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1. INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This report contains the draft of the "status quo" as well as drafts for identified opportunities constraints and the desired state for the EMF area. The purpose of this report is to serve as a basis for interaction with stakeholders and the public. In addition it will also be used as background information for the completion of the EMF, and it will also be 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.

It is a working document and should not be used for purposes outside the project as the information contained in the document is not properly referenced, some information may still be replaced or updated, and in a few instances information will be added (information that has been requested from government departments but which have not yet been received).

1.2 PURPOSE OF THE EMF

In addition and in support of the regulatory requirements for 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 EIA based on the environmental attributes of such areas;
- specify currently listed activities that will be excluded from EIA 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 PROJECT PROCESS AND SCHEDULE

The revised envisaged project schedule with key deliverables is as follows:

18 June 2009	Interim Status Quo Report (completed)
7 to 14 July 2009	Public survey and meetings in districts (completed)
31 July 2009	Draft Status Quo, Desired State & Opportunities/Constraints Report (completed)
4 to 12 August	Public open days to discuss EMF in the districts
28 August 2009	Strategic Environmental Management Plan and Guidelines
2 October 2009	Draft EMF Report
5 October to 5 November	Public review of draft EMF Report
16 November 2009	Submit draft EMF to DWEA and the Provinces for approval and adoption by the Minister

The reports for Status Quo, Desired State and Opportunities and Constraints are combined into one report that covers all aspects in order to simplify the stakeholder/public participation process, especially as it involves interaction across 10 different district municipalities.

Figure 1: The EMF area

2. THE PHYSICAL ENVIRONMENT

2.1 STRUCTURE AND SURFACE

2.1.1 Landscape and geology

The OLEMF area contains a wide variety of landscapes (including the highveld, bushveld, escarpment and lowveld) on a diverse geological base that includes the Karroo System, Bushveld Igneous Complex, Transvaal System and the old Archaean[1] Granite[2] and Gneiss[3] bedrock formations.

In the study area the Karroo System is a predominantly horizontal formation characterised by sedimentary[4] layers that overlay older rocks. It is a relatively young plateau[5] system that is in the slow process of being removed by erosion from the sub-Karoo surface. From an economic perspective the Karoo System is important as it contains rich bands of coal within the central sedimentary layers of the Karoo rock formations.

The Bushveld Igneous Complex consists of a magmatic[6] mass that is made up of plutonic[7] rocks. The magma intruded into the sedimentary rocks of the older Transvaal System in the following three phases:

---

[1] ***Archaean*** formerly called the Archaeozoic, is a geologic eon before the Proterozoic and Paleoproterozoic, before 2.5 Ga (billion years ago). The name comes from the ancient Greek "Αρχή" (Arkhē), meaning "beginning, origin".

[2] ***Granite*** is a common and widely occurring type of intrusive, felsic, igneous rock. Granite has a medium to coarse texture, occasionally with some individual crystals larger than the groundmass forming a rock known as porphyry. Granites can be pink to dark gray or even black, depending on their chemistry and mineralogy. Outcrops of granite tend to form tors, and rounded massifs. Granite is nearly always massive (lacking internal structures), hard and tough, and therefore it has gained widespread use as a construction stone. The average density of granite is 2.75 g/cm^3 and its viscosity at standard temperature and pressure is $\sim 4.5 \cdot 10^{19}$ Pa·s.

[3] ***Gneiss*** is a common and widely distributed type of rock formed by high-grade regional metamorphic processes from pre-existing formations that were originally either igneous or sedimentary rocks. Gneissic rocks are usually medium to coarse foliated and largely recrystallized but do not carry large quantities of micas, chlorite or other platy minerals.

[4] ***Sedimentary*** rock is one of the three main rock types (the others being igneous and metamorphic rock). Sedimentary rock is formed by deposition and consolidation of mineral and organic material and from precipitation of minerals from solution. The processes that form sedimentary rock occur at the surface of the Earth and within bodies of water. Rock formed from sediments covers 75-80% of the Earth's land area, and includes common types such as limestone, chalk, dolostone, sandstone, conglomerate, some types of breccia, and shale.

[5] ***Plateau***,is an area of highland, usually consisting of relatively flat terrain.

[6] ***Magmatic*** refers to the process of molten rock material that originates under the Earth's crust and forms igneous rock when it has cooled. When magma cools and solidifies beneath the Earth's surface, it forms what are known as intrusive rocks. When it reaches the Earth's surface, it flows out as lava and forms extrusive (or volcanic) rocks.

- The preliminary volcanic phase;
- the plutonic phase; and
- the subsequent volcanic phase.

In the study area the Bushveld Igneous Complex (BIC) occurs in the Bushveld Basin which is made up out of Waterberg System (a pre-BIC formation) in the south, Red Granites and the Rooiberg Series in the central parts, and Norite in the East.

[7] ***Plutonic*** refers to igneous rock that has solidified beneath the earth's surface to form rocks such as granite, diorite or gabbro.

Figure 2: Geological systems

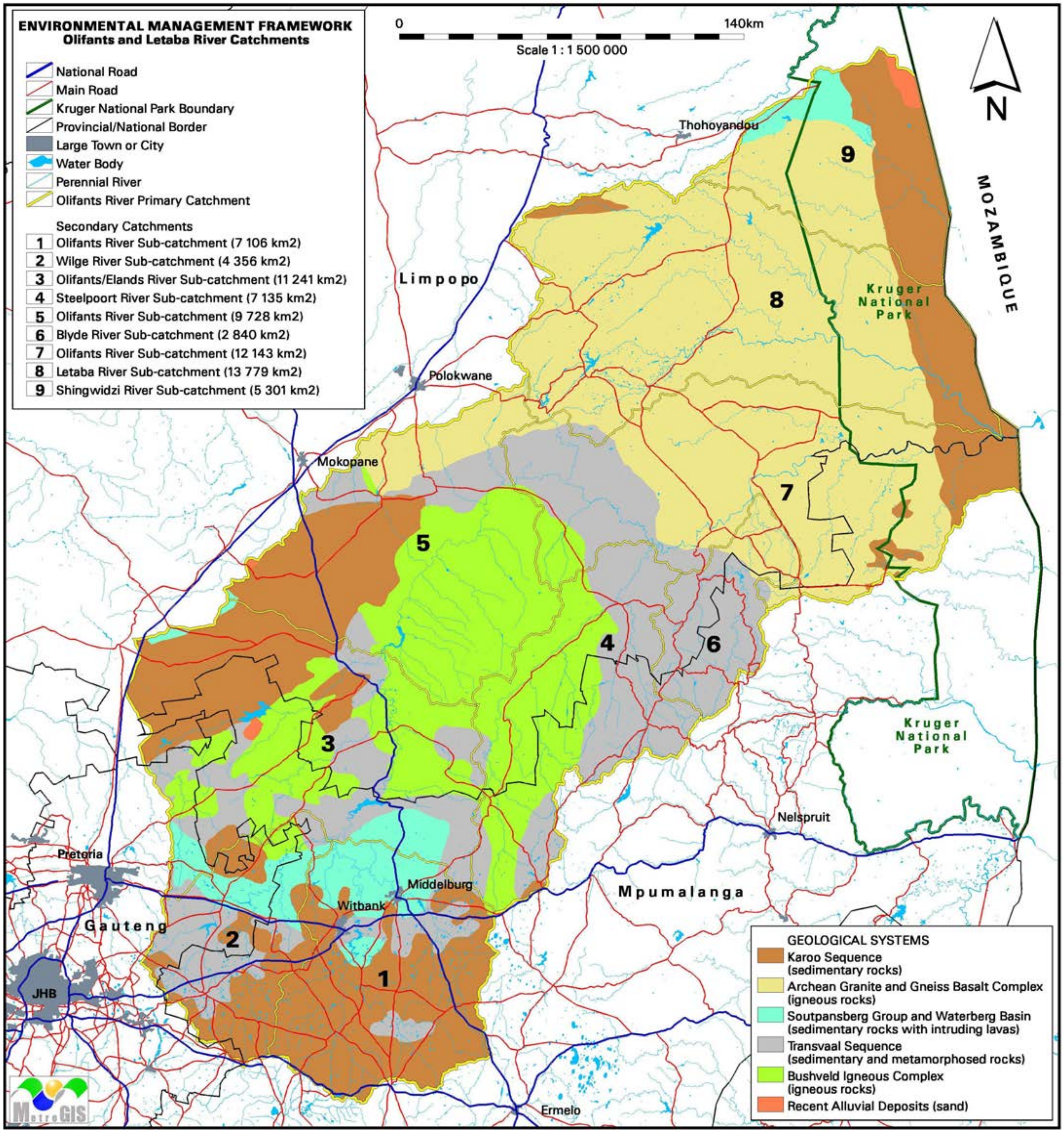
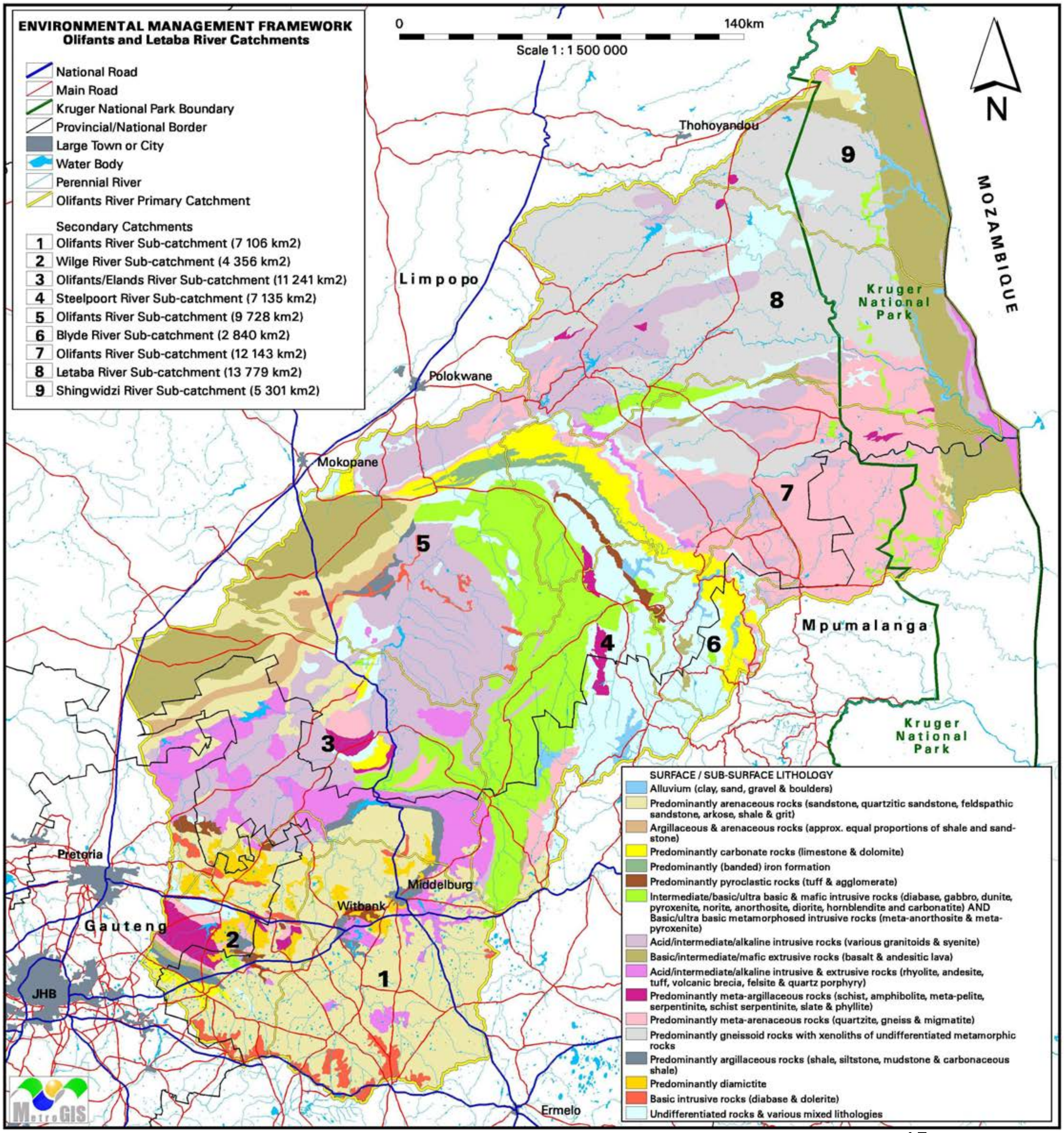


Figure 3: Lithology (rock types)



The Sringbok Flats, a Karoo System remnant encircled by igneous formations, makes up most of the northern part of the Bushveld Basin in the area. From an economic perspective the Bushveld Igneous Complex is very important due to its extraordinary mineral content. The most important minerals include large quantities of platinum, small quantities of gold and silver and a large variety of base metals[8].

The Transvaal System forms the rim of the Bushveld Basin. In the study area it consists of the so-called Pretoria Series (after its typical form in the Pretoria area) composed of three quartzite[9] layers (Timeball Hill, Daspoort and Magalies) with intervening shales[10] and lavas. It forms the mountains of Sechukuneland (eastern Bakneveld) at the edge of the Bushveld Basin as well as the bold escarpment of the Transvaal Drakensberg consisting of Black Reef Quartzite where the dramatic change in topography give rise to dramatic scenic views and vistas.

The Archaean Platform consists of the most ancient rocks of the sub-continent and forms the basement for later geological formations. It occurs in the eastern lowveld part of the study area and consist mainly of old Granite and Gneis formations and primitive groups of schistose[11] rocks including metamorphosed[12] sediments such as phyllites[13], banded ironstone[14], quartzite, conglomerate[15] and limestone[16], together

[8] ***Base metals*** is a term used to refer to a metal that oxidizes or corrodes relatively easily, and reacts variably with diluted hydrochloric acid (HCl) to form hydrogen. Examples include iron, nickel, lead and zinc. Copper is considered a base metal as it oxidizes relatively easily, although it does not react with HCl.

[9] ***Quartzite*** is a hard metamorphic rock which was originally sandstone. Sandstone is converted into quartzite through heating and pressure usually related to tectonic compression within orogenic belts. Pure quartzite is usually white to grey, though quartzites often occur in various shades of pink and red due to varying amounts of iron oxide (Fe_2O_3). Other colors are commonly due to impurities of minor amounts of other minerals.

[10] ***Shale*** is a fine-grained sedimentary rock whose original constituents were clay minerals or muds. It is characterized by thin laminae breaking with an irregular curving fracture, often splintery and usually parallel to the often-indistinguishable bedding plane. This property is called fissility and where it is not present the rocks are called mudstones or siltstones. Shale is the most common sedimentary rock.

[11] ***Schist*** is a group of medium-grade metamorphic rocks, chiefly notable for the preponderance of lamellar minerals such as micas, chlorite, talc, hornblende, graphite, and others. By definition, schist contains more than 50% platy and elongated minerals, often finely interleaved with quartz and feldspar. Schist is often garnetiferous.

[12] ***Metamorphosed*** or Metamorphic rock is the result of the transformation of an existing rock type, the *protolith*, in a process called metamorphism, which means "change in form". The protolith is subjected to heat and pressure (temperatures greater than 150 to 200 °C and pressures of 1500 bars) causing profound physical and/or chemical change. The protolith may be sedimentary rock, igneous rock or another older metamorphic rock. Metamorphic rocks make up a large part of the Earth's crust and are classified by texture and by chemical and mineral assemblage (metamorphic facies). They may be formed simply by being deep beneath the Earth's surface, subjected to high temperatures and the great pressure of the rock layers above it. They can be formed by tectonic processes such as continental collisions which cause horizontal pressure, friction and distortion. They are also formed when rock is heated up by the intrusion of hot molten rock called magma from the Earth's interior.

[13] ***Phyllites*** are types of type of foliated metamorphic rocks primarily composed of quartz, sericite mica, and chlorite; the rock represents a gradiation in the degree of metamorphism between slate and mica schist. Minute crystals of

with rocks of igneous[17] origin such as amphibolites[18], greenstone lavas[19], and chlorite-schists. The most important economic potential lies in the mining of granite and gneiss for use as polished stone and the occurrence of gold and other minerals in the greenstone lavas.

The eastern most hills, part of the Lebombo range, in the Kruger National Park consists of relatively recent volcanic rocks, which form part of the Lebombo Group that stretches from northern KwaZulu-Natal up to the Limpopo River in the north. It consists mostly of basalt and varies from dense to vesicular[20].

2.1.2 The general occurrence of metals and minerals

According to the map Simplified Geology, Selected Mines and Mineral Deposits - South Africa, Leshoto and Swaziland of the Council for Geoscience, the following metals and mineral deposits occur in economically viable quantities in the Mopani District: gold; vermiculite; antimony; copper; phosphate; andalusite; and asbestos.

The following metals and mineral deposits occur in economically viable quantities in the Vhembe District: gold; vermiculite; and phosphate.

graphite, sericite, or chlorite impart a silky, sometimes golden sheen to the surfaces of cleavage (or schistosity). Phylite is formed from the continued metamorphism of slate.

[14] ***Ironstone*** is a fine-grained, heavy and compact sedimentary rock. Its main components are the carbonate or oxide of iron, clay and/or sand. It can be thought of as a concretionary form of siderite. Ironstone also contains clay, and sometimes calcite and quartz.

[15] ***Conglomerate*** rocks are sedimentary rocks. They are made up of large sediments like sand and pebbles. The sediment is so large that pressure alone cannot hold the rock together; it is also cemented together with dissolved minerals.

[16] ***Limestone*** is a sedimentary rock composed largely of the mineral calcite (calcium carbonate: $CaCO_3$). The deposition of limestone strata is often a by-product and indicator of biological activity in the geologic record. Calcium (along with nitrogen, phosphorus, and potassium) is a key mineral to plant nutrition: soils overlying limestone bedrock tend to be pre-fertilized with calcium.

[17] ***Igneous*** rock or magmatic rock is one of the three main rock types (the others being sedimentary and metamorphic rock). Igneous rocks are formed by solidification of cooled magma (molten rock). They may form with or without crystallization, either below the surface as intrusive (plutonic) rocks or on the surface as extrusive (volcanic) rocks.

[18] ***Amphibolite*** is a grouping of metamorphic rocks composed mainly of amphibole (as hornblende) and plagioclase feldspars, with little or no quartz. It is typically dark-colored and heavy, with a weakly foliated or schistose (flaky) structure. The small flakes of black and white in the rock often give it a salt-and-pepper appearance.

[19] ***Lava*** is molten rock expelled by a volcano during an eruption. When first expelled from a volcanic vent, it is a liquid at temperatures from 700 °C to 1,200 °C (1,300 °F to 2,200 °F). Although lava is quite viscous, with about 100,000 times the viscosity of water, it can flow great distances before cooling and solidifying, because of its thixotropic and shear thinning properties.

[20] **Vesicular** refers to small cavities formed by the expansion of bubbles of gas or steam during the solidification of the rock.

The following metals and minerals occur in economically viable quantities in the Ehlanzeni District: gold; chromium; and copper.

The following metals and minerals occur in economically viable quantities in the Greater Sekhukhune District: platinum; chromium; vanadium; copper; iron; phosphate; and diamond (in Kimberlite).

The following metals and minerals occur in economically viable quantities in the Capricorn District: platinum; gold; copper; diamond (in Kimberlite); phosphate; and vanadium.

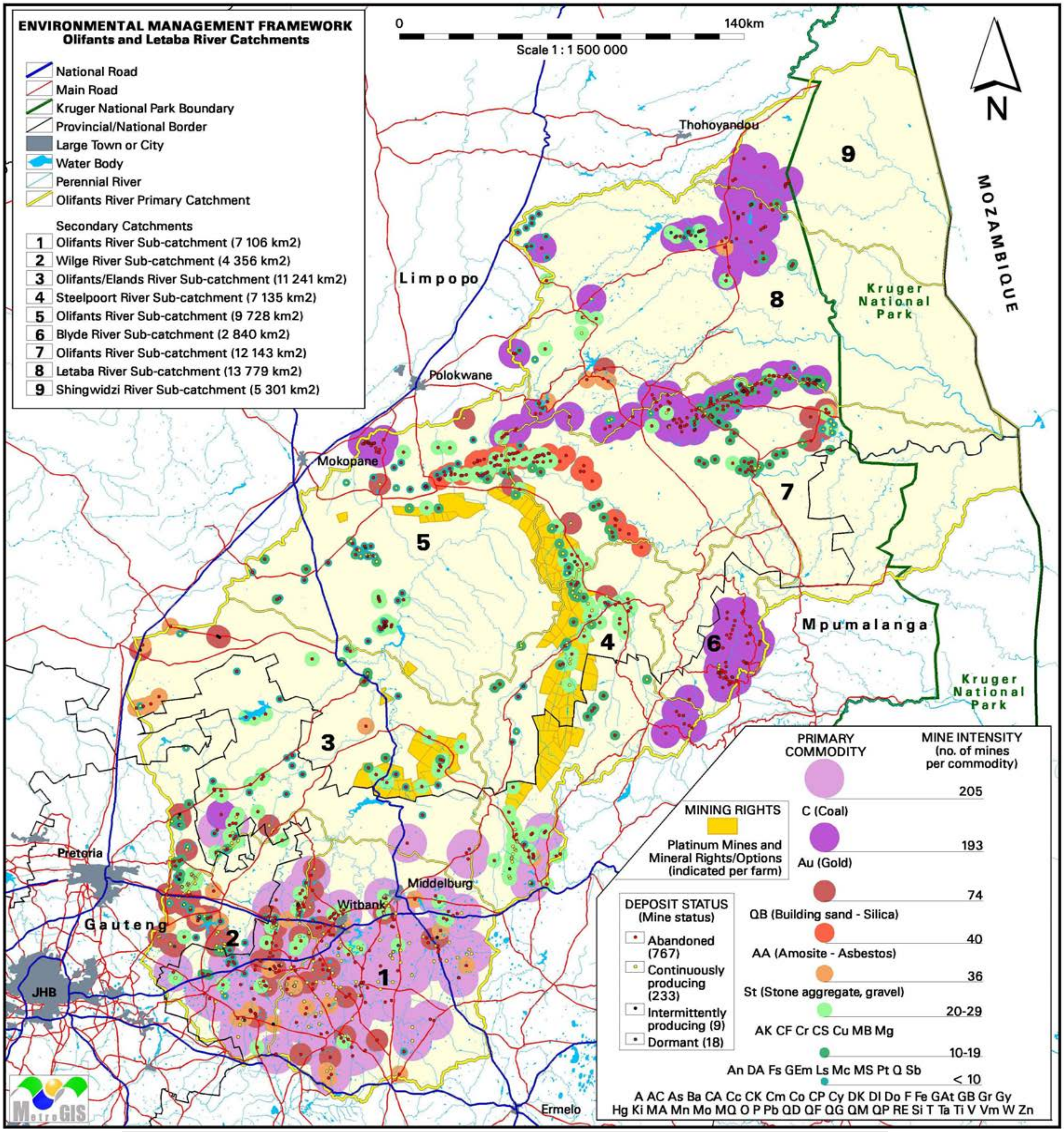
The following metals and minerals occur in economically viable quantities in the Waterberg District: copper; fluorspar; and zink.

The following metals and minerals occur in economically viable quantities in the Nkangala District (the "powerhouse" of South Africa): coal; copper; lead; and silicon.

The following metals and minerals occur in economically viable quantities in the Gert Sibande District: coal; gold; and zinc.

The following metals and minerals occur in economically viable quantities in the Metsweding District: fluorspar; manganese; diamond (in Kimberlite); and copper.

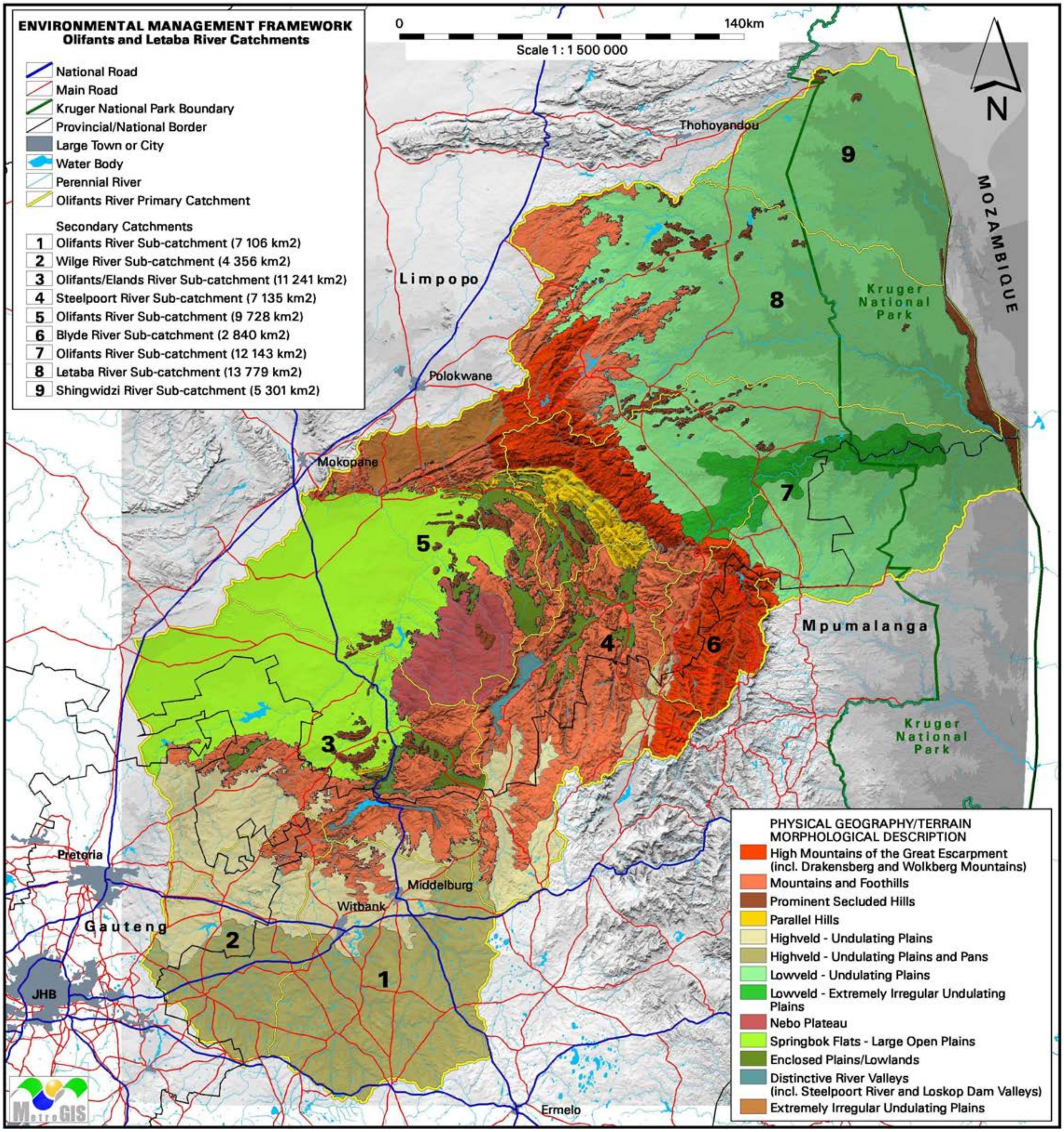
Figure 4: Mine intensity, commodities and mining rights for the platinum group metals



2.1.3 Terrain morphological division

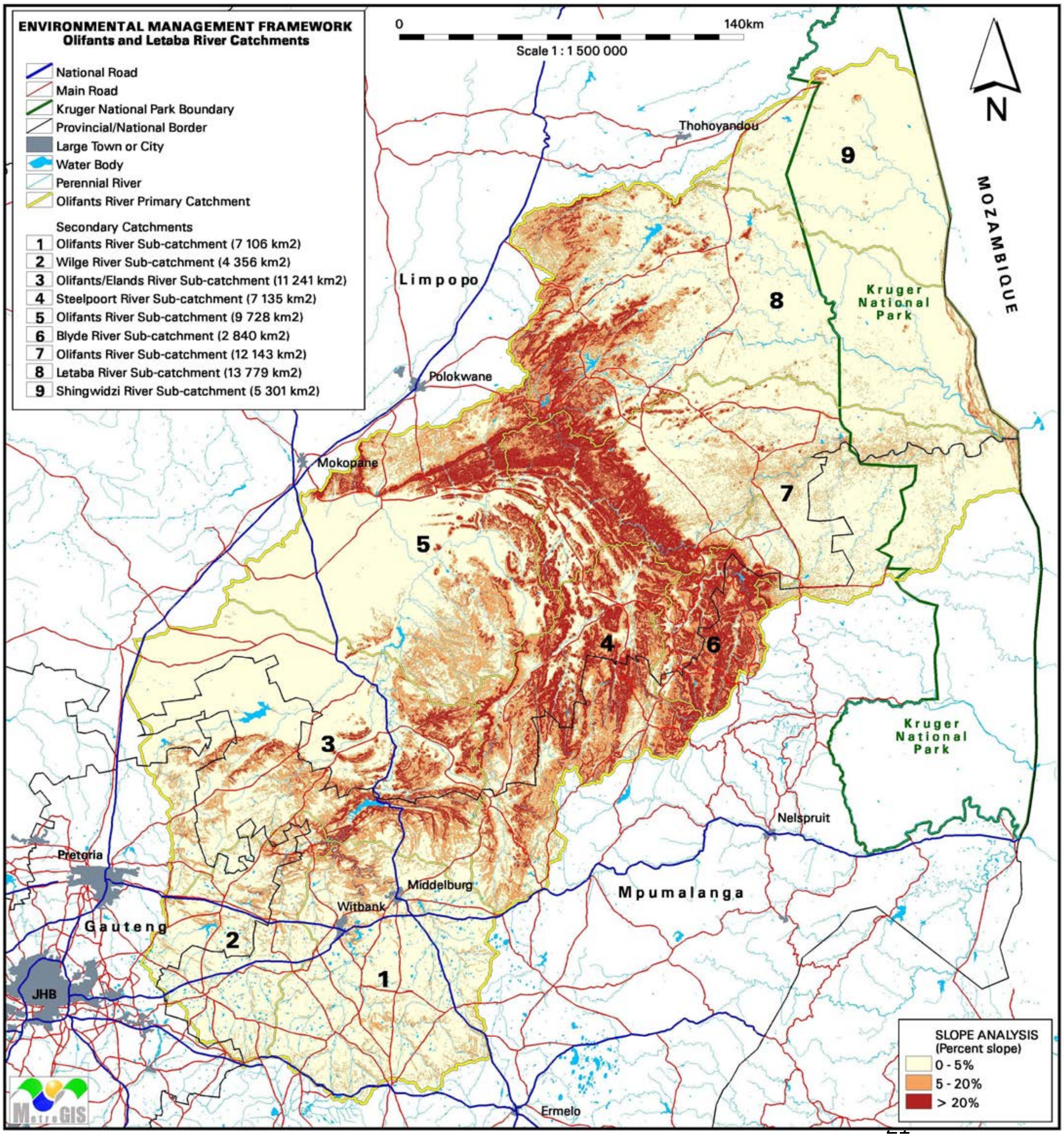
The terrain morphological units that occur in the area are illustrated in Figure 5.

Figure 5: Physical geography/terrain morphological description



The slope analysis of the area gives a clear indication of the extent of the mountainous terrain in the EMF area as illustrated in Figure 6.

Figure 6: Slope analysis



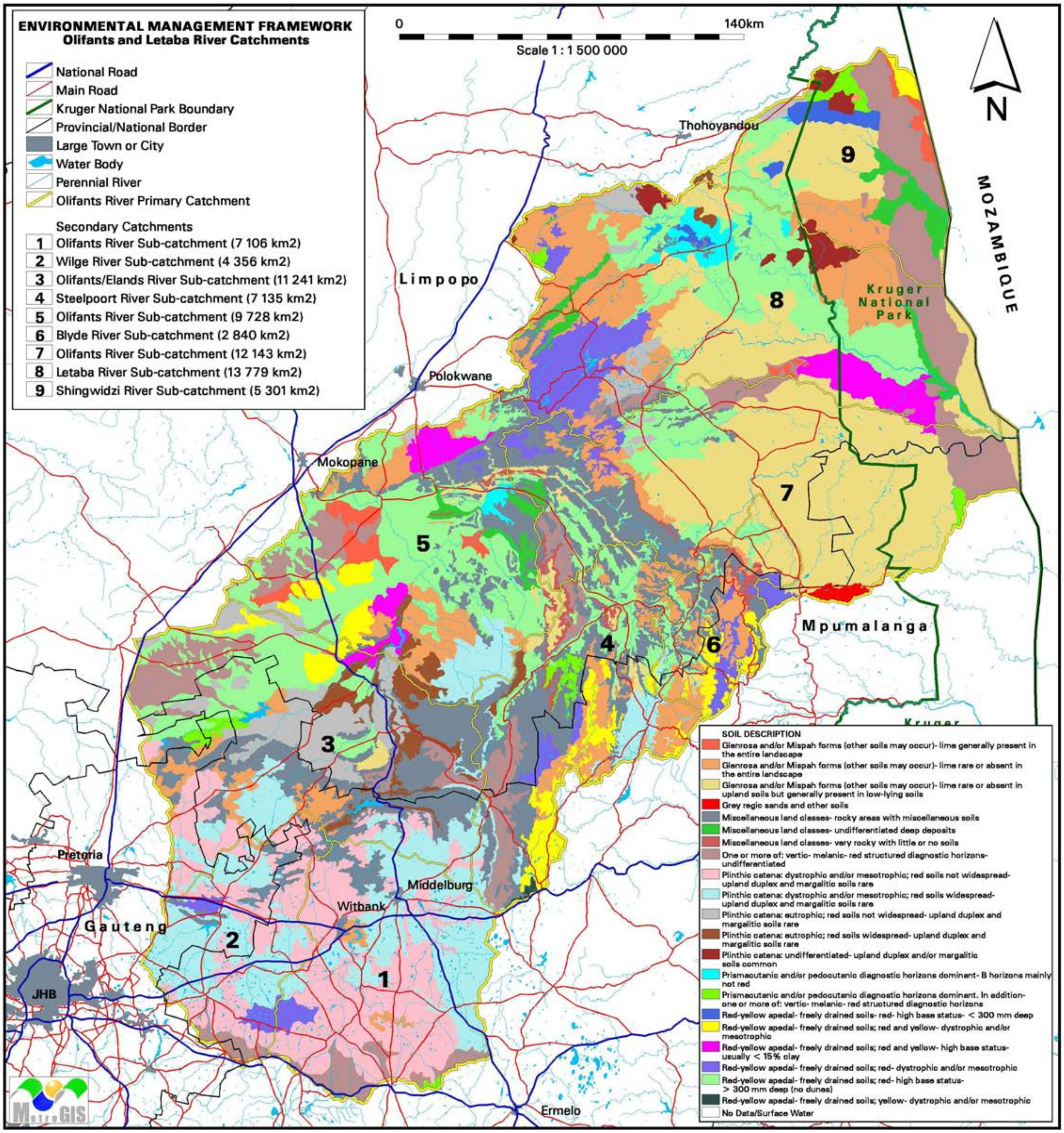
The soils that occur in the area are closely related to the geology and landforms of the area and are described in Table 1 below.

2.1.4 Soil types

Table 1: Soils that occur in the EMF area

SOIL DESCRIPTION	Area (km^2)	Percentage (%)
Glenrosa and/or Mispah forms (other soils may occur)- lime generally present in the entire landscape	697.01	0.95%
Glenrosa and/or Mispah forms (other soils may occur)- lime rare or absent in the entire landscape	7 601.97	10.33%
Glenrosa and/or Mispah forms (other soils may occur)- lime rare or absent in upland soils but generally present in low-lying soils	11 831.19	16.07%
Grey regic sands and other soils	126.36	0.17%
Miscellaneous land classes- rocky areas with miscellaneous soils	8 766.57	11.91%
Miscellaneous land classes- undifferentiated deep deposits	1 158.20	1.57%
Miscellaneous land classes- very rocky with little or no soils	498.33	0.68%
One or more of: vertic- melanic- red structured diagnostic horizons- undifferentiated	6 768.32	9.19%
Plinthic catena: dystrophic and/or mesotrophic; red soils not widespread- upland duplex and margalitic soils rare	6 160.34	8.37%
Plinthic catena: dystrophic and/or mesotrophic; red soils widespread- upland duplex and margalitic soils rare	6 974.62	9.47%
Plinthic catena: eutrophic; red soils not widespread- upland duplex and margalitic soils rare	2 484.12	3.37%
Plinthic catena: eutrophic; red soils widespread- upland duplex and margalitic soils rare	1 159.25	1.57%
Plinthic catena: undifferentiated- upland duplex and/or margalitic soils common	541.70	0.74%
Prismacutanic and/or pedocutanic diagnostic horizons dominant- B horizons mainly not red	514.00	0.70%
Prismacutanic and/or pedocutanic diagnostic horizons dominant. In addition- one or more of: vertic- melanic- red structured diagnostic horizons	608.33	0.83%
Red-yellow apedal- freely drained soils- red- high base status- < 300 mm deep	335.64	0.46%
Red-yellow apedal- freely drained soils; red and yellow- dystrophic and/or mesotrophic	1 846.66	2.51%
Red-yellow apedal- freely drained soils; red and yellow- high base status- usually < 15% clay	1 378.58	1.87%
Red-yellow apedal- freely drained soils; red- dystrophic and/or mesotrophic	2 621.67	3.56%
Red-yellow apedal- freely drained soils; red- high base status- > 300 mm deep (no dunes)	11 479.37	15.59%
Red-yellow apedal- freely drained soils; yellow- dystrophic and/or mesotrophic	37.37	0.05%
No Data/Surface Water	33.39	0.05%
Total	**73 622.98**	**100.00%**

Figure 7: Soils



2.1.5 Soil suitability for agriculture

The soils suitability for agriculture is indicated in figure 8 and in table 2. The main irrigated agricutre areas are indicated in Figures 9(a) and (b).

Table 2 : Land capability for arable agriculture agriculture

Landtype/Soil Capability Index	**Surface Area in (km^2)**	**Percentage %**
ARABLE LAND (classes below)		
2 Higher capability for arable agriculture	7255.460	9.85%
3 Medium capability for arable agriculture	17760.296	24.12%
4 Lower capability for arable agriculture	13380.454	18.17%
5 Grazing	10122.695	13.75%
6 Grazing	14727.933	20.00%
7 Grazing	1081.910	1.47%
8 Wildlife	9263.952	12.58%
WATER (included in dataset)	35.850	0.05%
Total area	**73628.550**	**100.00%**
Irrigated Agriculture (agricultural field boundaries)	**1571.934**	

Figure 8: Land capability for arable agriculture

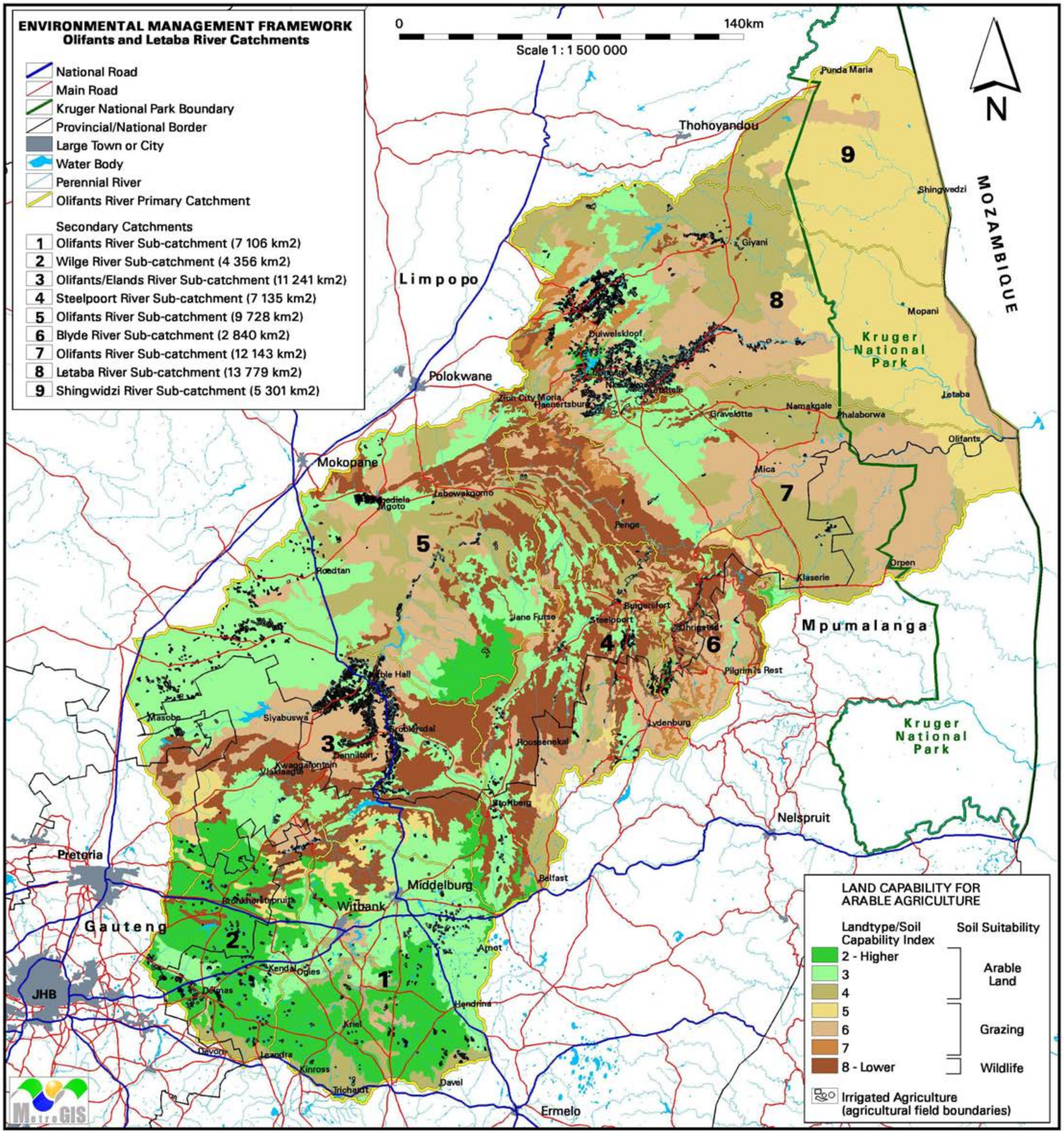


Figure 9(a): Irrigated agriculture in the Groblersdal area

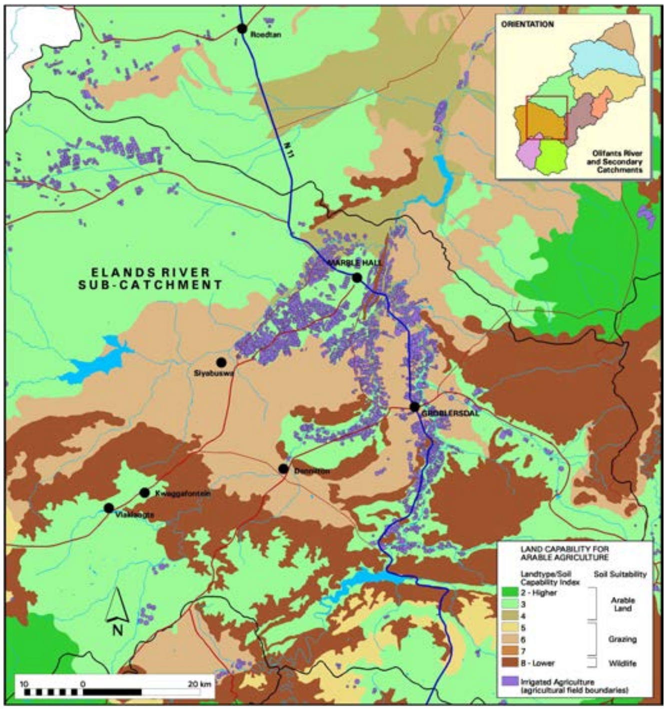
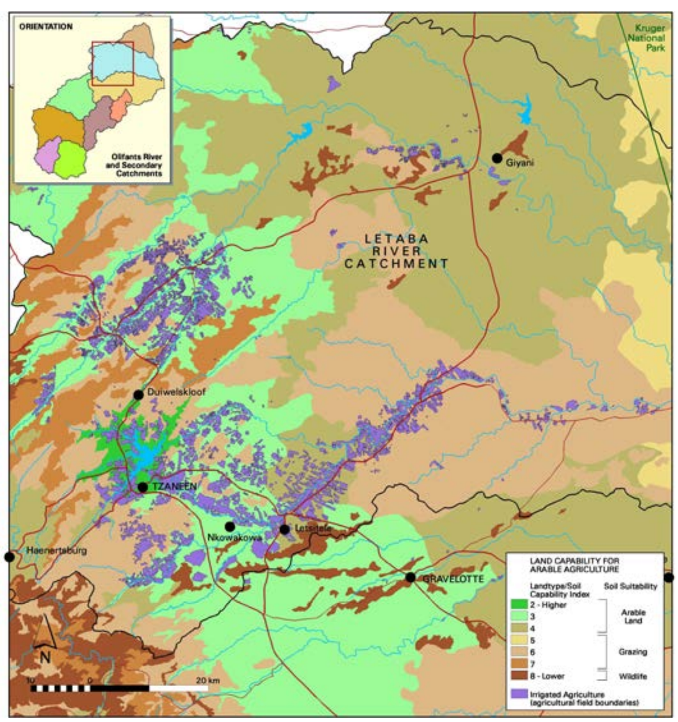


Figure 9(b): Irrigated agriculture in the Tzaneen area



2.2 CLIMATE

The study area falls across four climatic regions which include:

- The higveld with moderate maximum temperatures but very cold winter night temperatures where severe frost occurs regularly;
- the bushveld with high maximum temperatures, cool winter night temperatures without severe frost
- the escarpment that partially lies in the mist belt with moderate maximum temperatures and cool winter night temperatures; and
- the eastern lowveld with a hot sub-tropical climate.

The whole study area falls within the summer rainfall region. The following rainfall classes occur in the study area:

- Dry areas with 325mm/annum to 550mm/annum occur in parts of Sekhukhune and in the northern part of the eastern lowveld.
- In the highveld region and the southern part of the eastern lowveld the rainfall varies between 550mm/annum to 750mm/annum.
- A higher rainfall of between 750mm/annum and 1000mm/annum occur along the escarpment.

In the Wolkberg area annual rainfall exceeds 1000mm.

Detailed climatic information has also been collated for five selected weather stations spread over the EMF area. They are Witbank, Marble Hall, Graskop, Phalaborwa and Punda Maria.

2.2.1 Rainfall and runoff

The rainfall and runoff for the area is depicted in the maps and tables below. The influence of the topography of the area is clear.

Figure 10: Rainfall

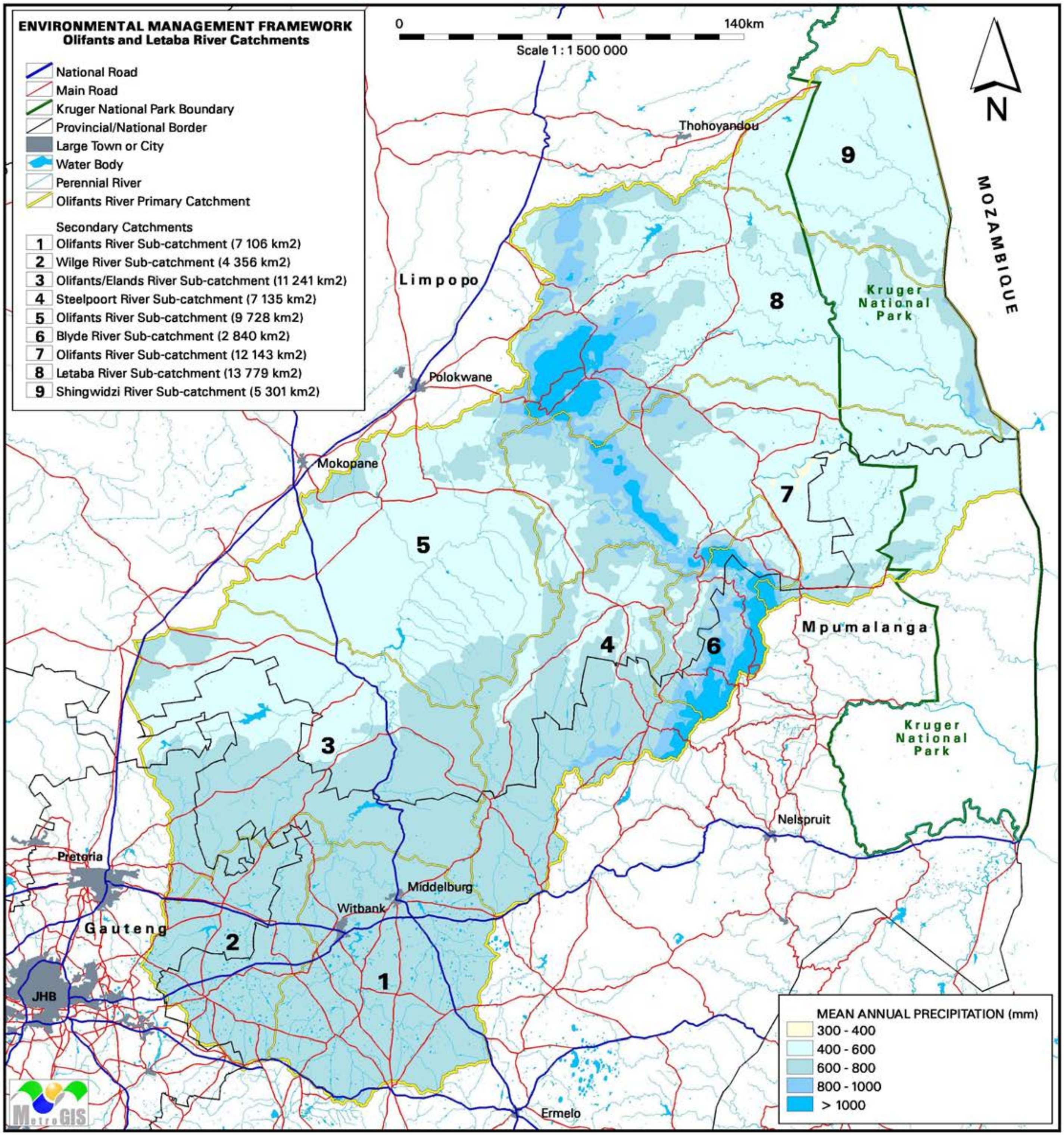


Figure 11: Runoff

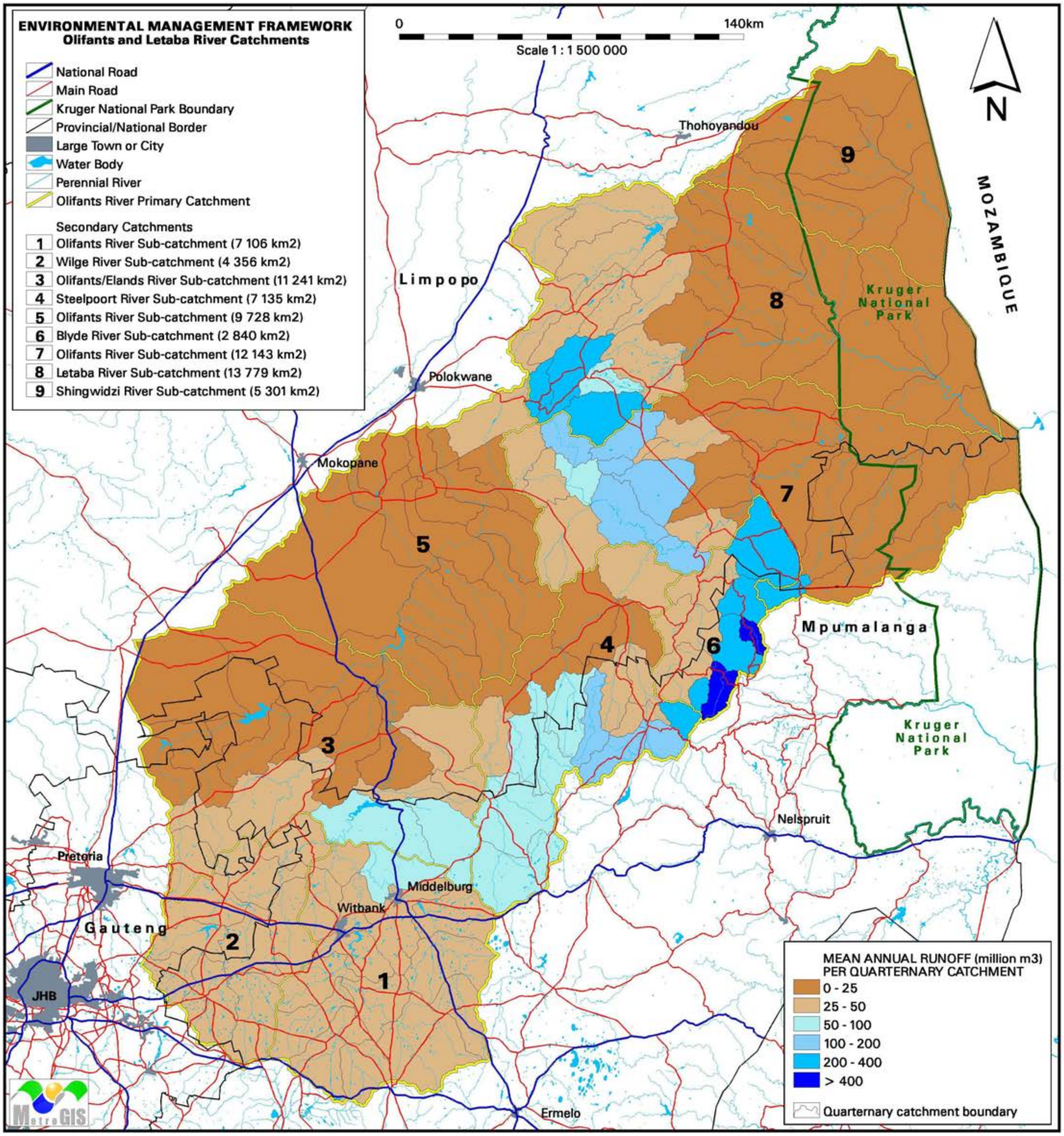


Table 3: Evaporation and rainfall in the tertiary catchments of the EMF area

Tertiary catchment (refer to figure 10)	S-pan evaporation MAE WR2005 (mm)	MAE WR90 (mm)	Rainfall MAP (mm)
Tertiary B11	1596	1597	687
Tertiary B12	1456	1567	695
Tertiary B20	1711	1708	522
Tertiary B31	1832	1828	596
Tertiary B32	1780	1784	644
Tertiary B41	1514	1530	658
Tertiary B42	1467	1430	727
Tertiary B51	1851	1869	557
Tertiary B52	1851	1813	548
Tertiary B60	1400	1419	824
Tertiary B71	1566	1562	686
Tertiary B72	1549	1573	563
Tertiary B73	1486	1491	465
Tertiary B81	2077	1585	684
Tertiary B82	1611	1619	609
Tertiary B83	1797	1802	544
Tertiary B90	2817	1708	502

Table 4: Monthly Daily Rain (mm) - WITBANK Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg monthly
1999	183.8	18.2	27.6	31.8	47.8	13	0	1	0	0	0	230.8	46.2
2000	242.8	110.6	156.4	68.6	15.6	10.2	0	2.2	0	106.8	123.4	115.8	79.4
2001	220.4	84.4	31	13	31.4	5.4	2.2	1.4	3	93.8	128.6	140.4	62.9
2002	82	111.4	32.6	22	28.4	9.8	0.2	39.2	1.8	35	9.6	35.8	34.0
2003	6.6	106.4	33.2	47.6	0	5.4	2.2	2.6	9	38.6	27.6	78.9	29.8
2004	115.6	160.8	133.8	41.8	0.4	0.4	9.8	0	0	41.2	101.2	110.6	59.6
2005	161	66.6	59.4	51.8	0	0	0	0.8	0	56.8	135.4	38.4	47.5
2006	179.8	78.4	63.2	10	3.2	0	0	25.4	0.6	14.6	65.8	130.4	47.6
2007	77.8	5	29.8	15.4	0	29	1.6	0	19.6	143.4	203.6	106.6	52.7
2008	225.2	55.2	121	10.6	21	4.4	1.4	0	0	68	145.6	99.2	62.6
Monthly Rain	149.5	79.7	68.8	31.26	14.78	7.76	1.74	7.26	3.4	59.82	94.08	108.7	52.2

Table 5: Monthly Daily Rain (mm) - MARBLE HALL Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg monthly
1999	67.1	19	34	20.5	37.5	0	0	0	7.2	53	32.7	149.8	35.1
2000	76.8	113.8	185.9	44.6	17	22	0	0.5	0	68	120	122.8	64.3

2001	49.5	77.5	4.7	0	45.5					45	178.6	97	41.5
2002	65.3	64	54	6.7	0.9	0	3.5	0	4.5	98	10		25.6
2003	55	35.5	21	0.7	0	1.5	0	0	0	12.9	42.4	27	16.3
2004	48	190	135	3	9	0	0	0	0	42.5	130.5	86.5	53.7
2005	6.5	0	49.5	0.5	0	0	0	0	0	8	99.5	104.5	22.4
2006	216.4	166	84.5		0.6	0	0	10.5	0	36	145.5	129.5	65.8
2007	15.1	8.1	12.8	34.5	0	9	5	0	28.5	81.5	182.5	157.1	44.5
2008	199	46	79	0	12.5	0.5	0	0	0	51.5	145.2	214	62.3
Monthly Rain	79.87	71.99	66.04	11.05	12.3	3.3	0.85	1.1	4.02	49.64	108.7	108.8	43.1

Table 6: Monthly Daily Rain (mm) - GRASKOP Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg monthly
1999	301	401.6	230.2	130.4	88.2	2.2	37.4	17.8	42.6				104.3
2000	64.4	999.8	415	133.6	71	43.2	2	4.2	85.8	105.4	62.6		165.6
2001	70		113.6	178.6	30	35.2	86.8	0.6	16.4	50.6	217.8	83	73.6
2002	51.6	16.4	86.4	42.9	7.6	80	21	0.4	32.2	87	67.2	165	54.8
2003	96.7	18	26.4	9.4	4.2	52.6	15.4	3.4	65.2	54	79	59	40.3
2004	65	406.6	148.4	60.8	27.6	11.6	48.8	0	0	20.2	7.2	98.8	74.6
2005	0.2	0.4	33.8	25	4.8	1	7.2	6.8	0	62	133	101	31.3
2006	0	0.4	58.2	0	3.4	6.8	4.2	21	7.4	100.6	149.6	0	29.3
2007	0	0	49.6	16.4	0	0	31.2	30.4	75	176.2	106.8	271.4	63.1
2008	180.6	0	0	5.2	8.4	0	0	0	38.6	72.2	161	178.2	53.7
Monthly Rain	82.95	184.3	116.2	60.23	24.52	23.26	25.4	8.46	36.32	72.82	98.42	95.64	69.0

Table 7: Monthly Daily Rain (mm) WOLKBERG Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg Monthly
1999	179.5	87.4	110.1	24.2	19.8	8	29.1	2.5	2.1	44.3	267.2	186.8	80.1
2000	208.7	750.6	170.9	110.2	17.3	68.1	16.6	0	17.2	67.8	115.4	236.9	148.3
2001	6.6	277.4	106.4	29.8	20.7	1.3	11.8	0	3.1	75.2	270.5	89.5	74.4
2002	205.5	22	27.4	48.5	27.8	8	3.6	15.7	15.7	33.8	5.9	67.1	40.1
2003	98	58	35.3	0	0	58.8	0	0	9.4	40.7	147.8	81.5	44.1
2004	83.2	117.2	248.1	54.2	0	8.6	3	2.2	7.5	36.1	134.5	105.5	66.7
2005	71.8	29.9	66	42.9	13.1	0	0	0	0	10	87.3	128.9	37.5
2006	148.9	203.5	200.5	15.4	36.5	5.7	0	6.9	0	46.6	157.6	266.7	90.7
2007	15.8	31.7	53.5	62.7	0	0	41	4.7	28.1	88.3	251.2	183.1	63.3
2008	81.5	63.9	33.5	57.8	1.8	4.5	0	0.6	4.5	101.7	176.6	120.8	53.9
Monthly Rain	110	164.2	105.2	44.57	13.7	16.3	10.51	3.26	8.76	54.45	161.4	146.7	69.9

Table 8: Monthly Daily Rain (mm) - PHALABORWA Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg Monthly
1999	52.8	177.6	9	56.4	19.8	0.2	4.8	0.4	5.8		111.2	61.2	41.6
2000	108.4	337.6	107.8	47.8	2.4	18.4	3.2	0	12.6	31.2	44.6	48.8	63.6
2001		179.6	89.4	44.4	3.4	19.6	0.2	0	0	39.8	122	42.8	45.1
2002	48.2	3.6	16.6	17.2	0	13.8	0	0.2	10.2	18.4	9.4	31.8	14.1
2003	15.4	45.4	87.6	7.2	1.8	8.8	0	0	12	46.2	15.8	4	20.4
2004	99	232.4	137	32.2	1.6	11	9.4	6.8	15.8	6.2	56.4	54.8	55.2
2005	27	18.6	7.4	14.8	0.2	0	3	0	0	4.2	36.8	53	13.8
2006	93.8	102.8	93.2	2.6	5.4	3.6	0	0.4	4	1	48.8	61.2	34.7
2007	42.8	48.4	29.8	15.2	0	0.8	8.4	0	32.2	31.8	79.4	144.4	36.1
2008	49.6	13											5.2
Monthly Rain	53.7	115.9	57.78	23.78	3.46	7.62	2.9	0.78	9.26	17.88	52.44	50.2	33.0

Table 9: Monthly Daily Rain (mm) - PUNDA MARIA Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg Monthly
1999	200.5	72	76.5	1.9	6.6	8.5	13	0	0.5	70	108.8	8.1	47.2
2000	208.3	515.1	196.8	32.1	9.8	30.4	3	0.3	13.7	31.2	79.3	25.9	95.5
2001	9.2	229.8	95.6	22.8	17	4.4	0.9	0.7	20.5	11.9	215.6	252	73.4
2002	93.9	10	2.7	28.2	1.5	27.5	4.1	8.6	9.1	37.1	50.9	121.1	32.9
2003	52.7	13.3	5.7	9.1	2.9	16.6	0	0	7.8	105.8	52.5	30.5	24.7
2004	146	36.7	172.1	25.2	1.1	6	6.8	1.3	10	19.9	14.7	59.5	41.6
2005	90.9	8.4	36.2	12.6	1.8	0.3	5	1.2	0	4.9	24.4	192.6	31.5
2006	292.2	134.7	63.8	10	6.4	8.2	0	0.6	0.4	0.4	125.7	44.4	57.2
2007	110.7	65.9	57.6	13	0	0.6	2.6	0	23.6	26.7	155.7	241.9	58.2
2008	90.2	57	54	0.2	0	0.7	0.2	0.6	0	0.8	18.4	138.2	30.0
Monthly Rain	129.5	114.3	76.1	15.51	4.71	10.32	3.56	1.33	8.56	30.87	84.6	111.4	49.2

2.2.2 Average of the daily maximum & minimum temperatures (℃)

Table 10: Average Daily Maximum Temperature - WITBANK

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max Ave. Temp.
1999	26	27.5	26.9	24.6	20.4	19.4	18.6	21.3	22.7	24.7	25.7	25.3	23.6
2000	23.7	23.8	24.1	20.1	18.7	18	17.8	21.2	23.7	24.4	23.4	25.4	22.0
2001	28.3	24.9	25.8	23.1	20.4	19.1	17.9	22.7	24	25.4	23.3	25.5	23.4
2002	27.3	25.7	25.9	24.9	21.3	17.3	18.4	21.2	22.9	25.6	25.8	25.2	23.5
2003	26	27.8	27.2	25.8	21.1	18.2	18.8	20.1	24.8	26.8	25.8	29	24.3
2004	26.2	24.9	23.3	22.5	21.6	16.9	17	22.1	22.8	25.9	27.6	25.4	23.0
2005	26.2	27.2	24.3	21.8	21.8	20.6	20.5	22.8	27.1	27.2	26.2	26.4	24.3

2006	25.3	24.9	22.6	22.1	18.3	18.5	20.2	18.8	24	27.3	25.4	27.3	22.9
2007	27.3	30	27.8	24.5	22.1	17.8	18.5	21.7	27.3	22.5	24.5	24.6	24.1
2008	23.9	26.8	23.6	22.3	20.6	18.5	18.1	22.1	24.8	27	25	26.8	23.3
Monthly Temp.	26.02	26.35	25.15	23.17	20.63	18.43	18.58	21.4	24.41	25.68	25.27	26.09	23.4

Table 11: Average Daily Minimum Temperature - WITBANK

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Min Ave. Temp.
1999	15.1	14.7	14	11	8	5	5.6	6	8.6	10.2	14.3	14.8	10.6
2000	13.9	15.2	14.7	10.2	5.6	6.5	3.3	6.3	9.5	12.1	12.1	14.3	10.3
2001	14.6	14.4	13.3	11.5	7.1	4.4	3.6	7.6	8.9	12.4	14.1	14.7	10.6
2002	15.4	14.8	13.5	11.1	7.5	5	4	8.2	8.7	11.8	12	14.8	10.6
2003	15	15.9	13	11.7	7.1	5.3	3.8	5.1	9.7	12.6	13.9	15.5	10.7
2004	15.2	14.6	13.8	10.9	7.3	3.9	3.3	7.5	7.4	11.4	14	14.5	10.3
2005	15.9	14.7	12.8	10.5	7.7	6.1	4.8	8.4	10.6	12.5	13.4	14.1	11.0
2006	16	15.5	12.9	10	5.4	4	6.9	5	8.3	12.8	13.4	15.3	10.5
2007	14.1	15	13.7	10.9	6.4	4.7	3.7	6.2	11.3	11.5	13.8	13.8	10.4
2008	15	14.4	13	9.2	7.7	5.2	4.3	7.3	8.4	12.4	14.3	14.9	10.5
Monthly Temp.	15.02	14.92	13.47	10.7	6.98	5.01	4.33	6.76	9.14	11.97	13.53	14.67	10.5

Table 12: Average Daily Maximum Temperature - MARBLE HALL

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max Ave. Temp.
1999	30.9	33.4	32.2	30	25.1	23.4	23.1	25.7	27.6	29.6	30.7	30.9	28.6
2000	29.2	29.2	29.6	26.2	23.4	22.2	22.1	25.8	28.3	30.1	29.2	31.6	27.2
2001	33.1	30.5	30.2	28.7	24.6	23.3	22.5	26.8	28.7	29.6	28.6	29	28.0
2002	31.8	30.6	31.1	29.6	26.2	22.4	23.8	26.9	29	31.7	32.9	31.8	29.0
2003	33.4	35.9	34.8	33.4	28.4	25.3	26.1	27.8	31	33.4	35.6	37.1	31.9
2004	32.2	34.2	33.1	34	29.8	25.7	26.7	30.5	27.6	34.8	34	30.1	31.1
2005	31.4		28.3	27.4	27.9	25.5	24	23.6	26.5	32.9	28.9	30	25.5
2006	30.9	29.7	28.1	27	23.4	22.7	24.4	23.2	28	31.5	30.2	31.8	27.6
2007	32.4	34.2	32.1	28.9	25.9	23.2	22.5	26.2	30.9	33.9	38.2	37.5	30.5
2008	29.2	31.9	29.5	27.5	25.4	23.6	22.9	23.7	29.4	31.9	29.6	31.2	28.0
Monthly Temp.	31.45	28.96	30.9	29.27	26.01	23.73	23.81	26.02	28.7	31.94	31.79	32.1	28.7

Table 13: Average Daily Minimum Temperature - MARBLE HALL

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Min Ave. Temp.
1999	18.4	19.5	18	14.8	10.5	5.8	7.1	8.7	12.6	15.2	19	18.7	14.0
2000	18.8	19.6	18.9	13.2	7.8	7.6	4.6	8.6	13	16.7	17.1	18.6	13.7
2001	19.9	19.1	17.9	15.6	9.3	6.1	5	9.5	13.8	17	18	18.6	14.2
2002	19.6	19.7	18	14.9	9.4	6.9	4.9	11.7	12.7	16	16.5	19.4	14.1

2003	19.7	20.8	18	16.1	10	7.3	5.1	7.2	13.6	18.1	19.9	20.4	14.7
2004	21.2	19.9	18.9	18.1	9.7	5.2	9.5	10.1	11.4	17.7	19.6	19.4	15.1
2005	19.2		17.4	15.1	10.3	7.6	6	10.1	14	17.3	19.1	18.4	12.9
2006	20.6	20.6	17.7	12.5	7.5	5.9	6.4	8.4	12.2	17.7	18.8	20.3	14.1
2007	19.1	19.8	19.4	15.5	9.4	7	5.1	8.2	15.2	17.8	18.8	19.1	14.5
2008	19.2	18.9	17.5	12.6	9.8	6.6	5.3	8.3	12.5	17.5	18.8	19.6	13.9
Monthly Temp.	19.57	17.79	18.17	14.84	9.37	6.6	5.9	9.08	13.1	17.1	18.56	19.25	14.1

Table 14: Average Daily Maximum Temperature - GRASKOP

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max Ave. Temp.
1999	22.4	21	21	20.4	19	18.4	16.9	18.8	19.3				14.8
2000	21.6	20.5	21.6	19.2	17.9	15.8	17.1	18.7	20.2	20.5	21		17.8
2001	21.2		21.3	20.6	19.4	18.2	17.4	23.5	21.1	21.8	21.2	22.4	19.0
2002	23.2	22.2	22.4	21.5	20.3	16.4	18.8	18.6	20.1	19.7	20.6	22.4	20.5
2003	23.5	24.3	23.8	21.8	19.2	16.1	17.3	19.8	21.5	23.5	21.3	26.9	21.6
2004	26.2		21.4	20.8	19.1	16.5	17	20.7	19.7	21.6	24.4	23.8	19.3
2005	23.7	24.7	22.5	20.6	20.3	20.1	18.3	22.1	23.4	23.2	23.4	22.2	22.0
2006	23.3	23.6	20.8	21.1	18.3	16.7	19.9	18.3	21.5	22.5	22.1	25.4	21.1
2007	23.5	25.1	23.7	20.9	19.8	17.8	17.6	20.3	22.7	19.9	23	22.2	21.4
2008	24.2	25.1	23.9	22	21.6	19.5	19.3	22	24.3	23.9	22.7	23.5	22.7
Monthly Temp.	23.28	18.65	22.24	20.89	19.49	17.55	17.96	20.28	21.38	19.66	19.97	18.88	20.0

Table 15: Average Daily Minimum Temperature - GRASKOP

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Min Ave. Temp.
1999	14.8	14.3	14.1	11.6	8.8	5	5.9	6.6	9.4				7.5
2000	14.3	15.5	15.1	10.8	6.8	6.4	4.9	6.3	9.8	11.9	13		9.6
2001	14.7		14.2	12.4	7.8	4.6	3.1	4.4	10	11	14.1	14.9	9.3
2002	15	15.1	13.9	11.6	7.9	5.2	5.2	8.8	8.3	10.8	10.8	14.4	10.6
2003	14.7	15.3	14	11.7	8	7.2	4.6	5.7	9	11.2	12.2	14.5	10.7
2004			13.7	12	6.9	3.9	4.2	7.8	7.8	11.7	13.3	14.6	8.0
2005	15.8	15	13.4	11.8	8.4	7.5	5.1	9.2	9.9	11.7	13.8	13.4	11.3
2006	15.9	15.3	13	11	6.5	4.5	5.4	6.1	8.1	12	13.2	15	10.5
2007	14.2	15.3	13.2	11.4	5.9	5.1	4.4	6.8	10.8	11.4	13.5	13.8	10.5
2008	14.9	14.6	13.8	10.3	9.9	7.6	7.2	9.2	9.6	11.6	13.8	14.6	11.4
Monthly Min Temp.	13.43	12.04	13.84	11.46	7.69	5.7	5	7.09	9.27	10.33	11.77	11.52	9.9

Note: Temperature is not measured at Wolkberg.

Table 16: Average Daily Maximum Temperature - PHALABORWA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max Ave. Temp.
1999	30.9	28.5	29.7	28.8	26.8	25.9	25.1	26.9	27.3		29.5	31.6	25.9
2000	28.8	28.3	28.8	26.6	25.2	24.3	23.9	25.9	27.3	29.2	29.4	32.2	27.5
2001		28.5	28.4	29.2	27.4	25.4	24.4	27.1	28.3	29.6	28.9	29.7	25.6
2002	32.6	31.4	32.5	29.9	28.2	24.5	26.2	26.8	28	29.6	29.8	32.4	29.3
2003	33.9	34	31.4	29.6	27.1	23.3	24.4	26.6	28.7	31.4	31.3	33.4	29.6
2004	31.5	30.2	27.4	27.2	25.7	23.9	23.8	27.1	27.7	29.6	33	32.4	28.3
2005	33	33.5	31.4	28.9	28.3	27	25.3	27.6	31.1	31.5	32.2	30.4	30.0
2006	31.5	31.1	27.6	27.9	26.3	24.6	26.3	26.1	28.9	31.6	30.7	34.8	29.0
2007	31.8	33.3	32.5	29.1	27.8	25.4	24.1	27.1	30	27	29.6	28	28.8
2008	29.9	33.8											5.3
Monthly Temp.	28.39	31.26	26.97	25.72	24.28	22.43	22.35	24.12	25.73	23.95	27.44	28.49	25.9

Table 17: Average Daily Minimum Temperature - PHALABORWA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Min Ave. Temp.
1999	20.9	20.4	20.1	17.1	13.2	8.4	9.5	10.4	13.5		19.3	20.2	14.4
2000	19.7	21.3	20.7	16.6	11.2	11	9.1	9.4	14.4	16.7	18.8	19.3	15.7
2001		20.5	19.3	18.6	13.3	9.1	9.1	12.3	14.6	17.5	19.3	20.5	14.5
2002	20.6	20.1	19.6	16.6	11.6	9.8	8.2	13	13.8	16.6	17	21.1	15.7
2003	21.7	22.5	20.7	17.2	13.2	11.8	8	9.7	14.1	17.5	19.6	20.5	16.4
2004	21	20.5	19.3	17.3	11.4	7.8	8.3	11.3	12.2	16	19.4	20.5	15.4
2005	21.5	21	19.5	16.7	12.6	10.8	8.8	12.7	15.2	17.4	20.2	19.2	16.3
2006	21.7	21.5	18.3	15.7	10.2	9.3	7.7	10.2	12	17.6	18.5	20.6	15.3
2007	19.8	20.6	19	16.1	8.3	7.5	6.5	8.1	13.6	15.3	16.9	18	14.1
2008	19.5	20.2											3.3
Monthly Min Temp.	18.64	20.86	17.65	15.19	10.5	8.55	7.52	9.71	12.34	13.46	16.9	17.99	14.1

Table 18: Average Daily Maximum Temperature - PUNDA MARIA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max Ave. Temp.
1999	31.3	28.2	28.9	28.9	27.4	25.8	25		28.9	29	29.2	33.4	26.3
2000	28.6	27.9	28.7		26	24.1	23.8	26	27.4	29.9	30.9	33.5	25.6
2001	33.2	28.6	28.4	28.6	26.6	25.6	24.6	28	28.4	30.5	29.1	29.2	28.4
2002	32.8	31.8	32.8	30.2	28.9	24.8	25.8	27.7	27.5	30.8	30.2	32.9	29.7
2003	33.6	35.5	32.6	30.1	27.8	22.7	24.1	27.5	29.7	32.4	31.8	33	30.1
2004	32.2	31.7	28.4	28.3	26.1	24.3	24.6	28.5	29.3	30.4	35.9	34	29.5
2005	34.5	34.4	32.2	30.1	29.1	26.8	25.9	29.3	32.1	32.9	33.6	29.5	30.9
2006	31.1	31.5	28.1	28.6	26.5	24.7	26.7	27.2	30	33.5	31.9	36	29.7
2007	32.7	34.5	33.1	29.9	28.5	26.6	25.5	27.9	31.3	29.9	32.6	28.4	30.1
2008	29.4	32.7	30.1	30.3	29	26.8	26.1	29.3	31.5	32	31.7	32.8	30.1

Monthly Temp.	31.94	31.68	30.33	26.5	27.59	25.22	25.21	25.14	29.61	31.13	31.69	32.27	29.0

Table 19: Average Daily Minimum Temperature - PUNDA MARIA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Min Ave.Temp.
1999	21.2	19.4	20.6	18.2	14.8	11.6	12.5	13.7	15.2	16.3	20.3	21.5	17.1
2000	19.9	21.6	21.4	16.9	12.9	12.6	11.4	11.5	15.8	17.3	19	20.2	16.7
2001	20.3	20.6	19.5	17.1	13.4	11.3	10.7	13.8	15.4	17.2	20.3	20.7	16.7
2002	20.4	19.8	19.6	17.2	14.1	12.1	11.9	14.9	14.9	16.4	17.1	20.4	16.6
2003	21.3	22.3	19.8	18.4	15.3	13.3	10.6	12.9	16.1	18.6	21.1	20.5	17.5
2004	21.1	21	20.2	17.9	13.6	11.3	11	13.1	14.5	17.9	20.5	21.6	17.0
2005	22.7	22.2	20.9	18.4	15.8	14.8	13.3	15.2	17.6	19.2	21.3	20	18.5
2006	22.1	21.9	19.3	17	13.1	12	11.1	12.8	14.3	19.2	20.4	21.8	17.1
2007	21	22.2	19.8	18.1	13	12.5	11.5	13.1	17.2	18.3	20.5	19.9	17.3
2008	20.4	20.2	19.5	15.9	16.9	14.2	13.6	13.8	18	21.2	20.5	22.1	18.0
Monthly Min Temp.	21.04	21.12	20.06	17.51	14.29	12.57	11.76	13.48	15.9	18.16	20.1	20.87	17.2

2.2.3 Average of the humidity (in %)

Table 20: Average Humidity(%)- WITBANK

Measured at 08:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	76	75	73	69	72	60	67	54	57	57	67	73	66.7
2000	77	80	83	81	71	77	56	0	0	0	0	0	43.8
2004	0	0	0	0	0	0	0	0	0	0	0	74	6.2
2005	0	0	0	0	0	0	0	0	0	0	0	66	5.5
2006	78	79	80	79	63	63	23	60	51	59	64	65	63.7
2007	64	60	59	77	56	75	63	56	57	79	77	78	66.8
2008	88	79	84	76	79	73	72	61	56	62	80	75	73.8
Monthly Ave	54.7	53.3	54.1	54.6	48.7	49.7	40.1	33.0	31.6	36.7	41.1	61.6	32.6
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	50	43	39	37	41	23	29	22	26	28	42	47	35.6
2000	54	60	57	54	36	39	6	0	0	0	0	0	25.5
2004	0	0	0	0	0	0	0	0	0	0	0	53	4.4
2005	53	40	45	47	28	25	18	26	14	25	39	38	33.2
2006	56	56	54	43	31	26	8	28	18	24	42	44	35.8
2007	35	26	28	37	24	38	28	30	28	57	55	58	37.0
2008	66	49	58	44	44	37	34	28	26	36	54	52	44.0
Monthly Ave	44.9	39.1	40.1	37.4	29.1	26.9	17.6	19.1	16.0	24.3	33.1	41.7	30.8
Measured at 20:00													

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	70	60	62	57	58	40	48	39	42	49	62	70	54.8
2000	71	77	76	73	56	63	17	0	0	0	0	0	36.1
2004	0	0	0	0	0	0	0	0	0	0	0	74	6.2
2005	69	59	65	67	47	42	35	41	28	46	55	57	50.9
2006	74	74	71	65	51	46	15	47	32	44	61	60	53.3
2007	56	45	49	61	38	57	44	39	41	79	75	74	54.8
2008	80	68	78	65	66	53	50	42	42	55	75	71	62.1
Monthly Ave	60.0	54.7	57.3	55.4	45.1	43.0	29.9	29.7	26.4	39.0	46.9	58.0	45.5

Table 21: Average Humidity(%) - GRASKOP

Measured at 08:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	94	0	97	0	0	0	0	0	0	0	0	0	15.9
2000	0	0	0	0	0	0	0	0	84	0	0	0	7.0
2001	98	0	0	0	0	0	0	0	0	0	0	0	8.2
2002	0	0	0	0	0	0	65	89	72	84	78	88	39.7
2003	81	84	85	87	85	89	77	64	66	72	85	83	79.8
2004	89	95	95	93	91	89	75	75	75	78	80	86	85.1
2005	94	91	95	92	87	82	82	80	73	79	87	87	85.8
2006	96	96	96	93	77	88	82	78	76	85	87	86	86.7
2007	89	91	81	81	64	73	67	58	65	78	73	80	75.0
2008	80	72	80	68	68	68	60	60	52	71	83	82	70.3
Monthly Ave	72.1	52.9	62.9	51.4	47.2	48.9	50.8	50.4	56.3	54.7	57.3	59.2	55.3

Measured at 14:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	86	0	87	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	70	0	0	0	5.8
2001	90	0	0	0	0	0	0	0	0	0	0	0	7.5
2002	0	0	0	0	0	0	42	67	51	66	65	74	30.4
2003	67	66	62	65	58	68	47	36	48	56	72	70	59.6
2004	79	83	84	78	61	57	52	54	57	63	69	75	67.7
2005	82	72	74	76	62	54	52	50	46	61	73	81	65.3
2006	86	83	85	78	62	61	47	55	54	72	80	74	69.8
2007	75	73	59	65	38	46	37	38	46	70	67	68	56.8
2008	68	58	63	59	47	47	37	38	36	57	73	75	54.8
Monthly Ave	63.3	43.5	51.4	42.1	32.8	33.3	31.4	33.8	40.8	44.5	49.9	51.7	43.2

Measured at 20:00

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	96	0	99	0	0	0	0	0	0	0	0	0	16.3
2000	0	0	0	0	0	0	0	0	87	0	0	0	7.3
2001	95	0	0	0	0	0	0	0	0	0	0	0	7.9
2002	0	0	0	0	0	0	63	82	68	83	77	86	38.3
2003	80	78	81	83	80	85	69	58	64	71	82	85	76.3

2004	90	93	97	95	90	84	75	73	77	77	83	90	85.3
2005	92	86	91	91	84	79	76	78	67	75	85	92	83.0
2006	97	96	97	95	84	85	75	74	75	87	88	88	86.8
2007	88	85	76	83	61	70	61	52	64	81	77	82	73.3
2008	84	75	77	74	69	67	54	58	56	73	84	86	71.4
Monthly Ave	72.2	51.3	61.8	52.1	46.8	47	47.3	47.5	55.8	54.7	57.6	60.9	54.6

Table 22: Average Humidity(%)- PHALABORWA

Measured at 08:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	97	100	93	93	97	94	91	87	79	0	89	84	83.7
2000	87	90	90	91	89	91	86	93	84	79	83	81	87.0
2001	0	95	97	0	0	0	0	0	0	0	0	0	16.0
2005	0	0	0	0	0	0	0	0	68	69	74	80	24.3
2006	81	84	85	87	78	85	87	72	69	71	72	72	78.6
2007	80	81	73	83	68	80	81	65	67	78	77	85	76.5
2008	82	68	0	0	0	0	0	0	0	0	0	0	12.5
Monthly Ave	61.0	74.0	62.6	50.6	47.4	50.0	49.3	45.3	52.4	42.4	56.4	57.4	54.1
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	76	84	70	63	59	45	48	46	47	0	65	55	54.8
2000	68	78	75	66	53	58	51	49	53	50	57	53	59.3
2001	0	79	82	0	0	0	0	0	0	0	0	0	13.4
2005	0	0	0	0	0	0	0	0	35	42	45	55	14.8
2006	55	56	61	53	37	41	34	35	33	40	48	39	44.3
2007	47	45	38	47	30	38	35	32	35	54	53	62	43.0
2008	56	35	0	0	0	0	0	0	0	0	0	0	7.6
Monthly Ave	43.1	53.9	46.6	32.7	25.6	26.0	24.0	23.1	29.0	26.6	38.3	37.7	33.9
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	92	99	90	86	90	84	84	71	66	0	80	76	76.5
2000	84	88	91	91	88	90	82	81	74	72	78	70	82.4
2001	0	89	97	0	0	0	0	0	0	0	0	0	15.5
2003	0	0	0	0	0	0	0	0	44	0	0	0	3.7
2005	0	0	0	0	0	0	0	0	56	57	63	73	20.8
2006	72	74	83	87	80	78	75	61	51	53	62	59	69.6
2007	63	61	54	80	71	74	72	61	57	75	76	82	68.8
2008	73	51	0	0	0	0	0	0	0	0	0	0	10.3
Monthly Ave	48.0	57.8	51.9	43.0	41.1	40.8	39.1	34.3	43.5	32.1	44.9	45.0	43.4

Table 23: Average Humidity(%) - PUNDA MARIA

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
Measured at 08:00													
1999	82	88	91	83	79	79	82	74	65	67	69	70	77.4
2000	85	90	90	87	81	93	83	82	78	75	76	71	82.6
2001	75	90	90	90	86	88	76	82	75	75	87	87	83.4
2002	81	80	79	84	77	85	69	82	72	68	69	74	76.7
2003	80	76	80	79	80	87	81	0	0	0	0	0	46.9
2008	0	0	0	0	0	0	0	0	0	0	67	66	11.1
Monthly Ave	67.2	70.7	71.7	70.5	67.2	72.0	65.2	53.3	48.3	47.5	61.3	61.3	63.0
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	55	73	63	50	46	41	40	31	35	37	55	43	47.4
2000	66	75	72	65	55	66	48	45	49	46	48	45	56.7
2001	42	70	67	56	50	44	41	43	45	43	67	66	52.8
2002	51	49	40	47	37	48	40	46	39	45	48	50	45.0
2003	47	42	46	48	48	62	45	0	0	0	0	0	28.2
2008	0	0	0	0	0	0	0	0	0	27	41	43	9.3
Monthly Ave	43.5	51.5	48.0	44.3	39.3	43.5	35.7	27.5	28.0	33.0	43.2	41.2	39.9
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
2000	0	0	0	0	0	88	76	66	69	62	64	59	40.3
2001	53	81	88	84	76	75	65	66	63	55	78	83	72.3
2002	70	71	58	68	63	75	64	64	56	61	62	61	64.4
2003	61	48	65	66	67	77	66	0	0	0	0	0	37.5
2008	0	0	0	0	0	0	0	0	0	34	53	55	11.8
Monthly Ave	36.8	40.0	42.2	43.6	41.2	63.0	54.2	39.2	37.6	42.4	51.4	51.6	45.3

2.2.4 Wind

Table 24: Average Wind Speed (m/s) - WITBANK

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
Measured at 08:00													
1999	3.2	3.2	3	2.2	2.3	2	2.5	2.5	3.4	3.6	3.5	2.6	2.8
2000	3.4	4.4	2.7	2	1.6	1.5	1.8	1.1	2.8	2.7	4.2	3.1	2.6
2001	3.4	3.4	2.8	1.9	1.3	1.5	2.4	2	3.6	3.2	3.5	3.3	2.7
2002	3.3	2.8	2.8	1.2	2	2.1	2.3	2	2.9	3	3.6	3.4	2.6
2003	3.4	2.7	2.7	1.8	2	2.4	1.6	2.3	3.1	3.8	3.5	3.3	2.7
2004	3	2.1	1.9	1.8	0.8	0.6	1.6	1	2.7	2.9	2.1	3.2	2.0
2005	3.1	2.9	2.5	2.1	1.7	1.5	2	2	2.6	3.5	4	3.9	2.7
2006	3.2	2.9	3.1	1.7	2.3	2.3	1.3	2.9	2.6	3	3.6	3.5	2.7
2007	3.5	3.5	2.7	2	1.8	1.9	2.6	1.9	2.4	3.3	2.8	0.1	2.4
2008	0.1	3	2.4	1.5	1.8	2	1.6	1.7	3.4	3.4	3.2	3	2.3
Monthly Ave	3.0	3.1	2.7	1.8	1.8	1.8	2.0	1.9	3.0	3.2	3.4	2.9	2.5
Measured at 14:00													

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	3.4	3.6	3.7	3.7	3.5	3.5	3.2	3.8	4.4	3.7	3.6	3.5	3.6
2000	3.8	4.2	3.3	3.2	3.2	2.9	3.2	2.9	4.2	3.3	4.2	3.5	3.5
2001	3.5	3.6	3.2	3.6	3.2	3.2	4.2	4.5	5.1	4.1	3.6	3.6	3.8
2002	3.3	3.2	3.3	2.9	3.4	3.3	4	4	4	4	4	3.4	3.6
2003	3.2	2.9	3.2	3.2	3.8	3.4	3.2	4.4	4.5	4.6	3.5	3.7	3.6
2004	2.9	2.8	2.6	2.6	2.6	2.7	3.2	3.6	3.5	3.3	2.5	3.3	3.0
2005	3.1	3.2	3.3	3.2	3.5	4	3.3	4.7	4.6	4.5	4.4	4.3	3.8
2006	3.1	3.6	3.3	3.4	4	3.9	3.8	4.6	4	4.1	3.6	4.1	3.8
2007	3.6	4.5	3.7	3.8	3.9	4.1	3.9	4.2	4.2	4.3	3.1	0	3.6
2008	0.3	3.5	3	3.3	2.9	3.3	3.4	4.2	4.7	4.6	4	3.2	3.4
Monthly Ave	3.02	3.51	3.26	3.29	3.4	3.43	3.54	4.09	4.32	4.05	3.65	3.26	3.6
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	2.7	3.7	3.1	3.1	2.5	2.1	2.3	3	3.5	4	2.9	3.2	3.0
2000	3.1	3.5	2.8	2.3	2	2.4	2.2	2.3	2.8	3.3	3.3	2.4	2.7
2001	3.5	3.4	3.3	2.3	2.1	2.2	2.8	3	3.5	3.4	2.7	2.9	2.9
2002	2.7	2.6	2.5	2.5	2.3	2.7	2.6	2.5	3.1	3.2	3.9	3.1	2.8
2003	2.8	2.6	2.7	2.5	2.7	2.6	2.3	2.9	2.9	3.4	3	2.8	2.8
2004	2.2	1.6	2.3	1.4	1.6	1.3	1.6	2	2.5	2.3	1.8	3.5	2.0
2005	2.4	2.8	2.6	2.2	2.3	2.3	2.4	2.4	3.2	4.1	3.8	3.4	2.8
2006	2.5	2.5	3.1	2.4	2.6	2.5	1.8	3.4	2.9	3.3	3.3	3.1	2.8
2007	3.5	3.4	3.2	3.1	2.6	2.2	2.7	2.8	2.9	3.8	2.3	0.2	2.7
2008	0.5	2.7	3	2.4	2.3	2.2	2	2.7	2.9	3.6	2.5	2.9	2.5
Monthly Ave	2.59	2.88	2.86	2.42	2.3	2.25	2.27	2.7	3.02	3.44	2.95	2.75	2.7

Note: Wind speed is not measured at the Marble Hall station.

Table 25: Average Wind Speed (m/s) - GRASKOP

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
Measured at 08:00													
1999	3.3	3.1	2.3	1.4	1.8	1.4	1.8	1.6	2.6	0	0	0	1.6
2000	2	2.6	0.7	0	0.3	1.6	1.4	0.8	2.3	2	2.4	0	1.3
2001	1.1	0	1.5	1.5	1.1	0.6	1.6	1.5	2	1.8	1.9	1.9	1.4
2002	2	1.9	1.5	1.1	1.4	1.3	1.7	1.4	1.5	2.6	2.2	1.9	1.7
2003	1.8	1.6	1.6	1	1.1	1.6	1.2	1.9	2	1.6	0.8	0.8	1.4
2004	0.6	1.4	1.4	1.5	0.8	0.9	1.4	1.4	2	2.3	1.3	1.7	1.4
2005	1.6	1.3	1.3	1.3	0.9	1.5	1.1	1.9	1.5	2	2	1.8	1.5
2006	0.8	0.7	1.7	1	2	0.9	0.9	1.8	1.7	1.5	1.9	1.8	1.4
2007	1.9	1.6	1.5	0.9	1	1.4	1.3	1.7	1.5	1.7	2.3	2.1	1.6
2008	1.7	2.1	1.9	1.1	1	1	1	1.6	1.6	1.3	0.9	0	1.3
Monthly Ave	1.7	1.6	1.5	1.1	1.1	1.2	1.3	1.6	1.9	1.7	1.6	1.2	1.5
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave

1999	3.6	3.4	1.4	2.8	2.9	2.6	3.2	3.3	3.5	0	0	0	2.2
2000	2.9	3.2	1.1	0	0.4	3.4	3.3	3.1	3.7	2.7	3.1	0	2.2
2001	1.3	0	2.8	2.6	2.5	2.8	3.1	3.3	3.4	3.1	2.6	2.9	2.5
2002	2.9	2.8	2.6	2.5	2.9	3.3	3.2	3	3.1	3.1	3.1	2.8	2.9
2003	2.8	2.7	2.8	2.7	2.8	2.6	2.7	3.5	3.2	2.4	2	2.1	2.7
2004	1.7	2.7	2.5	3	2.6	2.9	3	3.1	3.2	3	2.8	2.8	2.8
2005	2.7	2.7	2.9	2.4	2.7	2.9	2.8	3.1	3.4	3.2	2.9	2.7	2.9
2006	1.7	2.1	2.7	2.8	3	3	2.7	3.2	3.1	3	2.7	2.8	2.7
2007	2.8	2.8	2.7	2.6	2.9	3	2.9	3.2	3	3.1	2.5	3.1	2.9
2008	2.8	2.7	3	2.3	2.2	2.2	2.4	2.8	2.3	2.2	1.8	0	2.2
Monthly Ave	2.52	2.51	2.45	2.37	2.49	2.87	2.93	3.16	3.19	2.58	2.35	1.92	2.6
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	4.3	3.5	2.5	1.5	1.8	1.2	1.4	1.3	1.9	0	0	0	1.6
2000	2	2.7	0.8	0	0.2	2.5	1.6	0.6	1.9	1.5	1.9	0	1.3
2001	1	0	1.2	1	1.5	1.1	1.9	1.5	1.7	1.9	1.5	1.8	1.3
2002	1.7	1	1.1	0.9	1.4	1.1	1.3	1.4	1.6	1.7	1.8	1.4	1.4
2003	1.6	1.7	1.6	1.2	0.8	1.7	1.1	1.6	1.9	1.1	0.6	0.7	1.3
2004	0.4	1.3	1.5	1.2	0.8	1.2	1.7	1.5	1.7	1.3	1.2	1.4	1.3
2005	1.5	1.8	1.7	1.1	1.3	1.3	1.3	1.9	1.5	1.6	1.4	1.9	1.5
2006	1.1	0.8	1.2	1.1	1.2	1.1	0.8	2.1	1.1	1.2	1.5	1.2	1.2
2007	1.6	1.1	1.6	1.2	0.9	1.2	1.2	1.9	1	1.6	1.6	1.9	1.4
2008	2.1	1.9	1.2	1.6	0.9	1.1	1	1.6	1.7	1.1	0.8	0	1.3
Monthly Ave	1.73	1.58	1.44	1.08	1.08	1.35	1.33	1.54	1.6	1.3	1.23	1.03	1.4

Table 26: Average Average Wind Speed (m/s) - PHALABORWA

Measured at 08:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	0	0	0	0	0	0	0	0	0	0	0	1.2	0.1
2000	2.3	2.6	1.7	1.1	0.3	0.7	0.9	0.5	2.3	2.2	2.1	2.1	1.6
2001	0	2.4	1.5	0.8	0.6	0	1.1	1	2.1	2	2.2	2.5	1.4
2002	2.1	2	1.6	0.7	0.4	0.6	0.7	1	1.9	2.6	2.9	2.2	1.6
2003	2.5	2.2	2	1.3	0.9	1.1	0.6	1.3	1.6	2.4	2.3	2.2	1.7
2004	2.2	1.9	1.6	1.2	0.3	0.4	0.9	0.9	1.5	2.6	1.7	2.1	1.4
2005	1.7	1.9	1.6	1.3	0.6	0.6	0.4	0.9	1.6	2.6	2.3	2.3	1.5
2006	2	1.6	1.9	0.7	0.6	0.6	0.2	1.3	1.5	2	2.1	0	1.2
2008	2.7	3.1	0	0	0	0	0	0	0	0	0	0	0.5
Monthly Ave	1.7	2.0	1.3	0.8	0.4	0.4	0.5	0.8	1.4	1.8	1.7	1.6	1.1
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	0	0	0	0	0	0	0	0	0	0	0	1.5	0.1
2000	2.5	3	2.2	2	2.1	2.2	2.3	2.1	3.1	2.5	2.6	2.3	2.4
2001	0	2.4	2.1	1.9	2.1	1.8	2.4	2.3	2.9	2.4	2.4	2.5	2.1
2002	2.6	2.3	2.4	1.9	2	2.1	2.2	2.6	2.9	3	3.2	2.3	2.5
2003	2.5	2.6	2.4	2.2	2.2	2.4	2.1	2.4	2.8	2.8	2.5	2.3	2.4

2004	2.2	2.1	2.3	2.2	1.9	2	2.2	2.1	2.7	2.5	2.1	2.4	2.2
2005	2.2	2.1	2.3	2	2	2	2.1	2.5	2.7	2.6	2.3	2.5	2.3
2006	2.2	2.1	2.4	1.9	2.1	2.1	2.1	2.6	2.4	2.6	2.6	0	2.1
2008	3.5	3.4	0	0	0	0	0	0	0	0	0	0	0.6
Monthly Ave	2.0	2.2	1.8	1.6	1.6	1.6	1.7	1.8	2.2	2.0	2.0	1.8	1.7
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	0	0	0	0	0	0	0	0	0	0	0	0.7	0.1
2000	1.7	2	1.1	0.7	0.5	0.9	0.6	0.4	2	1.9	1.6	1.5	1.2
2001		1.4	0.9	0.7	0.6	0.3	1	0.7	1.9	1.7	1.2	1.6	1.0
2002	1.6	1.4	1.4	0.7	0.2	0.7	0.9	0.8	1.4	1.8	2.2	1.9	1.3
2003	1.8	1.6	1.1	0.6	0.5	1	0.3	0.9	1.8	1.8	2	1.6	1.3
2004	1.3	1.2	1.1	0.9	0.3	0.3	0.9	0.8	1.1	1.6	1	1.3	1.0
2005	1.6	1.3	1.5	1.4	0.6	0.7	0.7	1.2	0.9	1.6	1.4	2	1.2
2006	1.8	1.3	1.2	0.6	0.3	0.6	0.3	0.9	1.3	1.6	1.8	0	1.0
2008	2.8	3.5	0	0	0	0	0	0	0	0	0	0	
Monthly Ave	1.26	1.37	0.83	0.56	0.3	0.45	0.47	0.57	1.04	1.2	1.12	1.06	0.8

Table 27: Average Average Wind Speed (m/s) - PUNDA MARIA

Measured at 08:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	1.4	2.8	1.9	1.3	1.2	1.3	1.1	2	2.9	3.9	0.8	2	1.9
2000	2.2	2.3	2	1.4	1.4	0.7	0.9	0.7	1.8	1.9	1.7	1.2	1.5
2001	1.7	1.2	0.6	0.2	0.5	0.1	0.5	1.5	2.2	1.6	1.5	1.6	1.1
2002	1.5	0.7	1.7	0.7	0.3	0.2	1.3	1	1.8	1.7	2.9	2.2	1.3
2003	2.2	2.6	1.2	0.5	1.1	0.5	0.2	0.4	0.3	0.3	0.3	1.5	0.9
2004	3.7	3.4	2.9	1.2	0.7	0.3	1.4	1.2	2.1	3	1.3	1.4	1.9
2005	2.4	1.9	1.7	1.6	1.5	0.7	1.2	1.3	2.4	3.3	2.6	2.6	1.9
2006	0.8	0.7	2.1	1	0.8	1.3	0.4	2	1.9	2.5	1.5	1.7	1.4
2007	2.1	2.9	1.9	1.1	0.4	1.6	1.5	2.2	2.6	1.6	2.3	1.6	1.8
2008	2	1.5	1.6	1.9	0.7	0.9	0.9	0.9	2.7	2.8	1.4	1.2	1.5
Monthly Ave	2	2	1.76	1.09	0.86	0.76	0.94	1.32	2.07	2.26	1.63	1.7	1.5
Measured at 14:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
1999	1.8	2.8	3.5	1.8	2.1	2.9	3.1	6	4	5.3	1.3	1.9	3.0
2000	2.2	2.6	2	1.6	1.4	1.5	1.9	2.2	2.3	2.1	2	1.6	2.0
2001	2.2	1.9	0.6	0.7	1.4	1.3	2.9	2.9	2.5	1.6	0.8	0.5	1.6
2002	2.7	0.9	1.5	0.8	0.6	0.7	1.1	2.9	4.3	1.5	1.2	2.4	1.7
2003	3.4	3.5	2.4	1.9	2.5	0.6	0.8	0.6	0.5	0.5	1.7	3	1.8
2004	5.6	5.3	3.9	2.3	2.6	2.4	3.1	3.2	4	3.5	2.5	2.8	3.4
2005	2.8	3.3	2.8	2.4	2.8	2.3	2.6	2.6	3.6	4	2.1	2	2.8
2006	2.3	2.1	2.6	2.7	2.5	2.2	2.4	3	2.5	3.5	2.7	1.9	2.5
2007	2.8	3.5	2.9	1.6	2.1	2.5	3.3	2.8	3.4	3.3	2.3	2.3	2.7
2008	2.7	2.8	2.5	2.6	2.1	1.5	2.5	2.6	3	2.8	1.7	1.8	2.4
Monthly	2.85	2.87	2.47	1.84	2.01	1.79	2.37	2.88	3.01	2.81	1.83	2.02	2.4

Ave													
Measured at 20:00													
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Ave
2000	0	0	0	0	0	0.3	0.4	0.2	1	1.3	0.5	0.7	0.4
2001	1.3	0.6	0.4	0.2	0.2	0.2	1	0.3	1.2	1.1	1.6	0.7	0.7
2002	0.8	0.4	0.4	0.2	0	0.1	0.3	1	0.7	1.3	1.3	1.2	0.6
2003	0.7	2.4	0.1	0.2	0.4	0.3	0.1	0.1	0.3	0.2	0.2	1.4	0.5
2004	2.1	1.4	3	1.1	0.2	0.1	1.1	0.8	1.4	1.2	0.7	0.4	1.1
2005	1.2	0.7	1.3	0.5	0.5	0.7	0.7	0.9	0.8	2.1	1.1	1.3	1.0
2006	0.3	0.5	1.5	0.1	0.4	0.7	0.3	0.5	0.1	1	1.3	0.7	0.6
2007	0.2	1.3	0.9	0.6	0	0.4	0.3	0.7	0.9	2.1	0.9	1.2	0.8
2008	0.7	0.4	0.8	0.6	0.1	0.1	0.1	0.4	0.8	1	0.7	0.8	0.5
Monthly Ave	0.8	0.9	0.9	0.4	0.2	0.3	0.5	0.5	0.8	1.3	0.9	0.9	0.6

2.3 HYDROLOGY

2.3.1 General description of the hydrology in the EMF area

The Olifants River catchment (including the Letaba and Shingwedzi catchments) is a sub-catchment of the Limpopo Basin and the largest tributary of the Limpopo River. Rising on the continental divide, the headwater of the Olifants River flows northwards over the surface of Eca Sandstone exposing the pre-Karoo surfaces here and there. The character of the river in this Karoo surface is that of a generally open valley, narrowing and deepening as the river cuts through the harder sandstones. In this part of the course the gradient is fairly gentle, averaging approximately 1.2m per kilometre from Davel to the railway bridge east of Witbank. At this point the river enters the second part of its course, over the Waterberg surface, which together with the Rooiberg Formation, forms the northern margin of the highveld. Here the character of the river changes, partly due to the resistance to erosion of the Waterberg quartsites and conglomerates, and partly because the great basin of the Bushveld Basin which is hundreds of meters below. The Olifants valley becomes narrower and increasingly takes on the character of a gorge and due to the drop to the Bushveld Basin, the gradient of the river rapidly increases northwards. From the Witbank – Middelburg railway bridge to Loskop Dam the fall is approximately 510m and the gradient averages 6,25m per kilometer. In the lower part of its course through the Waterberg Formation the river winds in a gorge over

300m deep, a perfect example of a superimposed[21] river with deeply incised meanders.

Before it reaches the Loskop Dam the Olifants River is joined by the Wilge River which has a course even more interesting than the main stream. Rising in the main dolerite watershed near Leslie, and as the Bronkhorstspruit to the south of Delmas, the stream has uncovered a considerable area of pre-Karoo surface. The Bronkhorstspruit has begun to excavate ports in the recently denuded quartzites of the Transvaal System north of Delmas, and has cut a poort of 90m deep in the Magaliesberg quartzites to the south of Bronkhorstspruit. The whole transverse character of this drainage, so near to the surface of the Karoo Formation, is obviously due to superimposition. To the east of Bronkhorstspruit, at the old Premier Mine Dam, the Wilge River enters the Waterberg Formation and, like the Olifants, cuts a valley which deepens and become increasingly narrower in a northern direction. When it emerges from this gorge the stream flows for 24km through open granite country and then plunges again into the plateau to join the parent stream. The explanation for this curious phenomenon is that the stream course has been imposed upon the older surface from the overlying Karoo Formation, and maintaining its original direction, has eroded the softer granite much more rapidly than the harder Waterberg quartzites and conglomerates.

Some distance below the confluence of the Wilge and Olifants Rivers, the main river is dammed at Loskop, where folded quartzites and conglomerates of the Loskop System form the threshold to the Bushveld Basin. From this point the valley gradually widens, and terraces of alluvium on the left bank of the main stream, as well as in the tributary valleys of the Moses and Elands Rivers, are irrigated from the 145km long channel leading from the Loskop Dam. A distributary weir at Herefort also supplies the lower lands near the river course with water.

Skirting the Marble Hall marble quarries and the old Mutue Fides tin fields, the river flows northwards though the flattest part of the Bushveld Basin, which lies mostly to the west of its course, while to the east the surface rises rather steeply to the

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Bushveld granite country of the Pokwani highveld, culminating in the Sekhukuni Mountians.

The western part of the Olifants valley is demarcated very indifferently from the Nyl basin, whereas the eastern part of the basin is effectively bordered by the Pokwani plateau. The Strydpoort and Chunies Mountains of Black Reef Quartzite lies to the north. North-eastwards lies the terminal ridges of the Norite Lulu mountains. For the next 160km of its course the river flows transverse to the ridges of the eastern Bakenveld, transecting successively the Lulu Mountains the Tokane ridge, the Magaliesberg Quarzite, the Sakun ridges of the Daspoort and Timeball Hill Quartzite, the region of Dolomite, and finally at Olifants Poort, the Transvaal Drakensberg itself, formed by the Black Reef Quartzite.

Several tributaries join the Olifants in the transverse zone. From the north of the Strydpoort in the Chunies Mountains come the Zebediela, Chunies, Mphatlele, malips and Mithlipitsi Rivers. The sources of the first four of these streams are on the granite not far from the Chunies Mountains and their heawaters have hollowed out catchment basins of considerable size north of the range.

In the middle and lower part of its course the Steelpoort has cut a wide and deep valley, oblique in direction to the trend of the main ridges of the Eastern Bankenveld. The same is true of the Spekboom River and its tributary, the Waterval River. Parts of their courses are parallel to the structural ridges and wide valleys are formed in the softer shales. Other parts of their courses lie behind the ridges and deep gorge like chasms take the place of the wide, flat-floored moat-like valley in shales. The gorge type is most perfectly developed in the middle and lower course of the Blyde River where the stream has cut a canyon some 90m deep in Black Reef Quartzite before escaping to the open granite country where it joins the Olifants.

At Olifantspoort where the Sulemele kop stands sentinel, the Olifants begins the last stage of its course to join the Limpopo in Mozambique. For more than 300km the river winds its way over the somewhat uneven surface of the lowveld plain, which is broken by granite, gneiss and pegmatitic koppies and ridges as well as the barrier of the Lebombo range. The most significant tributary to join the Olifants in this section is the Letaba River that joins it close to the Mozambique border in the Kruger National Park, a few kilometres from the Massingir Dam. The Letaba River with its two main tributaries, the Groot Letaba and Klein Letaba Rivers drains the northern part of the eastern lowveld plain. The Shingwidzi River that drains the plain below the Soutpansberg joins the "Elephantes" a few kilometres below the Massingir Dam before the main river joins the Limpopo River at Estivana.

2.3.2 Water availability

(a) Introdcution

The water in the system is a commodity that is produced by nature. It is therefore also subject to fluctuations that occur naturally. Water supply and availability is not constant. It varies from season to season and from wet periods to drier periods and even drought periods.

The potential impact of climate change remain uncertain and based on the climate and water flow information over many years that is available for the EMF area it is still not possible to predict specific trends of the possible impacts it may have in the area. Given general predictions for the eastern half of the country, it is nonetheless likely that the seasonal variations and the intensity of fluctuations will increase. The variations between wet and dry periods may also become more pronounced and severe.

While groundwater is stored within surface layers of the earth and is therefore available for use where it occurs, surface water is relatively unusable in rivers and streams. It has to be dammed to make it useful.

Dams do not increase the volume of water in the system but allows for the storage and the distribution management of water as well as the evening out of supply between seasons and to a certain extent also between wet and dry periods. In order to maintain the ecological reserve and downstream needs, dams must be managed and be able to release water at rates that equals the average mean inflow into the dams. Dams should be mechanisms that store water from high flow events in excess of the average mean flow of rivers. Any dam, big or small, that is not or cannot be managed in this way restricts the natural flow of water and impacts on the availability of water in the system as a whole because it retains significant portions of the flow, especially in dryer periods. The impact of such dams is particularly severe in the headwaters of rivers and streams, also in the EMF area. They are more often than not private dams on farms or even dams for industrial or mining use.

(b) Water availability

The rivers in the EMF area have been dammed extensively and major irrigation schemes occur in the Groblersdal/Marble Hall and the Tzaneen areas. Major dams in the Olifants River Catchment include:

- The Bronkhorstspruit Dam;
- the Witbank Dam;
- the Middelburg Dam;
- the Loskop Dam;
- the Rhenosterkop Dam;
- the Flag Boshelo Dam;
- the De Hoop Dam (under construction); and
- the Blyde River Dam.

Major dams in the Letaba River Catchment include:

- The Ebenezer Dam;
- the Tzaneen Dam;
- the Middle Letaba Dam; and
- the Nsami Dam.

A number of smaller dams also occur in both catchments and also have a significant impact that is disproportionate to their sizes because they most often are not built to the same standards and specifications as the bigger dams.

The Shingwedzi River Catchment is non-perennial and no major dams are located in it.

The only potentially remaining viable dam site in the Olifants River Catchment is the Rooipoort dam site in Sekhukhune. In the Letaba River Catchment the only significant remaining dam site is the proposed Nwamita dam site in the Letsitele area. Given the remaining volume of water within the system and the reserve requirements, it is unlikely that these dams will be able to deliver the anticipated additional water quantities that prospective users expect. The cost efficiency of building the dams in terms of possible returns on investment is also likely to be very marginal. It is therefore unlikely that these dams will be built in the foreseeable future.

With the exception of the highveld and parts of the escarpment, the area has significant ground water resources. Most rural communities in the area, more than two million people, depend on these resources for their basic water needs. In places and especially on the Springbok Flats, these resources are also used for irrigation farming.

The maintenance of ground water to fulfil its important role in the supply of water to poor rural communities is of the utmost importance and should be the key factor in decision-making about the allocation of ground water resources to other uses in the EMF area.

The water resource in the EMF area is already over allocated (Tables 28 and 29). The ecological reserve requirements of the EMF area as a whole and of most rivers and streams that constitute it are not being met and any further allocation of water must come from the redistribution of existing water allocations. Further dams in the system will not increase the water available to users but may make the allocation of the resource more accessible to other parts of the EMF area.

The only way in which the volume of available water can be increased is to import water from external sources. This will be expensive and depending on the volumes and sources it could double in cost (from approximately 25c/m^3 to 50c/m^3 at current prices) and even quadruple (R1.00/m^3) if the water has to be imported from desalination plants at the coast. The increase in water supply to the area is not impossible but will be costly and will have to be taken into account fully in the valuation of projected future economic contributions of the various sectors as well as in the determination of the viability of proposed activities in the area.

Water is already imported into the area from the Vaal catchment (with its supplies being supplemented from water imported from Lesotho – very expensive water) to supply in the needs of the ESKOM coal fired power stations and mines in the highveld area. It would be wrong to assume that that water would remain available to the area once the coal in the area is depleted and the power stations close down (say in about 20 to 30 years from now), as the water will in all likelihood be reallocated to industrial and/or power generation activities in other areas. It is therefore almost certain that the water volume in the system will become even less than what it is at present.

Table 28: Factors that have a significant impact on the production of water in the EMF area catchments

Tertiary catchments	Catchment area		Forestry	Alien veg.	Irrigation	Farm dams	
	Gross (km^2)	Net (km^2)	area (km^2)	area (km^2)	area (km^2)	area (km^2)	volume (mcm)
Tertiary B11	4714	4380.8	15.90	116.26	54.99	32.82	86.13
Tertiary B12	2391	2150.3	20.3	12.7	46.366	16.33	45.65
Tertiary B20	4356	4260.4	30.5	78.8	77.41	16.2	27.34
Tertiary B31	6148	4900	29.4	222.5	171.4	20.27	9.88
Tertiary B32	4293	4293	0	0	342.31	9.4	37.69
Tertiary B41	5043	5043	54.7	0	37.21	0.4	1.38
Tertiary B42	2093	2093	7.6	0	39.01	0	0
Tertiary B51	6170	3916	0	0	81.24	3.6	14.81
Tertiary B52	3558	3558	27.4	0	3.25	4.07	14.91
Tertiary B60	2843	2843	148.2	257.12	129.24	1.48	6.61
Tertiary B71	3007.8	3007.8	12.9	0	23.13	1.18	3.2
Tertiary B72	4464	4464	0	1.7	66.67	2.64	11.21
Tertiary B73	4652	4652	20.1	11.1	7.64	1.32	3.84
Tertiary B81	4952	4957.3	530.4	0	58.33	6.47	27.41
Tertiary B82	6213	5453	126.4	0	38.44	5.43	35.87
Tertiary B83	3264	3167	0	0	0	0	0
Tertiary B90	5310	5113	2.9	0	0	0	0

The change in naturalised flow from 1920 to 2004 is depicted in table 29.

Table 29: Naturalised flow (1920-2004) in tertiary flows

Tertiary catchments	COMPARISON OF MAR AGAINST WR90		
	MAR[22] (WR90) Net (mcm)	MAR (WR2005) Net (mcm)	Change in MAR (percent)
Tertiary B11	175.9	222.9	26.7
Tertiary B12	81.6	95.12	16.6

[22] ***MAR*** means mean annual runoff.

Tertiary B20	166.9	174.84	4.8
Tertiary B31	75.4	84.1	11.5
Tertiary B32	123.8	99.8	-19.4
Tertiary B41	233	193.78	-16.8
Tertiary B42	164.9	148.97	-9.7
Tertiary B51	46.6	25.3	-45.7
Tertiary B52	59.6	57.99	-2.7
Tertiary B60	402.5	385.69	-4.2
Tertiary B71	202.4	179.99	-11.1
Tertiary B72	137.4	129.76	-5.6
Tertiary B73	78.8	85.83	8.9
Tertiary B81	380.9	430.74	13.1
Tertiary B82	151.9	163.42	7.6
Tertiary B83	41.3	51.17	23.9
Tertiary B90	86.5	84.4	-2.4

Table 30: Naturalised flow (1920-2004) quaternary catchments with significant declines

Qauternary catchments	COMPARISON OF MAR AGAINST WR90 MAR (WR90) Net (mcm)	MAR (WR2005) Net (mcm)	Change in MAR (percent)
Total B20 A & B	33.5	39.45	-12.9
B20C	13.9	13.06	-6
B20E	21	19.28	-8.2
B32A	41.4	35.41	-14.5
B32B	31.3	26.19	-16.3
B32C	11	9.88	-10.2
B32D	11.8	8.1	-31.4
B32E	6.9	4.17	-39.6
B32F	19.4	12.98	-33.1
B32G	24.9	22.37	-10.2
B32H	14	13.17	-5.9
B32J	4.5	2.94	-34.7
B41A	49.5	41.97	-15.2
B41B	48.2	40.55	-15.9
B41C	17.8	14.84	-16.6
B41E	4.2	3.57	-15
B41F	28	17.34	-38.1
B41G (total)	29.1	24.48	-15.9
B41H	7.4	6.32	-14.6
B41J	15.2	13.3	-12.5
B41K	17	15.33	-9.8
B42B (total)	33.4	29.48	-11.7
B42C	8.2	6.54	-20.2
B42D	34.6	28.03	-19
B42E	5.8	5.25	-9.5
B42G	10.6	9.42	-11.1

B42H	9.2	7.98	-13.3
B51A	5.3	2.76	-47.9
B51B	7.9	4.13	-47.7
B51C	6.2	3.29	-46.9
B51E	4.6	2.71	-41.1
B51F	6.4	3.75	-41.4
B51G	7.1	3.95	-44.4
B51H	9.1	4.71	-48.2
B52B	8.9	8.43	-5.3
B60A	92.6	87.14	-5.9
B60B	105.5	96.64	-8.4
B81A	63.9	56.89	-11
B81B (total)	155.6	144.05	-7.4
B81E (total)	29.5	19.59	-33.6
B82A	23.2	17.32	-25.3
B82B	18.1	14.29	-21
B82C	14.2	11.16	-21.4
B82D	16.5	13.22	-19.9
B82E	13.6	12.03	-11.5
B83B	8.6	5.98	-30.5
B90A	6.5	5.07	-22
B90C	9	2.09	-76.8
B90D	5.3	1.1	-79.2
B90E	5.1	1	-80.4
B90G	15.5	10.83	-30.1
B90H (total)	16.2	15.02	-7.3

Figure 12: Tertiary catchment areas

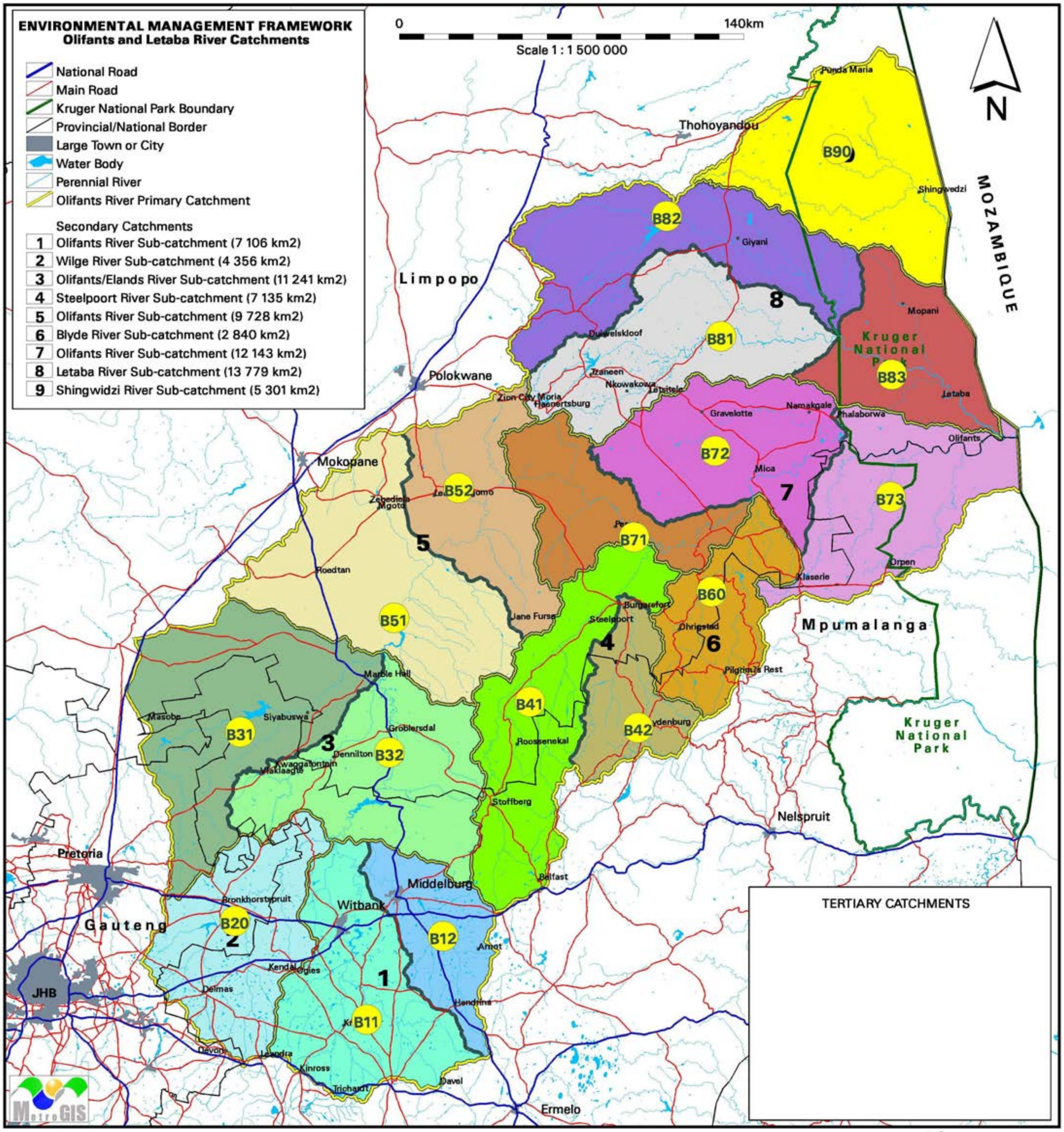


Figure 13: Rivers and major dams

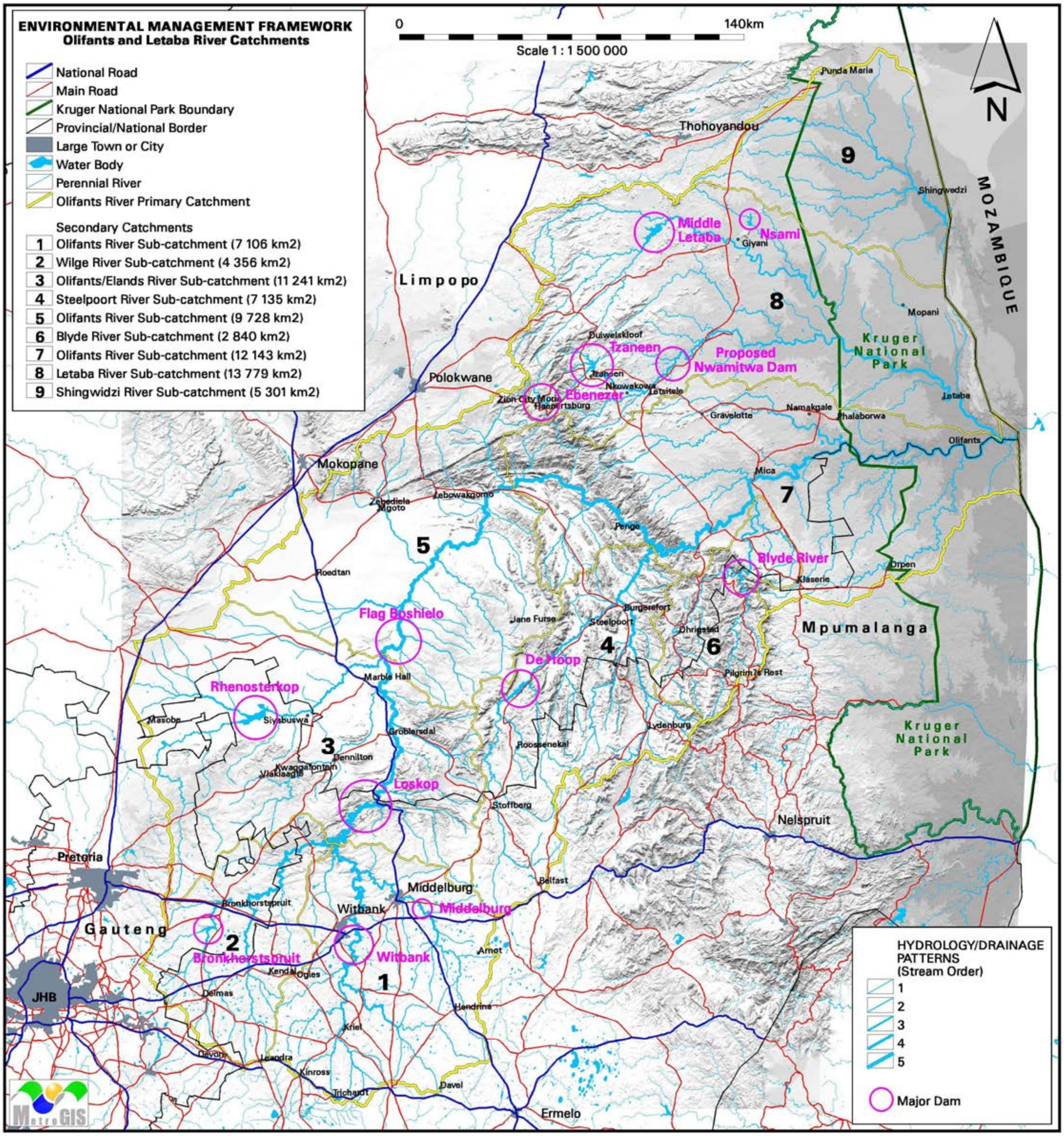
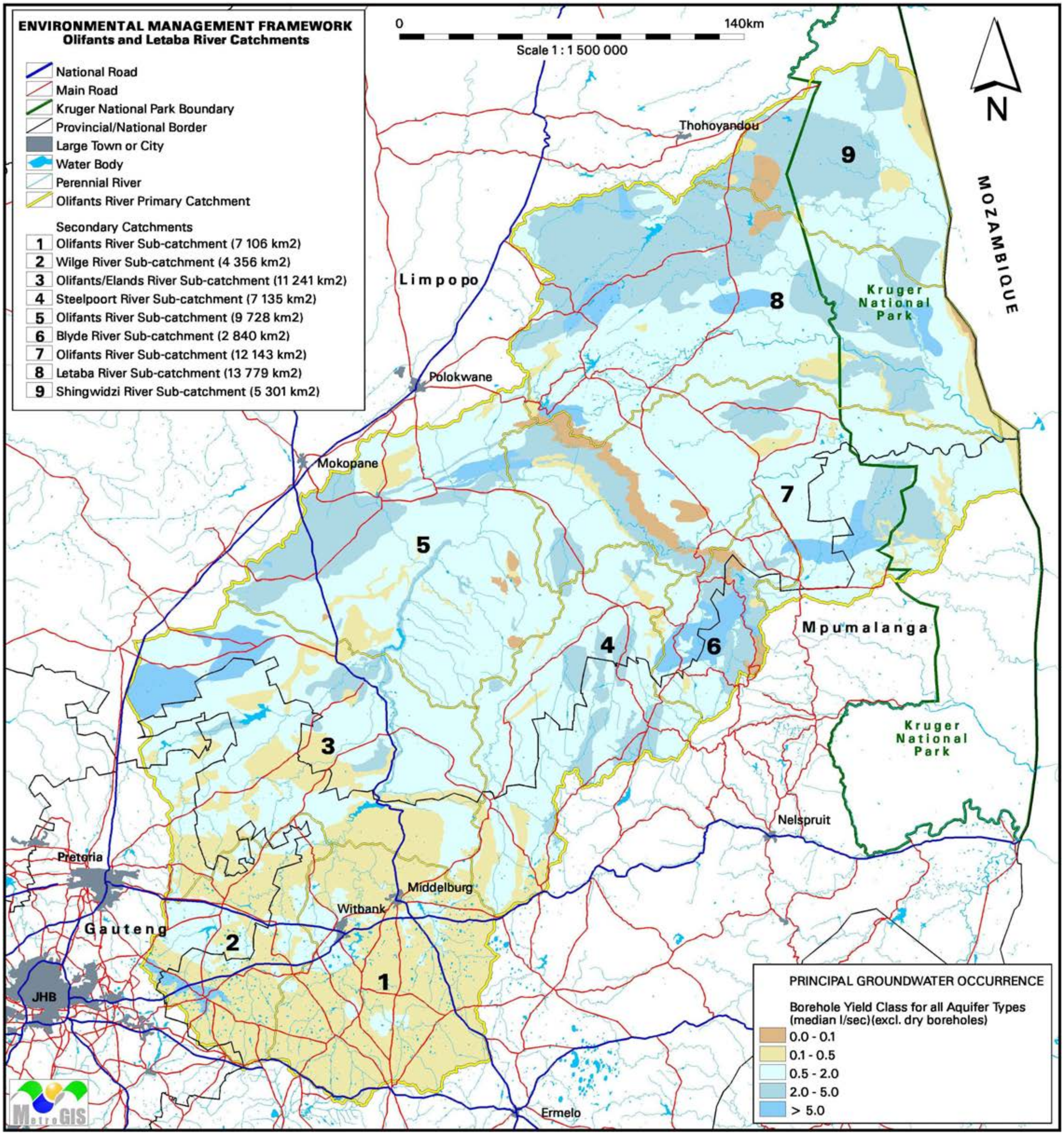


Figure 14: Groudwater yield



2.4 WATER QUALITY

The water quality for the EMF area is summarized in the Table 31 below. Significant and volumous information in respect to the ecological water requirement of the system is available in a number of DWAF documents that will be appended to the EMF documentation (on DVD). The most important findings are listed below:

Table 31 : Water quality of river reaches in the Olifants River catchment

Upper Olifants

River reach-delineated by segment numbers	Description	Comments
Olifants 1-8	Olifants river from its source to the confluence with the Steenkoospruit.	The upper reaches of the Olifants River are relatively undisturbed with dry land Agriculture being the main land-use and some coal mining at the bottom, end of the reach. Reference site : B1H006Q01 PES site: B1H018Q01
Olifants 9-13	Olifants river from the Steenkoolspruit confluence to the inflow into Witbank Dam	This reach of the Olifants is highly impacted by coal mining and power generation activities in the catchment it flows through as well as poor quality water in the Steenkoolspruit. Reference site : B1H018Q01 PES site: B1H005Q01
Olifants 14-27	Olifants River downstream of Witbank Dam to the Klipspruit confluence	This river reach is negatively impacted by water from the Spookspruit (due to coal mining activities) and the Klein Olifants River. There are no routine DWAF monitoring stations in this reach which can be used to asses the PES.
Olifants 28	Olifants River from the Klipspruit confluence to Wilge River confluence.	This river reach is negatively impacted by the poor water quality in the Klipspruit (due to old coal mining activities). There are no routine DWAF monitoring stations in this reach which can be used to asses the PES.
Olifants 29-37	Olifants from the Wilge River confluence to the inflow into Loskop Dam	This reach is positively impacted by good water quality in the Wilge river. There are no routine DWAF monitoring stations in this reach which can be used to asses the PES although the water quality in the Loskop dam was used to estimate the PES
Klein Olifants 1-4	Klein Olifants upstream of Middleburg Dam	The Klein Olifants river is highly affected by coal mining and power generation activities in its catchment. Reference site : B1H026Q01 PES site: B1H012Q01
Klein Olifants 5-12	Klein Olifants from downstream Middleburg dam to the confluence with the Olifants river	There are no routine DWAF monitoring stations in this reach which can be used to asses the PES and the weir downstream of Middleburg Dam was used for this purpose. Reference site : B1H026Q01 PES site: B1H015Q01
Wilge 1-6	Bronkhorstspruit from Bronkhorstspruit Dam to Premier Mine Dam	This reach is relatively un-impacted and agriculture is the main land- use activity Minor treated domestic sewage discharges at Bronkhorstspruit. Reference site : B2H007Q01 PES site: B2H003Q01

Wilge 7-20	Wilge River from the Premier Mine Dam to the confluence with the Olifants river	This reach of the Wilge River is in good conditions. The main land-use is agriculture. Reference site : B2H014Q01 PES site: B2H015Q01

Middle Olifants

River Segments	Descriptions	Comments
Olifants 39-57	Olifants River from Loskop Dam to Arabie Dam	This reach of the Olifants river is highly impacted by irrigation activities at the Loskop irrigation Scheme as well as the Moses and Elands Rivers which will also receive irrigation return flows Reference site : B3H015Q01 PES site: B3H001Q01
Olifants 58-84	Olifants River from Arabie Dam to Segment 84 downstream of Mohlapitse confluence	This Reach of the Olifants has the worst water quality. It is probably the result of irrigation return flows, poor land use practices adding substantial suspended sediment loads and evaporation losses concentrating salts in the river Reference site : B5H004Q01 PES site: B5H002Q01
Elands 1-15	Elands river from source to inflow into Rhenosterkop Dam	The upper Elands is in a moderately good condition with irrigation return flows, Below rust de Winter dam adding some salts to the system Reference site : B3H014Q01 PES site: B3H010R01
Elands 16-27	Elands river from downstream of Rhenosterkop Dam to the Confluence with the Olifants River	The lower Elands is highly impacted by irrigation return flows from the Loskop irrigation Scheme (Which Drains to the Olifants and Elands Rivers and Semi urban development at Siyabuswa. Reference site : B3H008Q01 PES site: B3H004Q01

Lower Olifants

River Segments	Descriptions	Comments
Olifants 85-99	Olifants river from Segment 84 to Blyde River confluence	This reach of the Olifants river is mostly affected by water quality in the Steelport River Reference site : B5H004Q01 PES site: B7H009Q01
Olifants 100-110	Olifants river from the Blyde River confluence To Selati River confluence to Selati River confluence	The Blyde River improves water quality in this reach of the Olifants Rive, Especially during the low Flow months. Reference site : B7H009Q01 PES site: B7R002Q01
Olifants 111-132	Olifants river from the Selati Confluence to Downstream border in the Kruger National Park	This reach of the Olifants river is negatively impacted by poor water quality in the Selati River as a result of Mining Activities at Phalaborwa. Reference site : B7H002Q01 PES site: B7H018Q01
Steelport 1-8	The whole of the Steelport River	Water quality in the Steelport river is affected by mining activities in the Steelport area and irrigation activities in Spekboom Catchment

		in the Burgersfort area Reference site : B4H007Q01 PES site: B4H011Q01
Blyde 1-8	The whole of the Blyde River	Water quality in the Blyde river is generally good and it has a positive impact on the Olifants River. Reference site : B6H001Q01 PES site: B6H004Q01
Selati 1-9	Upper Selati River from its source to Selati Ranch	Water quality in the upper Selati river is generally good. Irrigation is a major water use in this part of the catchments which has made a moderate impact on water quality. Reference site : B7H002Q01 PES site: B7H009Q01
Selati 10-18	Lower Selati river from Selati ranch to the confluence with the Olifants River	Water Quality in the bottom end of the Selati river is very poor as a result of water discharges from slimes of Dams and domestic effluents discharges in the Phalaborwa area. It has a large negative impact on the Olifants river water quality Reference site : B7H002Q01 PES site: B7H019Q01

The Olifants River Ecological Water Requirements Assessment (4 Volumes) provides a comprehensive study of the ecological reserve requirements of the system and will be made available as reference documents.

3. RIVER HEALTH

3.1 General Introduction

The sections below were adapted from extractions from the State of the Rivers Reports for the Olifants and Letaba River Systems (These are available as reference documents to the EMF).

3.2 The Olifants River Catcment

3.2.1 Introduction

The Olifants Catchment covers about 54 570 km^2 and is subdivided into 9 secondary catchments. The total mean annual runoff is approximately 2400 million cubic metres per year. The Olifants River and some of its tributaries, notably the Klein Olifants River, Elands River, Wilge River and Bronkhorstspruit, rise in the Highveld grasslands.

The upper reaches of the Olifants River Catchment are characterised mainly by mining, agricultural and conservation activities. Over-grazing and highly erodable soils result in such severe erosion, in parts of the middle section, that, after heavy rains the Olifants River has a red-brown colour from all the suspended sediments.

Thirty large dams in the Olifants River Catchment include the Witbank Dam, Renosterkop Dam, Rust de Winter Dam, Blyderivierspoort Dam, Loskop Dam, Middelburg Dam, Ohrigstad Dam, Arabie Dam and the Phalaborwa Barrage. In addition, many smaller dams in this catchment, have a considerable combined capacity.

The Olifants River meanders past the foot of the Strydpoort Mountains and through the Drakensberg, descending over the escarpment. The Steelpoort and Blyde tributaries, and others, join the Olifants River before it enters the Kruger National Park and neighbouring private game reserves. Crossing the Mozambique border, the Olifants River flows into the Massingire Dam.

3.2.2 Ecoregion 2.11 & 2.12

(a) Ecoregion and River Characteristics

These ecoregions span the escarpment. Ecoregion 2.11 is situated on the Highveld Plateau and the upper slopes of the escarpment, and is characterised by highveld grasslands. Ecoregion 2.12 is on the lower slopes, and sees the conversion to mixed bushveld. Moderate to high relief and sandy shallow soils are found in both regions, as is moderate rainfall (600 to 1 000 mm per year). Temperatures however, show greater variation, ranging from 10-16℃ on the upper slopes and 16-20℃ on the lower slopes.

The Spekboom and Steelpoort Rivers, tributaries of the Olifants River, arise in these ecoregions. The Spekboom has its source in the mountains near Lydenburg. It joins the Waterval River and flows in a northerly direction to the confluence with the Steelpoort River, north-west of Burgersfort. From here, the Steelpoort River flows in a north-easterly direction and converges with the Olifants River in the Drakensberg near Kromellenboog.

The river is steep, high lying, with riffles, rapids, and waterfalls in ecoregion 2.11. Wetlands and small gorges are also abundant. In 2.12 the river has a gentler slope, with predominantly sandy beds.

(b) Present Ecological State

Ecoregion 2.11

The Spekboom River is in a **good** state, with riparian vegetation slightly more impacted and reflecting **fair** health. The overall state of the Beetgekraal River is **fair**, with fish and invertebrates being **good**.

Ecoregion 2.12

The ecological state of the Steelpoort River is **fair** to **unacceptable**. The Spekboom River is generally in a **good** state. The habitats and riparian vegetation of the Waterval River are **fair**, while fish populations are **good** and invertebrates reflect a **natural** state of health.

(c) Drivers of Ecological Change (Land-use activities)

Overgrazing, and dryland cultivation throughout the ecoregions, including in the riparian zone, leads to erosion, which causes high silt levels in the rivers. The smothering of in-stream habitats and fish gills results in loss of invertebrate and fish species. Siltation also increases the risk of flooding. Runoff from mines and other activities lowers the water quality in this ecoregion, and conditions are not likely to improve in the short term.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the Spekboom River is **good**, and for the Beetgekraal, Steelpoort and Waterval Rivers it is **fair**.

3.2.3 Ecoregion 3.02 & 3.04

(a) Ecoregion and River Characteristics

This is an area of middle slopes (800-1 500 m) with mixed bushveld overlying shallow coarse sandy soils on mudstone, sandstone and shale. Average annual precipitation is 400-800 mm and temperatures range from 16-22℃.

The Rust de Winter Dam is situated in the Elands River, which rises east of Bronkhorstspruit. The Olifants River meanders from the Loskop Dam through relative flat landscape past Groblersdal and Marble Hall to the Arabie Dam, at the confluence of the Elands and Olifants Rivers. The riverbed is sandy due to alluvial deposits. From the Arabie Dam, the Olifants River flows through the Springbok Flats which forms part of the Bushveld Basin.

The river is steep with many riffles in ecoregion 3.02, becoming gentler with a sandy soft bed in ecoregion 3.04.

(b) Present Ecological State

River habitats in this region are in a **poor** to **unacceptable** state. The exception is upstream of the Rust de Winter Dam where the Elands River is in a **fair** condition. In-stream biota in the Olifants River is **fair** to **poor**, with the riparian vegetation being in a **poor** state. For the Elands River the riparian vegetation is **fair**, but in-stream biota varies from **fair** to **unacceptable**. The worst part is immediately downstream of Rust De Winter Dam, where the river is often dry because releases from the dam are insufficient or non-existent.

(c) Drivers of Ecological Change (Land-use activities)

Ecoregion 3.02

The riparian zone is in a degraded state due to deforestation within the riparian zone for small scale and subsistence agricultural activities or firewood collection. Cattle and goats graze in the riparian zone. Alien vegetation, including Seringa (*Melia azedarach*), is abundant.

On the Elands River, downstream of the Rust de Winter Dam, river flow is extremely regulated with very infrequent releases. The regulation of flow has a severe impact on in-stream biota but does not seem to affect riparian vegetation, probably due to groundwater availability. Eucalypts grow very aggressively and infestations occur.

On the Olifants River the riparian vegetation is overgrazed and over utilised. As a result, riverbanks are collapsing due to erosion, and sedimentation occurs in the riverbed.

Ecoregion 3.04

The Olifants River, upstream of the Arabie Dam, is impacted by agricultural activities. Runoff from commercial agricultural areas contains agro-chemicals, which cause eutrophication or contamination of water, either of which can impair the health of invertebrates and fish. Increased erosion and sedimentation is also a problem. The primary impact in the Elands River is ecologically insensitive releases of water from the Rhenosterkop Dam, for example no flow on one day followed by flooding the next. These artificial flow regimes change the riverbed causes erosion and results in undesirable habitat conditions for in-stream biological communities.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for this region is **fair**. Eucalypts (*Eucalyptus spp.*) Sesbania (*Sesbania punicea*) and Seringa (*Melia azedarach*), have the ability to spread aggressively, especially along streams and riverbanks, and should be contained and eradicated where possible. Water release management from Rust de Winter, Rhenosterkop and Arabie Dams must be improved. On the Olifants River the lowland floodplain is ecologically significant as it serves as a refuge area for fish. For this reason the area around the floodplain must be maintained in a **good** condition.

The determination of an ecological reserve and associated in-stream flow requirements will provide the basis for future improvements.

3.2.4 Ecoregions 7.02, 7.03 & 7.04

(a) Ecoregion and River Characteristics

This is an area of flat grasslands with rolling rocky zones on top of the escarpment (1 500-1 750 m amsl). Sandstone and shale harbor rich coal deposits, covered by deep, red to yellow sandy soils. Wetlands that overlie these deposits are threatened by potential mining activities. Precipitation is 600-800 mm per year, frequently in the form of summer storms. Mean annual temperatures range from 14-16℃.

The Wilge, Bronkhorstspruit and Klein Olifants Rivers are tributaries of the Olifants River that, together with the Olifants River, originate in the Highveld grasslands in these areas. The river structure varies from a narrow channel with no definite riparian zone up to a 20-30 m wide channel with well-defined riparian habitat. The Witbank and Doringpoort Dams are in this section

The in-stream and riparian habitats in these ecoregions show a **fair** to **unacceptable** state, with the general condition being **poor** and **fair** in ecoregions 7.02 and 7.04 respectively. Biological communities also reflect **fair** to **unacceptable** health, with the streams in ecoregion 7.04 in a slightly better state than those in ecoregion 7.02.

(b) Drivers of Ecological Change (land-use activities)

Mining, predominantly for coal, and other industrial activities in this area are the main contributors to poor in-stream and riparian habitat conditions. In-stream conditions are impaired by poor water quality, where acid leachate from mines is a primary contributor. Low pH (high acidity) and high concentrations of dissolved salts are characteristics of streams in this section.

Stream diversions occur as a result of agricultural and mining activities. In some parts, access roads, mostly related to mining and industrial activities, have resulted in severe disturbance of riparian habitats, and increased erosion of both land and riverbed. In some places the riverbeds are eroded down to the bedrock, leaving little suitable habitat for fish and aquatic invertebrates. Alien plants such as wattles also occur within the riparian zone, competing with indigenous vegetation and reducing available water in the riparian zone. Overgrazing occurs in some areas.

(c) Desired Ecological State and Response by Resource Managers

The upper reaches of the Olifants River system are heavily utilised. Yet, in the interest of downstream users, and to ensure sustainable development of the entire catchment, the ecological state of this section cannot be compromised. A short-term management state of **poor** may be the only realistic option for streams within ecoregion 7.02. However, the long-term goals should be to aim for a **fair** state. Both in-stream water quality and riparian conditions will need to improve to achieve this. The effluent from mining and other heavy industry will have to be treated before release into the river, and clearing of alien vegetation in the riparian zone is a priority.

For ecoregion 7.04, the recommended management state is **fair**. Rehabilitation and protection of the many important wetlands in the upper part of this ecoregion are management priorities.

3.2.5 Ecoregions 4.03 & 4.05

(a) Ecoregion and River Characteristics

This area lies in the upper slopes of the Drakensberg Mountains and the grasslands are interspersed with patches of afromontane forest. The high altitude (1 000 to 2 000 m amsl), shallow soils covering quartzite and shale, moderate to high rainfall (800 to 1 200 mm per year), and generally cool to moderate temperatures (10-18℃), are typical of the upper escarpment slopes.

The Steelpoort River joins the Olifants River where it meanders through the mountainous landscape of the Drakensberg. The stony riverbed varies between 50 and 80 m wide at the confluence with deep alluvial sands and silt deposits. In some areas the river forms secondary channels, floodplains and woody islands.

The Ga-Selati and Makhutswi Rivers arise near Leydsdorp. From here the rivers flow in an easterly direction. The Ohrigstad River joins the Blyde River at the Blyderivierspoort Dam in the Blyderivierspoort Nature Reserve.

(b) Present Ecological State

The Ga-Selati, Makhutswi, Blyde and Treur Rivers, as well as the Belvedere Creek are in **good** to **natural** ecological states. The present ecological state of the Spekboom River is slightly lower with the riparian habitats (**good** to **fair**) and fish (**poor**) being the worst components for this river. The Ohrigstad River has the lowest ecological state of the rivers in this region, with its overall condition being **fair** to **poor**. At places the state of in-stream and riparian habitats are **unacceptable**.

(c) Drivers of Ecological Change (Land-use activities)

Soils in this ecoregion are highly erodible. The situation is worsened by intensive cultivation and grazing, which have caused general degradation of land cover.

Serious erosion of the riparian zone of the Olifants and Ohrigstad Rivers occurs. In particular, sediment from Sekhukuneland settles here, resulting in siltation and loss of habitat. Cultivation and grazing also causes the riverbanks to destabilise, undercutting occurs and riverbanks are swept away by floods. Increased silt loads lead to high water turbidity and sedimentation on the riverbed. In addition to the loss of physical habitat, fine particles also have an irritating and clogging effect on the gills of fish and some aquatic invertebrates.

Agricultural activities next to the Blyde River include commercial citrus irrigation. Runoff contaminated with agro-chemicals may result, as well as increased erosion and sedimentation due to clearing of land under the fruit trees.

Cocklebur (*Xanthium strumarium*), a declared weed, dominates the low-lying sandbanks, dry riverbeds and floodplains.

Ecotourism developments flourish around the potholes, in the Blyde River. This is positive in terms of tourism revenue, but the increased traffic and associated erosion must be managed to prevent an increase in sedimentation in-stream.

The stretch in the Lekgalameetsi Nature Reserve is in a natural condition, but the section downstream of the nature reserve is impacted due to water abstraction and weirs. Citrus farming occurs along the banks.

The Makhutswi River flows through a reserve area and the ecological status is good to natural. Trout farming in the Spekboom River has resulted in the loss of indigenous fish species. Many weirs impact the river flow and change the habitat. In spite of this, the water quality is very good. The Blyde River gorge has been cleared of alien species like wattles and pines, and water from the Blyde River generally improves the water quality in the Olifants River downstream of their confluence.

The Belvedere Creek flows through the Blyderivierspoort Nature Reserve. Rare fish species like the Rosefin Barb (*Barbus argenteus*) have been recorded in this ecoregion. The Belvedere Creek is the only place in the Limpopo system where this species is found.

The Treur River forms part of the Blyderivierspoort Nature Reserve, The Treur River Barb (*Barbus treurensis*) dissappreared from the Treur River in the 1960's. It was, however, rediscovered in the upper Blyde River during the 1970's. This section of the Blyde River was proclaimed a National Heritage Site i 1985. The Natal Mountain Catfish (*Amphilius natalensis*) also occurs in this part of the Blyde River (the only isolated population in the Limpopo system). The reintroduced Treur River Barb now flourishes in the upper reaches of the Blyde River. The Treur River is also one of the few places where dobsonflies are found (they usually occur in mountainous areas of the Western Cape, KwaZulu-Natal and Mpumalanga).

Alien vegetation occurs in the riparian zone of the upper reaches.

Trout are found in the Ohrigstad River. Flow regulation and abstraction, especially in the upper parts of the Ohrigstad River, cause the river to dry up in places during dry periods. Tobacco farms near Ohrigstad have an impact on river habitats. Water abstracted for agricultural purposes changes river flow downstream. The river is completely dry in areas. Flow regulation by Ohrigstad Dam during dry periods results in sedimentation and scouring of the riverbed. Alien vegetation is abundant along the Ohrigstad River.

(d) Desired Ecological State and Response by Resource Managers

The desired state for the Makhutswi, Blyde and Treur Rivers, as well as for the Belvedere Creek, is **natural**. The Ga-Selati and Spekboom Rivers should be managed for a **good** state. A pragmatic management goal for the Origstad River is to achieve a **fair** state. However, the gorge-section that falls within the Blydepoort Nature Reserve should be managed for maintaining a **good** state. The Working for Water Programme has earmarked that area for alien clearing in 2001, particularly with respect to wattle, pine and eucalypts. Flow regulations during dry periods should be improved. Realistically, the Olifants and Steelpoort Rivers can only be maintained in a **poor** state, due to the nature and extent of activities in the catchment, which are likely to continue for a long time.

3.2.6 Ecoregions 5.05 & 5.06

(a) Ecoregion and River Characteristics

These ecoregions are lowveld regions, with a mean altitude of 300-600 m amsl, and a warm, dry climate (22℃ on average, with 400-800 mm precipitation per year). Lowveld bushveld is the major vegetation type.

The Blyde River meanders through the Drakensberg and enters the Lowveld before its confluence with the Olifants River. The riverbed is characterised by an abundance of big rocks, stones and pebbles. The riparian zone alternates between narrow zones close to the stream and broad zones with sandbanks and floodplains. The floodplains are elevated in relation to the riverbed.

(b) Present Ecological State

Ecoregion 5.05

The ecological state of the Klaserie River is **good** in terms of in-stream and riparian habitats, and in terms of fish populations. Invertebrates and riparian vegetation reflect a **fair** state.

Ecoregion 5.06

Upstream of the Phalaborwa Barrage, the Olifants River is in a **fair** to **poor** state in terms of in-stream and riparian habitat, while the biological indicators in general reflect a **fair** state.

The Blyde River is in an overall **good** state and in parts the fish population occasionally reflects **natural** health conditions.

The Klaserie River is in an overall **good** state, with fish and invertebrates occasionally reflecting **natural** health.

(c) Drivers of Ecological Change (land-use activities)

Ecoregion 5.05

This area is mainly an agricultural (citrus farming) and conservation area, with forestry in the upper-most part. Plantations close to the river cause in-stream sedimentation.

Ecoregion 5.06

The health of the Olifants River improves downstream of the confluence with the Blyde River, as the water coming in from the Blyde River is of better quality than that in the Olifants River.

Timeshare developments and other houses have been built in the riparian zone, requiring clearing of vegetation and increased risk of erosion. Mango and citrus orchards, which also allow little ground cover, flourish.

Ecologically insensitive releases for irrigation are a major problem to habitats and communities downstream of the Blyderivierspoort Dam. Very wide stretches of exceptionally well-developed riparian vegetation occur. The Bulldog fish (*Marcusenius macrolepidotus*) are abundant in the lower Blyde River. This species is particularly sensitive to high salinity as it uses electromagnetic pulses to find food and mates, and thus its presence is indicative of good water and habitat quality.

(d) Desired Ecological State and Response by Resource Managers

The Blyde River in this area forms part of the so-called "Kruger to Canyon" biosphere reserve initiative. This initiative will focus management towards conservation for a **natural** river state, as high water quality in this region is critical for maintaining water quality downstream in the Kruger National Park and other conservation areas.

The management goal for the Klaserie River is to maintain the river in a **good** ecological state.

Alien species like the wattle should be controlled. In order to control Xanthium strumarium, programmes will have to include the bigger catchment area since the seeds are spread by water.

The desired state for the Olifants River is **fair**.

3.2.7 Ecoregion 2.14 & 2.15

(a) Ecoregion and River Characteristics

This area has moderate to high relief, being in the foothills of the escarpment (1 000 to 1 500 m amsl). Granite, quartzite, mudstone, sandstone and shales are the main geological types, which give rise to coarse, sandy shallow soils. This, together with moderate to high temperatures (16-22℃) and relatively low mean annual precipitation (400-800 mm), supports a mixed bushveld vegetation type.

The Olifants River in this region is characterised by a single channel. After passing south of the foothills of the Strydpoort Mountains, the Olifants River converges with the Mohlapitse River. The source of the Mohlapitse River is in the Wolkberg Wilderness Area.

(b) Present Ecological State

The ecological state of the Tongwane and upper Mohlapitse Rivers is **natural**. Habitat conditions in the lower parts of the Mohlapitse River are more impacted, being **fair**, with invertebrates, fish and riparian vegetation reflecting **natural**, **good** and **fair** health respectively. For both the Olifants and Steelpoort Rivers in this region, the biological indicators reflect a predominantly **poor** state with river habitats being in an **unacceptable** state.

(c) Drivers of Ecological Change (land-use activities)

Ecoregion 2.15

The Wolkberg Wilderness Area is a high priority conservation area, and river conditions within the reserve reflect this. The Mohlapitse River is a very good refuge for fish species, as it runs through part of the Wilderness Area, where stream conditions and habitat integrity are good.

Ecoregion 2.14

Outside the Wolkberg Wilderness Area, land and vegetation are generally highly degraded due to bad land practices and over utilisation. In most parts riparian vegetation is completely absent. Small scale and subsistence crop cultivation are found in this region, as well as commercial banana plantations. Sections of the riverbank are seriously degraded due to clearing for planting of these crops, and for collection of fuel. The riparian vegetation is heavily grazed, and donga erosion is common in the riparian zone.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the Tongwane River and the part of the Mohlapitse in ecoregion 2.15 is **natural**. These are high priority conservation areas. The Mohlapitse River further downstream is utilised more intensively, but also represents an important refuge area for many fish species and lies near a wilderness area. As such, the short-term desired state could be **good**, with a long-term aim of upgrading this section to a **natural** state. The Working for Water Programme has identified this as a priority area for clearing of Triffid Weed (*Chromelaena ordata*).

3.2.8 Ecoregion 3.02 & 3.04

(a) Ecoregion and River Characteristics

This is an area of middle slopes (800-1 500 m) with mixed bushveld overlying shallow coarse sandy soils on mudstone, sandstone and shale. Average annual precipitation is 400-800 mm and temperatures range from 16-22℃.

The Rust de Winter Dam is situated in the Elands River, which rises east of Bronkhorstspruit. The Olifants River meanders from the Loskop Dam through relative flat landscape past Groblersdal and Marble Hall to the Arabie Dam, at the confluence of the Elands and Olifants Rivers. The riverbed is sandy due to alluvial deposits. From the Arabie Dam, the Olifants River flows through the Springbok Flats which forms part of the Bushveld Basin.

The river is steep with many riffles in ecoregion 3.02, becoming gentler with a sandy soft bed in ecoregion 3.04.

(b) Present Ecological State

River habitats in this region are in a **poor** to **unacceptable** state. The exception is upstream of the Rust de Winter Dam where the Elands River is in a **fair** condition. In-stream biota in the Olifants River is **fair** to **poor**, with the riparian vegetation being in a **poor** state. For the Elands River the riparian vegetation is **fair**, but in-stream biota varies from **fair** to **unacceptable**. The worst part is immediately downstream of Rust De Winter Dam, where the river is often dry because releases from the dam are insufficient or non-existent.

(c) Drivers of Ecological Change (land-use activities)

Ecoregion 3.02

The riparian zone is in a degraded state due to deforestation within the riparian zone for small scale and subsistence agricultural activities or firewood collection. Cattle and goats graze in the riparian zone. Alien vegetation, including Seringa (*Melia azedarach*), is abundant.

On the Elands River, downstream of the Rust de Winter Dam, river flow is extremely regulated with very infrequent releases. The regulation of flow has a severe impact on in-stream biota but does not seem to affect riparian vegetation, probably due to groundwater availability. Eucalyptus grow very aggressively and infestations occur.

On the Olifants River the riparian vegetation is overgrazed and over utilised. As a result, riverbanks are collapsing due to erosion, and sedimentation occurs in the riverbed.

Ecoregion 3.04

The Olifants River, upstream of the Arabie Dam, is impacted by agricultural activities. Runoff from commercial agricultural areas contains agro-chemicals, which cause eutrophication or contamination of water, either of which can impair the health of invertebrates and fish. Increased erosion and sedimentation is also a problem. The primary impact in the Elands River is ecologically insensitive releases of water from the Rhenosterkop Dam, for example no flow on one day followed by flooding the next. These artificial flow regimes change the riverbed, causing erosion and resulting in undesirable habitat conditions for in-stream biological communities.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for this region is **fair**. Eucalypts (*Eucalyptus spp.*) Sesbania (*Sesbania punicea*) and Seringa (*Melia azedarach*), have the ability to spread aggressively, especially along streams and riverbanks, and should be contained and eradicated where possible. Water release management from Rust de Winter, Rhenosterkop and Arabie Dams must be improved. On the Olifants River the lowland floodplain is ecologically significant as it serves as a refuge area for fish.

For this reason the area around the floodplain must be maintained in a **good** condition.

The determination of an ecological reserve and associated in-stream flow requirements will provide the basis for future improvements.

3.2.9 Ecoregions 2.08, 2.09 & 2.10

(a) Ecoregion and River Characteristics

This section of the Olifants River Catchment extends from the Highveld Plateau (2.08), descending the Drakensberg Escarpment (2.09) and bordering on the Bushveld Basin (2.10). The vegetation changes from highveld grassland to mixed bushveld with decreasing altitude (from 1 500 m to 1 000 m amsl). Mean annual precipitation decreases from 600-800 mm to 400-800 mm, and mean annual temperatures rise from 16-18℃ to 18-20℃. Conglome rates, granites and quartzites predominate, as do shallow, rocky, sandy soils, across the ecoregions. In the upper parts, where wetlands are common, and threatened by mining for coal deposits, Working for Water, DEAT and Mpumalanga Parks Board have completed a wetlands inventory and prioritisation for rehabilitation.

The confluence of the Olifants and Klein Olifants Rivers takes place in ecoregion 2.09. From here the Olifants River flows in a north-westerly direction where it joins the Wilge River, upstream of the Loskop Dam. The Loskop Dam is situated at the lower end of a scenic gorge with high aesthetic value. The river varies from a single channel to multiple channels with afforested islands. Riverbanks are steep in some areas. Riparian vegetation is sparse, comprised of a few grasses and reeds. Rapids and pools are common, as are boulders and large rocks in the riverbed. Floodplains are narrow.

(b) Present Ecological State

Ecoregion 2.08 & 2.09

This section of the Bronkhorstspruit is **good** to **fair**. The Wilge is in an overall **good** state and the state of the Klein Olifants is **fair**. The riparian habitats and vegetation of the Olifants River in this section are generally in **good** health. In-stream conditions are more variable, ranging from **good** to **fair**.

Ecoregion 2.10

This includes the Olifants River downstream of the Loskop Dam and the Moses River. In-stream habitat is in a **fair** state, fish **fair** to **poor** health, and invertebrates reflect **good** health. Riparian habitats and vegetation are in **fair** condition.

(c) Drivers of Ecological Change (Land-use activities)

Ecoregions 2.08 and 2.09

Agricultural activities are mainly restricted to grazing, with limited influence on the riparian vegetation. Wattles are abundant, especially along the Klein Olifants River. Conditions improve upstream of the Loskop Dam and downstream of the Bronkhorstspruit Dam, which overflows regularly. Water quality in the Olifants River is negatively impacted by the high acidity and high concentrations of dissolved salts in some of the tributaries, especially the Klip River.

Ecoregion 2.10

Intensive irrigation of crops (including fruit trees) extends from the Loskop Dam to Marble Hall. The heavy abstraction of water that this causes may reduce the water available for ecological functioning downstream. Commercial agricultural activities reach up to the riverbanks. The clearing of ground cover associated with these activities increases the potential for erosion and sedimentation in the river channel. Alien vegetation is abundant. Pump houses and weirs impact negatively on the river ecology through changes to the flow regime. Aseasonal and ecologically insensitive releases from, or retention in, the Loskop Dam have an adverse impact on in-stream biological communities and cause erosion of the riverbed, through scouring.

(d) Desired Ecological State and Response by Resource Managers

A **good** ecological state is desirable for the Wilge and Olifants Rivers. A large part of the Olifants River in this region lies in a scenic gorge with relatively high ecological importance and sensitivity. The desired ecological state for the Klein Olifants River and the Bronkhorstspruit is **fair**.

Wattles pose a threat to river health throughout these ecoregions. Their control or eradication is essential. The quality of the water in the Witbank Dam is poor, affecting the rivers downstream. The Klipspruit receives mine effluent and a long term management plan will be required to cope with the problem, because contaminant loads inherited from mining activities are likely to persist for many years.

The desired ecological state for the Olifants River downstream of the Loskop Dam is **fair**. A key step in achieving this is to determine the Instream Flow Requirements (IFR) for the river and to manage water releases from the Loskop Dam accordingly.

3.3 LETABA RIVER CATCHMENT

3.3.1 Introduction

Letaba Catchment comprises an area of approximately 13 670 km^2 with a mean annual precipitation (MAP) of 612 mm, a mean annual evaporation of 1 669 mm and a mean annual runoff (MAR) of 574 million m^3 (ranging from 100 to 2 700 million m^3)

The mean annual runoff (MAR) in the Letaba Catchment varies from more than 10% of the mean annual precipitation (MAP) in the wet mountainous zone to less than 2% in the drier parts of the catchment. More than 60% of the MAR in this catchment derives from only 6% of the area.

More than 20 major dams have been constructed in the Groot Letaba River catchment. The Tzaneen Dam on the Groot Letaba River and the Middel Letaba Dam are the two largest dams in the Northern Province. Other large dams in the catchment include the Ebenezer, Magoebaskloof, Nsami and Modjadji Dams.

As mountain and foothill streams, the Groot Letaba, Letsitele, Thabina, Debengeni and Magoebaskloof rivers have very diverse in-stream habitats. The river channels contain steep bedrock and fixed boulder rapids with cascades and occasional waterfalls. Cobble riffles occur in lower gradient sections. Deep pools are present in all river sections. These perennial rivers rise in the Great Escarpment Mountains.

The Klein Letaba, Nsama and Molototsi Rivers are typical sandy lowveld rivers, with deeply incised river channels. Wide sandy runs are interspersed with occasional gravel riffles. Bedrock dykes cross these rivers at infrequent intervals, occasionally causing deep pools on their upstream sides. River flows vary considerably during a single annual cycle.

Below the confluence of the Groot and Klein Letaba rivers, (at the KNP border) the Letaba River channel takes on the characteristics of the Klein Letaba River. The Letaba River passes through a steep confined gorge just before joining the Olifants River near the Mozambique border.

3.3.2 Ecoregions 2.15 (Groot Letaba Headwaters)

(a) Ecoregion and River Characteristics

The Groot Letaba headwater streams originate in the Drakensberg Escarpment, descending in long runs with an occasional riffle or pool. Bank sides are of gentle slope. Riparian vegetation is sparse. The natural grasslands have been replaced by commercial forestry. About 45% (more than 20 000 ha) of the total area of ecoregion 2.15 in the Letaba Catchment comprises of plantations. Less than 5% is undeveloped grassland.

The Broederstroom River has gently sloping riverbanks. In contrast the Politsi River valleys are very steep in this area. The sharp descent of the Groot Letaba River from the Central Highlands to the Lowveld makes this an area of incised streams and numerous waterfalls.

(b) Present Ecological State

The Broederstroom River is in a **fair** state by way of SASS[23] indication, with riparian vegetation (RVI[24]) and fish populations (FAII[25]) showing a poor health. Both the

[23] **SASS** means South African Scoring System and it is the biological index used for assessing aquatic invertebrate fauna. This index is based on the presence of families of aquatic invertebrates and their perceived sensitivity to water quality changes. SASS results are expressed both as an index score (SASS score) and the average score per recorded taxon (ASPT value).

[24] **RVI** means Riparian Vegetation Index, which determines the status of riparian vegetation within river segments based on the qualitative assessment of a number of criteria in the riparian zone. These criteria are vegetation removal, cultivation, construction, inundation, erosion/sedimentation and exotic species. The output is expressed as percentage deviation from natural or unmodified riparian conditions.

[25] **FAII** means Fish Assemblage Integrity Index, which is based on a categorisation of a fish community according to an intolerance rating which takes into account trophic preference and specialisation, requirement for flowing water during different life-stages, and

Politsi River and the Debengeni River has a SASS of natural, but their fish populations are in a poor state. The riparian vegetation for both rivers is in fair health.

(c) Drivers of Ecological Change (Land-use activities)

The Broederstroom River has a serious siltation problem originating from forestry roads. An improvement in the management of timber felling practices, especially during the rainy season, would reduce wash-off of soil into the river. Predatory trout have destroyed the indigenous fish populations in the Broederstroom. Sandmining for building purposes has disrupted the river channel and riparian zone of the Broederstroom.

Erosion in the riparian zone from bridge construction works occur along the Politsi River. Agriculture, forestry and informal settlements encroach on the riparian zone. Alien plants include bugweed, pines and eucalyptus.

The Debengeni Waterfalls on the Debengeni River attracts tourists. Tourism could be of great economic benefit to this area, provided authorities incorporate environmental considerations into their planning. Plantations and roads impair the functionality of the riparian zone. Alien plants and pine plantations are very close to the river's edge.

Bridge construction has disturbed bank vegetation on the Groot Letaba River, causing erosion. Bramble, lantana, bugweed, pines and other alien plants abound in this region.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the Broederstroom River, Politsi River and Debengeni River is **fair**. The desired ecological state for the Groot Letaba River is **good**.

association with habitats with unmodified water quality. Results of the FAII are expressed as a ratio of observed conditions versus conditions that would have been expected in the absence of human impacts.

3.3.3 Ecoregions 4.03, 4.04 & 5.05 (Politsi River below Magoebaskloof Dam, Letsitele and Thabina Rivers)

(a) Ecoregion and River Characteristics

Downstream of the Magoebaskloof Dam, the Politsi River enters the gently sloping Lowveld. A waterfall in the Letsitele River marks the transition from ecoregion 4.03 to ecoregion 4.04. Forestry plantations take up 30% of the total land cover of ecoregion 5.05 in this area and 64% of the area upstream of Tzaneen Dam. Subsistence farming covers 35% and commercial farming 7% of ecoregion 4.04. Ecoregion 5.05 in the Thabina and Letsitele catchments comprises 36% subsistence farming and 22% commercial farming (nearly 45% of the latter is under irrigation).

(b) Present Ecological State

The Politsi River in this region is in an overall **fair** state, with both SASS and fish populations indicating a **fair** condition. The riparian vegetation of the Politsi is in a **poor** condition however. The upper Letsitele River has a SASS of **good**, while the lower Letsitele River shows a SASS of **natural**. Both the upper and lower Letsitele River show **poor** fish population and a **fair** riparian vegetation condition. The Thabina River shows and overall **fair** condition, with SASS, fish population and riparian vegetation all in **fair** health.

(c) Drivers of Ecological Change (Land-use activities)

Magoebaskloof Dam, despite its small size, interrupts the natural flow pattern of the river. It is an irrigation dam with little capability for water releases, so that the resulting downstream flow pattern modifies river habitats. Roads next to the Politsi River and bridges across it cause erosion and siltation. Lantana, jacaranda, bugweed and eucalypts are some of the alien plant species infesting this site.

In the upper Letsitele River the riparian vegetation is in good condition, but invaded with numerous alien plants such as the castor-oil plant, sesbania, wild tobacco, large cocklebur and sugar cane. Small weirs allow abstraction for agricultural purposes.

In the lower Letsitele River alien plants invading the riparian habitat include peanut butter cassia, castor-oil plant, sesbania, ageratum and large cocklebur. A rail bridge and small weir dominate this stretch of river and solid waste pollution occurs. The river is used for irrigation and washing of clothes. Despite these impacts, the water quality and in-stream habitat is good.

In the Thabina River the riparian vegetation is under threat from excessive use by local communities and invasion by a host of alien plants, such as triffid weed (paraffin bush). No water is released from the Thabina Dam for ecological purposes. The seepage from the dam, the tributaries and the runoff that feeds the Thabina River downstream of the dam appears to be sufficient to maintain the in-stream habitat in good health.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the Politsi River and the lower Letsitele River is **fair**. The desired ecological state for the upper Letsitele River and the Thabina River is **good**.

3.3.4 Ecoregions 5.05 & 5.02 (Groot Letaba River between Tzaneen Dam and KNP)

(a) Ecoregion and River Characteristics

The Groot Letaba River has a rocky bed with many small channels and islands. Commercial agriculture, of which more than 42% is under irrigation, covers 55% of the Groot Letaba Catchment within ecoregion 5.05. Farming activities comprise also nearly 25% of ecoregion 5.02 in this catchment outside of the KNP. This is made up of about 55% subsistence farming (20 800 ha) and nearly 40% commercial irrigated farmlands (14 300 ha).

Hippos and crocodiles have successfully adapted to life in agricultural dams.

(b) Present Ecological State

The upper Groot Letaba River shows a **good** SASS, but the fish populations (FAII) indicates **poor** health. The riparian vegetation is in a **fair** condition. The middle

Groot Letaba River shows a **good** SASS but both fish and riparian vegetation are in a **fair** condition.

(c) Drivers of Ecological Change (Land-use activities)

In the upper Groot Letaba River bananas compete with invasive alien plants like lantana, castor-oil plant, bugweed, large cocklebur and peanut butter cassia for a place amongst the natural riparian vegetation.

In the middle Groot Letaba River towards the eastern part, local communities over-utilise the vegetation in the riparian zone through cutting and grazing. Alien plants have invaded the remaining riparian vegetation. The condition of the northern bank is worse than that of the southern bank.

Agricultural pesticides and fertilisers affect water quality and are the biggest threat to the western section of the Groot Letaba River.

Large weirs disrupt flows in river systems: apart from impeding fish migration, they cause bank scouring, sedimentation and loss of riparian vegetation.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for upper and middle Groot Letaba River is **fair**.

3.3.5 Ecoregions 5.03 (Molototsi and Nsama Rivers)

(a) Ecoregion and River Characteristics

The Molototsi River is a seasonal stream. The river is mostly a small trickle that disappears into the sand before it reaches the main river, but it experiences occasional heavy flooding during the summer months.

Subsistence farming is the main land-use in the Molototsi (36%) and Nsama River catchments (32%). Urban developments comprise 6,5% and 5% of the total catchment areas respectively.

(b) Present Ecological State

During the survey, the Nsama River in ecoregion 5.03 was dry and no fish or invertebrate index scores are available. The riparian vegetation for both the upper and lower Nsama River is **fair**. The upper and lower Molototsi River's riparian vegetation is in **fair** health. The lower Molototsi River has a SASS of **fair**, while the fish populations are in **poor** health.

(c) Drivers of Ecological Change (Land-use activities)

Around the upper Nsama River vegetation cutting by local communities and occurrence of alien invasive vegetation have negative impacts on the riparian habitats.

Rural communities and their cattle impact on water quality of the lower Nsama River, especially during the dry season. Washing, agriculture, cutting of trees and overgrazing within the riparian zone and other poor land-use practices all contribute to the problem. Fishing with shade nets is not a sustainable harvesting practice.

No releases are made from the Nsami Dam. A canal system exists for irrigation of bananas from the Nsami Dam. The Mangombe Nature Reserve is next to the Nsami Dam.

The Modjadji Dam, which stores water for domestic use, restricts flow downstream affecting the upper Molototsi River. The dam management programme does not include water releases that benefit the river ecology. This loss of flow is detrimental to the next 20-30km of river. Overgrazing, vegetation cutting and other poor agricultural practices occur in the catchment.

Around lower Molototsi River, environmentally unsustainable land-use practices result in accelerated erosion. Alien invasive plants occur within the riparian zone.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the upper and lower Nsama River as well as the upper and lower Molototsi River is **fair**.

3.3.6 Ecoregions 5.02 & 5.03 (Klein Letaba River)

(a) Ecoregion and River Characteristics

The Klein Letaba tributaries like the Soeketse and Koedoes rivers are wide, dry and sandy ditches for most of the year. The Middel Letaba Dam is situated in the Middel Letaba River.

Subsistence farming takes up 35% of the total land-use in ecoregion 5.03 in the Klein Letaba Catchment and 20% in ecoregion 5.02 upstream of the confluence with the Nsama River. There is no commercial farming and less than 8% subsistence farming downstream of the confluence with the Nsama River.

(b) Present Ecological State

The upper Klein Letaba River's SASS and riparian vegetation is **fair** condition. The lower Klein Letaba River's SASS and riparian vegetation is in **good** condition. Both the upper and lower Klein Letaba River's fish population is in a **poor** condition.

(c) Drivers of Ecological Change (Land-use activities)

Lantana and triffid weed are the most serious alien invader plants in ecoregion 5.03. Apart from alien invasive plants like large cocklebur, castor-oil plant and thistle in ecoregion 5.02, the riparian vegetation is in very good health.

Sand mining destroys natural habitat and is unsightly.

Agriculture consists of small-scale farming by rural communities and large commercial banana, papino, paw-paw and mango plantations upstream from Giyani. The commercial fruit farms are fed by the Middel Letaba Canal irrigation scheme.

The Middel Letaba Dam dates from the 1980s and has no facility to provide water releases that could benefit river ecology. The dam feeds a 60km long irrigation canal, which flows into the Nsama Dam. Spillage and seepage from the dam ensure good refuges for fish in the area just below the dam.

The lower end of the river (in this ecoregion) is in quite **good** condition. Population densities near the river are low because the roads and infrastructure tend away from the river.

The eastern area of this ecoregion around the Klein Letaba River has the potential to be incorporated into the Kruger National Park.

Soutini-Baleni, a geothermal wetland, is a Natural Heritage Site on the Ivory Route. Downstream of Soutini, the river has more permanent water. The river is close to natural with exceptionally good indigenous vegetation and almost no human impacts. A small salt works, fed by a natural geological fault, thrives.

Overgrazing in the riparian zone contributes toward donga erosion.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the upper Klein Letaba River is **fair**, while the desired ecological state for the lower Klein Letaba River is **good**.

3.3.7 Ecoregions 5.01, 5.07 & 6.01 (Letaba In the Kruger National Park)

(a) Ecoregion and River Characteristics

The very sandy reaches of the Letaba River support only a narrow riparian vegetation band. The riverbed in ecoregion 5.01 is sandy with increasing occurrences of bedrock downstream. The Letaba River in the KNP forms multiple channels of up to 300 m wide. In ecoregion 5.07 and 6.01 the Letaba River flows through a series of gorges and ravines. These could form significant fish barriers if water flows were to drop below a certain level. The very sandy reaches of the Letaba River support only a narrow riparian vegetation band. The riverbed in ecoregion 5.01 is sandy with increasing occurrences of bedrock downstream. The Letaba River in the KNP forms multiple channels of up to 300 m wide. In ecoregion 5.07 and 6.01 the Letaba River flows through a series gorges and ravines. These could form significant fish barriers if water flows were to drop below a certain level.

(b) Present Ecological State

The Letaba River in the upper and lower KNP are both overall in **good** health.

(c) Drivers of Ecological Change (Land-use activities)

This part of the Kruger National Park is a wilderness area with Shimuwini being the only tourist camp. Tourism impacts are therefore minimal. The Klein Letaba carries high sediment loads because of erodible soils and poor land management in the catchment. At the confluence of the Groot and Klein Letaba Rivers the gradient decreases and lower flow rates allow sediment to settle, aggravating the natural sand deposition on the Letaba River bed. Impoundment and abstraction, mainly for agriculture, reduce the flow of the Groot Letaba River, causing further settling of sediment.

In response to the lack of water brought in by the Groot Letaba, the Kruger National Park administration has had to build dams to provide water for game and to create habitats for fish, mammals, birds and reptiles. The setting of Ecological Reserves for rivers gives the KNP management the confidence to cease all dam building practices. A decision was made not to repair all the flood-damaged dams in the KNP, e.g. the Black Heron Dam is modified into a low flow guaging weir with fishladder and Shimuwini Dam completely removed.

There have been no recordings of the tiger fish in the Letaba River outside of the Kruger National Park since 1990. This temperature sensitive species dies at temperatures below 15℃. Dam walls obstruct migrati on towards warmer waters during cold spells. KNP in collaboration with Northern Province Environmental Affairs and private sponsors has recently begun reintroducing tiger fish into selected Northern Province dams.

Many Matumi, Sycamore Fig and Jackalberry trees occur along the lower Letaba River. Natal mahogany is also present, but some distance away from the river edge.

Both dams in this area, the Mingerhout Dam and the Engelhardt Dam further downstream near Letaba Camp, have good fishways.

The Kruger National Park's Letaba camp overlooks the Letaba River and is one of the most popular camps in the park. This is a wilderness area, with only a few hiking trails. The river is in a near natural state.

Very little riparian vegetation is present and the terrestrial vegetation grows right up to the rocky edges of the river. Most fish species found here are large and predatory. Crocodiles are abundant within the KNP.

(d) Desired Ecological State and Response by Resource Managers

The desired ecological state for the Letaba River in the upper and lower KNP is **natural**.

4. THE BIOLOGICAL ENVIRONMENT

4.1 VEGETATION

There are 52 vegetation types occurring within the OLEMF area. These are listed in Table 32 and shown in Figure 15. Of these, 29 occur in the Savanna Biome, 13 in the Grassland Biome and 5 in the Forest Biome. There are also 4 wetland vegetation types that are considered to be azonal (not limited to a single biome).

Table 32: Bioregions that occur in the EMF area

Name	Coverage/Km2	%
Alluvial Vegetation	166.448	0.226
Freshwater wetlands	62.2	0.243
Inland saline vegetation	2.792	0.004
Azonal Forests	5.528	0.008
Zonal and Intrazonal Forest	292.735	0.397
Mesic Highveld grassland	19, 618.487	26.643
Central Bushveld Bioregion	25, 708.328	34.925
Lowveld Bioregion	13, 866.307	18.832
Mopane Bioregion	13, 906.996	18.889
TOTAL	**73, 629.814**	

Table 33 : Vegetation types of the EMF area

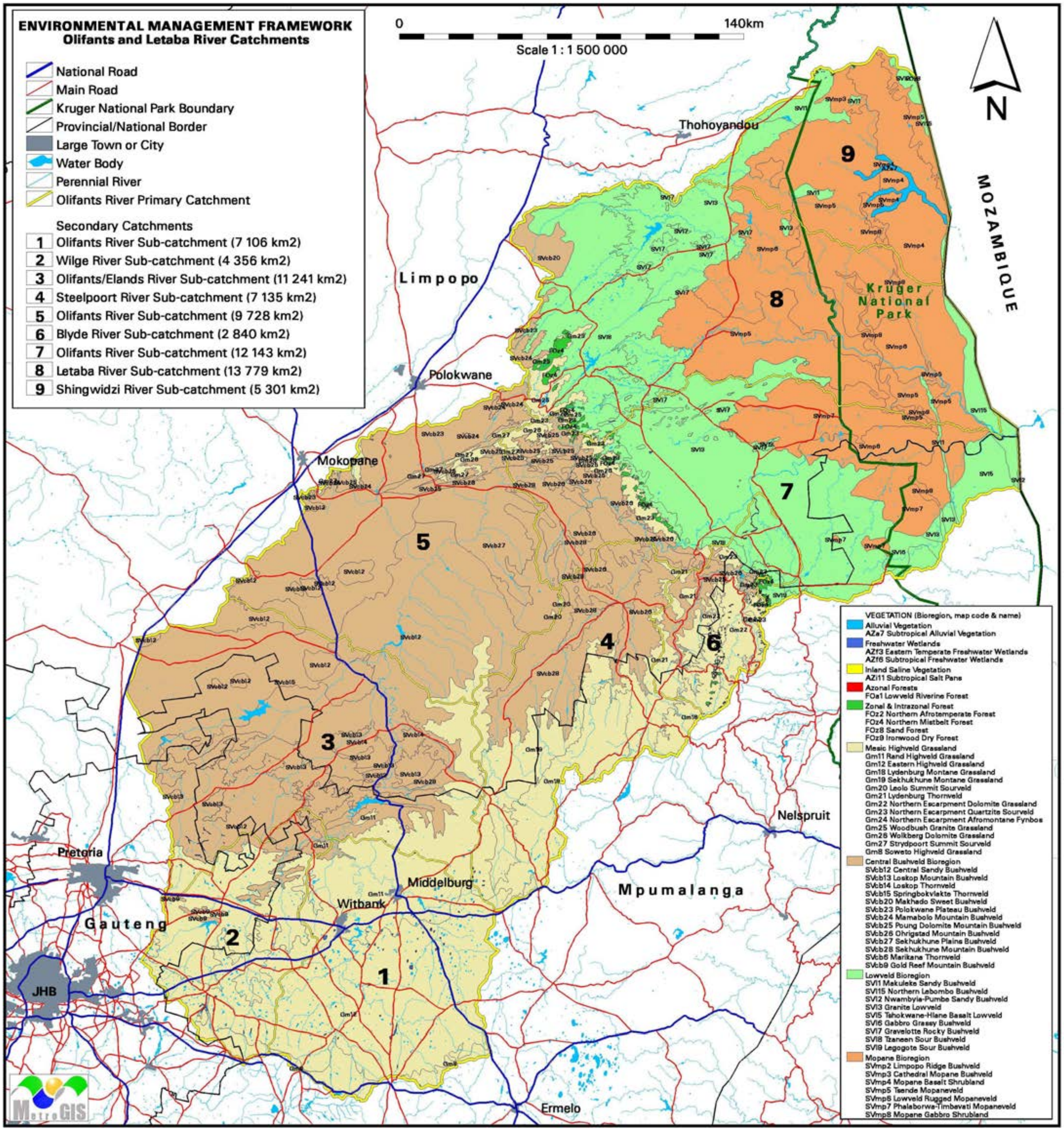
Name	Coverage (Km^2)	%
Subtropical Alluvial	166.448	0.226
Eastern Temperate Freshwater	49.263	0.067
Subtropical Freshwater Wetlands	12.939	0.176
Subtropical Salt pans	2.972	0.004
Lowveld Riverine Forest	5.528	0.008
Northern Afrotemperate Forest	1.220	0.002
Northern Mistbelt Forest	280.783	0.831

Sand Forest	6.736	0.009
Ironwood Dry Forest	3.986	0.005
Rand highveld Grassland	6, 027.493	8.186
Eastern Highveld Grassland	6, 264.644	8.508
Lydenburg Montane Grassland	2, 122.306	2.882
Sekhukhune Montane Grassland	1, 381.194	1.876
Leolo Summit Sourveld	20.344	0.028
Lydenburg Thornveld	1, 207.783	1.640
Northern Escarpment Dolomite Grassland	449.866	0.611
Northern Escarpment Quartzite Sourveld	654.765	0.889
Northern Escarpment Afromontane Fynbos	8.108	0.011
Woodbush Granite Grassland	331.682	0.450
Wolkberg Dolomite Grassland	260.845	0.354
Strydpoort Summit Sourveld	184.877	0.251
Soweto Highveld Grassland	704.580	0.957
Central Sandy Bushveld	7 906.648	10.738
Loskop Mountain in Bushveld	2, 044.407	2.777
Loskop Thornveld	759.911	1.032
Springbokvlakte	5, 341.311	7.254
Makhado Sweet Bushveld	370.419	0.503
Polokwane Plateau Bushveld	1147.280	1.558
Mamabolo Mountain Bushveld	395.141	0.537
Poung Dolomite Mountain Bushveld	846.795	1.150
Ohrigstad Mountain Bushveld	1, 998.128	2.714
Sekhukhune Plains Bushveld	2, 522.240	3.425
Sekhukhune Mountain Bushveld	2, 316.118	3.146
Marikana Thornveld	1.456	0.002
Gold Reef Mountain Bushveld	58.474	0.079
Makuleke Sandy Bushveld	512.620	0.696
Northern Libombo Bushveld	548.704	0.745
Nwambyia-Pumbe Sandy Bushveld	94.438	0.1283

Granite Lowveld	8, 470.518	11.504
Tshokwane-Hlane Basalt Lowveld	463.240	0.629
Gabbro Grassy Bushveld	219.909	0.299
Gravelotte Rocky Bushveld	309.489	0.420
Tzaneen Sour Bushveld	3, 123. 146	4.242
Legogote Sour Bushveld	124.243	0.169
Limpopo Ridge Bushveld	0.463	0.0006
Cathedral Mopane Bushveld	180.633	0.245
Mopane Basalt Shrubland	2, 761.235	3.750
Tsende Mopaneveld	5, 274.542	7.164
Lowveld Rugged Mopaneveld	3, 154.105	4.284
Phalaborwa-Timbavati Mopaneveld	2, 225.556	3.023
Mopane Gabbro Shrubland	310.462	0.422
TOTAL	**73, 29.814**	

Abbreviated descriptions of the vegetation types are included below.

Figure 15: Vegetation



4.1.1 Cathedral Mopane Bushveld (SVmp3)

The vegetation type is a moderately closed savanna. Savanna is characterised by extensive cover of grasses with scattered trees. There are tall shrubs in the understorey. The upper canopy is seldom closed and the vegetation occurs on flats or gentle slopes.

4.1.2 Central Sandy Bushveld (SVcb 12)

This vegetation occurs in low areas, sometimes between mountains and sandy plains. It supports tall, deciduous[26] woodlands. It contains two endemic species a grass and a herb. Rural communities heavily populate much of the area in the broad arc south of the Springbokvlakte. Several alien plants are widely scattered but often at low densities.

4.1.3 Eastern Highveld Grassland (Gm12)

This vegetation type occurs on slightly to moderately undulating[27] planes, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual highveld grass composition. There are small, scattered rocky outcrops with, wiry sour grasses and some woody species. Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. No serious alien invasions are reported.

4.1.4 Eastern Temperate Fresh Water Wetlands (AZf 3)

This vegetation type occurs on flat landscapes or shallow depressions filled with water bodies. It supports aquatic vegetation as well as vegetation adapted for growth in damp or wet environment of the temporary flooded grasslands. There are five species endemic to this area.

[26] **Deciduous** means a plant, which sheds its leaves each year.
[27] **Undulating** means moving up and down like waves or forming a series of regular curves.

4.1.5 Gabbro Grassy Bushveld (SVl 6)

This vegetation type is an open savanna with a dense grass cover. There are a few scattered trees and shrubs. Sparser grass cover is encountered on shallow soils. Very little is transformed and erosion is low.

4.1.6 Gold Reef Mountain Bushveld (SVcb 9)

The vegetation occurs on rocky hills and ridges often west-east trending with more dense woody vegetation often on the south-facing slopes associated with distinct floristic differences. Tree cover elsewhere is variable. Tree and shrub layers are often continuous. Grasses are dominant on the lower layers. Some areas have dense stands of alien plants. There are two endemic plant species, including one Aloe species, which occur in this area.

4.1.7 Granite Lowveld (SVl 3)

The vegetation type represents tall shrubland with few trees to moderately dense low woodland on the deep sandy uplands. Dense thicket to open savanna occurs in the bottomlands. More than 20% is already transformed, mainly by cultivation and by settlement development. Erosion is very low to moderate.

4.1.8 Gravelotte Rocky Bushveld (SVl 7)

The vegetation consists of open deciduous to semi-deciduous woodland on rocky slopes and steep sided hills composed predominantly of hard rock and rising abruptly above a plain. The vegetation contrasts strongly with the surrounding plains, and is not conserved in statutory conservation areas. Conservation of this unit is promoted due to the land use of game and cattle ranching and due to its low agronomic potential. Erosion is very low to moderate. This area contains one endemic small tree species.

4.1.9 Ironwood Dry Forest (FOz 9)

This vegetation type occurs on moderate to steep mountain slopes (up to 22°), forming dense forests (sometimes called 'thicket') dominated by Lebombo Ironwood which may build a closed canopy reaching up to 10 m. The adjacent bushveld communities are often sharply demarcated from the forest. There is a tall shrub species endemic to this area.

4.1.10 Legogote Sour Bushveld (SVl 9)

The vegetation type occurs on gently to moderately sloping upper pediment slopes[28] with dense woodland including many medium to large shrubs Short thicket occurs on less rocky sites. Exposed granite outcrops have low vegetation cover. It has been greatly transformed, mainly by plantations and also cultivated areas and urban development. There are scattered alien plants throughout the area and one endemic Aloe species.

4.1.11 Leolo Summit Sourveld (Gm 20)

The vegetation occurs on summit plateaus on major mountain ranges with steep slopes. Large boulders and stones cover the shallow soils on the hillsides and plateau. Dense, sour grassland occurs on the high-altitude upper slopes and summit of the mountain; scattered clumps of trees and shrubs occur in sheltered, rocky habitats on the plateau. There are seventeen species of endemic importance that grow within this area.

Although sparsely populated, very little of the Grassland Biome on the Leolo Mountains has remained undisturbed due to the extensive subsistence agriculture. Threatened by the mining of granite for dimension stone. Although the moist summit of the Leolo Mountains has important value as a water source to the surrounding arid valleys, it has never been regarded as a conservation priority. Erosion is very high.

4.1.12 Limpopo Ridge Bushveld (SVmp 2)

The vegetation occurs on extremely irregular plains with ridges and hills. Moderately open savanna with poorly developed ground layer. These are particularly striking landscapes with rock walls and passages within areas of sandstone of the Clarens

[28] **Pediment slope** means a broad gently sloping bedrock surface with low relief that is situated at the base of a steeper slope and is usually thinly covered with alluvial gravel and sand.

Formation (e.g. within the Mapungubwe National Park). Very little is transformed, mainly for cultivation and mining.

4.1.13 Loskop Mountain Bushveld (SVcb 13)

The vegetation occurs on low mountains and ridges with open tree savanna on lower-lying areas and a denser broad-leaved tree savanna on lower slopes and midslopes. Grasses dominate the herbaceous layer is. Cultivation and urban and built-up areas transform a small percentage of the vegetation. Erosion is mostly very low to low. There are two species endemic to this area.

4.1.14 Loskop Thornveld (SVcb 14)

The vegetation type occurs in valleys and plains of parts of the upper Olifants River catchment. Open, deciduous to semi-deciduous, tall, thorny woodland. About a quarter of the area is already transformed, mainly for agricultural crops requiring irrigation. Winter crops are the most common. Alien plants have invaded various parts of this area.

4.1.15 Lowveld Riverine Forest (FOa 1)

It is 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. An unknown portion has been irreversibly transformed by clearing for cultivation. Aliens species are serious invaders in places. 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.

4.1.16 Lowveld Rugged Mopaneveld (SVmp 6)

It occurs on irregular plains sometimes steep with slopes and prominent hills. It is usually composed of dense shrubs with occasional trees and a sparse ground layer. About 20% already transformed mainly by cultivation and some built up areas. This vegetation occurring outside the conserved areas is under pressure from high-density rural human populations and associated urban sprawl and agricultural activities.

4.1.17 Lydenburg Montane Grasslands (Gm 18)

The vegetation occurs on high-altitude plateaus, undulating plains, mountain peaks and slopes, hills and deep valleys, supporting predominantly very low grasslands on the high-lying areas. Height of the grass increases on the lower slopes. The grassland is very rich in broad-leaved herb species. Level of transformation is relatively high with mostly alien plantations and cultivated lands.

4.1.18 Lydenburg Thornveld (Gm 21)

The vegetation occurs at lower levels at the foot of the mountains and on undulating plains. This is open, frost-hardy woodland. Structurally it comprises closed grasslands which is almost always wooded, sometimes densely so in rocky areas and less so in frost-ridden valleys. Part of it has been transformed, mainly by dryland and irrigated cultivation. Rainfall is generally too low for plantations. There are three endemic species growing in this area.

4.1.19 Makhado Sweet Bushveld (SVcb 20)

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. There is one endemic species in this area.

4.1.20 Makuleke Sandy Bushveld (SVl 1)

It occurs on variable landscapes from low mountains, slightly to extremely irregular plains to hills. Tree savanna (or tall shrubs in places) occurs on the deep sands, and a moderate to dense ground layer. On stony soils the tree savanna and ground layer and dominated by different species than on the deep sands. Partly transformed, mostly through cultivation. Erosion is moderate to high in places. This area has three endemic species.

4.1.21 Mamabolo Mountain Bushveld (SVcb 24)

It occurs on low mountains, lower slopes of Strydpoort and Makapan ranges, and on rocky hills. Slopes are moderate to steep, and very rocky, covered by small trees and shrubs. Rock slabs or domes are sparsely vegetated, and then mostly with a mixture of xerophytic[29] or resurrection plants, with several succulents. Land uses include grazing wood harvesting and medicinal plant collecting. There are alien species growing in the area. Two endemic succulent shrubs grow in this area.

4.1.22 Marikana Thornveld (SVcb 6)

An open *Acacia karroo* woodland, occurring in valleys and slightly undulating plains, and some lowland hills. Shrubs are more dense along drainage lines, and rocky outcrops or in other places protected from fire. Considerably impacted, with 48% transformed, mainly cultivated and urban or built up areas. Near Pretoria, industrial development is a greater threat of land transformation. Alien invasive plants occur localised in high densities, especially along the drainage lines.

4.1.23 Mopane Basalt Shrubland (SVmp 4)

It occurs mainly on plains and slightly undulating plains with medium-low (1-2 m) shrubs dominated overwhelmingly by a mulistemed shrub form of Mopane Tree forms of Mopane are rare. The grass layer is well developed. Vegetation consists of three main variations depending on topographical position. Conserved in the Kruger National Park.

4.1.24 Mopane Gabbro Shrubland (SVmp 8)

The vegetation occurs on slightly irregular to slightly undulating landscape with numerous outcrops of gabbro[30]. Mainly a low shrub layer with two main structural variations: a shrubveld with practically no trees and a shrubveld with a few larger shrubs and trees. Species diversity is the highest in the latter variation. The ground layer of both variations is dense.

[29] **Xerophytic** means a plant adapted to living in a dry arid habitat.
[30] **Gabbro** means a usually coarse-grained igneous rock composed chiefly of calcic plagioclase and pyroxene.

4.1.25 Northern Afrotemperate Forest (FOz 2)

It is low, relatively species-poor forests of afromontane[31] origin and some of them still showing clear afromontane character. Occasional hot fires encroaching from the surrounding savanna woodlands, uncontrolled timber extraction, medicinal-plant harvesting, and grazing in forest can be viewed as the current major threats. There are four endemic species growing in this area.

4.1.26 Northern Escarpment Afromontane Fynbos (Gm 24)

The dominant structural form of the vegetaion type is shrubland comprised of shrubs with thick leathery evergreen foliage that retains water and herbs, many with stress tolerant fungal growth forms. It occurs in fragmented patches of high-lying quartzite ridges that experience frequent mist. Terrain is very rocky and fires are very rare. The landscape is rugged and soils shallow, therefore very little transformation has occurred.

4.1.27 Northern Escarpment Dolomite Grassland (Gm 22)

It is a very species-rich grasslands that occur along the Escarpment dolomite belt. The grasslands are characterised by a very diverse shrub layer, which varies in height and density. The herbaceous component becomes more dense northwards as the climate becomes drier. More than half has been transformed mainly by plantations and cultivated lands. Very little is currently protected.

4.1.28 Northern Escarpment Quartzite Sourveld (Gm 23)

The landscape where the vegetation occurs is characteristically very rugged, with steep east-facing cliffs. This escarpment is intersected in some areas with large east-flowing rivers. It is a short, closed grassland rich in broad-leaved herb species with scattered trees and shrubs. This area is very rocky and occurs on weather-resistant quartzite. The nutrient-poor soils lead to lower biomass, which, together with the rocky landscape, results in a reduced frequency and intensity of fires. Mainly

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

plantations have transformed a large portion of this area. There are seventy endemically important species growing in this area, including an Aloe and Protea.

4.1.29 Northern Lebombo Bushveld (SVI 16)

It is open bushveld on rocky slopes and ridges of a linear range of hills reaching about 100 m (and higher in places) above its surrounding basalt plains towards the west. Tree succulents are typical on steep, stony slopes. There has been virtually no transformation.

4.1.30 Nothern Mistbelt Forest (FOz 4)

It consists of tall, evergreen afrotemperate mistbelt forests occurring primarily in east-facing fire refugia where they form small fragmented patches. The herb layer supports a number of dominating herbs and so called ‘soft shrubs’, geophytic herbs and ferns. Encroaching subsistence agriculture, firewood collection in communal areas, and selective harvesting of bark are viewed as serious threats.

4.1.31 Nwambyia-Pumbe Sandy Bushveld (SVI 2)

It occurs on flats with several small pans embedded. The absence of well-defined drainage channels is conspicuous. Moderately open tall shrubland with few trees.

Three endemic species of plants grow in this area.

4.1.32 Ohrigstad Mountain Bushveld (SVcb 26)

It is an open to dense woody layer, with associated woody and herbaceous shrubs and closed to open grass layer. The vegetation occurs on moderate to steep slopes on mountainsides and sometimes deeply incised valleys; also fairly flat terrain in a few places. Aliens are scattered throughout the area. Erosion is variable. There are five endemic species in this area.

4.1.33 Phalaborwa-Timbavati Mopaneveld (SVmp 7)

It is an open tree savanna on undulating plains with the sandy uplands dominated by different trees than the clayey bottomlands. The field layer is usually well developed. A feature is the large number of termite mounds on the uplands.

4.1.34 Polokwane Plateau Bushveld (SVcb 23)

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 species are of concern.

4.1.35 Poung Dolomite Mountain Bushveld (SVcb 25)

It is open to closed woodland with well-developed shrub layers and occur on low to high mountain slopes on various slope angles, aspects and altitude, especially along the western extension. There are approximately twenty important endemic species growing in this area.

4.1.36 Rand Highveld Grassland (Gm 11)

The vegetation type occurs on a highly variable landscape with extensive sloping plains and a series of ridges slightly elevated over undulating surrounding plains. The vegetation is species-rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. There is a high diversity of herbs. Rocky hills and ridges carry sparse (savannoid) woodlands accompanied by a rich suite of shrubs. Poorly conserved, only small patches protected. Almost half has been transformed mostly by cultivation, plantations, urbanisation or dam-building. There are thirteen endemic species growing in this area.

4.1.37 Sand Forest (FOz 8)

Dense thickets of 5-6 m up to forests with the canopy reaching 15 m with a well developed shrub layer and a very poorly developed ground layer. Epiphytic orchids and lichens festoon all the tall trees. It is critically endangered due to its vulnerability and economic pressure. An unknown portion was lost through clearing for subsistence agriculture and grazing. Uncontrolled extraction of wood for fuel and woodcraft is a problem. Twenty-seven species that grow in this area are of endemic importance.

4.1.38 Sekhukhune Montane Grassland (GM 19)

It occurs on major chains of hills that transect the area and have a north-south orientation, creating moderately steep slopes with predominantly eastern and western aspects. Large norite[32] boulders and stones cover the shallow soils on the hillsides. Dense, sour grassland occur on slopes of mountains and undulating hills, with scattered clumps of trees and shrubs in sheltered habitats. Dense, tall grassland is found on the plains and encroachment by indigenous or invasion by alien small-leaved tree species is common in places. Approximately 30% of this area is under commercial or subsistence cultivation. Vast areas are mined for vanadium using strip mining. There is no formal conservation in the area.

4.1.39 Sekhukhune Mountain Bushveld (SVcb 28)

It is dry, open to closed small-leaved and broad-leaved savanna on hills and mountain slopes. Open bushveld often associated with soils containing a group of dark-colored minerals, composed chiefly of magnesium and iron on southern aspects. Bushveld on this type of soil contain a high diversity of species influenced by the soil rather than by the climate. Bushveld of mountain slopes generally taller than in the valleys, with a well-developed herb layer. Bushveld of valleys and dry northern aspects usually dense, like thicket, with a herb layer comprising many shortlived perennials. Dry habitats contain a number of species with xerophytic adaptations, such as succulence and underground storage organs. Both man-made and natural erosion dongas occur on footslopes of clays rich in heavy metals. An increasing area along the Dwars River Subsuite is under pressure from mining activities and its associated urbanisation. There are thirteen endemic species growing in this area.

4.1.40 Sekhukhune Plains Bushveld (SVcb 27)

It occurs mainly on semi-arid plains and open valleys between chains of hills and small mountains running parallel to the escarpment. Predominantly short, open to close thornveld with an abundance of *Aloe* species and other succulents. Heavily degraded in places and overexploited by man for cultivation, mining and urbanisation.

[32] Norite means a granular crystalline rock consisting essentially of a triclinic feldspar (as labradorite) and hypersthene.

Both man-made and natural erosion dongas occur in areas containing clays rich in heavy metals. Encroachment by indigenous small-leaved trees and invasion by alien species is common throughout the area. There is a high level of degradation of much of the remaining vegetation by unsustainable harvesting and utilisation. There are twelve endemically important species growing in this area.

4.1.41 Soweto Highveld Grassland (Gm 8)

It occurs on gently to moderately undulating landscape on the Highveld plateau, supporting short to medium-high, dense, tufted grassland. In places not disturbed, only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover. Only a handful of patches statutorily conserved or privately conserved. Almost half of the area already transformed by cultivation, urban sprawl, mining and building of road infrastructure. Dams have flooded some areas.

4.1.42 Springbokvlakte Thornveld (SVcb 15)

An open to dense, low thorn savanna dominated by Acacia species or shrubby grassland with a very low shrub layer. Occurs on flat to slightly undulating plains. Very scattered alien plants over wide areas. There is one central bushveld endemic species growing in this area.

4.1.43 Strydpoort Summit Sourveld (Gm 27)

It consists of short to tall grasslands along rocky summits and mountain slopes. The landscape has a very broken topography with incised valleys. The slopes are steep and rocky, and sparsely wooded. Transformation levels are very low. There are ten endemically important species growing in this area, including Aloes and Proteas.

4.1.44 Subtropical Alluvial Vegetation (AZa 7)

It occurs on flat alluvial[33] 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

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

flooded grasslands, short lived herblands and riverine thickets. Much of the area has been transformed for cultivation, urban development and road building. Alien woody species commonly occur in this vegetation.

4.1.45 Subtropical Freshwater Wetlands (AZf 6)

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 depressions formed by the erosion or deposition of weathered surface materials by wind, as well as fringing alluvial backwater pans or artificial dams. So far only about 4% has been transformed (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. There are sixteen important endemic species growing in the southern most distribution limit of this area.

4.1.46 Subtropical Salt Pans (AZi 11)

It occurs in shallow depressions, often found on old alluvial terraces of rivers, surrounded by zones of bank reeds or low herblands and in more perennial pans also filled with a dense carpet of macrphytic floating vegetation. Aliens plants invade edges of some pans. Alien species are dominant in some Lowveld pans when filled with water.

4.1.47 Tsende Mopaneveld (SVmp 5)

It occurs on slightly undulating plains with medium-high shrubby savanna, with some trees and dense ground layer. In the northwest parts the tree cover is greater and, together with the southern and northeastern outliers of the unit, these flatter landscapes include several trees. Some 63% statutorily conserved, almost all in the Kruger National Park.

4.1.48 Tshokwane-Hlane Basalt Lowveld (SVl 5)

It usually occurs on fairly flat plains with open tree savanna with a moderately developed shrub layer and a dense herbaceous layer. On some sloping areas with shallower soils, trees are stunted. About 64% statutorily conserved, mainly in the Kruger National Park. One endemic species grows in this area.

4.1.49 Tzaneen Sour Bushveld (SVI 8)

Deciduous, tall open bushveld (parkland) with a well-developed, tall grass layer, occurring on low to high mountains with undulating plains mainly at the base of, and on the lower to middle slopes of the northeastern escarpment. Very little currently conserved. Mainly cultivation and plantations transform about 41%. Scattered alien plants include occur throughout the area. The subtropical climate is conductive to the spread of certain alien plants. Erosion is variable.

4.1.50 Wolkberg Dolomite Grassland (Gm 26)

It occurs on a series of broad mountain ridges, broad elevated plateaus and adjacent slopes covered with species-rich short closed grasslands rich in forbs[34]. About half of this unit is formally protected within the Bewaarkloof and Lekgalameetse Nature Reserves and well as the Wolkberg Wilderness Area. There are at least ten endemically important species growing on this area, including a Protea.

4.1.51 Woodbush Granite Grassland (Gm 25)

It consists of mountainous plateaus covered by grassland, showing increased low-shrub density on steep south- and east-facing slopes. Only about 10% of this area is still in its natural state. There are no conservation areas protecting patches of this unit. Major land transformation is mainly due to forestry. Alien plants frequently grow in this area. The vegetation is subject to bush encroachment (from both scrub forest and sour bushveld) exacerbated by exclusion of fire.

[34] **Forb speices** means a broad-leaved herb other than a grass.

4.2 MEDICINAL PLANTS

The medicinal plants indicated in Table 34 are commonly harvested in the EMF area wherever they occur. The indigenous forests are however specifically targeted due to the densities that occur there.

Table 34: Commonly used medicinal plants that occur in the area

SPECIES	USE	SPECIES	USE
Abrus precatorius	Medicinal	Harpephyllum caffrum	Medicinal
Acacia burkei	Medicinal, fuel	Huernia hystrix	Medicinal
Acacia nilotica	Medicinal, fuel, tanning	Kigelia africana	Medicinal, food, beer
Acacia robusta	Medicinal, twine, tanning	Lonchocarpus capassa	Medicinal. pots, timber
Acacia xanthophloea	Medicinal, fuel, building	Manilkara mochisa	Medicinal
Adenia gummifera	Medicinal	Mentha longifolia	Medicinal
Adenium multiflorum	Medicinal	Mimusops zeyheri	Medicinal, food
Afzelia quanzensis	Medicinal, fuel	Munulea sericea	Medicinal, rope
Albizia adianthifolia	Medicinal, fuel	Ocotea bullata	Medicinal, ornaments
Alepidea amatymbica	Medicinal	Ocotea keniensis	Medicinal
Antidesma venosum	Medicinal	Pachycymbim rogersii	
Balanites maughamii	Medicinal, fuel, food	Pachypodium saundersii	Medicinal
Baphia racemosa	Medicinal	Peltophorum africanum	Medicinal, ornaments
Berchemia zeyheri	Medicinal, fuel, ornaments	Protorhus longifolia	Medicinal
Bersama lucens	Medicinal	Pterocarpus angolensis	Medicinal, furniture
Bolusanthus speciosa	Medicinal, ornaments	Rauvolfia caffra	Medicinal
Bowiea volubilis	Medicinal	Rhus chirindensis	Medicinal
Bridelia micrantha	Medicinal	Scadoxus multiflora	Medicinal
Capparis tomentosa	Medicinal	Schotia brachypetala	Medicinal, food
Clivia miniata	Medicinal	Sclerocarya birrea	Beer, food, cultural
Combretum erythrophyllum	Medicinal, fuel, timber	Sczobasis intricata	Medicinal
Combretum molle	Medicinal	Spirostachys africana	Medicinal, furniture
Curtisia dentata	Medicinal	Strychnos spinosa	Medicinal, food
Ekebergia capensis	Medicinal, furniture	Syzygium cordatum	Medicinal, food
Erythrina lysistemon	Medicinal	Trichilia emetica	Medicinal, furniture
Euclea divinorum	Medicinal	Vangueria cyanescens	Medicinal
Ficus sur	Medicinal, drums	Ximenia caffra	Medicinal, food
Garcinia livingstonei	Medicinal	Ziziphus mucronata	Medicinal, timber
Gardenia volkensii	Magic, timber, fuel		

4.3 CENTRES OF ENDEMISM

In addition to these priority conservation areas, there are also three Centres of Endemism that occur within the Olifants River catchment, the Sekhukhuneland, Wolkberg and Soutpansberg Centres of Endemism. The Sekhukhuneland Centre of Endemism is entirely within the catchment. Approximately half of the Wolkberg Centre of Endemism is within the catchment. Only a small part of the Soutpansberg Centre of Endemism occurs within the catchment. These Centres of Endemism contain high levels of diversity with many species restricted entirely to these areas.

4.3.1 Wolkberg Centre Endemism

The exact size of the Wolkberg Centre flora is unknown, but the area is extremely floristically rich. More than 40 species ore endemic/near endemic to the dolomites and more than 90 to the quartz- and shale-derived substrates. These figures are conservative, with more taxa likely to be added as knowledge of the flora improves.

The three families with the largest number of endemics on the quartzitic and related rock types are the Asteraceae, Iridaceae and Liliaceae. The asteraceous genus *Helichrysum* with 10 species being the most prolific in producing endemics. *Gladiolus* has more than ten species endemic to the region as a whole. The Liliaceae is the family with the largest number of dolomite endemics to the region as a whole, followed by the Euphorbiaceae, Lamiaceae and Acanthaceae. For mosses, the Wolkberg Centre is one of the main southern African centres of diversity and a secondary centre of endemism.

Significantly, nearly all the endemics (notably the quartzitic ones) are grassland species. Most of the taxa endemic to the Wolkberg Centre appear to be palaeoendemics.

The Wolkberg Centre, especially the arid dolomite areas, shares many species with the adjacent Sekhukhuneland Centre, several of which are endemic to the combined region.

The high-rainfall grasslands of the Wolkberg Centre are seriously threatened by mainly commercial afforestation. It is ironic that efforts to conserve the flora of the Wolkberg Centre have hitherto focused mainly on the protection of the patches of floristically poor Afromontane Forest, the endemic-rich grasslands are being allowed to be destroyed at an alarming rate, particularly by the timber industry. The little grassland that remains is also being threatened by invader alien plants (mainly from plantations) as well as lack of frequent burning, particularly in plantation areas. Frequent fires are essential for maintaining grassland structure and phytodiversity. Less than 1% of the montane grasslands, the vegetation type richest in Wolkberg Centre endemics, is conserved.

The Wolkberg Centre remains botanically poorly explored and new species are still being discovered, even in relatively well-collected areas.

4.3.2 Sekhukhuneland Centre Endemism

The vegetation of the Sekhukhuneland Centre has never been studied in detail. It is usually mapped as Mixed Bushveld. However, floristically the bushveld of Sekhukhuneland Centre is quite unique and certainly deserves recognition as a separate type. The *Kirkia wilmsii*, a species that is relatively rare in other parts of the Mixed Bushveld is a characteristic tree of this area. Vegetation differences between the north- and south-facing aspects of the mountains are often striking. Intriguing vegetation anomalies associated with heavily eroded soils are present throughout the region.

The flora of the Sekhukhuneland Centre is still poorly known, with many apparently endemic species awaiting formal description. Families particularly rich in Sekhukhuneland Centre endemics include the Anacardiaceae, Euphorbiaceae, Liliaceae, Lamiaceae and Vitaceae. A still-to-be-described monoptypic genus of the Alliaceae is endemic also. The area around Burgersfort is reputed to have the highest concentration of *Aloe* species in the world.

There is only one official nature reserve in the Sekhukhuneland Centre, namely Potlake Nature Reserve. Owing to the ruggedness of the terrain, however, the mountainous parts of the Sekhukhuneland Centre are still fairly intact. Overgrazing by domestic livestock has seriously degraded the vegetation in the densely populated areas. Population pressure is also impacting negatively on the flora of the Steelpoort River Valley.

The Leolo Mountains harbour relic patches of Afromontane Forest, Fynbos-type vegetation and several Sekhukhuneland Centre endemics. There are also some rare wetlands in the summit area.

There is a great need for closer taxonomic scrutiny of the taxa in the Sekhukhuneland Centre to ensure the appropriate labelling of ecotypes and endemic species. Botanically the Sekhukhuneland Centre remains one of the least known parts of the former Transvaal.

There are a number of forest patches along the escarpment within the catchment. These are considered to be sensitive and are also protected by law.

Other areas considered sensitive, but for which there is no detailed information currently in map format include wetlands and Red List plant species. There are also various parts of the catchment that occur within protected areas. The distribution of protected areas relative to the catchment is shown in Figure 17.

4.4 THREATENED ECOSYSTEMS

Four vegetation types are listed as Critically Endangered, eight as Endangered and eleven as Vulnerable.

Table 35: Conservation status of vegetation in the EMF area

Vegetation type	Biome	Cons. target	Protected	Remain	Conservation status
Cathedral Mopane Bushveld	Savanna Biome	19%	100%	99.6%	Least threatened
Central Sandy Bushveld	Savanna Biome	19%	2.4% (+2.2%)	75.9%	Vulnerable
Eastern Highveld Grassland	Grassland Biome	24%	0.3%	56%	Endangered
Eastern Temperate Freshwater Wetlands	Azonal Vegetation	24%	4.6%	85.1%	Least threatened
Gabbro Grassy Bushveld	Savanna Biome	19%	95.9% (+3.7%)	99.6%	Least threatened
Gold Reef Mountain Bushveld	Savanna Biome	24%	22.1% (+1.2%)	84.6%	Least threatened
Granite Lowveld	SavannaBiome	19%	17.5% (+17.3%)	79.2%	Vulnerable
Gravelotte Rocky Bushveld	Savanna Biome	19%	0% (+6.9%)	85.5%	Least threatened
Ironwood Dry Forest	Forests	100%	77.8%	99.9%	Critically endangered
Legogote Sour Bushveld	Savanna Biome	19%	1.6% (+2.3%)	50.4%	Endangered
Leolo Summit Sourveld	Grassland Biome	24%		See text	Vulnerable
Limpopo Ridge Bushveld	Savanna Biome	19%	18.1% (+1.8%)	99.1%	Least threatened
Loskop Mountain Bushveld	Savanna Biome	24%	14.5% (+1.9%)	97.6%	Least threatened
Loskop Thornveld	Savanna Biome	19%	11.3%	75.8%	Vulnerable
Lowveld Riverine Forest	Forests	100%	50% (+3%)	97.6%	Critically endangered
Lowveld Rugged Mopaneveld	Savanna Biome	19%	34.4% (+5.6%)	80.2%	Least threatened
Lydenburg Montane Grassland	Grassland Biome	24%	2.5% (+5.9%)	77.7%	Vulnerable
Lydenburg Thornveld	Grassland Biome	24%	1.9%	78.7%	Vulnerable
Makhado Sweet Bushveld	Savanna Biome	19%	0.8%	72.8%	Vulnerable
Makuleke Sandy Bushveld	Savanna Biome	19%	31.5%	73.3%	Vulnerable
Mamabolo Mountain Bushveld	Savanna Biome	24%	7.6%	93.9%	Least threatened
Marikana Thornveld	Savanna Biome	19%	0.7% (+1.5%)	52.1%	Endangered
Mopane Basalt	Savanna Biome	19%	100%	99.6%	Least threatened

Shrubland					
Mopane Gabbro Shrubland	Savanna Biome	19%	100%	99.7%	Least threatened
Northern Afrotemperate Forest	Forests	31%	28.8% (+2.8%)	98.5%	Least threatened
Northern Escarpment Afromontane Fynbos	Grassland Biome	27%	56.1% (+5.8%)	99.3%	Least threatened
Northern Escarpment Dolomite Grassland	Grassland Biome	27%	2.1% (+8.5%)	47.7%	Endangered
Northern Escarpment Quartzite Sourveld	Grassland Biome	27%	15.3% (+9.2%)	61.6%	Vulnerable
Northern Lebombo Bushveld	Savanna Biome	24%	98.8%	99.8%	Least threatened
Northern Mistbelt Forest	Forests	30%	10% (+25.2%)	83.7%	Least threatened
Nwambyia-Pumbe Sandy Bushveld	Savanna Biome	19%	98.7%	99.6%	Least threatened
Ohrigstad Mountain Bushveld	Savanna Biome	24%	7.6% (+4.2%)	90.7%	Least threatened
Phalaborwa-Timbavati Mopaneveld	Savanna Biome	19%	See text	95.1%	Least threatened
Polokwane Plateau Bushveld	Savanna Biome	19%	1.4% (+0.7%)	83.2%	See text
Poung Dolomite Mountain Bushveld	Savanna Biome	24%	9.9% (+6.2%)	94.1%	Least threatened
Rand Highveld Grassland	Grassland Biome	24%	0.9%	58.5%	Endangered
Sand Forest	Forests	100%	42.1%	98.5%	Critically endangered
Sekhukhune Montane Grassland	Grassland Biome	24%		72%	Vulnerable
Sekhukhune Mountain Bushveld	Savanna Biome	24%	(+0.4%)	86.3%	Least threatened
Sekhukhune Plains Bushveld	Savanna Biome	19%	0.8% (+1%)	74.5%	Vulnerable
Soweto Highveld Grassland	Grassland Biome	24%	0.2%	52.7%	Endangered
Springbokvlakte Thornveld	Savanna Biome	19%	1% (+2.6%)	50.7%	Endangered
Strydpoort Summit Sourveld	Grassland Biome	24%	17.2% (+1.7%)	99.4%	Least threatened
Subtropical Alluvial Vegetation	Azonal Vegetation	31%	See text	84.5%	Least threatened
Subtropical Freshwater Wetlands	Azonal Vegetation	24%	40%-50% (+10.5%)	96.4%	Least threatened
Subtropical Salt Pans	Azonal Vegetation	24%	42%	89.5%	Least threatened
Tsende Mopaneveld	Savanna Biome	19%	63.3% (+4.8%)	88.4%	Least threatened
Tshokwane-Hlane Basalt Lowveld	Savanna Biome	19%	64.4% (+3.4%)	83.5%	Least threatened
Tzaneen Sour Bushveld	Savanna Biome	19%	1.3% (+2.1%)	59.2%	Endangered
Wolkberg Dolomite Grassland	Grassland Biome	27%	48.6% (+6.2%)	96.7%	Least threatened
Woodbush Granite	Grassland	27%	0% (+14.9%)	See text	Critically endangered

Grassland	Biome

Figure 16a: Threatened ecosystems and centers of endemism (SANBI info)

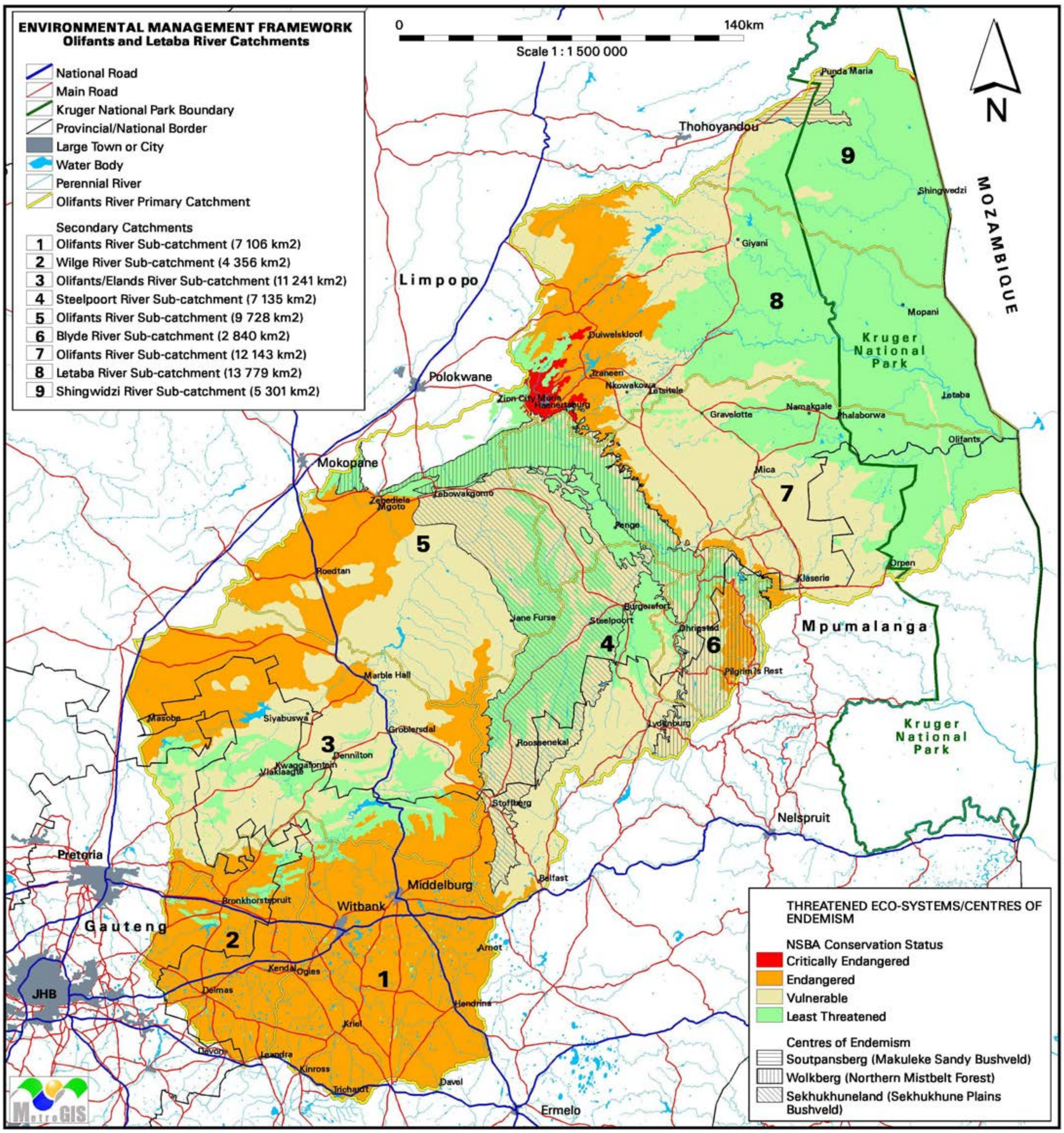
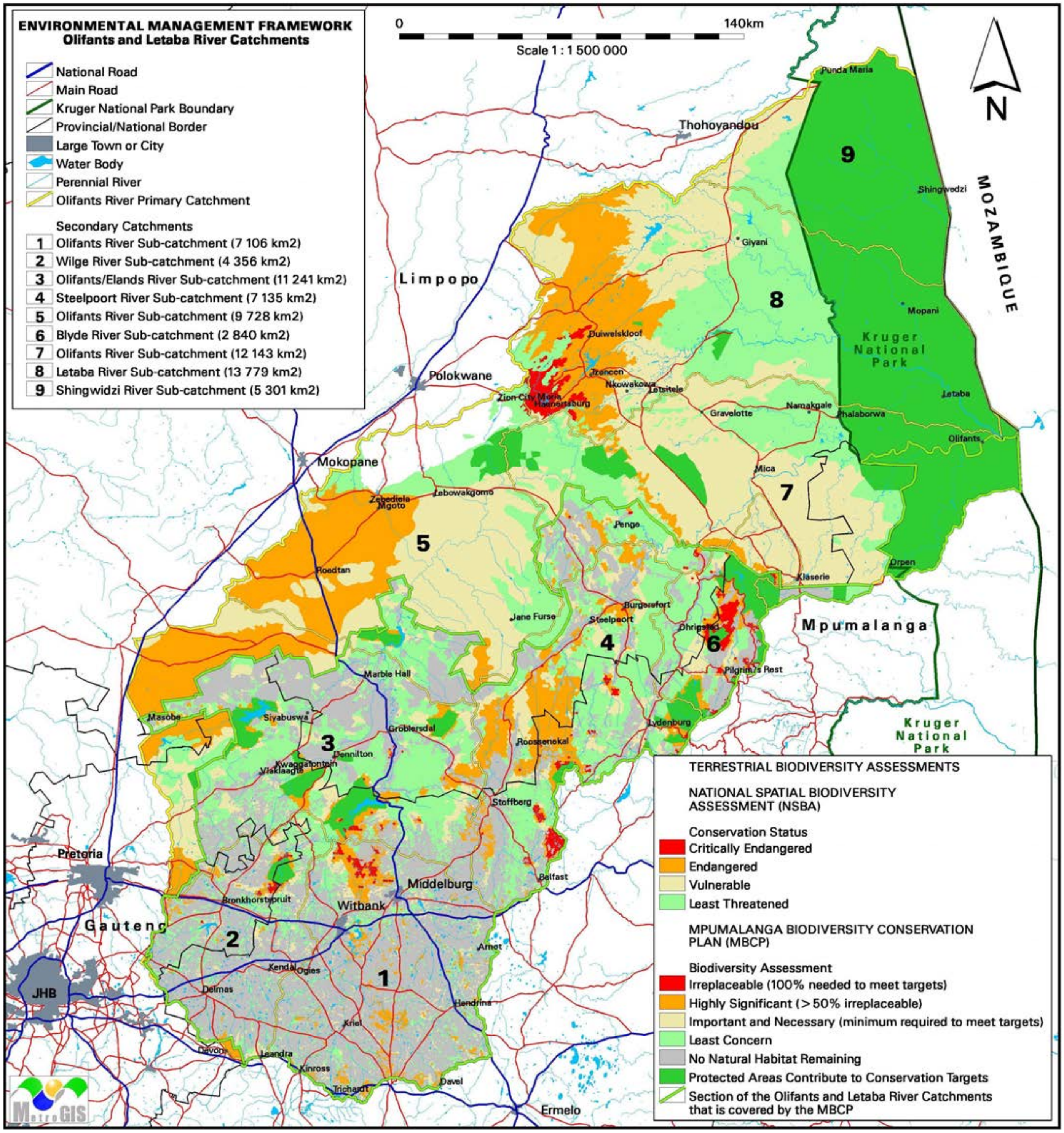


Figure 16b: Threatened ecosystems and centers of endemism (including the Mpumalanga Biodiversity Conservation Plan information)



4.5 CONSERVATION AND CONSERVATION TARGETS

Based on the conservation status of vegetation types, SANBI have identified areas of high conservation priority. The intention of this priority map is to indicate areas in need of immediate conservation effort. There may be other areas that have been afforded high levels of protection which are also high in diversity or are sensitive and deserve continued future protection.

The Park Interface Zones shows the areas outside a park within which landuse changes could affect a national Park. The zones, in combination with guidelines, will serve as a basis for a.) identifying the focus areas in which park management and scientists should respond to EIA's, b.) helping to identify the sort of impacts that would be important at a particular site, and most importantly c.) serving as the basis for integrating long term protection of a national park into the spatial development plans of municipalities (SDF/IDP) and other local authorities. In terms of EIA response, the zones serve largely to raise red-flags and do not remove the need for carefully considering the exact impact of a proposed development. In particular, they do not address activities with broad regional aesthetic or biodiversity impacts. Mapungubwe National Park has three Park Interface Zone, categories (Map 6). The first two are mutually exclusive, but the final visual/aesthetic category can overlay the others.

4.5.1 Priority natural areas (park expantion areas)

This zone aims to ensure the long term persistence of biodiversity, within and around the park, by identifying the key areas upon which the long term survival of the park depends. This includes areas important to both biodiversity pattern (especially reasonably intact high priority natural habitats) and processes (ecological linkages, catchments, intact hydrological systems, etc.). This does not imply any loss of existing rights (e.g. current agricultural activities or legal extractive biodiversity use such as fishing) within the area, but rather aims to ensure the parks survival in a living landscape.

Priority natural areas include areas identified for future park expansion as well as reasonably natural areas of high biodiversity value which are critical for the long-term persistence of biodiversity within the park. These include adjacent natural areas (especially high priority habitats) which function as an ecologically integrated unit with the park, as well as areas critical for maintaining ecological links and connectivity with the broader landscape.

Inappropriate developments and negative land use changes (such as additional ploughing of natural veld, development beyond existing transformation footprints, urban expansion, intensification of landuse through golf estates etc) should be opposed within this area. Developments with site specific impacts (e.g. a lodge on a game farm) should be favourably viewed if they contribute to ensuring conservation friendly land use within a broader area. Guidelines applicable for the Catchment Protection Section would also apply to these areas.

4.5.2 Catchment protection areas

These are areas important for maintaining key hydrological processes (surface and groundwater) within the park.

Within these areas inappropriate development such as dam construction, loss of riparian vegetation, and excessive aquifer exploitation should be opposed. In addition, the control of alien vegetation, the control of soil erosion, and appropriate land care (e.g. appropriate stocking rates) should be promoted.

4.5.3 Viewshed protection areas

These are areas where developments could impact on the aesthetic quality of a visitors experience in a park. This zone is particularly concerned with visual impacts (both day and night), but could also include sound pollution.

Within these areas any development proposals should be carefully screened to ensure that they do not impact excessively on the aesthetics of the park. The areas identified are only broadly indicative of sensitive areas, as at a fine scale many areas within this zone would be perfectly suited for development. In addition, major projects with large scale regional impacts may have to be considered, even if they are outside the Viewshed Protection Area.

4.5.4 Kruger to canyons biosphere reserve

The primary objectives of biosphere reserves are:

- The conservation of biological diversity;
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from the utilization of genetic resources (in accordance with the Convention on Biological Diversity).

Furthermore, a biosphere reserve is intended to fulfill three functions namely:

- Conservation - to preserve genetic resources, species, ecosystems and
- landscapes;
- development - to foster sustainable economic and human development; and
- logistic support - to support demonstration projects, environmental education and training as well as research and monitoring related to local, national and global issues of conservation and sustainable development.

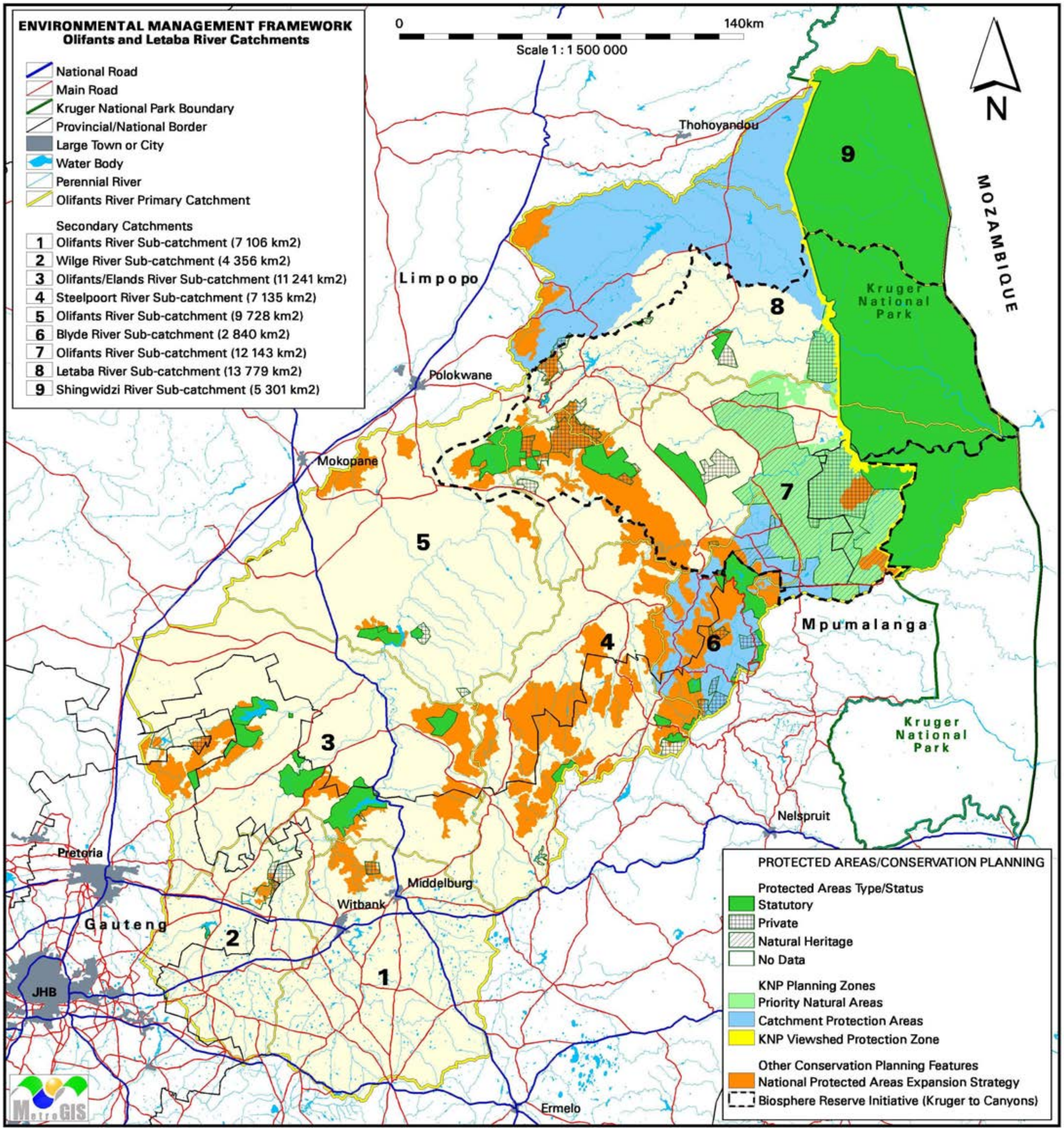
A biosphere reserve is organised into the following three elements:

- Core areas - securely protected sites for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses;
- buffer zones - surrounds or adjoins the core areas, and is used for co-operative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied and basic research; and
- transition areas - may contain a variety of agricultural activities, settlements and other land uses.

In addition, biosphere reserves are placed to provide the means for people to attain a balanced relationship with the natural world, to contribute to the needs of society, and to show a way to a more sustainable future.

Biosphere reserves should be used to develop alternative means of livelihoods and to conduct research, but in such a way that benefits should be shared with all stakeholders. Activities in biosphere reserves should therefore create some direct benefits to the people that live within the designated area.

Figure 17: Protected areas and conservation planning



5. THE CURRENT USE OF LAND

As part of the EMF, all (several thousand) "urban" areas have been identified and been demarcated on a GIS layer. This enables the EMF to identify areas within which activities can be excluded in terms of NEMA section 24(2)(c), thereby streamlining EIA's in the area to a significant extent.

This information has been collated with land cover and other land use information to produce Figure 18: The current use of land/landcover.

Table 36: Use of land/land cover

	Surface Area in (km^2)	Percentage %
Indigenous Forest	374.157	0.51%
Woodland	14 643.211	19.89%
Thicket and Bushland (incl. Herbland)	21 656.643	29.41%
Grassland	11 066.547	15.03%
Planted Grass	17.389	0.02%
Forest Plantation	1 231.863	1.67%
Water Body/Wetland	580.843	0.79%
Bare Rock and Soil (Natural)	180.490	0.25%
Degraded Land	7 229.180	9.82%
Irrigated Agriculture	1 941.989	2.64%
Dryland Agriculture	11 886.193	16.14%
Urban/Built-up (Residential)	2 236.441	3.04%
Urban/Built-up (Smallholdings)	84.268	0.11%
Mining/Industrial	495.973	0.67%
Total area	**73 630.049**	**100.00%**

In order provide a better context for the use of land, it is also indicated in terms of the preliminary environmental management zones, as it is identified later in the report.

Table 37: Use of land/land cover in environmental management zone A

	Surface Area in (km^2)	Percentage %
Mining/Industrial	325.871	3.71%
Water Body/Wetland	177.954	2.03%
Thicket and Bushland (incl. Herbland)	127.490	1.45%
Woodland	0.384	0.00%
Grassland	4 230.878	48.22%
Planted Grass	10.009	0.11%
Degraded Land	4.329	0.05%
Bare Rock and Soil (Natural)	7.388	0.08%
Dryland Agriculture	3 568.165	40.67%
Forest Plantation	88.799	1.01%
Urban/Built-up (Residential)	93.481	1.07%

Urban/Built-up (Smallholdings)	33.478	0.38%
Irrigated Agriculture	105.694	1.20%
Total	8 773.920	100.00%

Table 38: Use of land/land cover in environmental management zone B

	Surface Area in (km^2)	Percentage %
Mining/Industrial	66.998	0.53%
Water Body/Wetland	142.295	1.13%
Thicket and Bushland (incl. Herbland)	4 233.753	33.51%
Woodland	724.429	5.73%
Indigenous Forest	3.516	0.03%
Grassland	5 211.688	41.25%
Planted Grass	3.909	0.03%
Degraded Land	148.326	1.17%
Bare Rock and Soil (Natural)	70.922	0.56%
Dryland Agriculture	1 542.356	12.21%
Forest Plantation	170.106	1.35%
Urban/Built-up (Residential)	171.294	1.36%
Urban/Built-up (Smallholdings)	21.987	0.17%
Irrigated Agriculture	121.784	0.96%
Total	12 633.363	100.00%

Table 39: Use of land/land cover in environmental management zone C

	Surface Area in (km^2)	Percentage %
Mining/Industrial	5.058	0.28%
Water Body/Wetland	31.845	1.74%
Thicket and Bushland (incl. Herbland)	898.579	48.98%
Woodland	192.347	10.49%
Grassland	63.904	3.48%
Planted Grass	1.002	0.05%
Degraded Land	98.490	5.37%
Bare Rock and Soil (Natural)	1.584	0.09%
Dryland Agriculture	61.759	3.37%
Forest Plantation	0.047	0.00%
Urban/Built-up (Residential)	24.973	1.36%
Irrigated Agriculture	454.810	24.79%
Total	1 834.400	100.00%

Table 40: Use of land/land cover in environmental management zone D

	Surface Area in (km^2)	Percentage %
Mining/Industrial	18.737	0.30%
Water Body/Wetland	11.957	0.19%
Thicket and Bushland (incl. Herbland)	1 321.169	20.92%
Woodland	640.007	10.13%
Grassland	30.660	0.49%
Degraded Land	1 591.698	25.20%
Bare Rock and Soil (Natural)	3.107	0.05%
Dryland Agriculture	2 351.916	37.24%
Forest Plantation	0.750	0.01%
Urban/Built-up (Residential)	274.570	4.35%

Irrigated Agriculture	71.213	1.13%
Total	6 315.783	100.00%

Table 41: Use of land/land cover in environmental management zone E

	Surface Area in (km^2)	Percentage %
Mining/Industrial	19.043	0.18%
Water Body/Wetland	13.774	0.13%
Thicket and Bushland (incl. Herbland)	3 633.543	34.77%
Woodland	584.176	5.59%
Indigenous Forest	0.187	0.00%
Grassland	477.246	4.57%
Planted Grass	0.026	0.00%
Degraded Land	2 746.549	26.29%
Bare Rock and Soil (Natural)	11.616	0.11%
Dryland Agriculture	2 042.581	19.55%
Forest Plantation	2.470	0.02%
Urban/Built-up (Residential)	800.436	7.66%
Irrigated Agriculture	117.162	1.12%
Total	10 448.809	100.00%

Table 42: Use of land/land cover in environmental management zone F

	Surface Area in (km^2)	Percentage %
Mining/Industrial	9.415	0.04%
Water Body/Wetland	72.951	0.35%
Thicket and Bushland (incl. Herbland)	8 878.340	42.33%
Woodland	8 909.105	42.48%
Indigenous Forest	299.547	1.43%
Grassland	1 050.487	5.01%
Planted Grass	0.809	0.00%
Degraded Land	499.949	2.38%
Bare Rock and Soil (Natural)	54.289	0.26%
Dryland Agriculture	154.537	0.74%
Forest Plantation	621.336	2.96%
Urban/Built-up (Residential)	162.483	0.77%
Urban/Built-up (Smallholdings)	17.806	0.08%
Irrigated Agriculture	242.445	1.16%
Total	20 973.748	100.00%

Table 43: Use of land/land cover in environmental management zone G

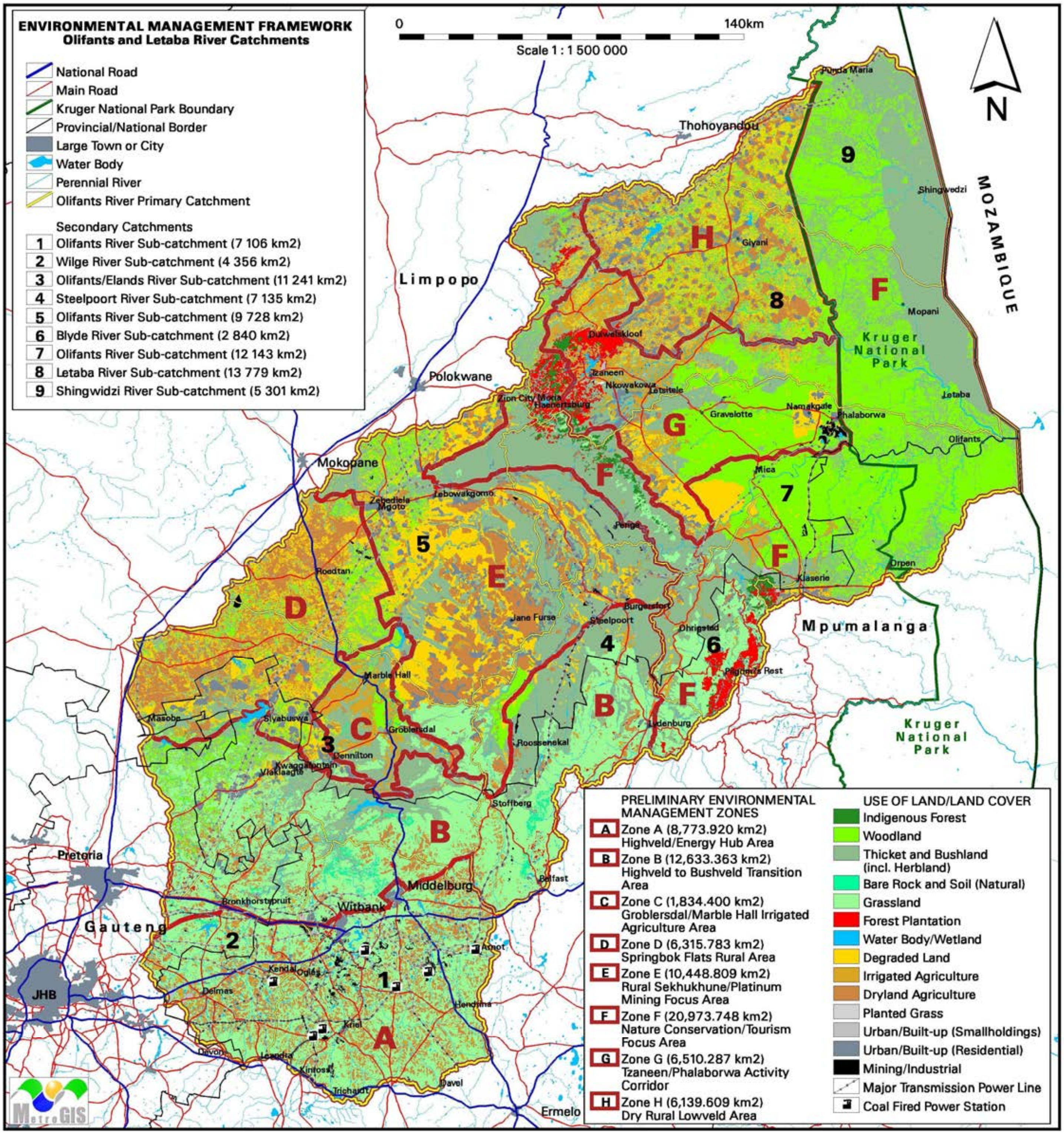
	Surface Area in (km^2)	Percentage %
Mining/Industrial	50.851	0.78%
Water Body/Wetland	85.279	1.31%
Thicket and Bushland (incl. Herbland)	1 650.053	25.35%
Woodland	2 405.152	36.94%
Indigenous Forest	70.907	1.09%
Grassland	1.683	0.03%
Planted Grass	1.634	0.03%
Degraded Land	800.840	12.30%
Bare Rock and Soil (Natural)	2.763	0.04%
Dryland Agriculture	128.957	1.98%

Forest Plantation	326.950	5.02%
Urban/Built-up (Residential)	192.513	2.96%
Urban/Built-up (Smallholdings)	10.997	0.17%
Irrigated Agriculture	777.093	11.94%
Total	6 510.287	99.93%

Table 44: Use of land/land cover in environmental management zone H

ZONE H	**Surface Area in (km^2)**	**Percentage %**
Water Body/Wetland	44.788	0.73%
Thicket and Bushland (incl. Herbland)	913.613	14.88%
Woodland	1 187.582	19.34%
Degraded Land	1 338.999	21.81%
Bare Rock and Soil (Natural)	28.822	0.47%
Dryland Agriculture	2 035.922	33.16%
Forest Plantation	21.405	0.35%
Urban/Built-up (Residential)	516.691	8.42%
Irrigated Agriculture	51.788	0.84%
Total	6 139.609	100.00%

Figure 18: The current use of land



6. AIR POLLUTION

6.1 SOURCES OF AIR POLLUTION

The main air pollution sources in the area include:

- Industrial emissions (including coal fired electricity generation);
- domestic fuel burning (coal, wood and liquid fuels);
- mining (underground fires in old coal mines, dust and chemicals released in blasting processes);
- transportation (emissions from vehicles, dust arising from mainly the transportation of coal and construction materials as well as dust generated from driving on unsurpassed roads); and
- veld fires (natural and deliberate).

While air pollution occurs across the EMF area it is only a critical factor on the highveld portion at this stage.

6.2 CLIMATIC CONDITIONS ON THE HIGHVELD

The highveld part of the EMF area is particularly severely affected by air pollution. It is situated in the belt of atmospheric circulation of the southern hemisphere that is dominated by recurrent, semi permanent anticyclonic cells. Subsidence of air prevails over the region throughout the year but is most pronounced during winter. That ensures that the atmosphere is highly stable for most of the time. Surface inversions are about 150 to 300m deep, are ubiquitous in winter and occur frequently in summer. The elevated subsistence inversion occurs at a height of about 1200 to 1400m above ground and prevents vertical diffusion above this level for most days during the year. This is compounded by the fact that near-surface, stable, local winds, with little dispersion power and with the ability to transport pollution over long distances, dominate the low-level wind field. At the top of the surface inversion, decoupling of the stable boundary level from the less stable air above is associated with a wind maximum and a region in which horizontal transport of pollution is maximized. Between the subsidence inversion and the top of the mixing layer, there is a layer in which pollution trapping produces a regional pollution hazard. These factors mean that the highveld part of the EMF area has an atmospheric pollution climate that is among the most adverse in the southern hemisphere and by far the worst in South Africa.[35] Figure 19 depicts the area that is affected by cold air inversion.

6.3 THE IMPACT OF COAL

The occurrence of extensive coal fields within this area meant that the bulk of South Africa's coal fired power stations were constructed either within (6 currently operating, 1 being recommisioned and 1 new power station being constructed at the moment) or to the south of the area. The coal as well as the electricity in the area also stimulated significant industrialisation in the area with some of the countries most polluting industries like Highveld Steel occurring in the area. Urban development and especially the development of under serviced township during the apartheid years contributed significant areas where primarily coal is being burnt for cooking and space heating.

Conditions in the area are favourable for the formation of pollutants such as ozone and peroxyacyl nitrates which exhibit phytotoxic[36] properties. The high concentrations of sulphate and nitrate aerosols in the atmosphere create conditions that can lead to acid rain.

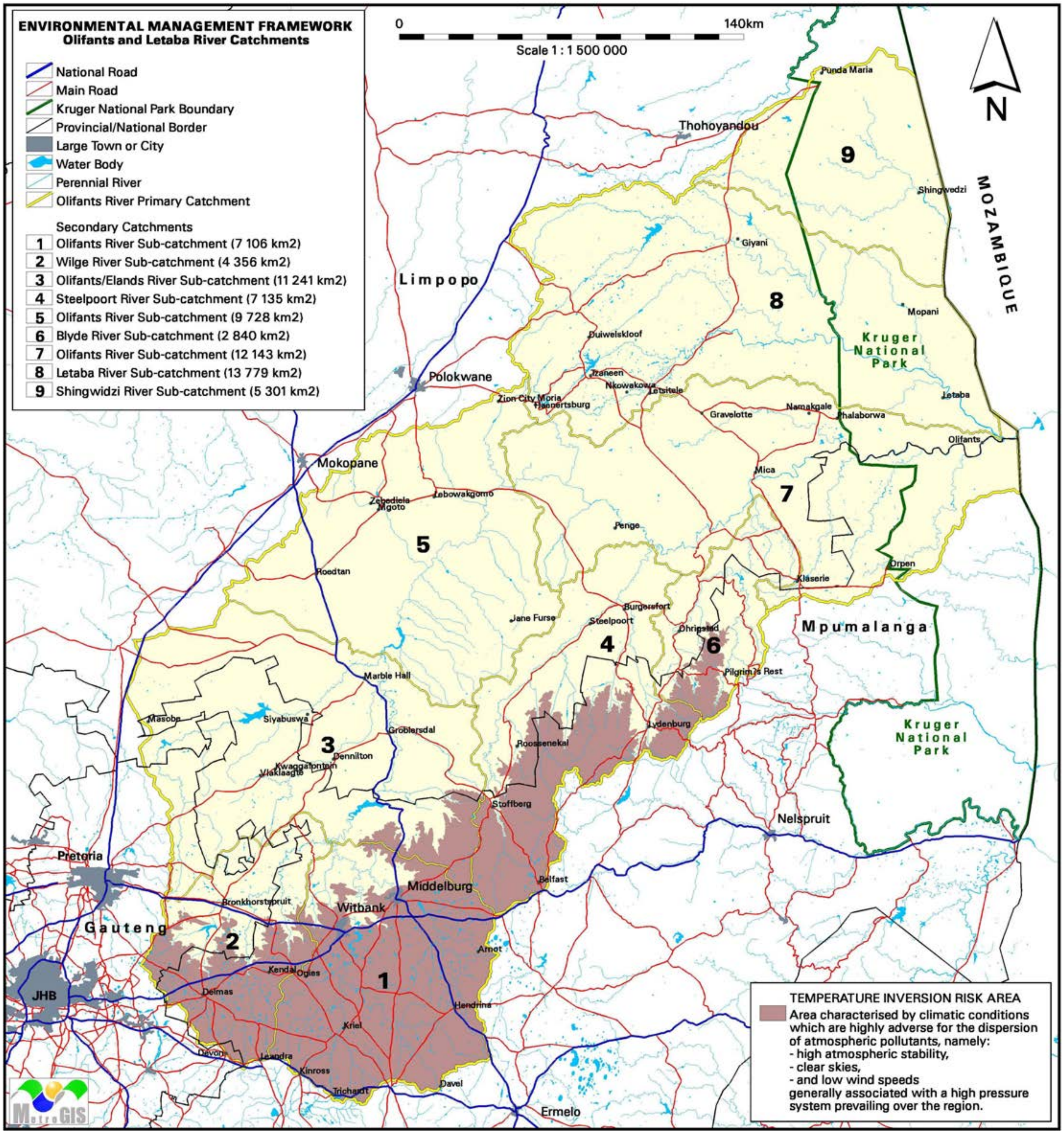
This combination of high levels of pollutants within the least favourable environment possible has led to very high level of ambient air pollution over the entire highveld portion of the EMF area. This was already recognised by government as a high priority in the 1980's and was investigated and documented in the *South African National Scientific Programmes Report No. 150, Atmospheric pollution and its implications in the Eastern Transvaal Highveld*, *1988*. Since that time significant further work were undertaken including:

- The Eskom Highveld SO^2 study (conducted by Airshed);
- the CSIR/Eskom/Sasol O^3 study (conducted by the CSIR);

[35] Tyson P.D., Kruger F.J. and Louw C.W.. 1988. *Atmospheric pollution and its implications in the Eastern Transvaal Highveld*. South African National Scientific Programmes Report No. 150. national Programme for Weather, Climate and Atmosphere Research of the Foundation for Research Development. Pretoria.
[36] **Phytotoxicity** is a term used to describe the toxic effect of a compound on plant growth.

- the APPA review database with detailed emission parameters (developed by DEAT); and
- the Ekurhuleni Emissions Inventory.

Figure 19: Temperature inversion risk area



In, or close to, the EMF area there are also a number of measuring points for ambient air quality including:

- Witbank, Belfast and Lydenburg (South African Weather Service); and
- Kendal, Leandra and Elandsfontein (Eskom).

Relevant information from these points will be included as an appendix to the final Status Quo Report.

6.4 THE HIGHVELD PRIORITY AREA

The Minister of Environmental Affairs and Tourism formally declared an area known as the "Highveld Priority Area" as a national air pollution hotspot in terms of Section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act No. 39 of 2004) (AQA) on 23 November 2007. The declaration gives recognition to the fact that people living and working in this area are exposed to air quality conditions that are harmful to their health and well-being.

The priority area provides for the following key strategic elements for air quality management:

- Focusing limited resources into dealing with recognised hot-spots as a first priority and, in doing so, building the necessary capacity to deal with other problem areas in a pragmatic, step-wise, fashion;
- formalising interdepartmental cooperation in a manner that allows for the management of air quality in problem areas that cross municipal boundaries to be coordinated by province and for problem area that cross provincial boundaries to be coordinated by the national department; and
- air-shed management to ensure that pollutants that are emitted from areas that are not part of hot spot areas but that contribute to the problems in the hot spot areas are also taken into account.

In declaring the Highveld Priority Area, the Minister confirmed that a situation exists within the area which is causing or may cause, a significant negative impact on air quality and that the area requires specific air quality management action to rectify the situation.

In order to address the Minister's concerns, the department, together with the affected provincial and municipal departments, is currently in the process of developing an air quality management plan for the area that is:

- Aimed at co-coordinating air quality management in the area;
- addressing issues related to air quality in the area; and
- providing for the implementation of the plan by a committee representing relevant role-players.

The Minister also indicated that the plan must be developed to his satisfaction by November 2009.

Until the management plan is finalised and available it is not possible to indicate the following in the EMF:

- The ambient concentrations of different pollutants;
- the sources of pollutants;
- the level of compliance of polluters with current permit conditions; and
- the extent to which permits conditions are to be revised, changed or re-issued.

6.5 PROSPECTS

Since 1 July 2009 the government started to impose a 2.25c/kWh "environmental levy" (carbon/pollution tax) on electricity users. It is anticipated that at least a part of the income from this will be used in support of the management plan.

It is, however, not likely that the air quality in the area will improve rapidly after the introduction of the management plan for the following reasons:

- The adverse environmental conditions will remain the same;
- the household use of coal for cooking and space heating is likely to continue for the foreseeable future as there does not seem to be cost effective;
- alternatives and initiatives to use cleaner burning technologies will take time to be adopted;
- while there may be a gradual decline of pollution emanating from coal fired power stations, they will continue to produce pollutants for the duration of their operational lives which varies from 10 to 60 years depending on the current age of the stations;

- it will take time to refurbish or close down polluting industries;
- the dust pollution emanating from the transport of coal is likely to increase as distances between mines and coal users increase; and
- the occurrence of veld fires in the highveld grasslands is a natural and necessary process that will continue.

Air pollution is, therefore, likely to remain a significant constraint for the development of economic opportunities that relies on clean air on the highveld part of the EMF area in the foreseeable future. Specific activities that are likely to be affected negatively include:

- Tourism and recreation activities of any kind;
- higher order residential development;
- industrial development (due to limited capacity for additional air pollution); and
- agricultural activities that is sensitive to air quality and sunlight.

It can be expected that the situation may gradually improve over the next 20 years and change significantly thereafter as coal start to run out on the highveld.

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6.6 SOLID WASTE MANAGEMENT

[Information received in respect to solid waste managmet is still being evaluated, processed and verified (especially the spatial location of the sites). It will be included in the final report.]

7. CULTURAL AND HISTORICAL FEATURES

7.1 INTRODCUTION

The EMF area lies across different landscapes. From the highveld region, at an average of 1500 metres above sea level in the south west, it include a section of the Bushveld, going down the escarpment to cross the lowveld and ending in the Mopane veld at an average of 400 metres above sea level. Each of these areas presents certain possibilities, but also sets a number of challenges, thereby influencing the various heritage resources that can be expected in the region. For example, the Lowveld area, with its hot and humid climate was prone to diseases such as malaria, tsetse flies, etc. making the occupation of the area by humans very difficult. In contrast, the highveld does not have such diseases, but as it was much colder and lacked resources such as wood for fire, it prevented people from settling there. The bushveld region, due to its complex geology and the occurrence of various minerals, led to significant mining endeavours, which gave rise to specific heritage resources.

7.2 DESCRIPTION OF THE HERITAGE

7.2.1 Stone Age

The larger region has been inhabited by humans since Early Stone Age (ESA) times. Tools dating to this period are mostly, although not exclusively, found in the vicinity of watercourses. The original dating and evolutionary scheme for the development of tools during this early period, was based on a study of the river terrace gravels of the Vaal River in the Vereeniging region, referred to as the *Older*, the *Younger* and the *Youngest gravels* (Söhnge, Visser & Van Riet-Lowe1937; Breuil 1948). However, on subsequent investigation, the findings derived from this proved to be unacceptable as it was based on incorrect interpretations of the river gravels. It was only with the excavation of similar material from sealed, stratified sites, that it was realised that the material from the river gravels was not in is its primary context, having been uncovered and washed about over many millennia.

Consequently, artefacts derived from such surface collections are now seen to have little significance.

The oldest of these tools are known as choppers, crudely produced from large pebbles found in the river. Later, *Homo erectus* and early *Homo sapiens* people made tools shaped on both sides, called bifaces. Biface technology is known as the Acheulean tradition, from St Acheul in France, where bifaces were first identified in the mid-19th century.

Biface Acheulean hand-axe

During Middle Stone Age (MSA) times (c. 150 000 – 30 000 BP), people became more mobile, occupying areas formerly avoided. According to Thakeray (1992) the MSA is a period that still remains somewhat murky, as much of the MSA lies beyond the limits of conventional radiocarbon dating. However, the concept of the MSA remains useful as a means of identifying a technological stage characterised by flakes and flake-blades with faceted platforms, produced from prepared cores, as distinct from the core tool-based ESA technology.

Open sites were still preferred near watercourses. These people were adept at exploiting the huge herds of animals that passed through the region, on their seasonal migration. As a result, tools belonging to this period also mostly occur in the open or in erosion dongas. Similar to the ESA material, artefacts from these surface collections are viewed not to be in a primary context and have little or no significance.

Late Stone Age (LSA) people had even more advanced technology than the MSA people and therefore succeeded in occupying even more diverse habitats. Also, for the first time we now get evidence of people's activities derived from material other than stone tools. Ostrich eggshell beads, ground bone arrowheads, small bored stones and wood fragments with incised markings are traditionally linked with the LSA.

In the case of the LSA people, they have also left us with a rich legacy of rock art, which is an expression of their complex social and spiritual believes.

LSA people preferred, though not exclusively, to occupy rock shelters and caves and it is this type of sealed context that make it possible for us to learn much more about them than is the case with earlier periods.

A number of stratified sites, of varying size and significance, are known to exist in the study area. One of these is Bushman Rock Shelter located a few kilometres north of Ohrigstad. Here, archaeological excavations have revealed that early humans had lived here, discontinuously, for thousands of years, from the Early Stone Age, through the Middle Stone Age, and into the Late Stone Age. Occupation did not stop here but continued, for shorter periods, during the Iron Age as well as in historic times. The various top layers, going back more than 40 000 years, revealed a rich legacy of artefacts, including a complex stone tool assemblage, bone tools, ostrich eggshell beads, some organic materials, pigments used for painting, as well as faunal remains (Plug 1978).

Painting of two female figures

7.2.2 Iron Age

Iron Age people started to settle in southern Africa c. AD 300, with one of the oldest known site at Silver Leaves south east of Tzaneen dating to AD 270. Having only had cereals (sorghum, millet) that needed summer rainfall, Early Iron Age (EIA) people did not move outside this rainfall zone, and neither did they occupy the central interior highveld area.

Other sites dating somewhat later are also known from the study region. Preliminary identification of the pottery indicates that it mostly belongs to the Doornkop phase of the Early Iron Age, and should have a date between AD 600 and 900. These are the same group of people that produced the remarkable clay masks found near Lydenburg in the 1960s. These settlements seem to have been followed at a slightly later date by settlements linked to the Eiland Facies of the Middle Iron Age (c. AD 1000-1200), first identified in the Hans Merensky Nature Reserve.

The occupation of the larger geographical area (including the study area) did not start much before the 1500s. To understand all of this, we have to take a look at the broader picture. Towards the end of the first millennium AD, Early Iron Age communities underwent a drastic change, brought on by increasing trade on the East African coast. This led to the rise of powerful ruling elites, for example at Mapungubwe. The abandonment of Mapungubwe (c. AD 1270) and other contemporaneous settlements show that widespread drought conditions led to the decline and eventual disintegration of this state.

Because of their specific technology and economy, Iron Age people preferred to settle on the alluvial soils near rivers for agricultural purposes, but also for firewood and water. Probably as a result of this, their sites cluster all along the larger rivers, in some cases becoming younger as one move further into the interior. Over time, these rivers and associated settlements became “routes” followed into the interior by traders. This trade revolved around the export of metals, ivory and slaves, in return for glass beads, porcelain and cloth. Up until this point, status of individuals in communities was based on the possession of large herds of cattle. However, manipulation of this trade by groups and individuals led to the merchandise becoming prestige items, which was further exploited to gain more wealth and political power. Soon centres of trade developed, for example Mapungubwe in the Limpopo River valley which revolved around ivory and gold. Other sites revolved around metals, for example copper in the Phalaborwa and Musina regions.

By the 16th century things changed again, with the climate becoming warmer and wetter, creating condition that allowed Late Iron Age farmers to occupy areas previously unsuitable, for example the Witwatersrand and the treeless, wind swept plains of the Free State and the Mpumalanga highveld.

This period of consistently high rainfall started in about AD 1780. At the same time, maize was introduced from Maputo and grown extensively. Given good rains, maize crops yield far more than sorghum and millets. This increase in food production probably led to increased populations in coastal area as well as the central highveld interior by the beginning of the 19th century.

This wet period came to a sudden end sometime between 1800 and 1820 by a major drought lasting 3 to 5 years. The drought must have caused an agricultural collapse on a large, subcontinent scale.

This was also a period of great military tension. Armed Qriqua and Korana raiders on horseback were active in the Northern Cape and Orange Free State by about 1790. The Xhosa were raiding across the Orange River about 1805. Military pressure from Zululand spilled onto the highveld by at least 1821. Various marauding groups of displaced Sotho-Tswana moved across the plateau in the 1820s. Mzilikazi raided the plateau extensively between 1825 and 1837, entering for example the Steelpoort valley in the early 1830s. The Boers trekked into this area in the 1840s.

Due to their specific settlement requirements, Late Iron Age people preferred to settle on the steep slope of a mountain, possibly for protection, or for cultural considerations such as grazing for their enormous cattle herds. Because of the lack of trees they built their settlements in stone. In the study area, hundreds of these sites exist, mostly on the escarpment. They are linked to the Koni, a loose attribution that include people of probable diver's origin. It is guessed that they occupied these sites some time after AD 1600.

Plotting the sites identified from aerial photographs revealed some interesting information. Although these findings are still preliminary, it seems as if these people preferred to occupy areas with a higher altitude (+1400m), within a specific ecological setting. Distance from water and aspect seem not to have played much of a role. Associated with settlements, are rock engravings which shows the layout of such settlements.

Rock engraving dating to the Late Iron Age

7.2.3 Ethno-history

Whereas it is impossible to correlate any living group of people to Early Iron Age communities, over time they were replaced by people belonging to groups recognisable in modern times, e.g. Sotho-speakers, for example the Pedi and Kwena, on the central plateau area, the Lobedu, Phalaborwa, Letswalo and Kgaga on the escarpment, Nguni-speakers, such as the Tau, Koni and Swazi on the plateau area, and TsiTsonga-speakers, such as the Nkuna in the lowveld region. Although located much further to the north, the Venda-speakers also had some influence in the study area, especially amongst the Lobedu. The Ndebele-speakers are located to the south and east in the study area. Swazi-speakers are found on the eastern edge of the study area.

Most of these groups entered the region by 1600 or shortly thereafter. Reconstructing the history of all of these groups is something that is outside of the scope of this study.

7.2.4 Historic period

Things were set to change drastically during the early part of the 19th century. Not only was it a time of population movement resulting from events to the south and east, but it was also the arrival of the first white settlers in the area.

Currently, a large number of towns exists in the area, with Middelburg, Burgersfort and Lydenburg some of the oldest. Others, such as Balfour, Witbank, Standerton and Ermelo following later. All of these dates to the latter half of the 19th century and each have its own history as it developed for a particular reason. As they were small and largely served farming communities, they did not expand rapidly. Consequently, all of them retained many buildings (shops, houses, churches, schools) and other features (cemeteries) of heritage significance.

However, the area remained up till today, a largely farming orientated community. Much of the heritage potential of the study area is therefore located within the many farmsteads in the area. Farmhouses and related structures (e.g. barns, sheds, etc.), as well as cemeteries dot the landscape. Equally important, are the homesteads, related structures and cemeteries of the farm labourers living on these farms.

In the 1830s various Voortrekker groups led by Louis Tregard, Karel Tregard, Andries Potgieter and Hans van Rensburg penetrated Mozambique. During the 1840s until the 1880s, the area was visited sporadically by prospectors, scientists, hunters and other explorers, most notably St Vincent Whitshed Erskine (1868 and 1871) and Karl Mauch (1870). These people were followed by missionaries (Merensky, Winter, etc.), administrators (Erasmus) and traders (Albasini).

The tropical climate, malaria, bilharzia, nagana, sleeping-sickness and other human and animal diseases prevented widespread colonial occupation of the lowveld region. The rinderpest of the 1890s (which decimated large numbers of wild animals and cut down the distribution of tsetse flies), the advent of the railways, planned land settlement of white farmers, the development of agriculture and the establishment of nature conservation areas changed this situation and resulted in increasing numbers of colonists settling in the region. One individual who played a prominent role in this was Dr L Annecke, whose work on the eradication of malaria in the 1930s onward contributed much in this regard.

The discovery of gold at what was to become Leydsdorp set the scene for outsiders to enter the area in large numbers. However, the gold did not last long and, after a heyday lasting approximately 10 years, the little town was largely forgotten.

As time went by, the area was divided into farms. This, of course, gave rise to conflict between the whites entering the area and the local Sotho and Tsonga communities. Soon conflict broke out, e.g. against the *Kgoši* Makgoba, occupying Magoebas Kloof, and the ZAR government. Other significant centres of conflict between white and black was between the Pedi and the British (during the first annexation of the ZAR), followed by a siege against the Ndzundza-Ndebele somewhat later.

The local population lost their autonomy, were divided up and, for example as was the case with the Ndzundza, were employed as labourers on farms. It was only during later years, with the development of the policy of separate development that an effort was made to bring them together into so-called homelands that was to be the basis of independent national states. Three of these former homelands are found in the study area: Lebowa, KwaNdebele and Gazankulu. All of this also left an imprint on the heritage resources found in the region. The struggle to overcome this system produced it own heritage sites and personalities, which, with the writing of a more inclusive history, will definitely find its rightful place.

Typical farm labourer homestead

Most of the railways in the *Zuid-Afrikaansche Republiek* (Transvaal Boer republic) were constructed and operated by the *Nederlandsche Zuid-Afrikaansche Spoorweg-*

Maatschappij (Netherlands South African Railway Company, or NZASM), a shareholder company with German and Dutch capital. Founded in Amsterdam in 1887, the NZASM's main objective was the establishment of a railway line between Pretoria and Komatipoort, known together with the Komatipoort-Maputo railway of the Portuguese colony of Mozambique as the Eastern Line.

The motives behind the Pretoria-Maputo line, known as the *Oosterlijn* (Eastern Line) were economical and political. Maputo was the harbour closest to Pretoria and the Witwatersrand, and the line would promote development on the Eastern Highveld and in the Lowveld. A link with this port would also make the Transvaal Boer republic less vulnerable to interference with its imports and exports at the ports of Natal and the Cape, both of which were colonies controlled by the British government which, in the minds of many Transvalers, posed a threat to their independence.

Although the route was surveyed as early as 1875 by Richard Thomas Hall and Major Joachim Machado in 1883, these were preliminary inspections. However, the Machado route used Komatipoort and much of his entire route was adopted by the NZASM's surveyors who started detailed survey work from Komatipoort in November 1887.This route is largely still in use today and long sections follows the current N4 national route.

For the landlocked Transvaal, Delagoa Bay in the Portuguese colony of Mozambique was its only link with the sea outside British control, the port of Lourenço Marques having been formally connected with Pretoria by rail on 8 July 1895 - the Eastern Line. Since the outbreak of the 2nd Anglo-Boer War, the British had attempted to control the flow of supplies through the port with varying degrees of success, but faced a constant haemorrhage through the long, unguarded frontier with the Transvaal and Swaziland along the Lubombo Range.

The various battles and skirmishes resulting from the conflict during the Anglo-Boer War (1899-1902) had a huge impact on heritage resources in the area, as many farms were burned down. Conversely, it also left a legacy of heritage sites scattered across the veld: fortifications and war cemeteries occur all over. Although most of the conflict centred on the railway line to Lorenço Marques (Maputo), e.g. Berg-en-Dal, incidents also took place in other areas, e.g. Bakenlaagte (Cloete 2000).

A contemporary photograph, showing the construction of one of the bridges during the building of the railway line in the 1880s

Monument to the dead British soldiers at Signal Hill, Machadodorp

When attempts to destroy the vital Komati railway bridge failed, Gen Buller raised his own special unit to make another attempt. This corps was commanded by Baron Francis Christian Ludwig von Steinaecker. Known as Steinaecker's Horse, the corps also failed and was then enlarged and given the task of patrolling the Transvaal-Mozambique border, gathering intelligence and harassing Boer forces. Its headquarters were at Komatipoort. It was disbanded after the end of the war but various members settled in the area or found employment at the Sabi Game Reserve managed by Stevenson-Hamilton. This eventually grew into the Kruger National Park.

In contrast to areas such as the Kruger Park that were protected from exploitation, the larger region was subjected to farming, forestation and mining activities. Although all of these activities gave rise to their own legacy of heritage to be found in the environment, many existing sites were destroyed as a result.

Adits excavated by Hans Merensky during his platinum exploration

7.3 IMPORTANT PEOPLE

Important personalities of the EMF area are listed in Table 45.

Table 45 : Important historic personalities of the catchments area

Albasini, Joao	Portuguese trader from Delagoa Bay who settle close to Pretoriuskop at the Sabie River
Annecke, Ludwig Dr.	Medical doctor, worked on eradication of malaria
Buchan, John	Author and later Canadian politician
Burgers, T.F.	President of the ZAR, town of Burgersfort named after him
Button, E	Early prospector
Caldiera, Antonio	Provided the earliest known record of copper trade between Rooiberg and Delagoa Bay, 1544
Chamusso, Patrick (Thibedi, Patrick)	ANC comrade responsible for the bombs at Sasol 2 (1981)
Dick, B.H.	Trader, author and native administrator
Dinkwanyane, Kgalema (Johannes)	Leader of the group of Christian converts who left Botshabelo in 1873 and built Mafolofolo (Spectboom River, Lydenburg Region)
Dinkwanyane, Micha	Chief of a group of descendants of Kgalema Dinkwanyane who bought the farm Boomplaats outside Lydenburg (1906)
Dinkwanyane, Victoria Thorometsana	Leader of the group of families who relocated from Boomplaats to Sterkspruit (Phiring) on 12 November 1956
Ekho, Nils	Norwegen timber expert responsible for the plantation in the Pilgrim’s Rest district (1947) for the Transvaal Gold Mining Estates
Erasmus, Johannes Abel	Field cornet and later native commissioner of the ZAR in the Lydenburg district
FritzPatrick, Percy	Transport rider between Transvaal and Deladoa Bay and author of the “Jock of the Bushveld”
Glynn, Henry	Wildlife hunter, prospector, farmer and early settler at Sabi, helped to develop the roads from Lydenburg and Pilgrim’s Rest to Spitzkop
Haigh, Richmond	Acting commissioner for the Pedi during the Pedi internecine and the second Anglo-Boer war
Hall, Hugh Lanion	Farmer and leading agriculturalist in the lowveld. His farm Mataffin, was owned by H.L. Hall and Sons until 2004 when it was sold as part of land restitution
Hart, Sue	Veterinarian and conservationist who established Ecolink EarthCare Programme in

	Mpumalanga (1986)
Joubert, P.J.	Commandant-General of ZAR forces
Lazarus, Esrael	A Lithuanian immigrant and successful farmer in the Bethal district (1911)
Lovedale, Richard Kelsey	English speaking Volksraad member for Barberton, 1891 to 1900 and member of the Legislative Council of the Transvaal, 1903 to 1907
MacLaglan, T	Early prospector
Makhushane	Phalaborwa chief
Mampuru	Pedi chief
Mauch, K	Early prospector
Merensky, Alexander	Missionary who established the mission station Botshabelo near Middelburg
Merensky, Hans	Son of the former and famous geologist
Modjadji	Lobedu chieftainess
Muzila	Tsonga chief
Nchabeleng, Peter	Leader of the UDF in Lebowa (1985) who was killed after been arrested by the police in April 1986
Ntuli, Piet	A key figure in the KwaNdebele Government and the vigilante organisation Mbokodo
Nyabele	Ndzundza chief
Phatudi, Cedric Dr	Chief minister of Lebowa, 1973 to 1987
Phosa, Matthews	ANC stalward and author
Sekhukhune	Pedi chief
Sekwati	Pedi chief
Sibande, Gert	Political activist and last president of the Transvaal ANC
Skosana, S.S.	Chief minister of KwaNdebele and with Ntuli a key figure in Mbokodo
Stevenson-Hamilton, James	Chief warden of the Sabie Game Reserve for 40 years (1902 – 1942)
Trechardt, K	Voortrekker leader and explorer
Trechardt, L	Voortrekker leader
Winter, J.H.	Missionary, established BaPedi Lutheran Church
Wolhuter, H	Conservationist

7.4 CONCLUSIONS

The aim of the review was to determine the nature and potential of cultural heritage resources found within the boundaries sections of Mpumalanga and Limpopo provinces. A large number of sites are known to exist but, on reflection, it probably represents only a small number of the possible total. The reason for this discrepancy can be attributed to the lack of information. For example, access to good quality aerial photographs would solve the problem of determining the distribution of the Late Iron Age stone walled sites, as, in many cases, they are easily recognisable from such photographs.

The conclusion drawn form this review is that the study area is blessed with a large number of heritage sites, representative of all temporal phases, all people and all events of the past, thereby making it possible, on a micro-scale, to present a good and representative picture of South Africa's history. A new initiative on the writing of the history of this province in particular, helps a lot in this regard.

In summary, the following can be said about the heritage sites in the area:

- Stone Age

This is one period in the past that is not well presented, probably as it is under researched. Detailed surveys would undoubtedly rectify this, as all indications point to the existence of many more sites dating to this period.

- Iron Age.

This period is represented by all phases and all type of sites. It is difficult to estimate the exact number of such sites that might exists, but it would probably run into thousands.

- Historic period

Sites dating to the modern period are much more diverse in type, accounting for their large number. Many of them are still in use, e.g. farmhouses, cemeteries, shops and elements of the infrastructure such as bridges. As a more inclusive approach to the country's history is being written, many more new sites would undoubtedly be added to this category, for example sites relating to the popular struggle and the various people who played a role in that.

The issues involving heritage sites and features can be categorised as follows:

- Ignorance as to the importance and value of heritage sites and their protection through legislation.

Land and property owners are, in most cases, ignorant about the value of heritage or their legal obligation to protect it. Current legislation is very clear as to the obligation of the land or property owner with regards to heritage management and preservation.

- Ignorance as to the nature and distribution of heritage resources.

  There is very little information available on heritage in the area. This can be overcome by a number of actions, e.g.

  - A system whereby members of the public can record the heritage sites in their communities or on their properties should be established. This can be achieved, for example by keeping a register at the local library.
  - The municipality and other authorities should make funds available for systematic surveys by which sites can be documented.

- Lack of information on heritage resources on the side of the authorities responsible for planning.

  This is the direct result of the above-mentioned problem. More information is needed.

- Tourism drive

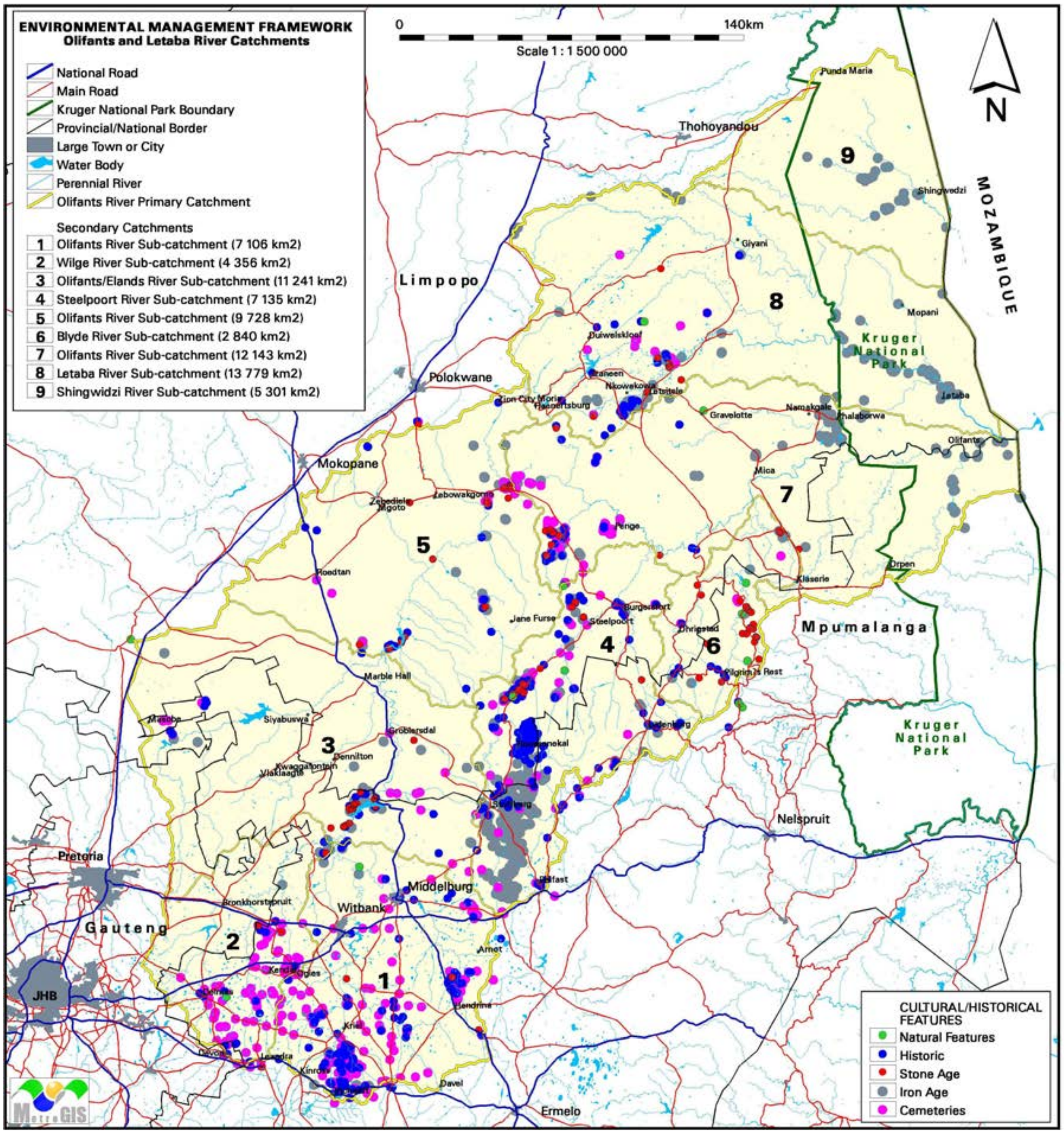
  Tourism is seen as a big driving force for development in the region under review. However, it is not always beneficial to heritage sites and should therefore be carefully managed. If sites are to be used as part of a tourism drive, i.e. the interpretation of the sites through interpretative plaques, guided tours (by trained guides) and interpretative exhibitions and centres, a permit must be obtained in terms of Section 44 of the HRA Act, No. 25 of 1999. This will only be issued on compliance of the operator to the standards set down by the Heritage Authority.

- Heritage is not static

  New heritage sites are continuously being created, due to events that take place, or, simplistically seen, because existing features and structures become older with the passage of time and all should be considered for their contribution to retelling the story of the past. The process of identifying and documenting heritage features would therefore, in theory, never stop.

  The project team has collated all information on existing cultural and historical maps into the GIS data base. A report (40 – 50 pages) highlighting important places events and persons is in the process of being finalised and will be incorporated into the next document.

Figure 20: Cultural historical features



8. POPULATION CHARACTERISTICS

8.1 DISTRIBUTION

The population of the EMF area is mostly rural supported by a significant number of small towns and a few urban centers. The high density of inadequately serviced rural settlements with dense population that is situated in the area poses specific challenges to the sustainable development of the EMF area.

Figure 21: Population density per Census ward

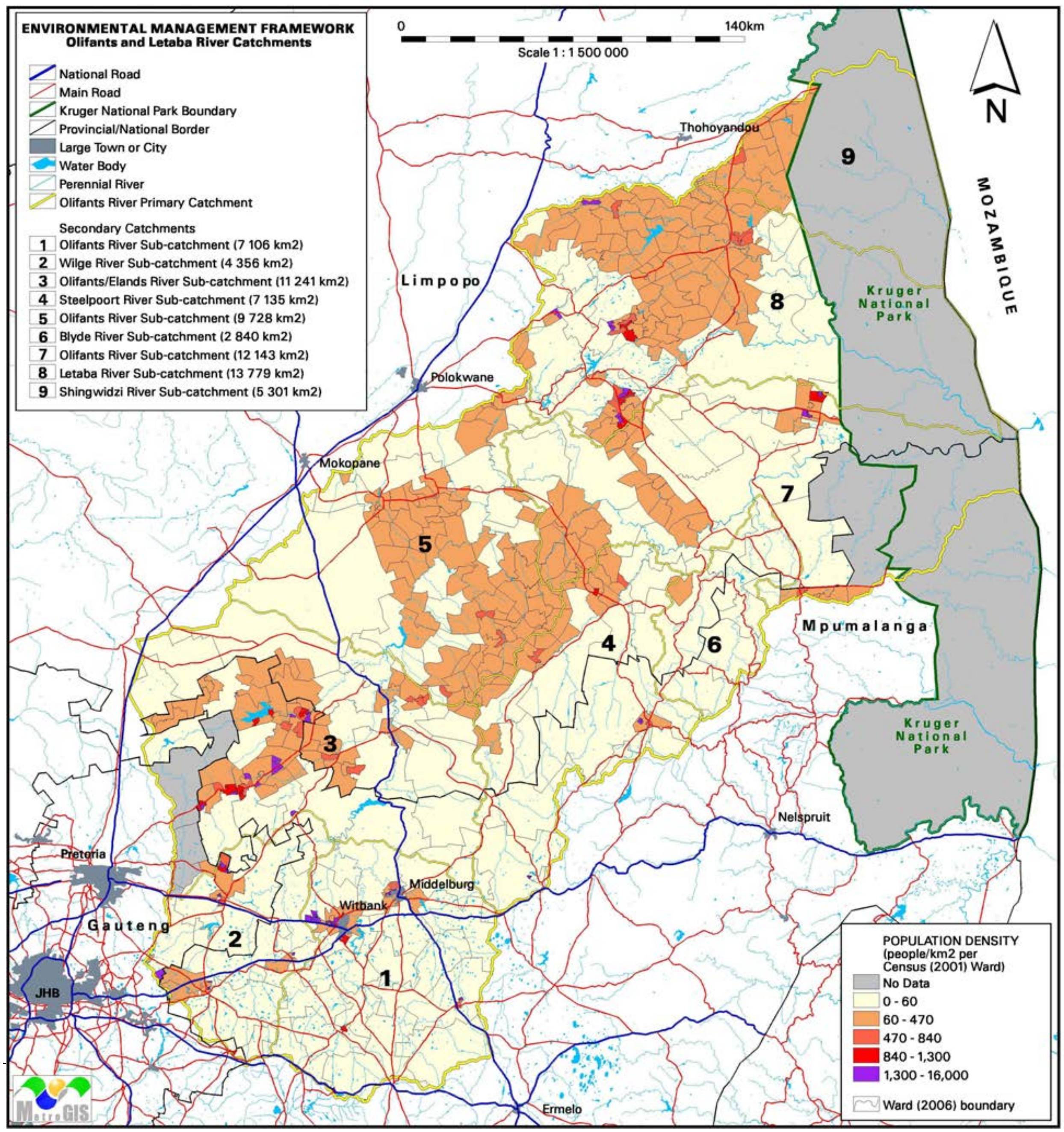
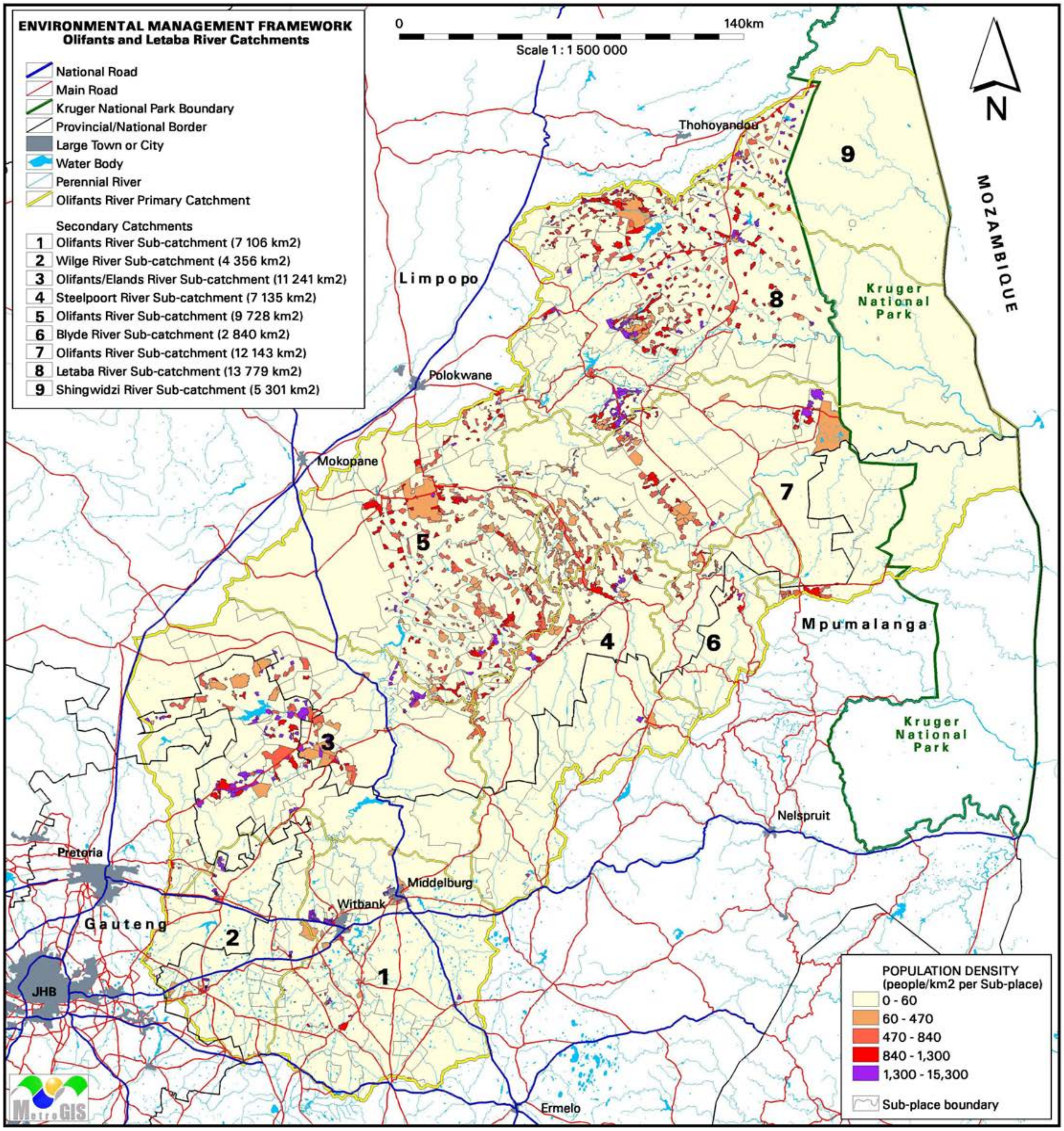


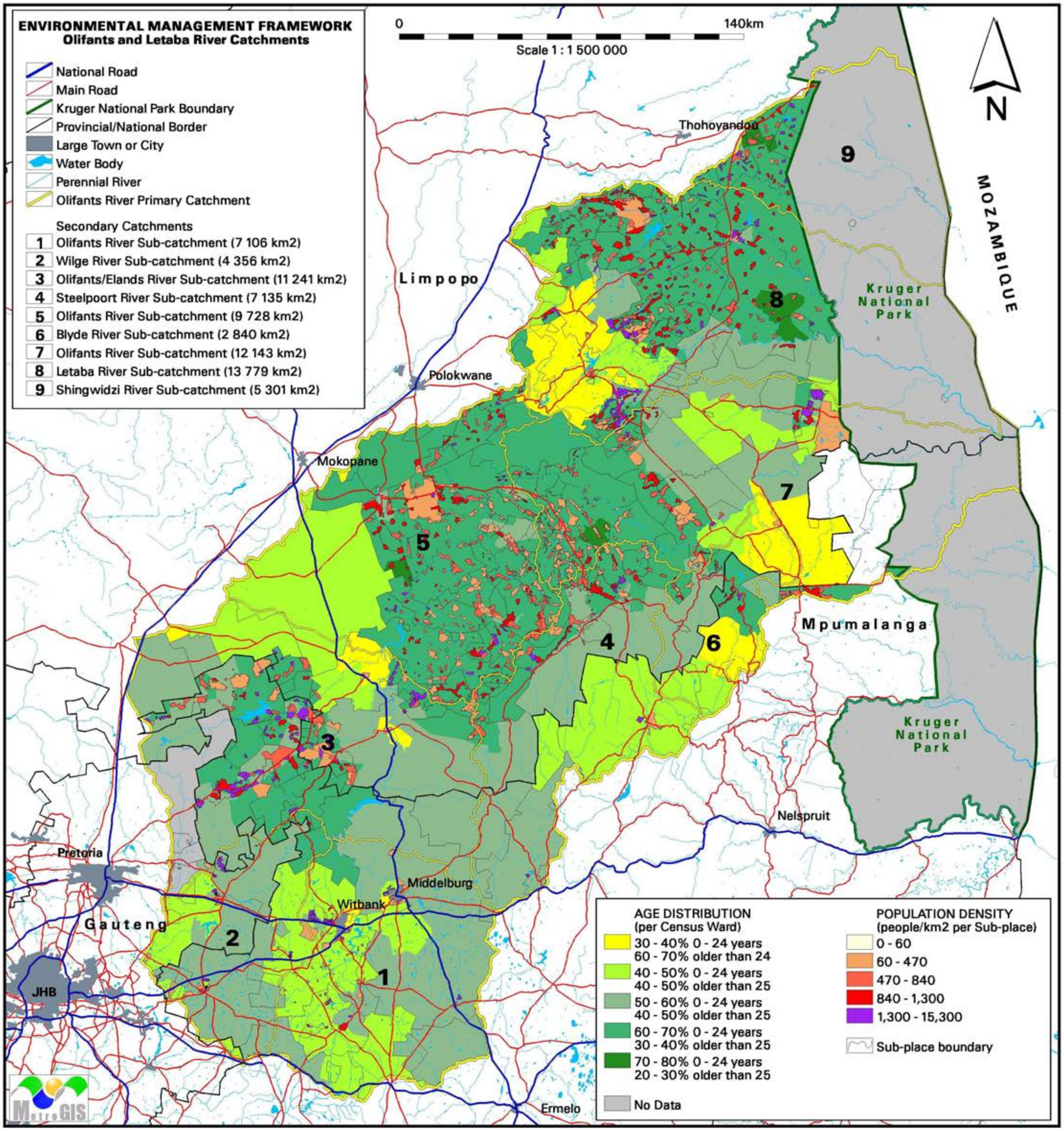
Figure 22: Population density per Sub-place



8.2 STRUCTURE

The young age of the dense rural population is a major concern.

Figure 23: Population structure



8.3 INCOME

Figure 24: Broad income distribution per household

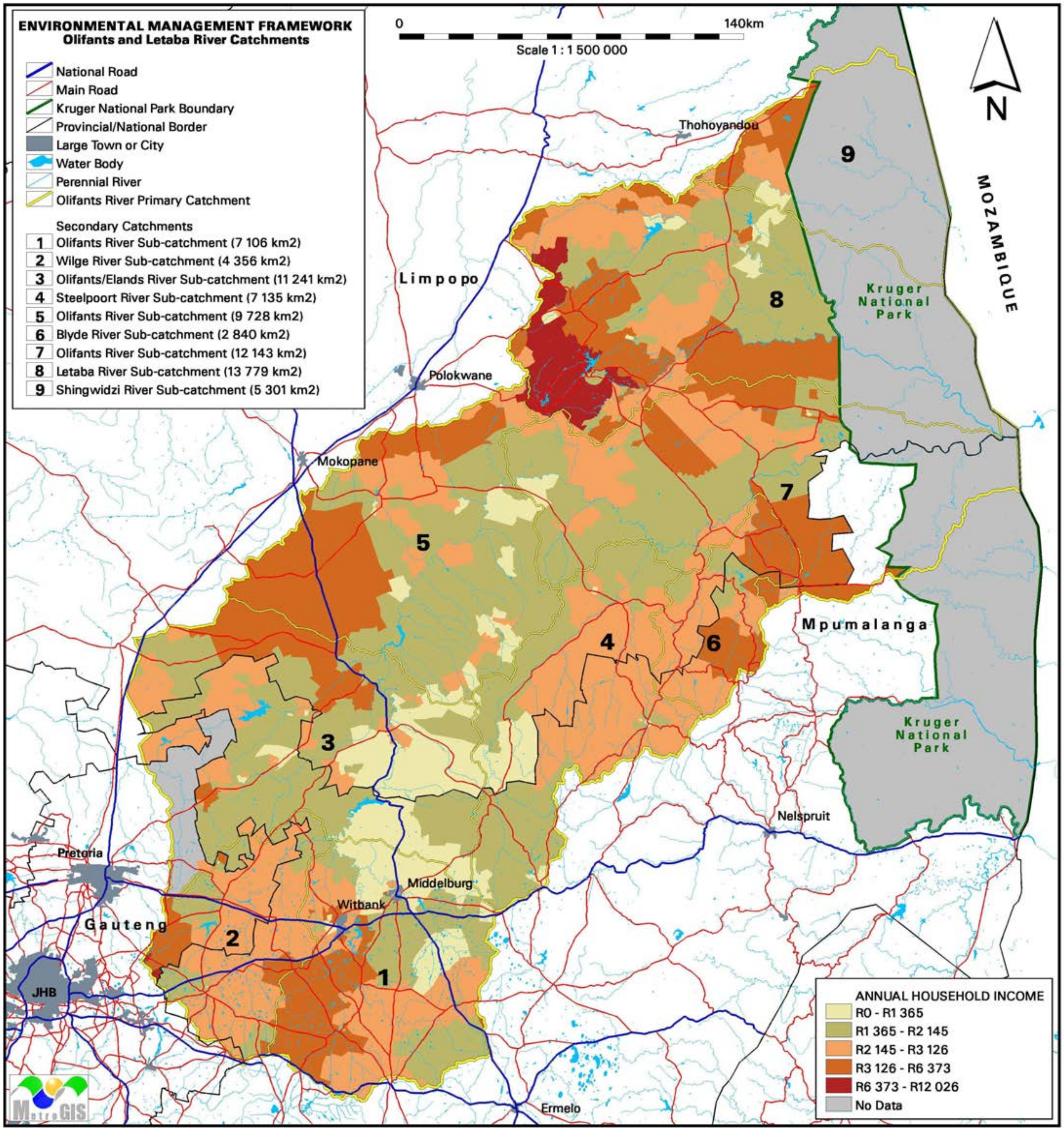


Table 46: Income distribution - Greater Sekhukhune District Municipality

	2001			2005			2007		
	M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1235	1194	2429	354276	434527	788803	165394	241265	406659
R 1 - R 400	8030	10653	18683	17757	26207	43964	9526	16013	25539
R 401 - R 800	6314	5482	11796	30234	60412	90646	10580	15526	26106
R 801 - R 1600	8287	3667	11954	9678	5050	14728	26118	32415	58533
R 1601 - R 3200	8821	3839	12660	9413	4530	13943	13453	6675	20128
R 3201 - R 6400	5879	4210	10089	6265	4628	10893	11742	5853	17595
R 6401 - R 12800	1625	648	2273	1946	977	2923	7483	5200	12683
R 12801 - R 25600	363	79	442	419	127	546	2492	793	3285
R 25601 - R 51200	113	31	144	161	118	279.00	516	119	635
R 51201 - R 102400	56	25	81	147	83	230	77	61	138
R 102401 - R 204800	30	3	33	107	78	185	249	208	457
R 204801 or more	23	13	36	27	15	42	51	0	51
Sub-total	**40776**	**29844**	**70620**	**430430**	**536752**	**967182**	**247681**	**324128**	**571809**

Table 47: Income distribution - Mopani District Municipality

	2001			2005			2007		
	M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1741	1695	3436	353571	433909	787480	154166	214507	368673
R 1 - R 400	21531	27398	48929	41504	55587	97091	18536	30414	48950
R 401 - R 800	16176	11431	27607	38572	60732	99304	24157	31377	55534
R 801 - R 1600	14785	6413	21198	17584	8952	26536	35737	37049	72786
R 1601 - R 3200	13741	6771	20512	15736	8215	23951	16488	5522	22010
R 3201 - R 6400	8661	5998	14659	9887	7175	17062	12273	7468	19741
R 6401 - R 12800	3862	1949	5811	4480	2451	6931	9024	7322	16346
R 12801 - R 25600	1096	236	1332	1234	324	1558	3358	1454	4812
R 25601 - R 51200	278	112	390	396	247	643	892	475	1367
R 51201 - R 102400	153	95	248	254	197	451	239	179	418
R 102401 - R 204800	67	19	86	166	158	324	0	63	63
R 204801 or more	42	14	56	71	47	118	0	59	59
Sub-total	**82133**	**62131**	**144264**	**483455**	**577994**	**1061449**	**274870**	**335889**	**610759**

Table 48: Income distribution - Vhembe District Municipality

	2001			2005			2007		
	M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1552	1730	3282	399040	481141	880181	165154	207402	372556
R 1 - R 400	17714	23716	41430	49213	70839	120052	34232	57526	91758
R 401 - R 800	13869	11033	24902	40936	80195	121131	26910	44095	71005
R 801 - R 1600	12442	6608	19050	13986	8459	22445	32675	39681	72356
R 1601 - R 3200	14342	9141	23483	15260	10155	25415	15270	9366	24636
R 3201 - R 6400	11274	7489	18763	11743	7840	19583	15267	10429	25696
R 6401 - R 12800	3830	1889	5719	4177	2211	6388	10376	7239	17615

R 12801 - R 25600	883	171	1054	976	274	1250	2348	1263	3611
R 25601 - R 51200	230	100	330	279	157	436	644	38	682
R 51201 - R 102400	161	92	253	330	288	618	133	123	256
R 102401 - R 204800	94	26	120	229	194	423	249	250	499
R 204801 or more	55	26	81	70	61	131	138	163	301
Sub-total	**76446**	**62021**	**138467**	**536239**	**661814**	**119805 3**	**303396**	**377575**	**680971**

Table 49: Income distribution - Capricorn District Municipality

	2001			2005			2007		
	M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1457	1777	3234	392401	454772	847173	178851	231853	410704
R 1 - R 400	11199	18689	29888	34785	52574	87359	14175	19154	33329
R 401 - R 800	14163	14595	28758	42966	81218	124184	16817	32456	49273
R 801 - R 1600	17012	9000	26012	18879	11504	30383	35270	44791	80061
R 1601 - R 3200	14897	10005	24902	16089	11125	27214	18901	10728	29629
R 3201 - R 6400	11520	10858	22378	12182	11374	23556	14727	13652	28379
R 6401 - R 12800	5747	3592	9339	6176	3997	10173	13402	11996	25398
R 12801 - R 25600	1933	507	2440	2043	580	2623	6091	2747	8838
R 25601 - R 51200	562	233	795	629	309	938	1376	917	2293
R 51201 - R 102400	247	161	408	314	212	526	426	318	744
R 102401 - R 204800	137	41	178	245	191	436	559	326	885
R 204801 or more	80	28	108	92	35	127	72	0	72
Sub-total	**78954**	**69486**	**148440**	526801	627891	115469 2	**300667**	**368938**	**669605**

Table 50: Income distribution - Waterberg District Municipality

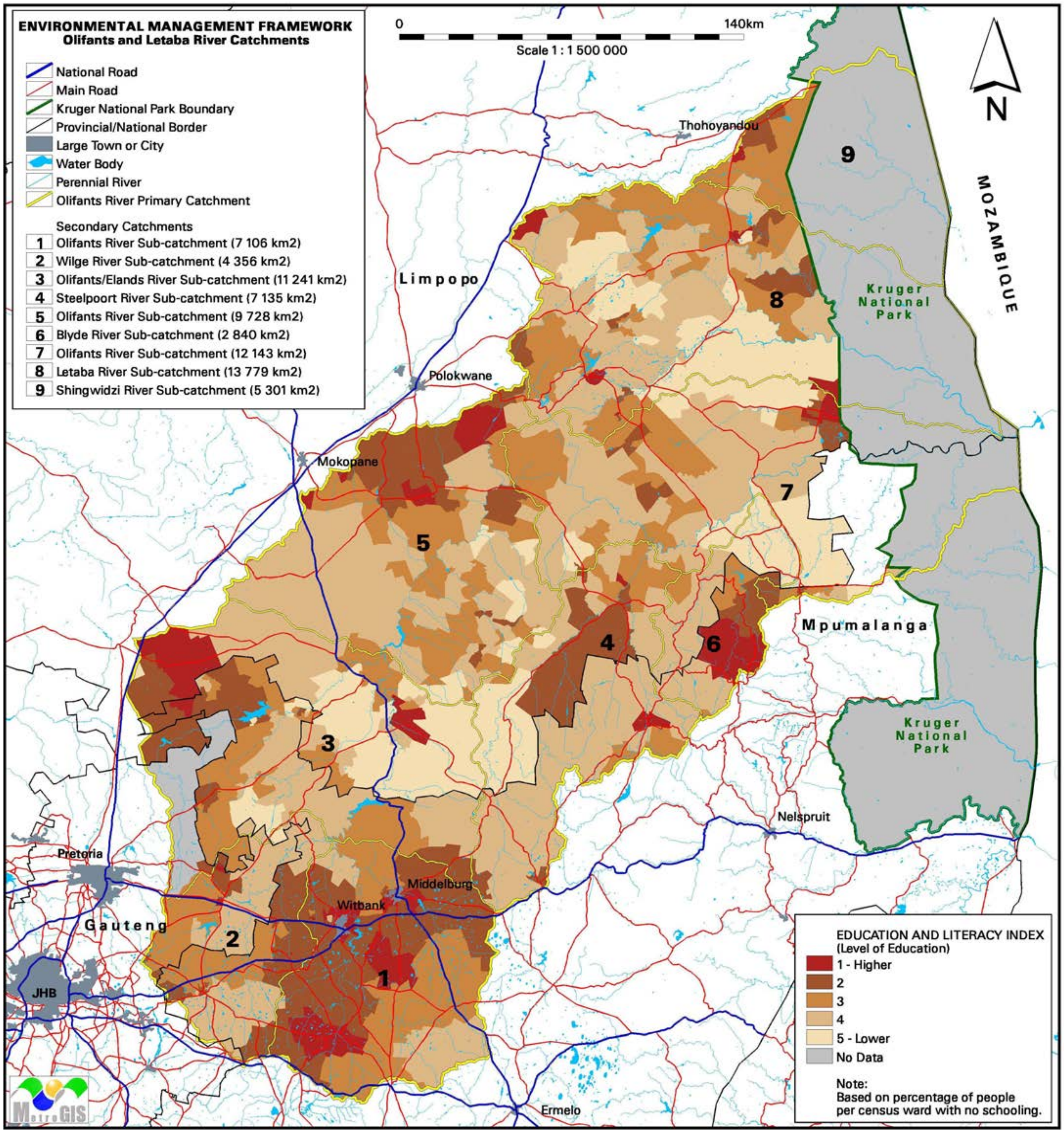
	M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**
No income	1380	1433	2813	186031	228939	414970	70837	101477	172314
R 1 - R 400	19849	22158	42007	25020	28975	53995	11177	12881	24058
R 401 - R 800	19873	12193	32066	33331	38285	71616	14064	16811	30875
R 801 - R 1600	15451	6156	21607	16866	7793	24659	31653	23322	54975
R 1601 - R 3200	14584	5601	20185	16046	7318	23364	17674	5963	23637
R 3201 - R 6400	8838	4880	13718	10225	5681	15906	13901	7188	21089
R 6401 - R 12800	4325	1207	5532	5048	1543	6591	8597	6923	15520
R 12801 - R 25600	1276	212	1488	1432	275	1707	4104	1516	5620
R 25601 - R 51200	392	125	517	474	175	649	1597	461	2058
R 51201 - R 102400	203	65	268	262	98	360	515	319	834
R 102401 - R 204800	93	27	120	152	109	261	445	33	478
R 204801 or more	38	19	57	54	22	76	174	85	259
Sub-total	**86302**	**54076**	**140378**	**294941**	**319213**	**614154**	**174738**	**176979**	**351717**

Table 51: Income distribution (Mpumalanga Districts)

Gert Sibanda District Municipality		
	2001 Census	
Income	**Male**	**Female**
No Income	2056	1747
R 1 - R 400	21781	21208
R 401 - R 800	23747	14008
R 801 - R 1600	25373	9399
R 1601 - R 3200	19182	7908
R 3201 - R 6400	11767	6508
R 6401 - R 12800	7864	2077
R 12801 - R 25600	2915	432
R 25601 - R 51200	658	150
R 51201 - R 102400	296	121
R 102401 - R 204800	153	16
R 204801 or more	96	10
Sub Total	115888	63463
Total	179, 351	
Nkangala District Municipality		
No Income	2258	1896
R 1 - R 400	10202	11852
R 401 - R 800	21308	19254
R 801 - R 1600	33853	15337
R 1601 - R 3200	30871	10405
R 3201 - R 6400	16578	8049
R 6401 - R 12800	9994	2735
R 12801 - R 25600	3196	470
R 25601 - R 51200	672	167
R 51201 - R 102400	256	123
R 102401 - R 204800	207	38
R 204801 or more	97	23
Sub Total	129492	70,349
Total	199, 841	
Enlanzeni District Municipality		
No Income	1901	1859
R 1 - R 400	28614	27485
R 401 - R 800	32504	21471
R 801 - R 1600	28044	11325
R 1601 - R 3200	16573	9254
R 3201 - R 6400	9585	7966
R 6401 - R 12800	5546	2528
R 12801 - R 25600	2083	504
R 25601 - R 51200	717	221
R 51201 - R 102400	288	167
R 102401 - R 204800	146	46
R 204801 or more	76	21
Sub Total	126, 077	82, 847
Total	208, 924	

8.4 EDUCATION AND LITERACY

Figure 25: Education and literacy



9. ECONOMIC CHARACTERISTICS

9.1 INTRODUCTION

The drivers for development in the study area to a large extend follow from current activities of which some have the potential to expand. Some activities have resulted in land utilisation patterns that are by nature not sustainable over the long term due to the fact it is depends on the consumptive use of resources. While considerable scope remains to expand some of these consumptive uses such as the expansion of agricultural activities, the mining of coal on the highveld and the exploitation of minerals elsewhere in the area, there is also a growing need to diversify the local economies away from these primary activities with a bigger focus on secondary and tertiary activities, especially those that are less consumptive or even non-consumptive.

The following discussion on drivers must therefore be interpreted as likely developments that will take place in the area in an almost inevitable way due to the socio-economic needs and also the economic market forces that drives development. It represents a double edged sword that on the one hand brings prosperity, but that on the other hand increase the risks and potential impacts to the environment.

9.2 KEY DRIVERS FOR DEVELOPMENT IN THE EMF AREA

The study area has a very diverse land cover and associated natural resources which have stimulated a variety of economic drivers within this catchment. The main sectors that drive the economy in the area are:

- The mining industry;
- agricultural activities which includes forestry; and
- tourism.

9.2.1 The mining sector

The primary sector dominating the catchment is the mining sector. Mining is a key catalyst for development and a major source of employment and economic growth. Various precious and base metals are present within this catchment. The main mining in this catchment are concentrated in the Sekhukhune and Ehlanzeni District Municipalities districts with the mining belt stretching in a north-south direction to link up with the extensive coal reserve located in the Nkangala District. This mining belt is associated with the Bushveld Igneous Complex which is very rich and diverse in deposits and is underlain by the Rustenburg, Lebowa and Rashoop geological formation.

The main mining cluster in this mining belt is the Dilokong mining corridor which is located between Polokwane and Burgersfort and includes the mining of platinum, chromite and vanadium ore. The proposed mining corridor which is planned further south of Dikolong Development Corridor, between Jane Furse and Lydenburg will also be a key driver as extensive resource exploitation will be undertaken.

The coal reserves present in the Witbank area within the Emalahleni Municipal District, contribute to other associated drivers such as the coal-fired power stations which generated over 60% of southern Africa's electricity. The coal deposits of this region are generally located on the highveld grasslands which were subjected to pressure and temperature over a long time period.

Other important mining clusters within the catchment include the Phalaborwa Mineral complex which surrounds Phalaborwa. Mining here includes the extraction of metals such as copper, iron ore and phosphates resources.

Other smaller mining clusters include the Giyani Green Stone Belt and the Murchison Green Belt concentrated in the greater Phalaborwa area. These mining belts again illustrate the diverse nature of metal and mineral deposits associated with the Bushveld Complex. The main resources mined here include gold and antimony.

9.2.2 Agriculture and livestock farming

The study area is diverse in habitat type and land cover because of the varied climates and underlying geology base. The dry woodlands and bushveld vegetation type which dominates the north, north-eastern portion of the study area are mainly utilised for livestock (cattle) and game farming activities. This landscape is generally associated with irregular plains and hilly terrain which are not suitable for arable agriculture.

The study area generally experiences a water scarcity in many places. The main commercial produce areas within the study area are concentrated in the following areas:

- The greater Witbank area especially Middelburg practices dry cultivation for the production of maize, wheat and sunflower;
- The Loskop Dam Scheme, Groblersdal area and the Orighstad Scheme are mainly associated with extensive irrigation activities such as the production of fruits and vegetables. Owning to its location in the Olifants River irrigation area below the Loskopdam, Groblersdal areas benefits fully from the availability of water. Intensive agricultural activities under 5 irrigation schemes cover a total surface area of 28 800 ha. Groblersdal is the centre of a progressive farming community because of the town's fortunate location.
- Two irrigation schemes fall within the Central Lowveld, namely the Olifants River System and the Blyde Irrigation Scheme, including the greater Tzaneen area which produces the majority of the countries citrus and sub-tropical fruits like oranges, mangoes, papayas, avocadoes and tomatoes.
- Apart from commercial farming, informal or subsistence smallholder farming is one of the most important provider of employment and food to the rural community in the study areas. A secondary opportunity therefore exists to empower the most disadvantaged farmers by encouraging small-scale farming where these farmers are integrated into the commercial industry and given an opportunity to fully participate in the market and contribute towards the GDP. Mobilising these farmers plays an important role in fostering rural development and poverty alleviation.

Agriculture is interrelated with the manufacturing sector thus a huge opportunity exists to stimulate the agro-processing industry further and to produce secondary goods such as:

- Processing of red meat, poultry, fruits and vegetables;

- leather production; and
- agri-tourist clusters.

Commercial plantations are also a prominent activity in the study area. Plantations are mainly concentrated in the greater Tzaneen and Origstad regions. Small-scale plantations are also evident east Middelburg and in the vicinity of Soutpansberg. Future areas identified as suitable for plantations include the greater Groblersdal area, the area towards the south-west of Lydenburg. Secondary drivers associated drivers with commercial plantations include saw-mills. Just in the Tzaneen area alone there are more than 40 saw-mills which are labour intensive and contribute towards skills development within the region.

There is an opportunity for implementing of various green programmes such as:

- The establishment of sustainable wood harvesting clusters which consist of fast-growing indigenous trees in densely populated rural areas where there is a continued demand for wood as an energy source for cooking, lighting and heating where the natural resources are over utilised due to a lack of access to basic services.
- The rehabilitation of decommissioned mines by means of greening these areas with appropriate species;
- Education and awareness raising; and
- The initiation of programmes of forestation where feasible.

9.2.3 Tourism

Tourism has been identified as one of the growth sectors of the catchment. The main economic driver from a tourist point of view is the Kruger National Park (KNP) which is situated along the easternmost edge of the study area. In addition thereto, the Greater Kruger National Park includes the following Game Reserves, namely Sabi Sabie Game Reserve, Timbavatie and Manyeleti Reserve, Thornybush Game Reserve and the Klaserie Reserve. These Game Reserves have been integrated with the KNP as private concessions enabling the free movement of animals as all fencing has been removed between the private concessions and the KNP.

The greater KNP is however becoming increasingly threatened by encroaching agricultural and mining activities, formal and informal housing settlements and urban sprawl which continues to expand in an uncontrolled manner.

Another tourist destination with huge potential is the Blyde River Canyon. This majestic area forms part of the Transvaal Drakensberg Escarpment which celebrates breathtaking views of the Blyde River Canyon and gorge, Blyde Dam, three Rondawels, Bourkes Luck Potholes, God's Window and the Pinnacle. Past investigations have revealed that the Blyde Canyon and Mariepskop (state forest) are to be proclaimed into one National Park and to acquire World Heritage status due to its ecological diversity and unique geology. Such an initiative will help conserve a stressed Olifants River catchment. Other opportunities in this regard include:

- The generation of additional income and employment which is linked to eco-tourism; and
- the initiation of programmes of forestation at Mariepskop where commercial timber is produced.

Another tourist destination includes the Loskop Dam, however, to fully capitalise on its economic potential focus must be placed on the following:

- Tourism marketing and awareness;
- establishing functional tourist centres; and
- development of a future tourist plan that focuses on implementing agri and eco-tourist attractions which focuses on the cultural and natural heritage of the area, whilst creating employment opportunities and increases skills development.

From the above economic sectors it is evident that the manufacturing sector must be further exploited by focusing on further processing of products of all sectors connected to the manufacturing sector such as the mining and agriculture sectors.

To maximize the development potential within the catchment the mentioned economic sectors must capitalise on the establishment of labour intensive secondary industries such as the manufacturing and agri-processing, construction, transport and communications sectors. If these activities continue to stimulate economic growth, additional residential dwellings, roads and infrastructure will have to be constructed, and basic services will have to be provided. This will in turn benefit the development of the retail and commercial sectors and in turn contribute towards skills development within the area.

Table 52: Employment per sector

	2001			2007		
	M	F	Total	M	F	Total
Mopani District Municipality						
Agriculture; hunting; forestry and fishing	19089	16170	41397	6003	5241	11244
Mining and quarrying	6556	438	7125	5367	253	5620
Manufacturing	7308	5014	12805	11578	5565	17143
Electricity; gas and water supply	1136	291	1514	1535	309	1844
Construction	6089	968	7674	7113	1287	8400
Wholesale and retail trade	10667	8739	20602	11537	12890	24427
Transport; storage and communication	3156	543	4995	4425	764	5189
Financial; insurance; real estate and business services	4344	2330	7127	6866	3646	10512
Community; social and personal services	14874	14342	32265	14111	16590	30701
Other and not adequately defined	3	5	5	6461	11956	18417
Private Households	2894	8339	12392			
Undetermined	6010	4944	12096	19804	16371	36175
Not applicable			449750	191958	269300	461258
Sub-total	82126	62123	609747	286758	344172	630930
Vhembe District Municipality						
Agriculture; hunting; forestry and fishing	12184	9881	22065	3080	2159	5239
Mining and quarrying	1540	243	1783	2862	529	3391
Manufacturing	4442	3716	8158	10705	8904	19609
Electricity; gas and water supply	1351	514	1865	1114	250	1364
Construction	7544	1725	9269	8197	2458	10655
Wholesale and retail trade	9616	8613	18229	13065	21658	34723
Transport; storage and communication	4139	642	4781	4688	1410	6098
Financial; insurance; real estate and business services	4519	2545	7064	7340	5270	12610
Community; social and personal services	22001	18743	40744	17432	19752	37184
Other and not adequately defined	0	0	0	3591	12471	16062
Private Households	3691	10641	14332			
Undetermined	5422	4755	10177	25276	22158	47434
Not applicable				218698	290282	508980
Sub-total	76449	62018	138467	316048	387301	703349
Capricorn District Municipality						
Agriculture; hunting; forestry and fishing	9376	7405	16781	4763	2907	7670
Mining and quarrying	1301	125	1426	1648	147	1795
Manufacturing	6809	3378	10187	14678	6869	21547
Electricity; gas and water supply	1227	371	1598	2342	407	2749
Construction	7930	959	8889	9350	2121	11471
Wholesale and retail trade	14011	10585	24596	12700	14069	26769
Transport; storage and communication	5414	855	6269	4457	1451	5908
Financial; insurance; real estate and business services	6444	4137	10581	9577	7789	17366
Community; social and personal services	18773	22220	40993	16712	25300	42012
Other and not adequately defined	5	3	8	5083	14180	19263
Private Households	3036	15564	18600			
Undetermined	4627	3886	8513	15624	13722	29346

Not applicable				215934	290386	506320
Sub-total	78953	69488	148441	312868	379348	692216
Waterberg District Municipality						
Agriculture; hunting; forestry and fishing	22659	11141	33800	4545	2004	6549
Mining and quarrying	12492	586	13078	20205	1789	21994
Manufacturing	5972	2378	8350	8970	3600	12570
Electricity; gas and water supply	1066	165	1231	1013	351	1364
Construction	6318	680	6998	7641	1002	8643
Wholesale and retail trade	9266	7499	16765	10849	7595	18444
Transport; storage and communication	2777	551	3328	3071	1510	4581
Financial; insurance; real estate and business services	3360	1988	5348	5530	3118	8648
Community; social and personal services	10720	10421	21141	7876	12491	20367
Other and not adequately defined	0	0	0	4601	10321	14922
Private Households	6259	14709	20968			
Undetermined	5414	3963	9377	13293	8799	22092
Not applicable				93236	128388	221624
Sub-total	86303	54081	140384	180830	180968	361798
Sekhukhune District Municipality						
Agriculture; hunting; forestry and fishing	6075	5309	11384	1434	1827	3261
Mining and quarrying	5340	254	5594	11812	1234	13046
Manufacturing	2502	835	3337	5567	2853	8420
Electricity; gas and water supply	609	102	711	840	101	941
Construction	2969	302	3271	6039	1000	7039
Wholesale and retail trade	4845	4344	9189	6821	9078	15899
Transport; storage and communication	2424	241	2665	3693	614	4307
Financial; insurance; real estate and business services	1898	798	2696	4210	2217	6427
Community; social and personal services	8178	9048	17226	9325	10801	20126
Other and not adequately defined	3	0	3	2365	5568	7933
Private Households	2157	5539	7696			
Undetermined				19349	20975	40324
Not applicable	3775	3072	6847	190337	281063	471400
Sub-total	40775	29844	70619	261792	337331	599123
Nkangala						
Agriculture; hunting; forestry and fishing	10872	2876	13748	2254	1512	3766
Mining and quarrying	24339	1424	25763	25522	2989	28511
Manufacturing	15757	3923	19680	28843	7543	36386
Electricity; gas and water supply	5810	985	6795	5808	1195	7003
Construction	14017	1046	15063	19848	2029	21877
Wholesale and retail trade	15566	11713	27279	15478	13541	29019
Transport; storage and communication	7753	991	8744	8939	2114	11053
Financial; insurance; real estate and business services	7768	4162	11930	15714	10271	25985
Community; social and personal services	14165	17309	31474	11808	21028	32836
Other and not adequately defined	6	8	14	13213	31190	44403
Private Households	4903	20520	25423			
Undetermined	8534	5396	13930	53666	31384	85050
Not applicable			0	196846	271605	468451
Sub-total	129490	70353	199843	397939	396401	794340
Ehlanzeni						
Agriculture; hunting; forestry and fishing	35375	18980	54355	7802	5704	13506
Mining and quarrying	3310	232	3542	7116	918	8034
Manufacturing	17287	6507	23794	34052	12988	47040
Electricity; gas and water supply	1399	244	1643	1772	725	2497
Construction	11567	1148	12715	16852	2564	19416
Wholesale and retail trade	17379	13920	31299	18822	20380	39202
Transport; storage and communication	5843	1020	6863	8997	2427	11424

Financial; insurance; real estate and business services	7926	4049	11975	19637	14400	34037
Community; social and personal services	14934	17844	32778	19897	29610	49507
Other and not adequately defined	9	9	18	12916	29393	42309
Private Households	4697	14095	18792			
Undetermined	6351	4793	11144	31057	26701	57758
Not applicable			0	247857	345862	593719
Sub-total	126077	82841	208918	426777	491672	918449

Figure 26: Employment in the mining sector

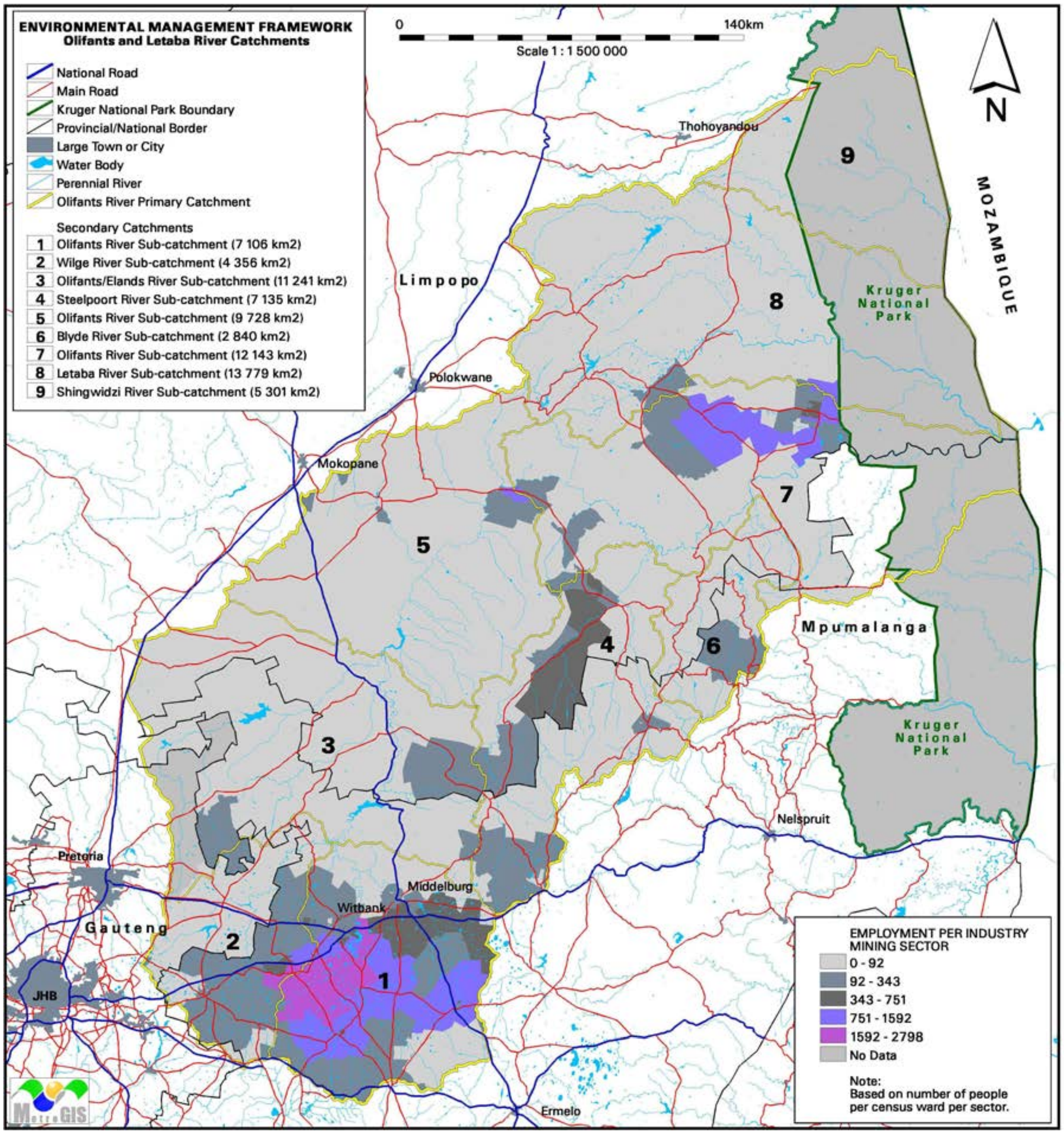


Figure 27: Employment in the agricultural centre

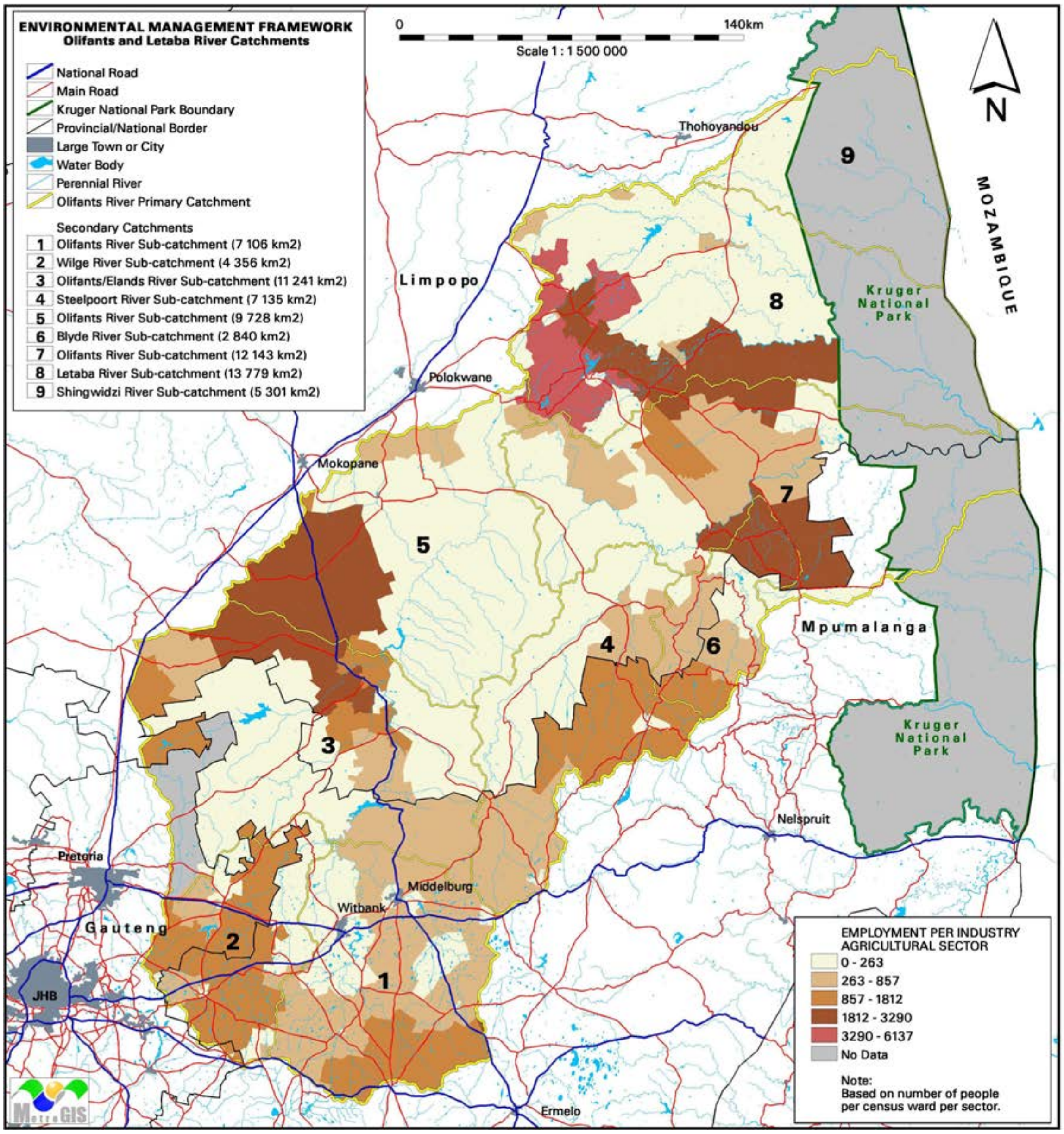


Figure 28: Employment in the manufacturing sector

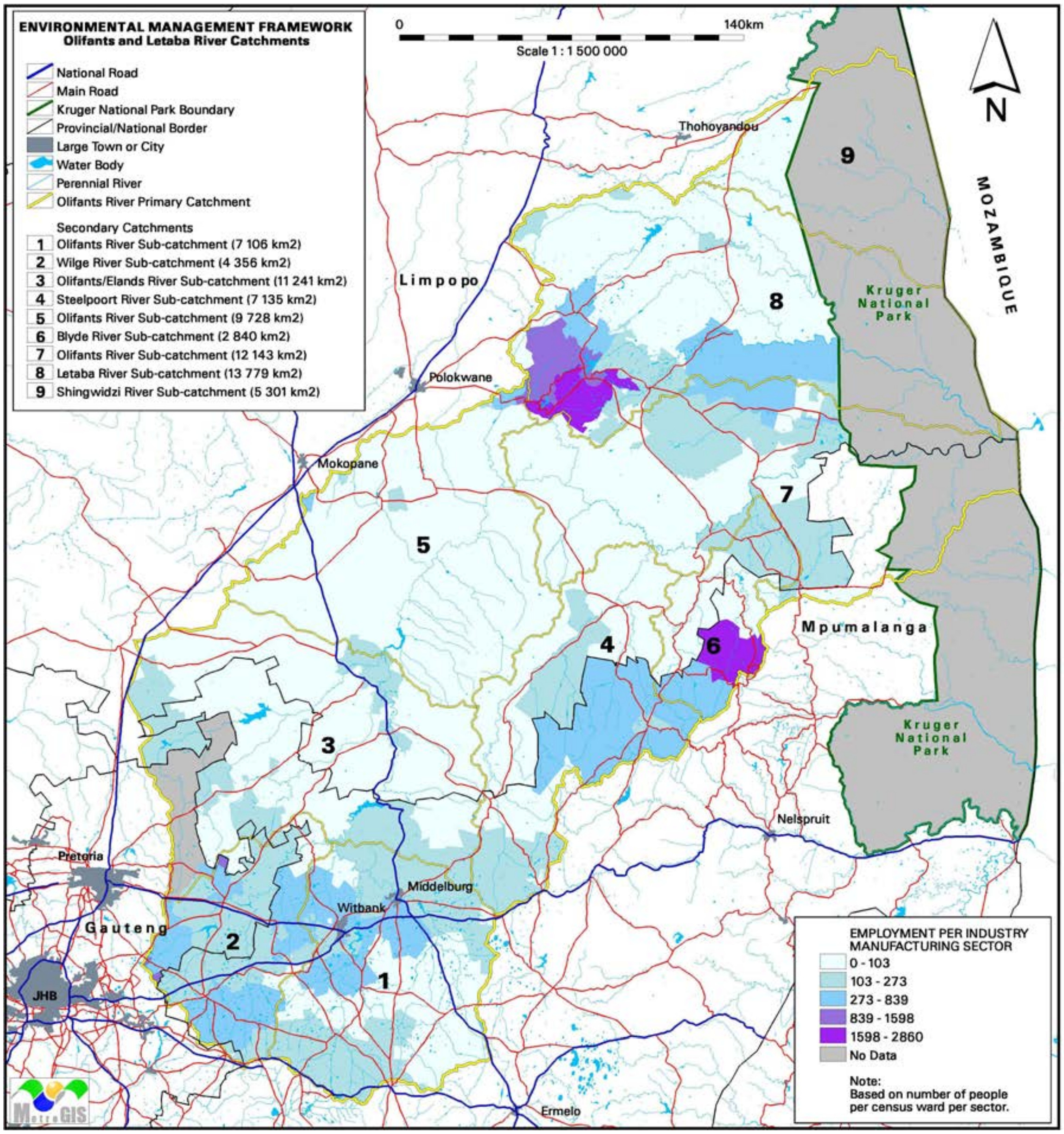
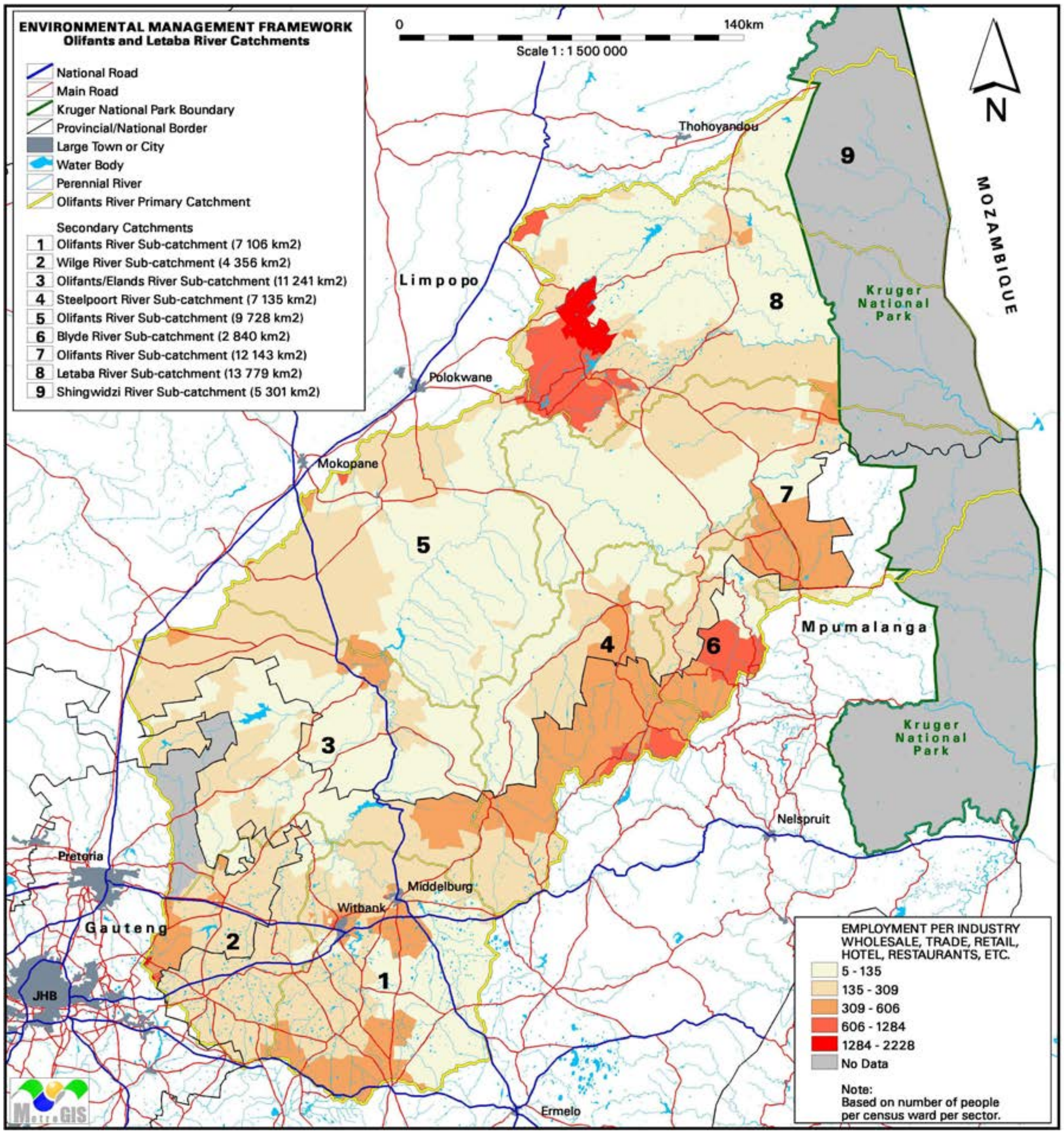


Figure 29: Employment in the trade and tourism related sectors



10. PRESIDENTIAL POVERTY NODES

The 22 poorest areas of South Africa (15 rural and 7 urban), where some 10 million people live, are known as the Presidential Poverty Nodes, and are described by the Department of Provincial and Local Government as the "spatial manifestation of the second economy". They are characterised by underdevelopment, contribute little to the GDP, and incorporate the poorest of our urban and rural poor.

In 2005 the Department of Local and Provincial Government established a Programme of Action "for building productive and sustainable nodal economies", to accelerate the development of these areas defined as Presidential Poverty Nodes.

Large parts of the study area falls within these nodes, most notably Sekhukuneland and the northern parts of the lowveld area. The importance of this is that these areas need specific and special intervention and support in every possible way. The application of the EMF principles (as reflected in this report) is therefore of the utmost importance in these areas.

11. PUBLIC AND STAKEHOLDER PARTICIPATION

11.1 THE FIRST VERSION OF THE BACKGROUND INFORMATION DOCUMENT (BID)

The BID was prepared in order to inform participants of the EMF and was distributed to stakeholders, relevant district municipal officials and members of the community within the EMF area. It contained the following:

- An introduction,
- the purpose of the EMF,
- public participation process; and
- an invitation to comment and provide inputs.

11.2 MEETINGS WITH REPRESENTATIVE OF THE DISTRICT MUNICIPALITIES

Meetings were held with the following District Municipalities:

- Capricorn District Municipality;
- Ehlanzeni District Municipality;
- Mopani District Municipality;
- Vhembe District Municipality; and
- Waterberg District Municipality.

The objectives of these meetings were to introduce the project to the District Municipalities (DM), to determine the relevant liaison persons at the DM offices, to establish good working relationships with the affected DMs and to encourage the affected DMs to take ownership of this EMF. Other district municipalities (on the margins) were communicated with by means of letters via letter.

A meeting with Kruger National Park (KNP) representatives was also held, with similar objectives.

11.3 THE SECOND VERSION OF THE BID

The BID was updated after the first round of meetings with the district municipalities. The updated second version of the Background Information Document was distributed to all stakeholders, relevant district municipalities and interested and affected parties. The updated bid contained all previous headings and also included:

- Key issues;
- guiding principles; and
- a project schedule.

11.4 FOCUS GROUP MEETINGS

Focus group meetings were held in order to discuss the EMF with stakeholders and to determine key issues opportunities, constraints and the desired state as viewed from each group's perspective.

11.4.1 Conservation and tourism

A meeting was held with conservation and tourism groups on the 7th of July 2009 at St. Peter's Anglican Church, in Tzaneen. The following key issues were raised:

- Groundwater sufficiency to meet in the long term needs of society is questioned.

- Sustainability was not being met. Sustainable development was just words and EIA was simply rubberstamps as government only has a development growth at all cost approach and it continues to push environmental costs to future generations.
- Concerns over water sharing with Mozambique were pointed out. It was stated that international obligations towards Mozambique are not being honoured to the full extent and that water access to Mozambique should be guaranteed.
- Ecological reserves need to be protected. There is a need for government to put in long term planning measures for ecological reserves. Ecological reserves are regarded as a nice to have by authorities. DWAF don't see the reserves as fixed assets. Reserves should be guaranteed; planning should be less short sighted and should have a long-term view.
- Forestry takes up large amounts of water that can be better used to grow other higher value crops in the catchments and should therefore be phased out as far as possible.
- Exclusion areas (in terms of NEMA 24(2)(c) must have adequate guidelines to ensure that it does not result in unacceptable runoff etc.
- The issue of sewerage failures across the area is a major concern for water quality. DWAF must take responsibility as provinces and local authorities are unable to do it effectively.

11.4.2 Mining and industry

A meeting was held with mining and industry groups on the 3rd July 2009 at Sefapane Lodge in Phalaborwa as well as on the 9th July 2009 at Middelburg District Municipality in Middelburg. The following key issues were raised:

- Mining contributes to 85% of GDP of Phalaborwa, but it has a limited lifespan and will close down in 25 to 30 years.
- Tourism on its own will not be enough to replace the income, as it offers only limited support.
- What are the area's current assets, and how will they change in the long term, especially when the mines are no longer there – that should be at the forefront of planning.

- Water usage and allocation is the biggest concern of mining in the area.
- Legislation is not managed efficiently – legislation is ahead of capacity in the institutions.
- Water supply for mining in Burgersfort area needs to be ensured.
- Mining needs another dam the size of the De Hoop Dam fairly soon (within 10 years).
- The allocation policies of DWAF are a high risk to mining – shortage of water supply may hit mining and industry the hardest and that will hamper development.
- The lack of issuing water use licenses and clear direction in respect of the reserve is of concern to mining.
- Institutional failure in terms of water use permits – users are not given the opportunity to comply with legislation.
- Investors are put off by uncertainty created by indecision of government.
- Burgersfort area has a long term up to 100 years (60 years + at least) life for the mining of platinum group metals.
- Mining of platinum group metals are going to lead to huge increases in economic growth in the Limpopo Province.
- Platinum mining processes are not very sensitive to water quality and can use polluted water from the highveld coal mining activities.
- Certain mines produce excess water of acceptable quality during certain times of the year that can be released back into the system fro re-use or to maintain ecological flow requirements, but the mines are currently prevented from doing so by DWAF.
- Policy certainty of government is needed to provide an environment that is conducive to investment decision-making.
- Green corridors to connect natural areas through mining areas and township areas should be provided for by the planning authorities at the various levels.
- DWAF has a view that agriculture does not use their water efficiently and that mining companies should negotiate with agriculture but the mining industry believes that DWAF must provide a water bank and should obtain excess water

from agriculture and the release it back into the system to be used by mining and other demands.

- Mines do not oppose the construction of wetlands as a possible mechanism to clean water, but it is questioned if the government will find the proposal acceptable and the sustainability of the wetlands in long term.
- Abandoned mines are creating spillage into the river system and no one is responsible for that.

11.4.3 Agriculture

A meeting was held with the agricultural groups on the 10th of July 2009 at Loskop Valley Lodge in Groblersdal. The following key issues were raised:

- Government control bodies are toothless bulldogs. They do not react to complaints. Green/blue scorpions do nothing. Institutional failure of government occurs at the implementation level – laws are good. Agriculture feels powerless.
- Issuing of mining and prospecting permits that ignores the rights (especially the above ground rights) of the landowners. Prospecting occur without consent of farmers on productive land on which huge investments have been made.
- Groblersdal and Marble Hall area is dependent on the quality of the water in the system. Continued pollution of the water will have devastating effects on export of agricultural produce. Eurogap has already identified the water quality of the area as problematic.
- The requirements for obtaining water licenses for mines are not acceptable as mines are allowed start as long as they have applied for permits.
- The decrease in the water quality of the Olifants River is significant. There is especially concern about: arsenic level, DDT and other pollutants. The medical community at Groblersdal (also represented at the meeting) is very concerned about the health impact of water on the population.
- The purification of the water for Groblersdal is questioned. There is a constant high level of chlorine in the local water that makes it almost undrinkable – many people buy drinking water.
- Political will is not there to solve the problem. As a result:
    - Food security will be affected

    - Food exports will end
    - We will be hungry
    - Epidemics will start to occur
    - Medical expenses will rise
    - Agricultural production will decline and eventually stop altogether
- Planning of infrastructure etc. is lacking in the area.
- Air pollution e.g. the regular burning of the local waste dump in Groblersdal and especially the fallout is not acceptable.
- Medical concerns (from a doctor) about health effects in the population. Environmental pollution is the biggest contributor to declining health.

11.4.4 Eskom

A meeting was held with Eskom on the 21st of July 2009 at Megawatt Park Johannesburg. The following key issues were raised:

- There is a need to also consider effects of the activities happening outside the boundary of the EMF as these activities may influence what happens inside the boundary.
- It was suggested that provision be made through the different management zones to cater proactively for infrastructure serve corridors in the most sensible places. A dedicated workshop will be held to investigate this issue further.
- Some mines are facing severe water shortages as they do not have water use licenses. Eskom is dependent on coal from some of these mines.
- Some mines have significant water within the mines. DWAF, however, does not allow for the necessary water transfer so as to utilise the underground water.
- Eskom indicated that desired state of the EMF will be important for Eskom in determining its policies to provide energy to the suggested management zones.

11.5 TESTING PUBLIC OPINION

Questionnaires were prepared and the public was randomly asked to participate. Approximately 100 questionnaires were completed in total from selected towns and settlements falling within the EMF study area. The questionnaire covered three general aspects, namely the environment, service delivery and employment. The general feel was that the majority of people, around 75%, understand and appreciate the natural environment, but feel that it should be improved and managed better. There is also a general opinion that there should be improved communication and environmental education. Around 40% of the people asked have basic service delivery. The questionnaires indicated that around 55% are employed with the majority working in the agricultural and mining sectors.

It is however significant to note that most people put a much higher premium on development and job creation than on environmental conservation and management. Sustainable solutions that does not create jobs and improve the living conditions of the population will not work in this EMF area.

11.6 REQUEST FOR INPUTS FROM THE PUBLIC

An invitation to participate and provide inputs into the "Desired State" of the Olifants Letaba Catchment Areas along with a copy of the updated BID was sent out to all stakeholders. Stakeholders were invited to share their ideas, thoughts and expectations on the concept of a desired environmental state. Inputs are currently being awaited.

11.7 PUBLIC OPEN DAYS

Stakeholders and Interested and Affected Parties were invited to attend the public open days, where information will be shared with the public in respect to the status quo, opportunities, constraints as well as proposed management zones and the possible future state of the area. The meeting dates and venues have been arranged as follows:

Date	Place	Venue	Time
3 August 2009	Giyani	Giyani Community Hall	13h00 to 16h00

4 August 2009	Phalaborwa	Phalaborwa Municipality, Activity Hall	13h00 to 16h00
5 August 2009	Tzaneen	St. Peter's Anglican Church	13:00 to 16h00
6 August 2009	Burgersfort	Burgersfort Municipality, Council Chambers	13h00 to 16h00
11 August 2009	Middelburg	Middelburg District Municipality	13h00 to 16h00
12 August 2009	Groblersdal	Loskop Valley Lodge	13h00 to 16h00

12. GUIDING PRINCIPLES FOR THE EMF

The following guiding principles have been adopted for the EMF:

- Sustainable development that include:
  - meeting the basic requirements for natural water catchment basin functioning across all sub-catchments;
  - meeting biological conservation targets;
  - protecting and using the natural resource base optimally to ensure benefits over the long term;
  - ensuring that ecosystem function is not compromised by inappropriate development;
  - ensuring the equitable and appropriate allocation of available water to competing needs; and
  - promoting development (including mining and industries) that would secure long term sustainable income without excessive unmitigated impacts on the environment.
- pro-poor that include:
  - not allowing any activity that will impact negatively on the poor in the region;
  - planning activities to be positively biased towards the poor even if it requires intervention from the state; and
  - placing the poor at the centre of strategies and guidelines for the development of the area.
- capture value that should include:

  - ensuring that public investment in infrastructure and services is directed to increase the value of local private land and the potential value of entrepreneurial enterprise that can occur on such land; and
  - ensuring that public policy and investment support the creation of competitive advantages for local communities.
- support local economic development that include:
  - developing local skills for new employment opportunities;
  - obtaining supplies for enterprises locally or through local agents; and
  - forming partnerships with local entrepreneurs.
- focus on what is important, appropriate and possible in the area including:
  - making sure that development initiatives are feasible in all respects including having adequate licensed access to water;
  - ensuring that conservation initiatives contribute to national and provincial targets or to the development potential (tourism etc) of the area;
  - allocating water to users that are willing to pay a market price for water and that will use it effectively to achieve and promote government policies and objectives for the area; and
  - allocating water to users that will have the least negative effect on other legitimate users.
- internalise externalities by:
  - enforcing the polluter pays principle to ensure that negative impacts of activities is internalised as part of the cost of those activities during the planning and authorisation stage.

The approach that was adopted for addressing these principles for the area as a whole as well as for the different management zones that is an “asset base” management approach. The EMF area as a whole and each environmental management zone (discussed later in the report) has a “basket” of current assets, some of which can be maintained over the long[37] term and even indefinitely and some that are temporary and will be depleted some time in the short[38] to medium[39] term future. The aim is to promote long term sustainability which means that as short to medium term assets including coal, copper and other minerals are depleted, the development of additional long term assets are promoted to the extent possible to ensure a continued asset base for people to live of in the area. The maintenance, and rehabilitation of natural and cultural/historical resources in the process is vital in retaining long term sustainable development.

[37] Long term means at least a hundred years from now.
[38] Short term means up to fifty years from now.
[39] Medium term means between fifty to hundred years from now.

13. KEY ISSUES

The following key issues have been identified in the EMF area:

- The water resource in the EMF area is already over allocated and any further significant allocation of water must come from the redistribution of existing water allocations;
- impoundment of rivers (especially in the mountainous areas) may cause irreversible damage to the hydrological regime as well as the ecosystems and human enterprises that depend on it;
- excessive pollution of water bodies and rivers has a negative impact on the user value of the water in the system and in some instances even have potential disastrous effects on ecological and economic processes that depend on the quality of the water;
- erosion, turbidity and sediment deposition in hydrological systems that result from practices that remove vegetation cover in the catchment areas significantly diminish the potential of the hydrological system;
- mining activities (often inadequately rehabilitated) occurs in scenic areas and impacts unnecessarily on the value that such areas has for tourism because their impacts have not been internalised to the extent where rehabilitation is adequate to retain or replace the original value of the site and area for tourism;
- extreme levels of air pollution, especially on the highveld originating from heavy industry, electricity generation and burning of coal for space heating and cooking pose health risks to the people who stay in the affected areas and has a devastating effect on the scenic qualities of the affected areas, especially during winter months;
- poverty and its associated impacts occur over extensive parts of the EMF area;
- inadequate services and infrastructure remains a significant problem in certain areas;

- the extensive use of indigenous trees for firewood is not sustainable;
- the unsustainable harvesting of medicinal plants especially in indigenous forests is causing severe damage to the vegetation in certain parts of the area; and
- the uncertainty about the potential future impacts of climate change makes it difficult plan for contingencies.

14. ENVIRONMENTAL MANAGEMENT ZONES

Based on the Status Quo information the area has been divided into preliminary environmental management zones. The reason for this is that the areas have distinct environmental features and it was also clear that each area have very specific opportunities and constraints as well as expectations of stakeholders (desired state). Each of these areas also requires a different set of management interventions.

The eight zones that were identified are described in the paragraphs below.

14.1 ZONE A: THE HIGHVELD/ENERGY HUB AREA

The zone represents the current powerhouse of South Africa with extensive coal fields that cover almost all of the area, numerous large coal mines, 6 coal fired power stations (soon to be 7), several major industries and towns that are located in the area. It is also the area where the sensitive headwaters of the Olifants River catchment occur and water quality impacts that originate in the areas have significant implications for downstream areas. The natural vegetation of the areas has been almost completely destroyed and the remaining pans and wetlands are important refuges for natural life. ;

14.2 ZONE B: THE HIGHVELD TO BUSHVELD TRANSITION AREA

This area comprises mostly of the hilly areas between the highveld and the flat areas on the Bushveld Igneous Complex. It is a relatively unspoilt natural environment with good opportunities for conservation, recreation and tourism. Mineral economic significance occurs in places but is not dominant in the area;

14.3 ZONE C: THE GROBLERSDAL/MARBLE HALL AGRICULTURAL AREA

This zone occurs on the fertile soils of the Bushveld Igneous Complex in a climate that is suitable for food production area. The irrigation scheme that gets its water from the Loskop Dam led to the creation of a strategically important irrigated agricultural production area.

14.4 ZONE D: SPRINGBOK FLATS RURAL AREA

The zone is located on fertile soils in a relatively mild climate. It is dependent on extensive dry land agriculture, limited irrigated agriculture as well as limited mineral resource extraction. The area is rural in nature with a few settlement scattered across it.

14.5 ZONE E: RURAL SEKHUKHUNE/PLATINUM MINING FOCUS AREA

It is an area with beautiful mountains, rare vegetation, rich culture/history, high density impoverished rural communities and very high platinum mining extraction possibilities in a presidential poverty node;

14.6 ZONE F: NATURE CONSERVATION/TOURISM FOCUS AREA

This area of natural beauty includes the Kruger National Park, the majestic mountains of the escarpment and exclusive private nature reserves in a relatively sparsely populated area.

14.7 ZONE G: TZANEEN/PHALHABORWA ACTIVITY CORRIDOR

This is an important agricultural area supported by mining, manufacturing and nature orientated tourism in an area that is transitional between Zone F and Zone H.

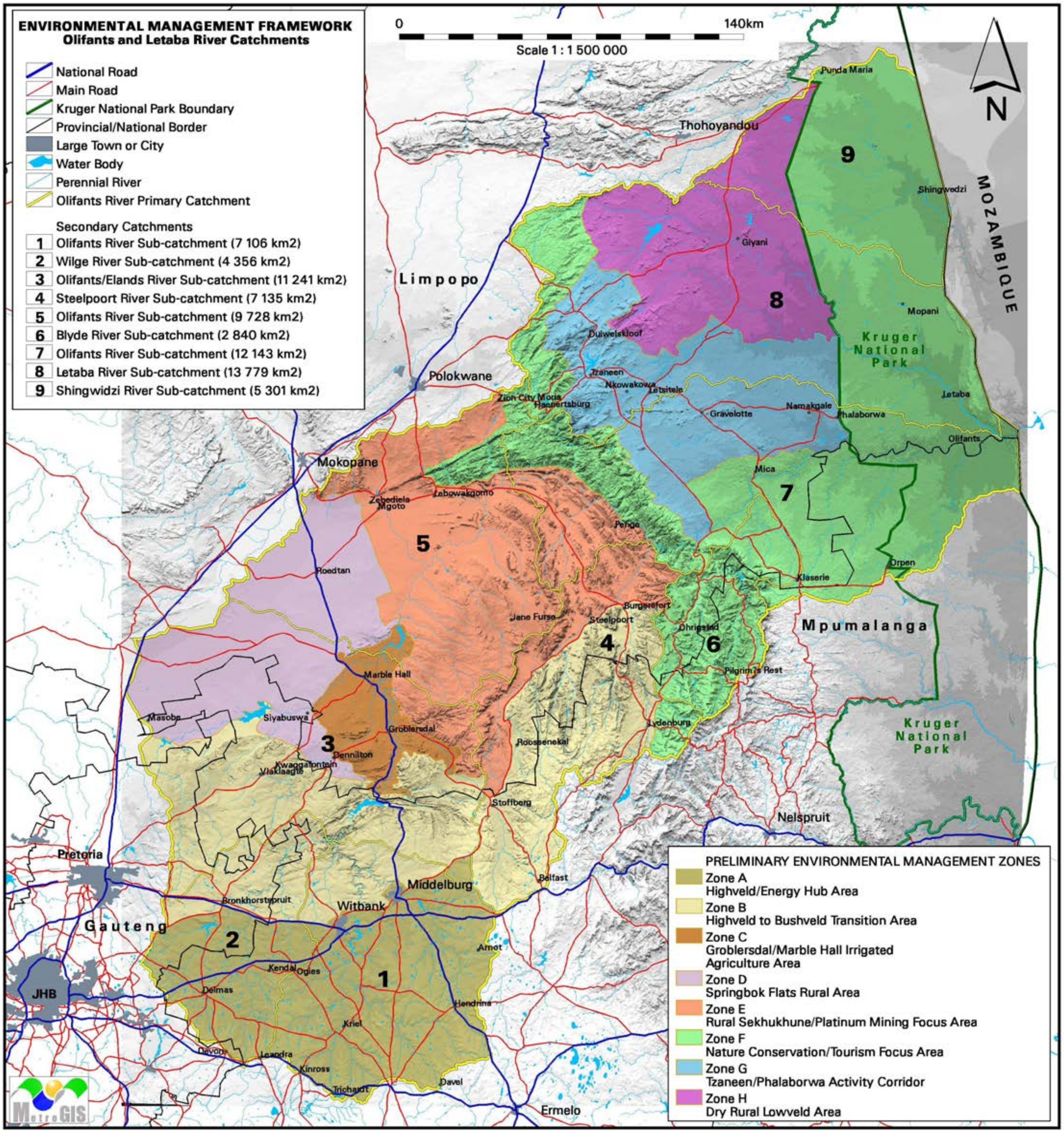
14.8 ZONE H: DRY RURAL LOWVELD AREA

This area is rural in nature with a high level of poverty that depends on subsistence farming. The government and education sectors are important in this area.

Table 53: Preliminary environmental management zones

	Surface Area in (km^2)	Percentage %
ZONE A: The highveld/energy hub area	8 773.920	11.92%
ZONE B: The highveld to bushveld transition area	12 633.363	17.16%
ZONE C: The Groblerdal/Marble Hall agricultural area	1 834.400	2.49%
ZONE D: Springbok flats rural area	6 315.783	8.58%
ZONE E: Rural Sekhukhune/platinum mining focus area	10 448.809	14.19%
ZONE F: Nature conservation/tourism focus area	20 973.748	28.49%
ZONE G: Tzaneen/Phalaborwa activity corridor	6 510.287	8.84%
ZONE H: Dry rural lowveld area	6 139.609	8.34%
Total Area	73 629.919	100.00%

Figure 30: Preliminary Environmental Management Zones



15. MAJOR OPPORTUNITIES IDENTIFIED TO DATE

15.1 CONSERVATION

The EMF area has a very high diversity of landscapes with great potential for conservation. Currently protected areas make up more than 17 000km^2 of the EMF area of which more than 10 000km2 falls within the Kruger National Park. Significant potential areas have been identified that are suitable for the expansion of protected areas.

15.2 MINING

While mining in the Phalaborwa and highveld area is slowly coming to an end, new prospect for extensive platinum mining is opening up in the Sekhukhune area. Mining will remain an important economic activity in the EMF area for the next 60 to hundred years.

15.3 AGRICULTURE

The suitable climate, a variety of suitable soil types together with the existing irrigation infrastructure make the EMF area one of South Africa's most important agricultural areas. Subsistence farming also makes an important food contribution to over a million households in the area.

15.4 RICH CULTURAL AND HISTORICAL HERITAGE

The rich cultural heritage of the area is captured in many known sites that range from the pre-historic to the present day.

15.5 TOURISM

Tourism is an important and growing activity in the area. It is has enormous potential to develop in an environment that has a diverse range of natural and cultural experiences that can be exploited. This is especially important in the poor rural areas.

16. MAJOR CONSTRAINTS IDENTIFIED TO DATE

16.1 WATER AVAILABILITY

As indicated in the draft Status Quo Report, the water resource in the EMF area is already over allocated and in places severely degraded by pollution. The ecological reserve requirements of the EMF area as a whole and of most rivers and streams that constitute it are not being met and any further allocation of water must come from the redistribution of existing water allocations. This is a constraint across all of the environmental management zones.

16.2 WATER POLLUTION

Water pollution, especially pollution emanating from the upper Olifants catchment, poses severe risks to other users. Irrigated agriculture in the Groblersdal/Marble Hall area is at risk of losing its extensive export market due to not meeting the standards set by importing countries. Water pollution also has a detrimental affect on aquatic life in the system and the sporadic occurrence of fish mortalities in the Loskop Dam and crocodile deaths in the Kruger National Park is indicative of this.

16.3 SOIL EROSION

Soil erosion has a severe impact on the river systems and dams in the EMF area. Soil erosion has reached acute levels in the Sekhukhune area, to the extent that there is very little topsoil left in an area that used to produce significant subsistence crops.

16.4 LOSS OF VEGETATION

Loss of natural vegetation occurs across the area for a variety of reasons including overgrazing, firewood harvesting, bush clearing for agricultural fields and mining. These losses contribute to endangering ecosystems to the extent that more and more ecosystems are becoming endangered and critically endangered.

16.5 LOSS OF SCENIC QUALITY

A variety of activities but especially mining in scenic landscapes is causing major losses of scenic quality in the EMF area. This has a significant impact on the tourism potential of such areas. The Sekhukhune area with its fast developing platinum mining activities is most severely affected by this.

16.6 AIR POLLUTION

The air pollution on the highveld part of the EMF area is severe and a limiting factor in the development of a significant number of activities including tourism and recreation.

16.7 POVERTY

Abject poverty that is exacerbated by high levels of unemployment and low education levels is widespread across the EMF area. The extent of the problem is such that it is unlikely that any measure of development will make a significant change to the situation in the foreseeable future.

17. DESIRED STATE

17.1 THE DESIRED BASIS FOR WATER ALLOCATION

Water is a public good. It does not belong to and is not automatically available for use to the owners/users/occupiers of land where it originates, occurs or flows through in a natural water course or underground water body.

Due to the scarcity of water in the area, the allocation of water should take the following into account:

- The public interest that includes the contribution needed to meet dire immediate needs in society as well as sustainable long term development;
- the volume of water that is available for allocation, if any (in excess of the ecological reserve requirements);
- the relative economic efficiency with which competing potential users can utilise the water;
- the effective use of existing infrastructure;

- the ability of potential users to pay a market based price for water; and
- existing rights to the use of water.

The availability and cost (including probable significant future price increases) of water must be taken into account in the assessment of the viability of any proposed activity as well as the continued viability of existing activities.

17.2 WATER PRICING

As a minimum, water pricing to all users should be at levels where costs are recovered in order to make its supply sustainable over the long term. In addition, in order to provide an equitable and efficient allocation of water to users and to capture the real value of water, water supply allocation to private enterprise should be regulated by the availability of water and a willingness to pay for it, i.e. the price of water should be set by the market somewhere above the cost recovery level and be allocated to the portions of the market that is prepared to pay the most for it. The allocation and reallocation of available water between irrigated agriculture, plantation forestry, tourism facilities, mining and industry should therefore be dictated by the market (demand management based on pricing of water) with minimum intervention from the state. The profits that result from such an approach can be used by government to improve the management and maintenance of infrastructure that purify and maintain the quality of previously used water in order to improve the quality of water in the system to a level that is appropriate for all the users in the area.

17.3 SUBSIDISING THE COST OF WATER

Subsidistation of water, especially for private enterprise should be avoided as far as possible. Were it is not possible to avoid subsidies, it should be well motivated and the potential consequences should be clear and transparent. In a stressed system like that of the EMF area, any direct subsidies (e.g. lower prices for certain users to meet government objectives such as food security) or indirect subsidies (e.g. carbon credits for bio-fuel production) to private enterprise users that would increase or benefit their competitiveness in relation to other potential users of the resource, should be treated with great circumspection and be avoided if at all possible. If it cannot be avoided measures and oversight must be implemented to ensure that subsidies are not perverse[40] and therefore result in unintended consequences or inequitable allocation of water resources that is not in the best interest of long term sustainable development.

17.4 WATER SUPPLY PRIORITIES

The ecological water reserve (supply necessary to maintain natural processes in the system at a sustainable level) and social water reserve (supply necessary to maintain the government's obligation to provide for the basic water needs to the population) water reserves in the system should not be negotiable and should at least be maintained at current levels that are already severely stressed.

17.5 WATER SUPPLY TO AREAS THAT IS CLEARLY UNSUSTAINABLE

The viability to continue to supply water to areas that have little potential for sustainable development (including supply to certain rural communities) with scarce and expensive water over the long term should be investigated with the aim to identify alternatives or scenarios that can be implemented to provide a better future for such areas and the people that currently live in it. There is no point in continuing to flog a dead horse – a reality that has to be faced. It is important to provide a catalyst to bring change to the lingering effects of apartheid policies in the impoverished rural "ex-homeland" parts of the EMF area and to the people who live in it.

The significant unintended negative consequences of policies and practices such as the "child grant" and the employment of large numbers of foreigners on mines in poor rural areas should also be investigated. Such policies and practices cause severe indirect impacts in the area. They contribute to development that is not sustainable with environmental consequences such as over exploitation of arable soil to the extent that it no longer productive, erosion of watercourses that clogs the hydrological system up with sediments in other areas and destruction of natural vegetation as a result of overgrazing and firewood harvesting.

This is especially relevant in zones D, E and H.

[40] An example of a perverse subsidy in the EMF area would be if below market price water, that is intended to support to food security objectives, is used to grow irrigated crops such as tobacco, cotton or export fruit.

17.6 CONSERVATION

Conservation of threatened ecosystems is becoming more important in the EMF area as development pressures increases. While expansion of national and provincial protected areas are possible and advisable in certain areas, private initiatives must play an increasingly more important role. In this respect it is important that activities such as mining that are responsible for considerable destruction of habitat should play a bigger role in the securing of protected areas through an offset programme that should be built into the authorisation process.

Private natural and cultural based conservation that derive income from tourism and recreation should also be supported. This is especially important in the rural areas where a more diversified income stream is important.

18. DEVELOPMENT OPPORTUNITIES, CONSTRAINTS AND PRIORITIES

This section of the report provides a brief summary of the opportunities, constraints and development priorities for the various District Municipalities in the EMF study area. It highlights the difficulties experienced within each municipality as well as potential opportunities. The development priorities are what each municipality is focusing on in order to improve the development status. The IDP and SDF documents are available as reference documents to this EMF.

18.1.1 Enlanzeni District Municipality

The Thaba Chweu and the Bushbuckridge Local Municipalities are the two local municipalities in the EMF study area. Sabie, Maartensshoop, Buffelsvlei, Krugerspostberg and Leroro are the areas that fall within the EMF study area for the Thaba Chweu local municipality and a small portion of Bushbuckridge.

Bushbuckridge local municipality as a whole has a small economy with a limited resource base. Agriculture and tourism make a considerable contribution to the local economy. Thaba Chweu's economy is driven by agriculture, forestry, tourism, manufacturing and the service sector.

(a) Opportunities

The opportunities the area includes:

- A significant potential for expansion of the mining industry;
- potential for further plantation forestry development;
- significant tourism potential that is not yet fully captured; and
- the Matibidi water scheme in Thaba Chweu has the potential to stimulate economic growth for a considerable period.

(b) Constraints

The main constraints in the area include:

- Thaba Chweu gets very little direct benefits from primary produce as most of the produce are exported outside the area (this applies to the whole municipality);
- employment is largely limited to unskilled labour due to low levels of education in area; and
- the Matibidi and the Leroro areas have minimal economic activities and prospects for improvement.

(c) Planning and development priorities in the area

Planning and development priorities in the area are focused on:

- Improving the basic service infrastructure in Thaba Chweu;
- the construction of a bus route in Matibidi; and
- improving the agricultural sector.

18.1.2 Gert Sibande

The Govan Bheki and the Musukaligwa Local Municipalities occur in the EMF study area. Towns include Evander, Kinross, Secunda, Bethal, Trichardt and Musukaligwa.

Some of the major urban centres in the district municipality include Evander, Secunda and Bethal, with Secunda being the most important development node. Outside these nodes the district is predominately rural in character with agriculture, mining, nature reserves and forestry being the major sectors.

Economical activities are concentrated within the major urban nodes, which include business, retail, social services and industry (petroleum, chemical and rubber production).

(a) Opportunities

The opportunities in the area include:

- A well developed transport network;
- a strong agricultural sector with Bethal as it's core;
- Gert Sibande has a strong mining sector and industrial base (mining of gold and coal), especially in the Secunda area;
- there is potential for growth in the tourism sector where especially the mining and industrial activities is gaining popularity as attractions; and
- areas like Secunda and Evander are strategically located from an economic perspective.

(b) Constraints

The main constraints in the area include:

- Environmental effects and conditions due to the mining and industrial activities the area not favourable for creating healthy and clean living and working conditions;
- insufficient government land for low cost development in urban areas;
- insufficient of road maintenance;

- the decline of Davel as an economic node due to the closure of the coal mine in Ermelo has added to the social and economical impacts; and
- Musukaligwa municipality faces a lot of security and safety issues.

(c) Planning and development priorities

Planning and development priorities include:

- To manage the natural environment resource of the municipality;
- to capitalise on the district's five economic strips;
- to link all settlements with the economic nodes;
- to promote urban aforestation within and along the tourism corridor;
- to promote intensive farming throughout the district and facilitate and concentrate subsistence farming activities in the rural areas;
- to ensure all communities have at least minimal basic services; and
- to facilitate and accommodate mining in the district in a sustainable manner.

18.1.3 Greater Sekhukhune District Municipality

The Greater Sekhukhuni District Municipality is one of the municipalities in the EMF. The Municipality consists of five local municipalities, namely:

- Fetakgomo Municipality;
- Greater Tubatse Municipality;
- Makhuduthmaga Municipality;
- Greater Marble Hall Municipality; and
- Elias Motsoaledi Municipality.

The District is rural in character with towns including Groblersdal, Marble Hall, Burgersfort, Jane Furse, Origstad, Steelpoort and Driekop. The economic activities are predominately concentrated in the Greater Marble Hall, Greater Tubatse and Elias Motsoaledi local municipalities, with intensive commercial agriculture and platinum mining being the dominant economic activities. Nature orientated tourism is also a growing activity in the area.

(a) Opportunities

The opportunities in the area include:

- Greater Sekhukhune has good agriculture potential with agriculture products such as citrus fruits, grapes, cotton, vegetables, corns being cultivated and exported from irrigated fields;
- livestock farming that include cattle, goats and game;
- the Greater Tubatse local municipality region has rich deposits of platinum, chrome, vanadium, andalusite, silica and magnetite that can sustain a growing mining industry for more than a hundred years; and
- the location of the Loskop Dam in the area serves as a source for irrigation water and is also a popular tourism destination (water sports and fishing).

(b) Constraints

The main constraints in the area include:

- The availability of water is a major constraint to the further development of the area and has led to conflicts between the farming communities, tourism organisations, conservation groups and mining companies;
- the district has a poor and dilapidated road network that is not well maintained; and
- the district has a very large rural population with very high levels of unemployment, a lack of skills and low levels of education.

(c) Planning and development priorities

Planning and development priorities include:

- To actively protect, manage and enhance the natural environment in order to reduce conflicts between the mining, agriculture and tourism sectors in the area;
- to promote mining activities in the area to ensure job creation;

- to promote tourism focussed on the natural environment and cultural historical features;
- to promote farming, industry and food production (agri-processing) especially in the area of the new De Hoop Dam;
- to speed up development by focusing on education and skills development; and
- to implement the proposed local economic development anchor projects for the district.

18.1.4 Mopani District Municipality

The District Municipality consists of five local municipalities, namely:

- Greater Tzaneen Municipality;
- Greater Letaba Municipality;
- Greater Giyani Municipality;
- Ba-Phalaborwa Municipality; and
- Maruleng Municipality.

The Mopani district, like other districts in the EMF study area, is largely rural in character. The major economic nodes in the district are Phalaborwa and Tzaneen.

The economic sectors include mining (mostly in the Phalaborwa area), agriculture (citrus and sub-tropical fruits) largely found in the Tzaneen area and tourism which is also a dominant economic activity in the area. The other areas in the district also have limited economic activities with low levels of economic growth.

(a) Opportunities

The opportunities in the area include the following:

- There has been considerable growth in the agriculture, transport and communication sectors, with local municipalities like the Greater Letaba and even Greater Giyani registering some positive growth;

- the growth in the agriculture sector has in turn encouraged the growth of the manufacturing sector in the district, especially in the Tzaneen region;
- the Mopani district also has a large mining sector concentrated in Phalaborwa, with copper, magnetite and vermiculate as the major commodities;
- the district lies adjacent to the Kruger National Park which is a major tourist attraction; and
- game farming is an important economic sector which is most common in the Maruleng local municipality.

(b) Constraints

The main constraints in the area include:

- Settlements in the district are scattered which makes development planning and service delivery difficult;
- the district suffers from high levels of migration of the economically active population which has a negative impact on the labour force as well as the economic growth potential in the area;
- the manufacturing sector in the area has been showing signs of decline over the years, which is regarded as an indication of the sector moving to areas outside the district;
- although mining is currently seen as the economic backbone in the district, its is life span is limited to the short to medium term which will have both negative economic and social impacts in the area once the mines close; and
- the Mopani district has general infrastructure backlogs which hamper development.

(c) Planning and development priorities

Planning and development priorities in the SDF include the implementation of economic infrastructure support through various programmes such as:

- The development of district-level economic databases and local business support structures/services;

- establishment of depots of national wholesalers and retail trade development;
- agriculture diversification;
- agriculture product development;
- revitalisation of irrigation scheme activities;
- promotion and marketing of potential tourism;
- development of mining services and processing; and
- expansion of small scale farming and skills development.

18.1.5 Nkangala District Municipality

There are six local municipalities within the District Municipality, namely:

- Dr. JS Moroka Municipality;
- Thembisile Municipality;
- Delmas Municipality;
- Emalahleni Municipality;
- Steve Tshwete Municipality; and
- Emakhazeni Municipality.

The Nkangala District Municipality is predominately a rural area, comprising of extensive farming, forestry, nature reserves and mining. There are approximately 165 towns and villages spread throughout the area.

Witbank and Middelburg are the two main towns in the district, both in terms of location and function. Delmas and Belfast are secondary service centres serving as central places to the surrounding farming areas. The tourism potential of the region has resulted in the regeneration and growth of towns such as Dullstroom and Waterval-Boven.

(a) Opportunities

The opportunities for sustainable development in the area include:

- A strong industrial, mining and agricultural base;

- the region has rich deposits of coal and chrome;
- Eskom power stations;
- Nkangala has an extensive road and rail network;
- the main towns (Witbank and Middelburg) are strategically located along the Maputo Development Corridor;
- Nkangala is also located close to Gauteng which is an added advantage; and
- the region also has tourism potential due to its natural beauty.

(b) Constraints

The main constraints in the area include:

- The environmental effects of coal mining such as land surface degradation, ground water and air pollution;
- the municipality lacks land for low income residential development, which has contributed to rapid mushrooming of informal settlements around the urban areas;
- Nkangala has high levels of unemployment due to a shortage of appropriate skills; and
- the roads are poorly maintained and are dilapidated, due to the mines coal haulage.

(c) Planning and development priorities

Planning and development priorities include:

- To develop and classify the N12 freeway as a development corridor as it links Nkangala with the Ekhurhuleni Metro and promote development activities in areas such as Belfast and Machadodorp;
- to transform the R555 route as a “Local Development Corridor” with emphasis on agri-processing, service industry for the agriculture sector manufacturing, warehousing as well as improving the railway network to encourage export to Maputo;

- to promote a "Tourism Belt" in the region which will incorporate sensitive wetlands and nature reserves in the area;
- to enhance mining activities in the southern region to contribute to job creation;
- formalise and upgrade the informal settlements to ensure that the community has access to basic services; and
- to promote industrial areas in the district as well as upgrading services in priority areas.

18.1.6 Vhembe District Municipality

Thulamela and Makhado local municipalities are partially located in the EMF area the two local municipalities in the EMF study area.

(a) Opportunities

The opportunities for sustainable development in these areas include:

- Thulamela and Makhado local municipalities have good climatic conditions which make them favourable for cash crop and fruit farming;
- Makhado has potential for value-adding to primary products which is curretnly underdeveloped;
- Makhado also have potential for the further development of the mining sector; and
- both areas have tourism potential e.g. the Ben Levi Nature Reserve for Makhado and Lake Fududzi for Thulamela.

(b) Constraints

The main constraints in the area include:

- Both municipalities lack proper telecommunication and transport infrastructure;
- basic service delivery is poor with water access being a major problem;
- local farmers in the area lack proper markets to sell their produce;
- the farmers lack farming inputs;

- the tourism sector is poorly marketed; and
- there is lack of serviced land for development in the area.

(c) Planning and development priorities

Planning and development priorities include:

- To implement development proposals for business and residential development, and the construction of a sports stadium in Makhado;
- Thulamela local municipality has plans to develop the agriculture sector through the increase of irrigation schemes for small scale farmers;
- to increase business investments and create value-adding sector in the area;
- to implement the Thulamela gateway project which is meant to improve the access linkage network in the area; and
- both areas plan to develop the tourism sector (Thulamela proposed gate for the Kruger National Park).

18.1.7 Waterberg District Municipality

The Waterberg District Municipality has three local municipalities in the EMF study area, namely:

- Mookgopong Municipality;
- Bela-Bela Municipality; and
- Modimolle Municipality.

It should be noted that the EMF study area only covers small portions of these municipalities.

(a) Opportunities

The opportunities in these areas include:

- Modimolle, Bela-Bela and Mookgopong are allocated along the N1 which gives them an advantage of being accessible;
- Modimolle and Bela-Bela have a strong agricultural sector in the district;

- the service sector in the district is showing positive growth especially in Modimolle and Mookgopong;
- the district has a strong tourism base (Bela-Bela); and
- there is also an increase in mining activities in the district.

(b) Constraints

The main constraints in the area include:

- The Bela-Bela local municipality has a weak service sector;
- the district municipality has a low agriculture potential; and
- the rural component of the district show limited development potential as the levels of substance farming are low.

(c) Planning and development priorities

Planning and development priorities include:

- To support mining sector in terms of land and service availability;
- to promote non restrictive development in rural areas of the district;
- to promote investment in tourism; and
- to promote agriculture as an important economic activity as well as provide good roads for produce transportation.

18.1.8 Capricorn District Municipality

The Capricorn District Municipality has the smallest area falling within the EMF study area. The area in question is rural in nature with a small population. No measurable economic activities take place in this area.

18.1.9 Gauteng municipalities

The Gauteng municipalities that are part of the EMF area are already covered by local EMFs and are therefore not addressed here.

19. STRATEGIC ENVIRONMENTAL MANAGEMENT PLANNING

The next step in the EMF will be to develop the strategic environmental management plan including the final products of the EMF that will include:

- Inputs from the public open days that will be held in August 2009;
- The compilation of an environmental sensitivity index (map) for the area;
- The adjustment and finalisation of the environmental management zones;
- The identification of geographical areas and the specification of activities (a map and a proposal for inclusion in the national system); and
- Guidelines in terms of Regulations 73 and/or 74 for each of the environmental management zones.

These will all be contained in the the Draft EMF that will be advertised formally for comment and thereafter be submitted to the Minister for adoption by the end of the year.

20. BIBLIOGRAPHY (INCOMPLETE)

Acocks, J.P.H. 1975. *Veld Types of South Africa*. Memoirs of the Botanical Survey of South Africa, No. 40. Pretoria: Botanical Research Institute.

Barnard, C. (Ed.) 1975. *Die Transvaalse Laeveld: kamee van 'n kontrei*. Kaapstad: Tafelberg Uitgewers.

Bergh, J.S. (Red). 1998. *Geskiedenisatlas van Suid-Afrika. Die vier noordelike provinsies*. Pretoria: JL van Schaik.

Cloete, P.G. 2000. *The Anglo-Boer War: a chronology*. Pretoria: JP van der Walt. Pp. 243.

Collett, D.P. 1979. *The Archaeology of the stone-walled settlements in the Eastern Transvaal, South Africa*. Unpublished MA Thesis. University of the Witwatersrand.

Collett, D.P. 1982. Excavations of stone-walled ruin types in the Badfontein Valley, Eastern Transvaal, South Africa. *South African Archaeological Bulletin*. Vol. 37.

De Jong, R.C, Van der Waal, G-M. & Heydenrych, D.H. 1988. *NZASM 100: The buildings, steam engines and structures of the Netherlands South African Railway Company*. Pretoria: Chris van Rensburg Publications.

Delius, P (ed.) 2007. *Mpumalanga: History and Heritage*. Scotsville: University of KwaZulu-Natal Press.

Delius, P. & Hay, M. 2009. *Mpumalanga: an illustrated history*. Johannesburg: The Highveld Press.

Evers, T.M. 1975. Recent Iron Age research in the Eastern Transvaal, South Africa. *South African Archaeological Bulletin.* Vol 30.

Holm, S.E. 1966. *Bibliography of South African Pre- and Protohistoric archaeology*. Pretoria: J.L. van Schaik.

Huffman, T.N. 2005. *Mapungubwe: ancient African civilisation on the Limpopo*. Johannesburg: Wits University Press.

Huffman, T.N. 2007. *Handbook to the Iron Age*. Scottsville: University of KwaZulu-Natal Press

Joubert, C. 2001. *Olifants River Ecological Water Requirements Assessment – Social Utilisation of the Olifants River*. Department of Water Affairs and Forestry. Pretoria.

Joubert, H. n.d. *Die Mapoch-oorlog 1882-1883*. Ongepubliseerde manuskrip.

Küsel, U.S, 2004. *Scoping report of cultural heritage resources of the farm Lakenvlei*. Unpublished report- Pretoria: African Heritage Consultants.

Küsel, U.S, 2004. *Final report on the recording and development of cultural heritage resources in the Sekhukhune district municipality*. Unpublished report. Pretoria: African Heritage Consultants.

Louw, D. Palmer, C. 2001. *Olifants River Ecological Water Requirements Assessment – Ecological Management Class: Technical Input*. Department of Water Affairs and Forestry. Pretoria.

Marker, M.E. & Evers, T.M. 1976. Iron Age Settlements and soil erosion in the Eastern Transvaal, South Africa. *South African Archaeological Bulletin*. Vol. 31.

Mason, R.J. 1968. Transvaal and Natal Iron Age settlements revealed by aerial photography and excavation. *African Studies* 27:1-14.

Mason, R.J. 1969. *Prehistory of the Transvaal*. Johannesburg: Witwatersrand University Press.

Mönnig, H.O. 1967. *The Pedi*. Pretoria: J.L. van Schaiks.

Moore, MPJ. 1987. *The Transvaal's potential for the development of prehistoric site museums. Unpublished report*. Pretoria: Transvaal Provincial Museum Service

Mucina, L. & Rutherford, M.C. (eds.) 2006. *The Vegetation Atlas of South Africa, Lesotho and Swaziland*. Strelitzia 19. Pretoria. South African National Biodiversity Institute.

Murimbika, E. 2005. *Environmental Impact Assessment: Infrastructural Development Specialist Study: Cultural Heritage Assessment*. Polokwane: Nzumbululo Heritage Solutions.

Nkangala District Municipality 2004. Formalization of Cultural and Historical sites. Pretoria: BKS (Pty) Ltd and Cultmatrix cc.

Palmer, C. Rossouw, N. 2001. *Olifants River Ecological Water Requirements Assessment – Water Quality*. Department of Water Affairs and Forestry. Pretoria.

Palmer, R. 2001. *Olifants River Ecological Water Requirements Assessment – Water Quantity*. Department of Water Affaris and Forestry. Pretoria.

Praagh, L.V. (ed.) 1906. *The Transvaal and its mines*. London: Praagh & Lloyd.

Plug, I. 1978. *Die Latere Steentydperk van die Boesmanrotsskuiling in Oos-Transvaal*. Ongepubliseerde MA verhandeling. Pretoria: Universiteit van Pretoria.

Raper, P.E. 2004. *South African place names*. Johannesburg: Jonathan Ball Publishers.

Republic of South Africa, 1999. *South African National Heritage Resources Act (Act No. 25 of 1999)*. Pretoria: Government Printer.

Pienaar, U de V. (Red.) 1990. *Neem uit die verlede*. Nasionale Parkeraad: Pretoria.

Pistorius, J.C.C. 1989. *Die Metaalbewerkers van Phalaborwa*. Ongepubliseerde D.Phil thesis. Pretoria: Universiteit van Pretoria.

Richardson, D. 2001. *Historic sites of South Africa*. Cape Town: Struik Publishers.

Schoeman, M.H. 1997. *The Ndzundza Archaeology of the Steelpoort Valley*. Unpublished MA dissertation. Johannesburg: University of the Witwatersrand.

Söhnge, P.G., Visser, D.J.L. & Van Riet-Lowe, C.1937. *The Geology and Archaeology of the Vaal River Basin*. Geological Survey Memoir No. 35. Pretoria: Government Printer.

Thackeray, A.I. 1992. The Middle Stone Age south of the Limpopo River. *Journal of World Prehistory* 6(4):385-440.

Van Coller, H.P. 1941. Mampoer in die stryd om die Bapedi-troon. *Historiese Studies* 3:97-152.

Van Schalkwyk, J.A. 2007a. *Final survey report and mitigation recommendations for cultural heritage resources in the De Hoop Dam, Steelpoort River, Limpopo Province*. Unpublished report DHD2007/01. Pretoria: National Cultural History Museum.

Van Schalkwyk, J.A. 2007b. Mototolong Early Iron Age site, Limpopo Province. *Research by the National Cultural History Museum*, in press.

Van Schalkwyk, J.A. 2007c. *Cultural heritage resources review for the Emakhazeni municipal district, Mpumalanga Province*. Unpublished report 2007KH085. Pretoria: National Cultural History Museum.

Van Vollenhoven, A. & Van den Bos, J. 1997. *'n Kultuurhulpbronstudie van die Britse blokhuisstelsel van die Tweede Anglo-Boere-oorlog (1899-1902) in die voormalige Transvaal (ZAR)*. Pretoria: Raad vir Geesteswetenskaplike Navorsing.

Van Warmelo N.J. 1935. *A Preliminary Survey of the Bantu Tribes of South Africa*. Ethnographic Publications No. 5. Pretoria: Government Printer.