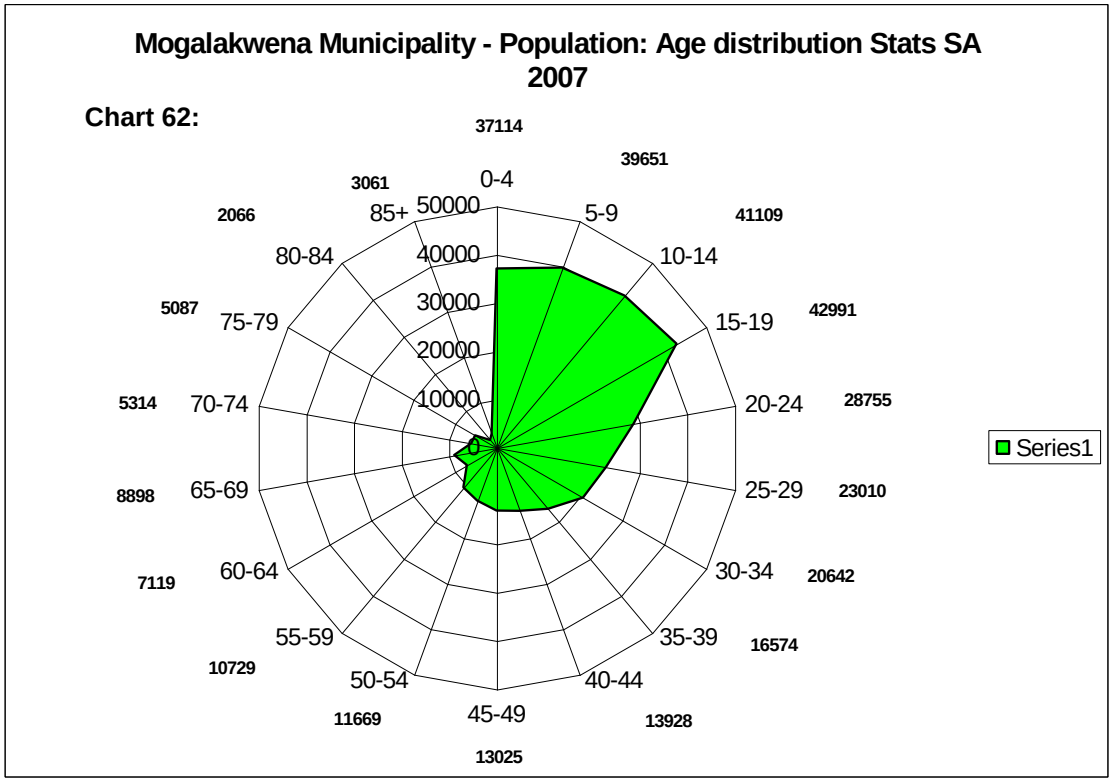
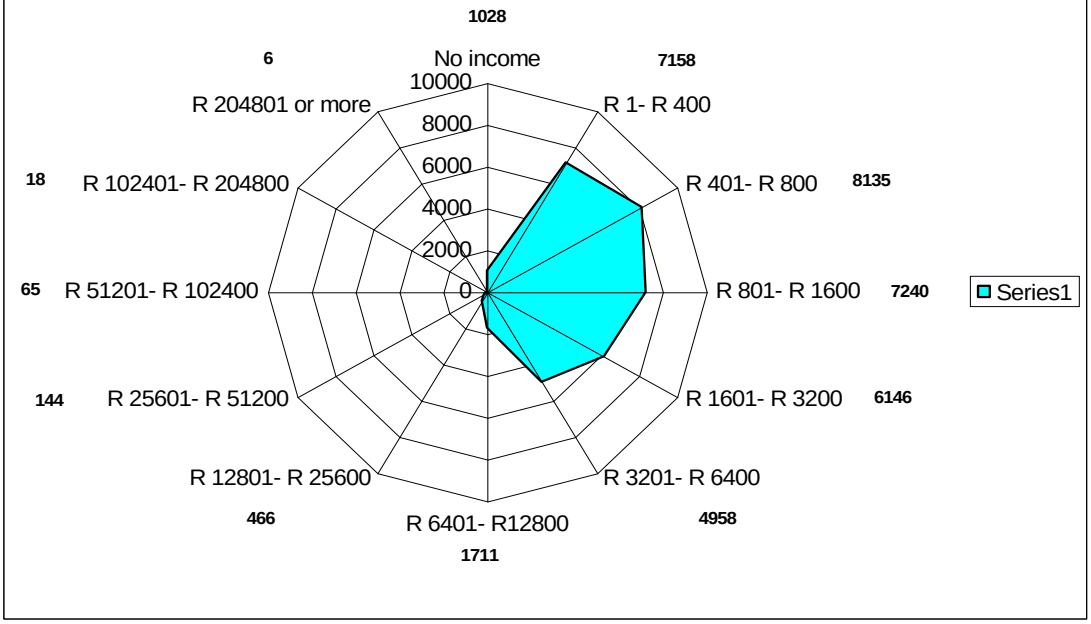


Table 45: Mogalakwena Local Municipality Population - Age and gender						
	2001			2007		
Age	**M**	**F**	**Total**	**M**	**F**	**Total**
0-4	15972	16064	32036	17558	19556	37114
5-9	20724	20381	41105	20521	19130	39651
10-14	21205	21282	4287	20975	20134	41109
15-19	20104	20069	40173	21361	21630	42991
20-24	11850	13591	25441	14467	14288	28755
25-29	8514	11417	19931	12010	11000	23010
30-34	6499	8641	15140	9564	11078	20642
35-39	6113	8684	14797	7453	9121	16574
40-44	5381	7211	12592	5684	8244	13928
45-49	4464	6555	11019	5589	7436	13025
50-54	3795	5408	9203	4303	7366	11669
55-59	2957	3942	6899	4861	5868	10729
60-64	2993	5203	8196	3394	3725	7119
65-69	2042	4040	6082	2961	5937	8898
70-74	1867	3921	5788	1931	3383	5314
75-79	1098	1877	2975	1322	3765	5087
80-84	893	1895	2788	388	1678	2066
85+	560	1241	1801	892	2169	3061
Sub-total	**137031**	**161422**	**298453**	**155234**	**175508**	**330742**

Table 46: Mogalakwena Local Municipality Population - Income distribution						
	2001			2007		
Income	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	486	542	1028	67555	79127	146682
R 1- R 400	2698	4460	7158	42927	46455	89382
R 401- R 800	4164	3971	8135	8733	12619	21352
R 801- R 1600	5044	2196	7240	18740	2761	21501
R 1601- R 3200	3813	2333	6146	6138	2504	8642
R 3201- R 6400	2747	2211	4958	3988	2758	6746
R 6401- R12800	1223	488	1711	2936	3602	6538
R 12801- R 25600	398	68	466	1344	427	1771
R 25601- R 51200	96	48	144	96	79	175
R 51201- R 102400	46	19	65	30	119	149
R 102401- R 204800	18	0	18	85	0	85
R 204801 or more	3	3	6	243	85	328
Sub-total	**20736**	**16339**	**37075**	**152815**	**150536**	**303351**

Mogalakwena Local Municipality - Income distribution Stats SA 2001

Chart 63:



Mogalakwena Local Municipality - Income distribution Stats SA 2007

Chart 64:

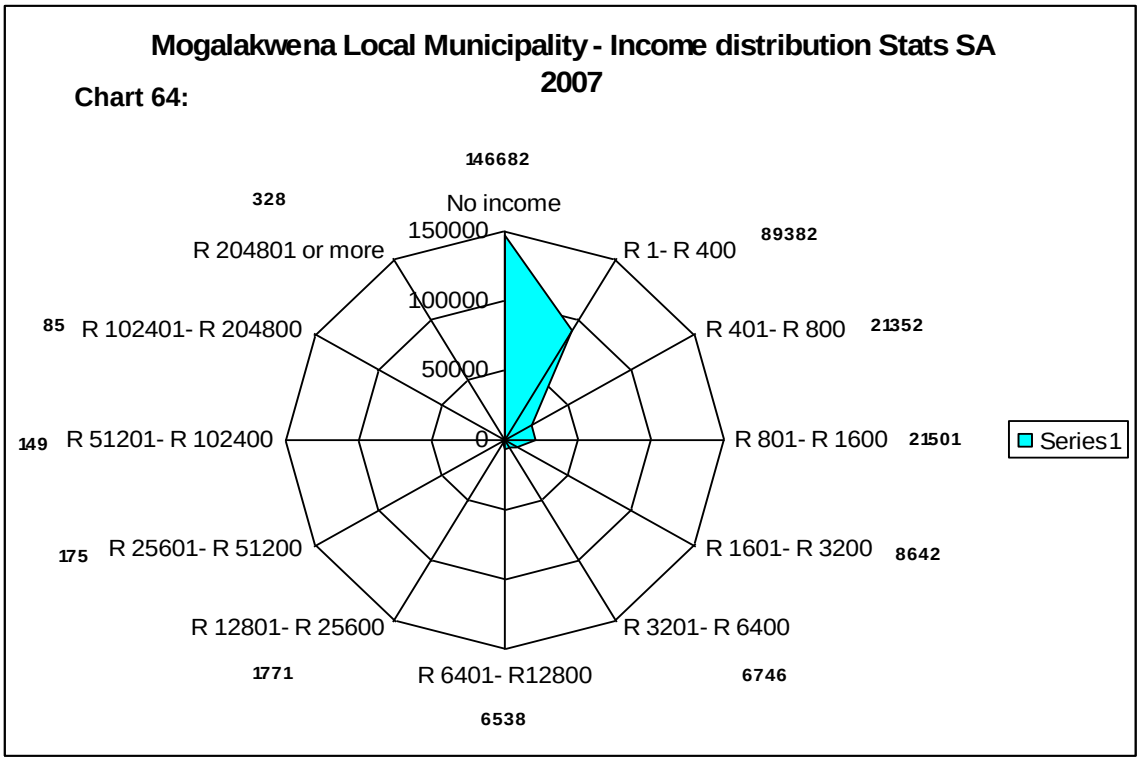


Table 47: Mogalakwena Local Municipality Population - Institution attended								
2001					**2007**			
Schooling	**M**	**F**	**Total**		**Schooling**	**M**	**F**	**Total**
No schooling	15320	29513	44833		Pre- school	2548	1897	4445
Some primary	9740	11573	21313		Primary	28596	27349	55945
Complete primary	3551	4362	7913		Secondary	28685	29469	58154
Some secondary	17488	21434	38922		College	392	1054	1446
Grade 12/	8809	11284	20093		University /Tech	421	504	925
Higher	4111	5455	9566		Adult basic	0	0	0
Sub-total	**59019**	**83621**	**142640**		Other	368	110	478
					Not applicable	14926	13207	28133
					Unspecified	810	911	1721
					Institutions	580	681	1261
					Sub-total	**77326**	**75182**	**152508**

Table 48: Mogalakwena Local Municipality Population - Employment Industries						
	2001			**2007**		
Sectors	**M**	**F**	**Total**	**M**	**F**	**Total**
Agriculture; hunting and fishing	2343	1392	3735	2240	1154	3394
Mining and quarrying	1476	121	1597	2572	238	3010
Manufacturing	2007	1014	3021	4895	1889	6784
Electricity; gas and water supply	187	15	202	525	93	618
Construction	1871	234	2105	2392	655	3047
Wholesale and retail trade	3513	2635	6148	5238	2528	7766
Transport; storage and communication	1109	193	1302	1069	823	1892
Financial; insurance; real estate and business services	1364	742	2106	2628	939	3567
Community; social and personal services	3988	4411	8399	4234	6788	11022
Other and not adequately defined	0	0	0	1069	4389	5458
Private households/ not applicable	1024	1468	2492	58632	77347	135979
Undermined	1862	1420	3282	3259	3000	6259
Sub- total	**20744**	**13645**	**34389**	**88753**	**100043**	**188796**

6.4. HOUSEHOLD INCOME

Waterberg Local Municipalities Annual Household Income for 2001: population group of head of household.

6.4.1. Thabazimbi Local Municipality

Table 49: Thabazimbi Local Municipality - Annual Household Income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	3 417	6	0	111	0	3 534
R1- R4 800	2 931	9	0	32	0	2 972
R48 01-R 9 600	3 428	18	0	94	0	3 540
R9 601-R 19 200	4 032	10	0	188	0	4 320
R19 201- R38 400	5 456	6	1	342	0	5 805
R38 401-R76 800	2 069	20	1	610	0	2 700
R76 801-R153 600	499	10	4	954	0	1 467
R153 601-R307 200	109	3	0	427	0	539
R307 201-R614 400	19	0	0	104	0	123
R614 401-R1 228 800	7	0	0	35	0	42
R1 228 801-R2 2457 600	16	0	0	31	0	47
R2 2457 601 or More	4	0	0	13	0	17
Not applicable (institutions)	0	0	0	0	19	19
Total	**21 987**	**82**	**6**	**2 941**	**19**	**25 035**

6.4.2. Lephalale Local Municipality

Table 50: Lephalale Local Municipality - Annual Household Income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	4 957	7	0	124	0	5 088
R1- R4 800	5 946	7	0	30	0	5 983
R4 801-R 9 600	6 841	17	1	90	0	6 949
R9 601-R 19 200	3 510	15	0	203	0	3 728
R19 201- R38 400	2 288	1	0	307	0	2 596
R38 401-R76 800	1 537	6	4	562	0	2 109
R76 801-R153 600	478	6	4	654	0	1 142
R153 6001-R307 200	117	3	1	362	0	483
R307 2001-R614 400	37	0	0	93	0	130
R614 4001-R1 228 800	11	0	0	42	0	53
R1 228 801-R2 2457 600	14	0	0	34	0	48
R2 2457 601 or More	9	0	0	11	0	20
Not applicable (institutions)	0	0	0	0	30	30
Total	**25 475**	**62**	**10**	**2 512**	**30**	**28 359**

6.4.3. Mookgophong Local Municipality

Table 51: Mookgophong Local Municipality - annual Household Income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	801	1	0	49	0	851
R1- R4 800	1 675	6	0	11	0	1 692
R4 801-R 9 600	2 268	0	0	108	0	2 376
R9 601-R 19 200	1 842	10	0	201	0	2 053
R19 201- R38 400	881	5	2	320	0	1 208
R38 401-R76 800	276	5	0	465	0	746
R76 801-R153 600	88	0	0	332	0	420
R153 601-R307 200	20	0	1	112	0	133
R307 201-R614 400	7	0	0	30	0	37
R614 401-R1 228 800	0	0	0	18	0	18
R1 228 801-R2 2457 600	10	0	0	4	0	14
R2 2457 601 or More	1	0	0	12	0	13
Not applicable (institutions)	0	0	0	0	8	8
Total	**7 869**	**27**	**3**	**1 662**	**8**	**9 569**

6.4.4. Modimolle Local Municipality

Table 52: Modimolle Local Municipality - annual household income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	3007	8	3	216	0	3 234
R1- R4 800	2978	18	0	54	0	3 050
R4 801-R 9 600	4926	24	6	168	0	5 124
R9 601-R 19 200	3484	18	3	318	0	3 823
R19 201- R38 400	1981	13	7	589	0	2 590
R38 401-R76 800	780	1	7	812	0	1 600
R76 801-R153 600	271	1	4	747	0	1 023
R153 601-R307 200	71	0	2	255	0	328
R307 201-R614 400	16	0	1	65	0	82
R614 401-R1 228 800	13	0	0	37	0	50
R1 228 801-R2 2457 600	7	0	0	17	0	24
R2 2457 601 or More	2	0	0	3	0	5
Not applicable (institutions)	0	0	0	0	29	29
Total	**17 536**	**83**	**33**	**3 281**	**29**	**20 962**

6.4.5. Bela-Bela Local Municipality

Table 53: Bela-Bela Local Municipality - annual household income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	2 210	23	6	107	0	2 346
R1- R4 800	1175	8	0	15	0	1 198
R4 801-R 9 600	3 088	35	3	155	0	3 281
R9 601-R 19 200	2 755	27	10	196	0	2 988
R19 201- R38 400	1 717	31	16	357	0	2 121
R38 401-R76 800	688	15	17	474	0	1 194
R76 801-R153 600	223	5	8	426	0	662
R153 601-R307 200	39	5	5	176	0	225
R307 201-R614 400	7	0	1	61	0	69
R614 401-R1 228 800	6	1	0	35	0	42
R1 228 801-R2 2457 600	3	0	0	20	0	23
R2 2457 601 or More	0	0	0	5	0	5
Not applicable (institutions)	0	0	0	0	17	17
Total	**11 911**	**150**	**66**	**2 027**	**17**	**14 117**

6.4.6. Mogalakwena Local Municipality

Table 54: Mogalakwena Local Municipality - annual Household Income for 2001						
	African / Black	**Coloured**	**Indian / Asian**	**White**	**N/A**	**Total**
No income	22 056	9	8	127	0	22 200
R1- R4 800	5 611	7	1	27	0	5 646
R4 801-R 9 600	17 207	15	7	188	0	17 417
R9 601-R 19 200	10 053	16	6	347	0	10 422
R19 201- R38 400	6 197	13	30	430	0	6 670
R38 401-R76 800	3 385	6	44	776	0	4 211
R76 801-R153 600	1 403	10	52	788	0	2 253
R153 601-R307 200	359	2	23	479	0	863
R307 201-R614 400	91	1	4	122	0	218
R614 401-R1 228 800	24	0	5	39	0	68
R1 228 801-R2 2457 600	74	0	0	13	0	87
R2 2457 601 or More	20	0	0	6	0	26
Not applicable (institutions)	0	0	0	0	55	55
Total	**66 480**	**79**	**180**	**33 42**	**55**	**70 136**

7. CURRENT LAND USE AND LAND USE PLANNING

7.1. BACKGROUND

The Waterberg District Municipality hosts a unique landscape of serene mountain ranges, fertile valleys and bushveld flats which so far have been spared exhaustive development. The district also hosts valued resources in the form of minerals and wildlife which provide ample opportunities for economic development as well as conservation. The main economic activity is mining, contributing almost 50% to the GDP of the district. Other activities include agriculture, game farming on rural land, and tertiary services associated with towns dispersed through the area. The mining sector is expected to experience rapid growth in the near future with associated downstream industrial development and expansion of services (housing, infrastructure, social services, etc.). Consequently the "wilderness" character of the district is under threat, hence the necessity of an environmental management framework, to guide economic growth and secure conservation in a sustainable manner.

This section describes the status of development in context of spatial planning, looking into the following themes:

- Human settlement;
- economic development pattern;
- infrastructure;
- broad land patterns;
- expected economic development & growth; and
- planning initiatives as contained in spatial development frameworks.

7.2. DEVELOPMENT PATTERN

The development pattern is established over years of economic development and is expressed in terms of human settlement and infrastructure in support of these economic activities. The development pattern is also influenced by climate and physical factors, in particular the topography.

Map 21: Mining and industrial development

7.3. ECONOMIC DEVELOPMENT PATTERN

7.3.1. Primary activities

7.3.1.1. Mining

The exploitation of minerals such as iron, platinum and coal has led to the development of nodes which have grown into the largest of the towns in the district. With the exception of iron, the mineral potential in the district is large enough to spur further growth of existing nodes such as Lephalale and Mokopane, and even the development of new settlements in undeveloped areas. The direct impact of mining expansion is the loss of farmland.

7.3.1.2. Areas with dominant mining potential

Lephalale is one of the areas with dominant mining potential. Plans to expand the current coal mine and the addition of a new coal mine are already being discussed. This development is to coincide with the upgrading of the existing Matimba power station and the development of a new coal fired power station.

The possibility of establishing platinum mine, as well as the expansion of the existing mine in Mokgale exists.

7.3.1.3. Agriculture

Commercial farming mainly occurs on the “Springbok flats” in the south-east of the district, towards Marble Hall, as well as the broad valley towards Alma. Game farming occurs in the Waterberg and Steenbokpan area. Cattle farming have gradually given way to game farming. The impact of agriculture is the loss of biodiversity due to the planting of crops. Overgrazing and poor land management also contributes to the loss of biodiversity where game numbers are not controlled on farms.

7.3.1.4. Areas with dominant agricultural potential

The Lephalale Municipality proposes to expand the existing agriculture activities and the expansion of the irrigation scheme already in place.

The Modimolle Local Municipality area has an active agricultural sector, which the Municipality hopes to expand and strengthen. Some of the development projects and opportunities that have been identified by the Municipality include:

- Alma hydroponics;

- Meropa vegetables;
- Waterberg Agriculture training project;
- Limpopo Dipudi project, which is a goat abattoir;
- LDA Leseding poultry project in Vaalwater;
- the Busy Bee aquaculture project;
- community game farm projects;
- organic vegetable projects; and
- venison processing project

The Mookgophong Local Municipality area has a very dominant agricultural sector, which the Municipality hopes to expand and strengthen. Some of the development projects and opportunities in the area that have been identified by the Municipality include:

- Paprika production under the irrigation schemes;
- expansion of citrus production in Nyl/Mokgalakwena;
- spices and granadilla production in Nyl/Mokgalakwena;
- meat processing in Naboom;
- hydroponics in the Springbok flats; and
- game farming in the Tambotie floodlands.

7.3.2. Secondary activities

7.3.2.1. Industrial development

In context with the district at large, little industrial development has taken place. The power stations near Lephalale (Matimba and Medupi) are singled out as the first heavy industrial development in the district. Small scale manufacturing and service industries are located in Bela-Bela, Thabazimbi and Mokopane. At present growth in the manufacturing sector is slow because the sector is too small to attract more industries, and it is not well located in terms of existing markets (Thabazimbi Municipality Integrated Spatial Development Framework, 2008). Proclaimed industrial townships in Mogalakwena and Bela-Bela have no significant growth, as is evident from vacant stands that remain undeveloped. (Mogalakwena Spatial Development Framework, 2009 & Bela-Bela Spatial Development Framework, 2006).

7.3.3. Tertiary and quaternary activities

These activities are primarily present in town centres and mostly function on a local to sub-regional level. An exception, however, is the tourism industry which is experiencing rapid growth by virtue of private lodges and tourist facilities associated with the game farming industry. Residential development has also taken a new dimension with the development of eco-estates particularly in the Waterberg.

7.3.3.1. Bela-Bela

The town serves as gateway to Gauteng and is one of the prime inland resort destinations in South Africa. Some of the major tourism attractions are:

- Aventura Spa (Forever Resort);
- Warmbaths dam;
- Klein Kariba;
- Carousel Entertainment Centre;
- Waterfront;
- Mabula Game Reserve;
- Rust de Winter Nature Reserve (included in Tourism Mater plan for Dinokeng); and
- Malibungwe Game Reserve.

7.3.3.2. Lephalale

The strategic location of this municipality in relation to the Limpopo River is noted as it adjoins Botswana. Tourist attractions include:

- Welgevonden private game reserve;
- Mokolo Dam Nature Reserve;
- D'Nyala Nature Reserve;
- an extension of the Limpopo River;
- a variety of private game reserves;
- a big portion of the Waterberg Biosphere Reserve; and
- game hunting in the Myriad Game Reserve and ranches in Lephalale.

7.3.3.3. Modimolle

Modimolle is associated with the name of the town. The key landmark in this municipality is the solitary hill of Kranskop. Other attractions comprise of:

- Parts of the Waterberg mountains;
- Donkerpoort Dam;
- Kiepersol Game Farm;
- Dinaka Hunting Farm;
- Waterberg Game Reserve;
- Welgevonden Private Game Farm;
- Bataleur Game Reserve; and
- Wegbreek Game and Nature Farm.

7.3.3.4. Mogalakwena

Opportunities exist to develop village tourism products in the rural communities located in the development zone of the Biosphere Reserve. Other tourist destinations in this municipality are:

- Makapan Caves;
- Percy Five Nature Reserve;
- Masebe Nature Reserve;
- Moepal Farms;
- National Zoo Breeding Centre;
- Ettrich Game Farm;
- Doorndraaidam Nature Reserve;
- Leshoko Thabang; and
- Attractive Waterberg Escarpment.

7.3.3.5. Mookgophong

Key attractions include the internationally recognised Nylsvley floodplains and Nature Reserve. Other attractions include:

- Boekenhout Lodge;
- Entabeni;
- Kingfisher Lodge;
- Eagle's Nest;
- Lakeside Lodge;
- Ravineside Lodge;
- Wildside Camp; and
- Mabote.

7.3.3.6. Thabazimbi

Attractions in and around Thabazimbi include:

- Authurstone Nature Reserve;
- Ben Albert Nature Reserve;
- Thabo Tholo Eco-park;
- Marakele National Park; and
- Properites within Marakele National Park: Kwela-Anget, Boschfontein Guest Farm, Great Land Safaris, RRA Ditau Game Lodge, Tlop'I Tented Camp, Modiekela Private Camp and Handy Hints.

7.3.3.7. Areas with dominant conservation potential

The areas with dominant conservation potential include the Waterberg Massive area and the surrounding escarpment. The area already contains many established conservancies. The Waterberg Biosphere Reserve also falls within this area. The zones of the Biosphere are somewhat discontinuous in terms of core and buffer zones.

The Nylsvley RAMSAR site is another important site in terms of conservation. Although already protected, its future protection and management should be ensured.

It has been proposed that the currently state owned D'Nyala as well as the Mokolo Dam and Nature Reserve are privatised. A venture to develop conservation in the Makapan's valley has also been proposed.

7.4. HUMAN SETTLEMENT

7.4.1. Brief history of the Waterberg

The Waterberg area has been inhabited by *Homo Sapiens* since the Stone Age. According to fossil finds at the Cave of Hearts fossil site in the Makapan Valley, there is evidence of occupation in earlier times by an early homonid *Australopithecus africanus.* A trade route going through Makapan Valley past Polokwane to Mapungubwe has been established and maintained in the Iron Age, which is indicative of economic activity since early times. In these times San people took refuge in the Waterberg as they were brutally suppressed by Iron Age agriculturalists. Other groups in the area since the 19th century include the Tswana and Ndebele[15].

The Waterberg area was populated sparsely by humans because of its remoteness and inaccessibility. In South African context this was the last place where European pioneers settled. Hunting has always been a primary activity and agriculture mostly restricted to cattle farming. Due to the relative dry climate crop farming was only introduced with the advance of irrigation technology.

7.4.2. Settlement pattern

The settlement pattern in the district is fairly dispersed, with a high concentration of towns and villages in the east and the south (Mogalakwena, Bela-Bela and Thabazimbi municipalities), as indicated on Map 22 below. This development pattern is contributed to the following:

- Mining activities;
- corridor development along the N1 (Gauteng/Polokwane link), N11 (Mokopane / Botswana link) and (Bela-Bela/Thabazimbi link);
- topographical features (Waterberg range); and
- tribal land.

[15] Walker C. and Bothma J. 2005. The Soul of the Waterberg. Waterberg Publishers and Sky Publishing. Houghton.

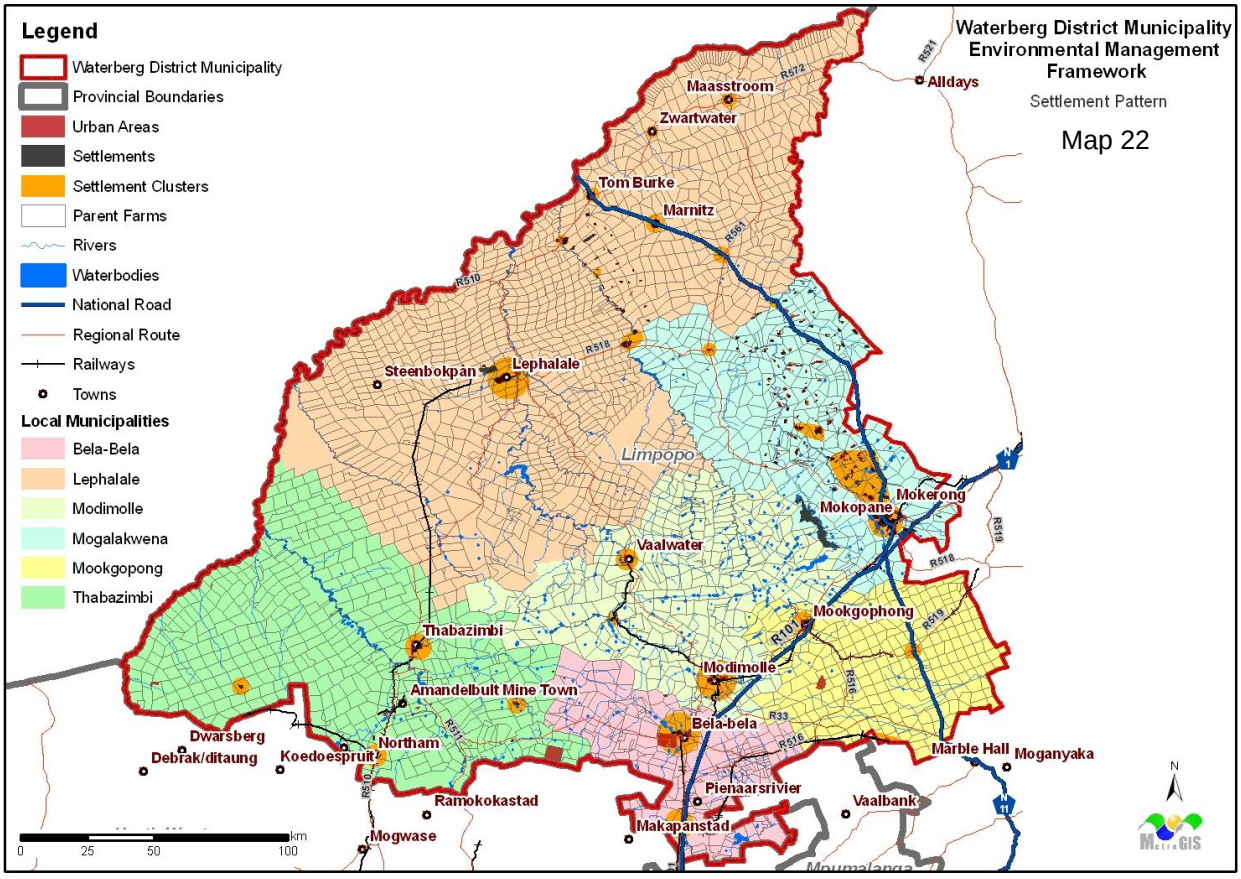
According to the Waterberg District Municipality SDF (2009, p59) the distribution of households according to land type is as follows:

Land Type	% Distrubution
Farms	20
Formal Towns	39
Informal Settlements	2
Tribal Areas	39

This is indicative of a large rural development component.

Rural development is characterised by transformation from its natural state, which is contributed to the expansion of mining activities and the emergence of eco-estates and game lodges on farmland.

Map 22: Settlement pattern



Densification associated with rapid economic growth is taking place in the following centres:

- Mokopane (platinum mining);
- rural villages around Mokopane (population influx associated with mining);
- Lephalale (coal mining and power generation);
- Thabazimbi (iron mining and tourism); and
- Bela-Bela (tourism).

Lephalale has attained the status of a growth node of national importance. It is identified as a Provincial Growth Point by the Spatial Rationale and is experiencing enormous growth in mining and the energy industries, with subsequent demand for services such as housing and infrastructure. Companies such as Eskom, Exxaro, Anglo Coal and Sasol have identified a number of development projects which will significantly change the development pattern of the region. In this instance the Lephalale SDF (2010) identifies the triangle between Lephalale, Stockpoort node and Steenbokpan as a node that will be spatially re-defined.

7.5. INFRASTRUCTURE

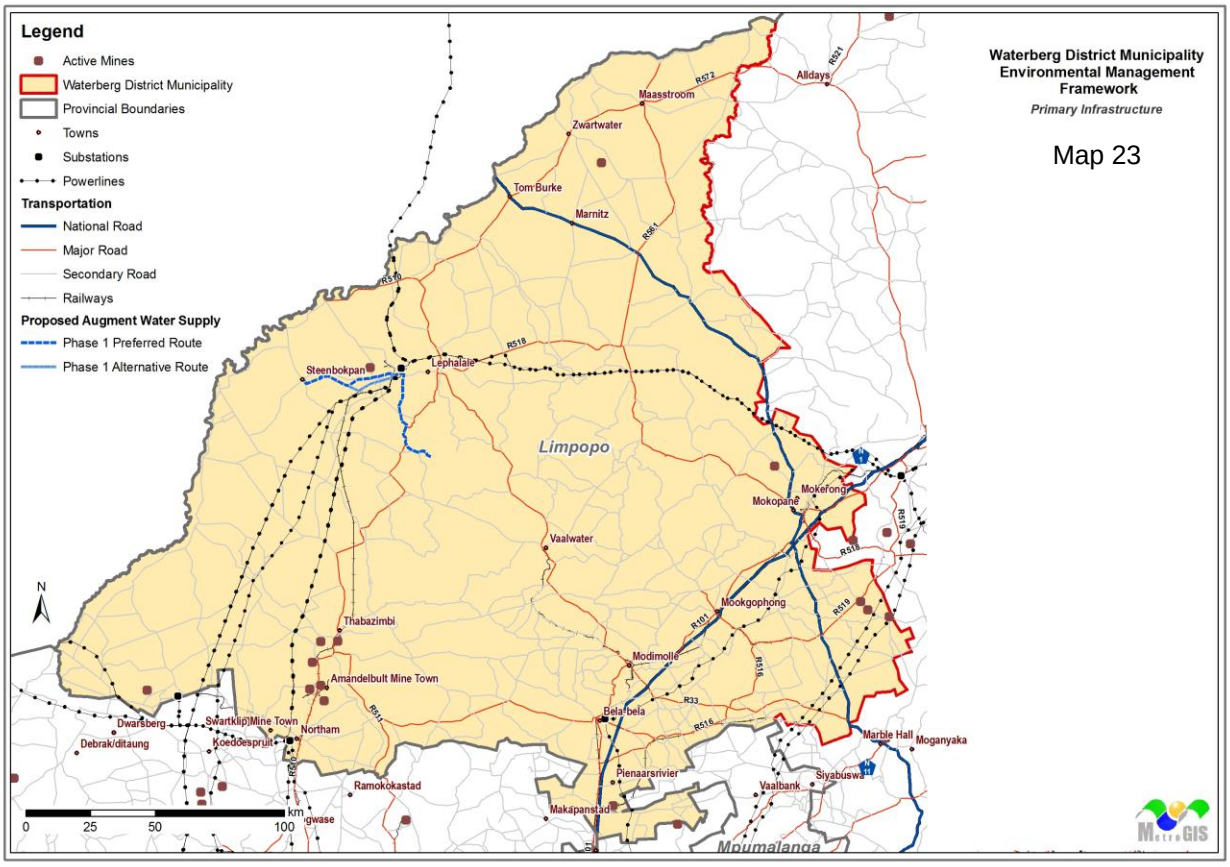
7.5.1. Roads

Road links are well established in the Waterberg District Municipality area. The road network encompasses the whole hierarchy from national to provincial and local roads. The major linkages are the following:

- N1: A north-east - south link running through the area. This link is of international importance and serves as an export link for especially mining products from Zambia and Zimbabwe. This route bypasses the main urban centres, but affected towns such as Mokopane, Modimolle and Bela-Bela do have access roads to the N1.
- N1 – R33: A north – south link from Gauteng in the south to Lephalale in the north through Vaalwater. This link is significant as it carries transport associated with development around Lephalale.
- R510: A north – south link from Rustenburg in the south to Lephalale in the north through Thabazimbi.

- R516: An east – west link from Rustenburg to Polokwane through Bela-Bela. This is a main transport route for platinum ore from the Rustenburg area to the smelter in Polokwane.
- Other routes are mainly district roads, most of which are unpaved and poorly maintained.

Map 23: Primary infrastructure



Whereas north-south linkages are well-established in the district, lateral linkages between the western and eastern parts of the Waterberg District Municipality area are constrained by the mountainous core of the area.

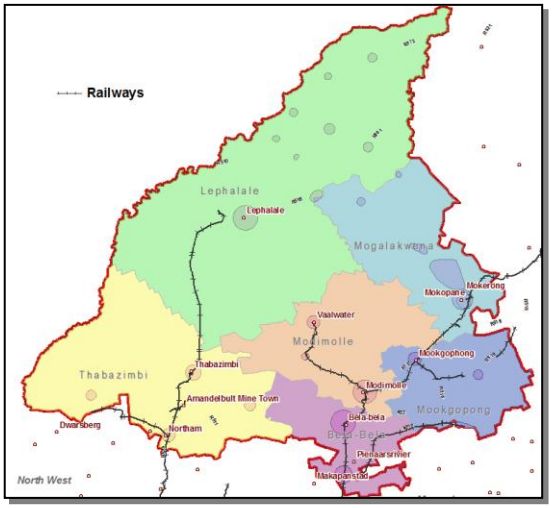
With the exception of the N1, which is a toll road, the R-routes are not well-maintained and are deteriorating. Heavy vehicles transporting ore and construction material frequent these routes on a daily basis. Besides damage to the road surfaces, they also restrict the flow of traffic as these routes are mainly single-lane roads. This problem is exacerbated in mountain passes.

7.5.2. Proposed road development

There is a proposal to re-route the N11 to bypass Mokopane to alleviate the problem of congestion through town. Details around road building and surfacing projects could not be obtained.

7.5.3. Rail links

Rail links are associated with the major routes as described above. This means that only north-south rail linkages exist, as indicated on the map (right).



7.5.4. Airfields

Major towns such as Thabazimbi, Lephalale, Bela-Bela, Modimolle and Mokopane have airfields which accommodate light aircraft. At present no commercial flights exist. A number of private airfields occur in the Waterberg mountain area, which are mostly associated with the tourism industry, providing quick access to game lodges.

7.5.5. Engineering services

All formal towns are serviced with basic infrastructure (water, electricity and sanitation). Most of the rural areas are dependant on boreholes for water and wood for energy, although the greater parts of these areas do not have access to basic sanitation services. Informal townships around major centres such as Mokopane are poorly serviced and the majority of households do not have access to basic services. It is expected that this situation will remain, or even worsen in future, as rapid expansion exceeds the rate of service provision.

There are plans to secure water provision through a bulks system from Lepele Water for the northern regions while Magalies Water plays an important role in the southern parts of the Waterberg District area.

7.5.6. Status of wastewater treatment systems in the Waterberg District Municipality

Reports in the media have highlighted the poor state of wastewater treatment facilities in South Africa. In response to this hazard, the Department of Water Affairs has undertaken an assessment of water service providers (WSPs) and waste water treatment works (WWTW) in

different municipalities in the country. The methodology used in the Green Drop Report (2009) employed assessing municipalities using a range of criteria comprising of the following:

- The design capacity of plants;
- flow amount exceeding, on, or below capacity;
- number of non-compliance trends; and
- compliance/non-compliance in terms of technical skills.

Modimolle Local Municipality was the only municipality in the Waterberg District to participate in the study. Modimolle Local Municipality scored 12% in the assessment. The other 5 municipalities did not participate in the study and were therefore allocated zero Green Drop scores.

7.5.7. Water augmentation project

The water augmentation project from the Lower Crocodile and the Mokolo Dam was commissioned in order to combat the water insufficiency and the growing demands for water in the Waterberg area.

The project will be implemented in three phases. The first phase involves the construction of pipelines that will run parallel to an existing pipeline. This supplies the Lephalale Municipal area with water from Mokolo dam until a transfer pipe from the Crocodile River can be implemented.

The second phase will involve the transfer scheme from the Crocodile River at Vlieeport near Thabazimbi to the Lephalale area.

The last phase will involve De-bottlenecking. This entails the construction of the first 9 km of the proposed gravity pipeline (for Phase 1) with interconnections to the existing pipeline (Exxaro pipeline).

7.5.8. Integrated waste management plan for the Waterberg District Municipality

The Integrated Waste Management Plan (IWMP) for the Waterberg District Municipality effectively reviews the status quo assessment of waste management and recommends measures to be implemented to set up an integrated waste management system. The major challenges to the implementation of effective waste management system are:

- Lack of capacity in municipalities;

- indigent households without the means to pay for services;
- waste collection service catering for urban areas;
- rural areas and resorts/farms not catered for;
- lack of capacity to monitor or implement the minimum waste management standards as outlined by DWA;
- no permitted landfill site in some areas (e.g. Lephalale);
- no waste management bylaws (need to development and implement);
- no consideration given for waste minimisation and recycling; and
- lack of waste information system.

There is no information on proposed landfill sites or any areas that may be affected as a result of waste management systems. The IWMP did highlight the need for an environmental management system that should form part of a waste management system.

7.5.9. Integrated transport plan for the Waterberg District Municipality

As required by the National Land Transportation Transition Act 22 of 2000, each District Municipality is required to prepare an Integrated Transport Plan (ITP) which ought to include:

- Projects to be implemented in 5 years;
- include all modes and infrastructure;
- general strategy for travel demand management; and
- be synchronised with other planning initiatives, i.e. must be component of IDP and must be gazetted/approved by MEC.

The provincial roads traversing the Waterberg District Municipality are to be transferred to SANRAL.

There is as yet no roads master plan for the Waterberg District Municipality. The current practice for prioritising road projects are based on community requests and action by the ward councillors.

The Roads Agency Limpopo (RAL) is the custodian of all provincial roads in the Limpopo Province. The maintenance and upgrade of local roads must therefore be addressed in the

Road Master Plan for the district. The Roads Master Plan addresses the maintenance and upgrade programme of roads.

The maintenance and upgrade of local roads, Implementation Programme for ITP include:

- Draw up a Road Master Plan;
- road projects (N11 – Mpumalanga to Globersgurg) – budgeted for 2004-2009 cycle by WDM, SDM, CDM;
- set up a road management system;
- prepare integrated land use and traffic models for major towns; and
- the establishment of disaster management centres.

Several road projects listed in the ITP (predominantly upgrade of access roads to towns), though these projects are for the 2004-2009 budget cycle. IDPs for local municipalities seem old. It is recommended that a list of projects be prepared in consultation with the Waterberg District Municipality planning forum.

7.6. THE USE OF LAND AND SPATIAL PLANNING

As indicated above settlement patterns are associated with historic and economic developments. The spatial pattern is further described in the context of land use. A brief overview of spatial planning strategies is also given.

The use of land

The use of land is described in terms of land cover, which includes primary human activity and natural phenomena such as vegetation cover. The footprint of the categories, as shown on the map, indicates a large prevalence of natural veld consisting of bushland, woodland, grassland with zones and nodes of development. These are mostly associated with human settlement, mining, and agriculture (mainly crop farming).

A spatial interpretation of land cover reveals distinct zones and nodes of activity and natural environment, i.e.:

- **An agricultural hub** in the south-western sector, east of the N1 highway (Springbok flats);
- **Nodes** of human settlement and economic activity around major towns;

- **Flats** associated with the Limpopo river valley, especially the area north of the N11 towards the Limpopo River as well as the area west of the R510 towards the Limpopo River. These areas are characterised by little development;
- **The Waterberg** as a geological feature, forming a topographical core in the centre of the Waterberg District Municipality area. Development in this zone is primarily associated with game farming (lodges) and some agriculture. This zone hosts the highest concentration of private game lodges; and
- **Valleys** associated with the Waterberg escarpment, in particular the Makapan Valley east of the Waterberg and the Mokopane-Alma-Thabazimbi valley where crop farming is the primary activity.

The large extent of natural land cover in the Waterberg District Municipality area is illustrated by the figures in Table 55 below. Natural features, including vegetation waterbodies and rocky outcrops cover 80% of the area, whereas degraded and developed land only covers 20%. Of this agriculture is the biggest (11%). Urban development, mining and industrial development only cover 1% of the area.

Table 55: Summary of land cover

Use of Land	Area(ha)	%
Thicket, Bushland, Bush Clumps, High Fynbos	2104965.520	42.50%
Shrubland and Low Fynbos	2007.266	0.04%
Natural Grassland	7016.829	0.14%
Woodland	1829067.496	36.93%
Forest Plantation/Planted Grass	440.192	0.01%
Waterbodies	6851.179	0.14%
Wetlands	10884.032	0.22%
Bare Rock and Soil (natural)	638.215	0.01%
Degraded Land	393998.919	7.96%
Cultivated Land/Agriculture	547485.195	11.06%
Urban/Built-up Land	35223.417	0.71%
Industrial	1518.514	0.03%
Mining	12196.988	0.25%
TOTAL	4952293.762	100.00%

7.7. SPATIAL PLANNING AND FUTURE DEVELOPMENT

The Spatial Development Framework for the Waterberg District Municipality (2009) acknowledges the role of physical and natural features in "structuring the spatial manifestation of human development".

Proposals for development are structured around existing form-giving elements and include the following:

- Strengthen existing development nodes;
- improve networks linking theses nodes;
- promote development in the major economic sectors, i.e. conservation and tourism, mining and agriculture (including game farming); and
- strengthen rural development.

External linkages with the Capricorn District Municipality to the east and Mpumalanga to the south are important to consider, especially with regard to conservation and agriculture.

7.8. OTHER PLANNING PROPOSALS

7.8.1. Game farming sector

The Pre-Feasibility Study and Project Proposals done by Aurecon, recommends bringing the wildlife regulatory and administrative divisions in government and the wildlife industry closer to each other. These recommendations are aimed at facilitating a common understanding and commitment towards designing principles and procedures that will streamline the day-to-day interaction between the role players in order to grow the industry and to give a better service to the visiting tourists.

A concern about the deteriorating relationship between provincial government (LEDET, Limpopo) and the wildlife industry, predominantly in the hunting sector has been raised. The deteriorated state of this relationship has hampered the development of the industry. Although some of the industry's associations such as the Professional Hunters Association of South Africa (PHASA) and the Wildlife Ranchers Association of South Africa (WRSA) frequently engage with government and regulatory bodies, these debates do not appear to contribute to a positive healthy working relationship between government and industry.

Industry maintains that a large percentage of land-owners are commercial farmers, who opted to revert from commercial stock farming to game farming based on economic principles and in

many areas also on ecological reasons. The dilemma is that there are legislative restrictions on a game farmer that does not apply to ordinary stock farmers, tax laws, limited state support and subsidies that hampers economic growth in the game sector.

The game farming industry proposed to the state to be placed under the same legislative framework (Department of Agriculture) as commercial stock farming and retain conservation agencies such as private, provincial and national nature reserves under the current environmental legislative framework. It is thought that such a distinction will enable commercial game farmers to produce wildlife and tourism products in a sustainable manner. While still providing the conservation agencies with the legal power they need to conserve and secure the integrity of game species for future generations.

A possible intervention strategy is needed to build a better relationship between government and industry. This is intended to benefit both parties in order to stimulate growth within the industry, facilitate transformation and create opportunities.

Objectives of such an intervention strategy could include points such as:

- The re-establishing a relationship of trust between sectors;
- facilitation open discussion between stakeholders;
- facilitation of a permanent and effective discussion forum (structure) for the industry;
- reaching agreement on mutual goals and industry objectives; and
- facilitation of a memorandum of understanding (MOU) that could be formalised in a wildlife charter document.

The strategy would assume both parties are committed to finding a workable solution and that the need for a solution is more important than the agendas of individuals. One of the possible constraints involved is the lack of a strong enough facilitator (leadership) to drive the process of reconciliation.

A healthy working relationship between industry and the government will promote the sustainability of the industry and prove beneficial for all parties involved.

7.8.2. Branding strategy

A pre-feasibility study on a possible branding strategy was conducted by Aurecon for the Waterberg District Municipality. The findings of this study is summarised in the following section.

Branding and the need for a strategy for the Waterberg appear to be widely confirmed. It has been suggested that the brand not be confined to a single geographical area as the Waterberg District offers a variety of unique destinations and products. So as not to clutter the brand and confuse the market a common denominating brand applicable to all sectors is proposed. This brand could then be used across the entire district without creating competition between geographical areas or product categories.

Such a strategy would require a large support base and a buy-in from the community as a whole. If achieved however, it would develop a stronger more reliable brand. Developing a common brand will take more time and require a larger budget, but is less likely to vulnerable to sectoral deficiencies and changing market demands.

The government, specifically the Waterberg District Municipality would need to facilitate such a process. The possibility of appointing a knowledgeable service provider (facilitator) to assist industry and the community to define and build a branding strategy for the region is an option.

The objective of destination branding includes:

- Brand loyalty and commitment from the entire community;
- inform local people of product development strategies, service levels and tourism culture;
- engage and entice new and larger market segments;
- raise occupancies, extend periods of stay and increase local spending; and
- raise market awareness and visitor loyalty.

There are numerous possible risks and constraints involved in such an undertaking. These include:

- A lack of government support and vision;
- lack of stakeholder support or agreement;
- limitations in financial avenues;
- lack of knowledgeable facilitator;
- lack of implementation capacity (resources);
- negative perceptions; and
- continuity in government support (2011 municipal elections).

It has been suggested that government be the initial driver by leading and funding interventions. After which the industries of the area should take initiative themselves and mobilise the community to support government wherever possible. They should also take ownership of the process and make available resources and capacity in a united effort. Although government has been identified as the initial source of funding external sources of funding should be identified and approached.

The report also proposes the expansion of the Waterberg Biosphere Reserve. The expansion is proposed to include the whole of the Waterberg mountain range and escarpment. The reasoning for this is to include the higher rainfall areas of the river catchments for water conservation's sake. The other reason given is preserve the biodiversity associated with the mountains.

The proposed expansion of the Waterberg Biosphere Reserves borders suggested that important conservation and heritage areas be included. The areas highlighted are the Nylsvley Ramsar site, the Makapan Valley and Caves and the Entabeni Safari Conservancy.

An Icon Development Strategy was also put forward in the report. According to the report an Icon is defined as something unique that is found only in a specific area and attracts attention and visitors to the area. An Icon could be based on cultural, historical, natural and or man-made features.

Several notable icons already exist in the Waterberg District area. These included Nylsvley, the Waterberg Biosphere Reserve and Entabeni Safari Conservancy, which are internationally recognised. Other local icons include the Bela-Bela Hot Springs and Marakele National Park.

Several destinations still have tourism potential that may be unlocked. The current constraint facing these destinations is a lack of infrastructure and sound management systems.

The support of the government institutions in developing these icons is important. The role of infrastructure to such as roads and telecommunication was also highlighted as being important to support the growth potential in the tourism industry.

8. CONCERNS AND UNCERTAINTIES

The largest concern across all sectors in the Waterberg District is uncertainty. Everyone appears uncertain as to the direction that the District will move in. This in turn creates development that occurs haphazardly which is problematic.

Another large concern is the infrastructure of the area. It is already clear that the current infrastructure is not sufficient to support future development in the area. Major upgrading is necessary. It may also be necessary to build new infrastructure such as a railway line to link the Grootegeluk mine to the coast and to Mpumalanga. The building of such a railway raises concerns that the most direct route will be chosen, directly through the Waterberg Biosphere Reserve. Such a railway would divide the reserve and decrease its conservation value and effectiveness.

9. KEY ISSUES

9.1. INTRODUCTION

A number of key issues were identified before the first round of public participation had commenced. Following the first round of public participation, additional key issues were brought to light.

9.2. BEFORE THE FIRST ROUND OF PUBLIC PARTICIPATION

9.2.1. Air pollution

Although air pollution is not currently a very large issue, the possibility of additional coal mines and coal fired power stations near Lephalale raises the issue of future air pollution in the area.

Monitoring of the air quality and control of the pollutants that are released will become a key factor in ensuring that Lephalale does not become a pollution hot spot similar to the Highveld. It is vital that the air quality management of the area become a priority to ensure that pollution damage remains at a minimum.

9.2.2. Water utilisation

Although there are a number of established dams in the area, they are all fully allocated. Thus water will be a constraint in the development of the area. Many of the rivers in the EMF area have not yet been assessed in terms of condition, and many do not have an established

ecological requirement. As a result the natural river ecosystems may be experiencing pressure or damage.

Before any further options of dam raising or building are taken into consideration, the ecological requirements and state for the rivers should be well established.

9.2.3. Water pollution

A number of the rivers are not currently well monitored. Those that have been monitored show various degrees of pollution, mostly of an agricultural and organic sewage nature. The possible future development of mines, power stations and various other industrial plants within the area as well as more extensive agriculture raises the issue of increased levels of water pollution.

Water quality and its impact on the natural environment may also become an issue to note.

9.2.4. Change of character of certain areas

The character of the Waterberg District is viewed as a distinct and unique character found nowhere else. This unique character is said to add extreme value to the area. The Waterberg District's character, one of unspoilt natural beauty, is used by the eco-tourism industry as one of its largest selling points.

The issue has been raised that the new development planned will irreversibly change the character of certain areas. Concerns that this loss of character will have a large negative impact not only at the localised area, but also on the District as a whole, have been highlighted.

9.2.5. Loss of land for certain land uses

The development of the area may result in the loss of viable agricultural land, or the loss of tourism potential.

9.3. AFTER THE FIRST ROUND OF PUBLIC PARTICIPATION

9.3.1. Service needs

Services in the area were raised as being a very large issue. The poor condition of roads was raised as a concern. Telecommunications infrastructure is described as being poor to non-existent. The existing telecommunication infrastructure is severely overloaded. The quality of water and water pollution are a major concern. Failure of the sewage treatment plants is allowing raw sewage to enter the water systems.

9.3.2. Environmental issues

A variety of environmental issues were raised. These included:

- Issues such as the visual impact developments (new power stations) would have on the area;
- concerns of an increased level of noise pollution;
- the rapid growth of towns, such as Lephalale; and
- the capacity of services to deal with the increased levels of waste production.

The issue of protecting important catchment areas, areas of important biodiversity and landscape features was raised as an issue.

9.3.3. Main planning and development issues

The current infrastructure of the Waterberg District was noted as being insufficient to cater for the development taking place. The large influx of people into the area, in anticipation of the development, has led to issues such as lack of jobs, housing and increased crime rates. Extremely low levels of education, has led to a lack in skills in the area. Training facilities and skills development was raised as an issue.

10. LIST OF DOCUMENTS REVIEWED

10.1. NATIONAL LEGISLATION

The following pieces of national legislation were reviewed:

- National Environmental Management Act, 1998 (Act 107 of 1998), as amended;
- Development Facilitation Act, 1995 (Act 67 of 1995), as amended and taking recent judgments in respect to chapters 5 and 6 into account;
- Conservation of agricultural Resources Act, 1983 (Act 43 of 1983), as amended;
- National Water Act, 1998 (Act 36 of 1998), as amended;
- Electricity Regulation Act, 2006 (Act 4 of 2006);
- Environment Conservation Act, 1989. (Act No 73 of 1989)
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983).
- Limpopo Environmental Management Act, 2003 (Act No. 7 of 2003).
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