PROPOSED
POWER LINE BETWEEN ETNA AND GLOCKNER SUBSTATIONS

ECOLOGICAL ASSESSMENT REPORT

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1 EXECUTIVE SUMMARY

A baseline ecological survey was undertaken of an area of Highveld Grassland situated between the Etna and Glockner Substations in Gauteng, The purpose of the survey was to assess the climatic regime, biodiversity status and ecological sensitivity of the area, due to be impacted by the erection of a 30km, 400 kV power line between the two substations. Existing data about the biota of the study area were utilized to supplement those yielded by a field survey. Ecologically sensitive areas that warrant impact mitigation measures were recorded in the study area. These include untransformed ridges, water courses, riparian areas and a small patch of untransformed pristine grassland. None of the known threatened or endangered biota potentially occurring in the study area was recorded during this survey. Habitat suitable for the near threatened Giant Bullfrog *Pyxicephalus adspersus* occurs in the study area, and the presence of this species cannot be discounted. Major direct impacts on the biota are likely to occur only during the construction and implementation phases, while the long term impact of the power lines on large bird species should be managed. Of the alternative routes proposed by the client, one (Option/Route 1) is recommended, since it has the least coincidence with sensitive biological features.

2 INTRODUCTION

Naledzi Environmental Consultants appointed the authors of this report to conduct an ecological assessment for the proposed construction of a 30km long double circuit 400kV power line in the Gauteng Province. This report follows an ecological overview of the study area and forms part of the Impact Assessment Report to be submitted by Naledzi Environmental Consultants.

3 TERMS OF REFERENCE

3.1 OBJECTIVES OF THE ECOLOGICAL SURVEY

The objectives of the baseline ecological survey were to:

- Identify key issues for biodiversity;
- Identify alternatives that could avoid or minimize impacts on biodiversity;
- Respond to and evaluate biodiversity-related issues raised by I&APs;
- Identify measures to reduce these impacts, and/or measures to optimise or enhance possible benefits to biodiversity;
- Advise on whether or not there is sufficient information to determine reliably the likelihood of unavoidable significant impacts at this stage, and/or the need for additional specialist studies;
- Advise the need for additional specialists to investigate specific ecosystem components and the scope and extent of the information required from such studies;
- Assist in drawing up the TOR for involvement of additional biodiversity specialists should these be required;
- Present climatological data which may influence development in the study area;
- Provide recommendations that include mitigation measures and alternatives so as to minimize the impact of the proposed development on the biological environment.

3.2 SCOPE AND PURPOSE OF STUDY

3.2.1 Scope of the study

The scope of the study entails the following deliverables:

- Ecological Assessment of the study area.
- Sensitivity analysis of the study area.
- Climatological analysis of the study area

3.2.2 Purpose of the study

The purpose of the study is to meet the requirements of Regulation 33 of the Regulations compiled in terms of section 24(5) read with section 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998). In terms of the Convention on Biological Diversity South Africa has an international obligation to work towards conservation of its biodiversity. In terms of this Convention, conservation entails:

- The protection of species and ecosystems that warrant national protection;
- Sustainable use of indigenous biological resources; and
- The fair and equitable sharing of its benefits.

3.3 CONSTRAINTS

The scope of the study does not make provision for quantitative biological surveys of the study area. For the purpose of the study therefore, only baseline surveys have been conducted. Species lists were drawn up from previous recordings for the same vegetation types and environmental conditions as found in the study area. Although information from these lists is considered sufficiently reliable for predicting the likely significance of key issues and associated impacts, priority species (endemics, Red Data listed etc.) may be overlooked in the process. Some of these plant species have no foliage above ground, and for all practical purposes disappear during the dry season when they are dormant, and

only reappear after the annual spring rains. Faunal species may also migrate (e.g. birds) or move when disturbed and an inclusion of a mere species list recorded in the study area at the time of the survey would thus be pointless. Assessments have therefore been made based on the assumption that information gained from previous recordings is sufficiently reliable for this purpose.

3.4 ENVIRONMENTAL CONTEXT OF THE STUDY AREA

3.4.1 Location of the study area

The study area is located in Gauteng Province, from Etna Substation (just north of Ennerdale, 26°23'02.7"S and 27°52'31.0"E) to Glockner Substation (next to Rothdene, 26°36'15"S and 27°59'14.4"E) (Figure 1). The study area comprises two vegetation types which fall within the Grassland Biome.

3.4.2 Biodiversity Considerations in the Study Area

Grasslands host a very high diversity of plant species, second only to the Cape Floral Kingdom (greater at a 1000m^2 scale; O' Connor & Bredenkamp 1997). A high degree of endemism also occurs with nearly half of South Africa's 34 endemic mammals found in the Grassland biome. Several small and threatened mammals are also restricted to the biome. It is home to 52 of the 122 Important Bird Areas in South Africa, including the Endemic Bird Area with the highest global priority, which contains 10 of the 14 globally threatened bird species found in South Africa. The biome houses 22% of South Africa's endemic reptiles, a third of threatened butterflies and 5 of the 17 Ramsar wetlands in South Africa.

In terms of ecosystem services, the biome is an important source of many provisioning services of food, fibre, medicines and water, has high carbon storage potential, is an important source of forage and livestock and forms an important component of the country's tourism industry. The grasslands are also an area of importance to freshwater

biodiversity. Although less is known about this component of the grassland biome, 44 river ecosystems have been identified within the grasslands (Nel *et al.* 2004). Six of these ecosystems are marginal to the grasslands, but the rest rely on the Grassland biome for the maintenance of their biodiversity.

The grasslands of South Africa are thus undeniably important both in terms of their terrestrial and river biodiversity, and the services they provide to most of South Africa's human population. This importance is increasingly being recognised, and the National Grasslands Biodiversity Program is an example of this increasing recognition.

4 ISSUES IDENTIFICATION: METHODOLOGIES AND APPROACH

4.1 DESK TOP STUDY

Best available information were gathered and synthesized: type and status of the receiving environment; recordings and data for the vegetation types found in the study area; lists of priority species that may occur within the study area; biodiversity frameworks and bioregional plans; biodiversity management plans and grassland priority cluster reports.

4.2 SITE VISIT

The site was visited and surveyed from a vehicle and on foot; all aspects of potential interest were visited and recorded. A baseline survey was conducted to record the present status of the bio-physical environment and identify areas of potential concern.

4.3 CAUSE-EFFECT-IMPACT PATHWAYS

Cause-effect-impact pathways were determined at appropriate levels of detail to the proposed project, in order to focus on potentially significant issues.

4.4 CONSULTATION PROCESS

Other specialists were consulted to determine the status of some species and ecosystems and the appropriate management actions needed to minimise the potential impacts on them.

4.5 METHODOLOGY SELECTION

The best methodology to address the particular project related issues were determined, and methods and techniques that are standard to and recognized by the professional discipline were used. Methods that were chosen took into account the quality and quantity of available information.

5 RESULTS: ECOLOGICAL ASSESSMENT OF THE BIO-PHYSICAL ENVIRONMENT

5.1 CLIMATOLOGICAL FACTORS

All climatological data used for the purpose of the study were recorded at weather station no: 04387843 (Vereeniging) Lat:-26.5670 & Lon: 27.9500 Height: 1479 m.

5.1.1 Temperatures

Appendix II contains average temperature data for the past five years. This was recorded at the weather station located at Vereeniging, which is the station closest to the study area. Average maximum temperatures recorded in the study area are around 24.6^{o}C and minimum temperatures 9.1^{o}C.

5.1.2 Wind

Appendix II shows that the strongest winds are experienced from August to November each year. All considered, the predominant wind direction in the study area is northern to slightly north-western, but the strongest winds are mainly eastern winds. Hellman's formula may be used to convert wind speeds to different heights should the need arise. A simplified version of Hellman's formula: $V_h = V_{10}(0.233+o.656\ log(h+4.75))$ h = height in metres; V_{10} = velocity at 10 meter height in m/s; V_h = calculated velocity at height h.

The frequency of tornados has been recorded in Appendix II. A total of 24 tornados (accompanied by thunderstorms) were recorded for Gauteng in the past 100 years. Only one was recorded for the study area in 1948, when eight homes were destroyed.

5.1.3 Lightning Frequency

Appendix II shows lightning flash density maps for South Africa. Seven to eight lightning flashes to ground per square kilometre per year are experienced in the vicinity of the study area.

5.2 BIOTIC FACTORS: VEGETATION

From the general assessment of the bio-physical environment of the study area it is evident that it has been poorly conserved. Habitat destruction and fragmentation through urbanisation is the most serious threat posed to the survival of plant and animal species. Within the boundaries of the Ekurhuleni Metropolitan Municipality (EMM), natural grasslands in various stages of degradation prevail on untransformed land, ridges are sparsely distributed in the centre of the EMM and the Klipriviersberg protrudes into the south-west section of the EMM. Wetlands and water bodies (both natural and man-made) abound within the metropolitan area. Bird and frog species of conservation importance are concentrated in the wet areas, while plant and invertebrate species of conservation importance are concentrated mainly on the ridges.

In the Gauteng province of which the study area forms part, 8 plants have been listed as critically endangered, 6 as vulnerable and 12 as near threatened. Nineteen of the 44 threatened bird species that are breeding residents, regular visitors or regular migrants to Gauteng were prioritized for conservation attention in the province. Thirty-seven invertebrate species have been prioritised for conservation action. Table 1 outlines the Red Data Status for each taxonomic group in Gauteng.

5.2.1 Flora of the Study Area

5.2.1.1 Vegetation In A National Context

The study area is located within the Grassland Biome of South Africa. The Grassland Biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. Urbanization is a major additional influence on the loss of natural areas - the Witwatersrand is centred in this biome. The Grassland Biome is considered to have an extremely high biodiversity, second only to the Fynbos Biome. Rare plants are often found in the grasslands, especially in the escarpment area. These rare species are often endangered, comprising mainly endemic geophytes or dicotyledonous herbaceous plants. Very few grasses are rare or endangered. (Van Rooyen & Bredenkamp, 1996). A total of 15 vegetation types is recognised in the grassland biome by van Rooyen & Bredenkamp (1996) with the study area situated mostly in what is described as the Moist Cool Highveld Grassland vegetation type. Mucina, Rutherford & Powrie (2005) in comparison recognised a total of 82 vegetation types. The study area in this case is situated in what is described as the Soweto Higveld Grassland.

The Grassland Biome

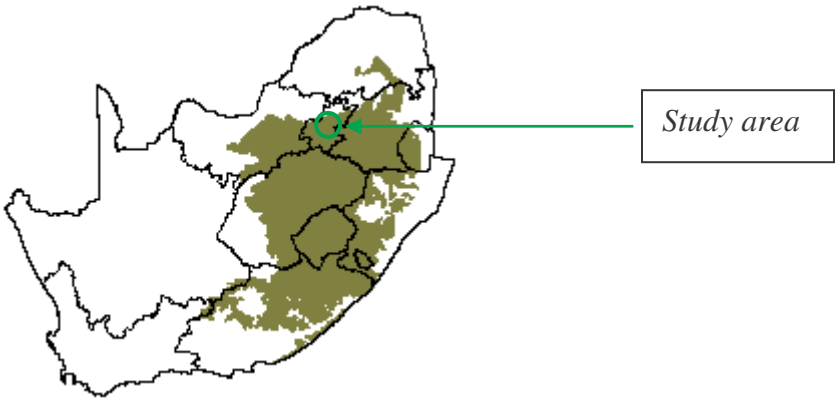

Figure 1. Grassland distribution in South Africa

5.2.1.2 Vegetation In A Regional Context

Mucina, Rutherford & Powrie (2005) recognised the Soweto Highveld Grassland of which a total of 33.66 % of this vegetation type is found in the Gauteng province. At a regional level 31.44% of the Gauteng province forms part of this vegetation type. A total of 50.17% of the vegetation type that is found in the province is transformed with only 1.56% under formal conservation. Conservation of this vegetation type is poor. Cultivation, urbanisation and development has lead to the ploughing up of most of this vegetation type. The remnant patches of natural vegetation are intensively grazed and are consequently often degraded.

5.2.1.3 Vegetation Of The Study Site

Although according to the clasification by Mucina, Rutherford & Powrie (2005) the study area falls in the Soweto Highveld Grassland, this vegetation type in the study area can be further divided into plant communities. Different plant communities was recognised comprising of the grassland areas, ridges, wetlands and riverine vegetation each with its associated species driven by specific ecological factors like soil type, elevation and moister regime. Floristically this vegetation type is not as rich in species with no

endemics listed by both Mucina, Rutherford & Powrie (2005) or van Rooyen & Bredenkamp (1996).

5.2.1.4 Species Of Special Concern

Neither Mucina, Rutherford & Powrie (2005) nor van Rooyen & Bredenkamp (1996) in their literature highlight any species of concern. Van Rooyen & Bredenkamp (1996) describes the Moist Cool Highveld Grassland vegetation type in its pristine condition as dominated by entire stands of Redgrass *Themeda triandra.* Although the possibility can not be ruled out no species of concern was found during field surveys.

5.2.1.5 Alien And Invasive Species

The conservation value of the vegetation is degraded in some areas by the of invasion by exotic species. The most common exotic invader in the study area is *Acacia mearnsii, Eucalyptus comaldulensis, Salix babylonica,* and *Populus canescens.*

5.3 BIOTIC FACTORS: FAUNA OF THE STUDY AREA

Table 1 shows the number of species with Red Data status in Gauteng, also expressed as the percentage of species in each major taxonomic group.

Table 1. Summary of the Red Data status for each taxonomic group in Gauteng.

Taxonomic group	Number of species in Gauteng	Percentage Threatened species (Number of threatened[13] species)	IUCN Red Data category (% of Gauteng total)					
			EX	CR	EN	VU	NT	DD
Plants	2411	0.9% (22)[14]	1 (0.04%)	8 (0.33%)	8 (0.33%)	6 (0.25%)	12 (0.5%)	6 (0.25%)
Mammals[15]	130	7.7% (10[16])	0	1 (0.8%)	3 (2.3%)	6 (4.6%)	1 (0.8%)	2 (1.5%)
Birds[17]	483	1.9% (9)	1 (0.2%)	0	0	9 (1.9%)	10 (2.1%)	0
Reptiles[18]	87	0%(0)	0	0	0	0	0	0
Amphibians[19]	30	0% (0)	0	0	0	0	1[20] (3.3%)	0
Invertebrates	752	0.2% (1[21])	0	0	0	1 (0.13%)	1 (0.13%)	0
Total			2	9	11	22	25	8

Critically Endangered (CR), Endangered (EN) and Vulnerable (VU). Red Data categories include CR, EN and VU as well as extinct (EX), Near Threatened (NT) and Data Deficient (DD)

5.3.1 Birds

Due to the fact that the Gauteng vegetation is highly threatened by urbanization, industrialisation and mining, and, to a lesser degree, agriculture, bird habitat in the study area is also limited and confined to the ridges; wetlands and the small pristine patch (see Figure 2 of Appendix 1). Roberts (2003) listed 350 species which have a distribution that includes the study area. The Gauteng Conservation Authority listed as near threatened or vulnerable a total of 19 priority bird species, while 16 bird species recorded in Gauteng are endemic to South Africa (Whittington-Jones, 2004). Birds move in and out of the study area. Although no specific species of concern was noted during field surveys, birds like cranes, owls and storks are of general conservation concern in view of the proposed development. These species are likely to be affected by power lines in the long term, as

they are highly mobile, with cranes and storks flying long distances to get to nesting sites and foraging areas.

5.3.2 Terrestrial invertebrates

The distribution of terrestrial invertebrates is largely dependent on the ridges, wetlands and the small pristine patch in the study site (Figure 2, Appendix I). The Gauteng Conservation Authority listed as near threatened or vulnerable a total of 37 priority invertebrate species for the province. These consist mostly of butterflies, baboon spiders and trapdoor spiders (Forsyth, 2004). Terblanche (2006) did a study in the Soweto Highveld Grassland vegetation type, within which the study site falls, on invertebrates in the vicinity of the study site on the farm Elandsfontein 412 IR. A total of 25 butterfly species is likely to occur in the area according to literature, but only nine of these species were recorded during this study. None of the six Red Data listed butterfly species was found in the area. Butterfly species like *Chrysoritis aureus* (Heidelberg Copper) and *Aloeides dentatis dentatis* (Roodepoort Copper) occur on very limited sites of a few hectares and need specific habitat.

5.3.3 Mammals

No large game or predators, or any signs of them, were observed in the study area during field surveys. Ten wild mammals that are Red Data Listed occur in Gauteng (Table 1). These species include Lion, Leopard, Cheetah, Brown Hyena, White Rhino etc. that do not occur in the study area. No indication of other smaller, Red Data Listed species was found i.e. Schreiber's long-fingered bat, Short-eared trident bat and Springhare (2003 IUCN Red list of threatened animals).

5.3.4 Amphibians and reptiles

Amphibians are an important and often neglected component of terrestrial vertebrate faunas and are important components of wetland systems. They are well represented in Gauteng with 30 of the 115 species present (Table 1). No endemic species occur in the study area and only one of the species, the Giant Bullfrog *Pyxicephalus adspersus,* is of conservation concern. This species is listed as Near Threatened. The distribution of *P. adspersus* corresponds with the study area, and it could occur in the seasonal shallow grassy pans, vleis and dams in the study area (Du Preez, & Cook, 2004).

The Gauteng province is home to 87 reptile species. No endemic species occur in the study area and none are of conservation concern (Table 1).

5.4 SENSITIVITY ANALYSIS OF THE STUDY AREA

5.4.1 Sensitive and Protected Areas

The following criteria were used to identify sensitive areas within the study area:

i) 40m or less from rivers, wetlands, or pans.

ii) River crossings

iii) Within 1:50 year flood plains

iv) Bird sanctuaries

v) National parks, wilderness areas, state forests, private nature reserves, protected natural environment, and or adjoining properties in as far as the activity or structure may affect the ecosystem function and the aesthetic value of the feature.

vi) Natural heritage sites

vii) Any environmentally protected areas including the open spaces (grassland) within any designated area.

viii) Any part joining the property of the cultural and historical importance e.g. historical site as proclaimed by the National Heritage Resources Act, Graveyards, places of worship and gateways.

ix) Any koppies and ridges.

x) Areas for the conservation for the indigenous flora and or fauna.

xi) Areas in close proximity of the tourist roads or of scenic significant

xii) Any big indigenous tree with some historical significance.

xiii) Within 50 meters of any road, road crossings and inside road reserves.

5.4.2 Sensitivity Analysis

5.4.2.1 Ridges

i) Introduction

The quartzite ridges of Gauteng, together with the Drakensberg Escarpment, should be regarded as one of the most important natural assets in the entire region of the northern provinces of South Africa. They are characterized by a unique plant species composition that is found nowhere else in South Africa or the world (Bredenkamp & Brown, 1998).

ii) Delineating Ridges of the Study Area

The essential characteristic defining the topographic features of a ridge is the slope of the site, whereby any topographic feature in the landscape that is characterized by slopes of

5^{o} or more, is defined as a ridge. Although rocky outcrops may not be regarded as ridges, they are regarded as sensitive areas characterized by high biodiversity and as such are regarded as sensitive areas.

iii) The Value of Ridges

Due to their high spatial heterogeneity ridges provide vital habitat for many threatened species. Ridges are particularly suitable as future refuges for biodiversity in an urbanized landscape as they function as islands even within a natural landscape. They also form natural wildlife corridors, which promote ecological processes and benefit regional and local biodiversity.

iv) Ridges in the Study Area

Figure 2 in Appendix I indicates an area in the northern part of the study area that should be avoided as a result of its characteristic ridges. The majority of the ridges in the study area may be classified as a class 1 ridge (0 –5% transformed) with a small portion or ridge located towards the southern part of the area indicated as ridges in Figure 2 of Appendix I, that may be classified as a class 4 ridge (65 – 100% transformed).

5.4.2.2 Wetlands and Water Courses

i) Introduction

The National Water Act 36 of 1998 defines wetlands as land transitional between terrestrial and aquatic systems where the water is usually at or near the surface, or the land is periodically covered with shallow water and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil. Wetlands include rivers, lakes, pans, seeps and vleis.

ii) Delineating Water Courses and Wetlands of the Study Area

The approach commonly followed that identifies the indirect indicators of prolonged saturation by water was used to delineate wetlands in the study area, i.e.: wetland plants (hydrophytes) and wetland (hydromorphic) soils. The presence of these distinctive indicators in an area implies that the frequency and duration of saturation is sufficient to classify the area as a wetland. Terrain unit is another indicator, which will help identify those parts of the landscape where wetlands are more likely to occur.

iii) The Value of Wetlands

These systems have indispensable ecological value, being repositories of biodiversity and providing essential life support for a range of plant and animal species. The conservation and wise use of all wetlands is therefore in the national interest, not only from a biodiversity perspective, but also for water resource conservation and management.

Wetlands protect and regulate the water resource. Acting like giant sponges, they hold back water during floods and release it during dry periods. In a dry country like South Africa, this is crucial. By regulating water flows during floods, wetlands reduce flood damage and help prevent soil erosion. Wetlands recharge ground water sources, and also remove pollutants from the water. Being natural filters, they help to purify water by trapping many pollutants, including sediment, heavy metals and disease causing organisms. Some wetlands, such as estuaries, serve as important breeding grounds for oceanic fish. Many wetlands (such as floodplains) can be used as grazing areas, if done on a sustainable basis. Besides performing these vital functions at very little financial cost, wetlands, in association with appropriate buffer strips, are also natural storehouses of biological diversity, providing life support for a wide variety of species, some totally reliant on wetlands for their survival. Many of these species are used for food, craft manufacture, medicines, building material and fuel, both for subsistence and commercially.

iv) Water Courses and Wetlands in the Study Area

Figure 2 in Appendix I indicates the presence of wetland areas (indicated as watercourses) that should be avoided when planning pylon positions. The process of pylon construction poses the greatest threat especially when temporary access roads are constructed in sensitive areas. After construction, the power line should have minimum impacts on aquatic species.

5.4.2.3 Rivers and Riparian Habitat

i) Introduction

The National Water Act defines a riparian habitat as follows: "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas." Riparian habitats, also known as riparian areas, include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes, or drainage ways.

ii) Delineating Rivers and Riparian Habitat in the Study Area

Riparian areas are associated with a watercourse; contain distinctively different plant species than adjacent areas; and contain species similar to adjacent areas but exhibiting more vigorous or robust growth forms and may have alluvial soils.

iii) The Value of Riparian Habitat

Riparian areas perform a variety of functions that are of value to society, especially the protection and enhancement of water resources, and provision of habitat for plant and animal species. Riparian areas store water and help reduce floods; stabilize stream banks;

improve water quality by trapping sediment and nutrients; maintain natural water temperature for aquatic species; provide shelter and food for birds and other animals; provide corridors for movement and migration of different species; act as a buffer between aquatic ecosystems and adjacent land uses; can be used as recreational sites; and provide material for building, muti, crafts and curios.

iv) Rivers and Riparian Habitat in the Study Area

Three watercourses with their associated riparian habitats were identified in the study area; the Rietspruit watercourse, the Varkensfonteinspruit watercourse and the Fouriespruit watercourse (Figure 2 in Appendix I)

5.4.2.4 Untransformed Patches of Pristine Grassland

i) Introduction

Grasslands cover about 40% of the earth's non ice-bound terrestrial surface and are home to over 1 billion people. Globally, grasslands house many important fauna and flora occurring in 15% of Centres of Plant Endemism, 11% of Endemic Bird Areas and 29% of ecoregions with outstanding biological distinctiveness (White *et al.* 2000).

ii) Delineating Untransformed Patches of Pristine Grassland

Patches of grassland that were relatively untransformed were identified and recorded for the purpose of the study. Although criteria for the minimum size of untransformed grassland were not available, any patch larger than a few hectares were considered significant.

iii) The Value of Pristine Grassland

In addition to their biodiversity importance, grasslands provide essential ecosystem services required to support human life and well being. These services broadly include food (grain), forage, livestock, water and nutrient cycling, soil stabilization, carbon storage, energy supply, and tourism and recreation. Their importance to all life on earth is thus indisputable. The grasslands are also an area of importance to freshwater biodiversity.

Although less is known about this component of the grassland 44 river ecosystems have been identified within the grasslands (Nel *et al.* 2004). 6 of these ecosystems are marginal to the grasslands, but the rest rely on the Grassland biome for the maintenance of their biodiversity. The grasslands of South Africa are thus undeniably important both in terms of their terrestrial and river biodiversity, and the services they provide to most of South Africa's human population. This importance is increasingly being recognized and the National Grasslands Biodiversity Program (of which this assessment is a component) is an example of this increasing recognition.

iv) Pristine Grassland in the Study Area

Only one patch of untransformed grassland was identified within the study area (Fig 2, Appendix I). Figures 6 and 7 of Appendix I show the locality of sensitive areas and important sites as determined by the Gauteng Conservation Plan.

6 DATA ANALYSIS

6.1 POTENTIAL IMPACTS IDENTIFIED

6.1.1 Construction Phase

6.1.1.1 Access Roads

Access roads may disturb or destroy sensitive plant species or habitats and animals like Bullfrogs or their habitat. The rehabilitation of access roads may cause more damage if not done correctly. Roads should be limited to the service road where possible and driving through the veld by construction vehicles should be avoided to prevent unnecessary disturbance of the vegetation as this gives aggressive exotic plant species often a foothold to colonize that was not there before.

6.1.1.2 Pylon Construction

Pylon construction may have the same impacts as access roads and debris or other waste created during the construction process may have further impacts on the environment if not managed correctly. Unnecessary disturbance around the pylons during construction should be avoided to prevent unnecessary disturbance of the vegetation as this gives aggressive exotic plant species often a foothold to colonize that was not there before.

6.1.1.3 Cable Attachment and Tensioning

The process of cable attachment may require further access roads that could potentially have the same or larger impacts than access roads for pylon construction.

6.1.2 Implementation Phase

6.1.2.1 Pylon Presence

Pylons may have an impact on some bird species that try to perch or nest on the pylon structures. Specifically cranes and storks are vulnerable to injury

6.1.2.2 Cable Presence

Some bird species may be harmed or killed when they accidentally collide with power cables. Specifically cranes and storks are vulnerable to injury by power lines especially if it is across migratory routes or close to foraging areas.

6.1.2.3 Maintenance of Power Lines

Maintenance activities may have an impact on sensitive species if vehicles have to leave existing roads to reach parts of the power line or pylons for maintenance purposes.

6.2 IMPACT ANALYSIS

6.2.1 Nature of the Impact

The impact may be divided into several stages; construction, implementation and maintenance. Direct impacts on the physical environment will occur during the first stage when access roads have to be made and pylons are constructed. After construction the direct impact is reduced, with a shift to more indirect impacts where some bird species may be affected. Maintenance may also potentially have a high impact if pylons have to be visited by vehicle. From an economic point of view the impact may be positive, but only impacts on the biological environment is considered for the purpose of this report.

6.2.2 Ranking of Impacts Identified

Alternative 1 seems to coincide least with sensitive environmental features of the study area. Three main categories were identified within the study area e.g. ridges, water courses and pristine grassland. Alternative 2 and 3 both traverse ridges which could be suitable as future refuges for biodiversity in an urbanized landscape as they function as islands even within a natural landscape. They also potentially form natural wildlife corridors, which promote ecological processes and benefit regional and local biodiversity. The route proposed for alternative two also coincides with two water courses which are undesirable. None of the routes should impact on patches of pristine grassland which were identified in the study area. Alternative 1 passes close to a water course in one place and care should be exercised to avoid impact on these sensitive habitats. The majority of potential impacts are predicted for the construction phase and the only significant impact after construction is related to some birds species like storks etc.

6.2.2.1 Impacts on the Vegetation

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative- Impacting on the vegetation due to the physical damage as a result of construction and erection activities	Local	Short term if mitigated	Medium	Probable	Medium	Low	Medium
Alternative 2		Local		Medium	Probable	Medium	Low	Medium
Alternative 3		Local		Medium	Probable	Medium	Low	Medium
Operational Phase								
Alternative 1	Negative- impacting on the vegetation due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local	Long term	Low	Probable	Medium	Low	Medium
Alternative 2				Low	Probable	Medium	Low	Medium
Alternative 3				Low	Probable	Medium	Low	Medium

6.2.2.2 Impacts on Ridges

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative-Impacting on ridges due to the physical damage as a result of construction and erection activities	Local	Short term if mitigated	Low	Improbable	Low	Low	Medium
Alternative 2		Local		Medium	Probable	Medium	Low	Medium
Alternative 3		Local		Medium	Probable	Medium	Low	Medium
Operational Phase								
Alternative 1	Negative-impacting on ridges due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local	Long term	Low	Improbable	Low	Low	Medium
Alternative 2				Medium	Probable	Medium	Low	Medium
Alternative 3				Medium	Probable	Medium	Low	Medium

6.2.2.3 Impacts on Wetlands and Water Courses

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative- Impacting on wetlands due to the physical damage as a result of construction and erection activities	Local	Short term if mitigated	Low	Improbable	Low	Low	Medium
Alternative 2		Local		Medium	Probable	Medium	Low	Medium
Alternative 3		Local		Low	Improbable	Low	Low	Medium
Operational Phase								
Alternative 1	Negative- impacting on wetlands due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local	Long term	Low	Improbable	Low	Low	Medium
Alternative 2				Medium	Probable	Medium	Low	Medium
Alternative 3				Low	Improbable	Low	Low	Medium

6.2.2.4 Impacts on Rivers and Riparian Habitat

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative-impacting on rivers and riparian habitat due to the physical damage as a result of construction and erection activities	Local	Short term if mitigated	Low	Improbable	Low	Low	Medium
Alternative 2		Local		Medium	Probable	Medium	Low	Medium
Alternative 3		Local		Low	Improbable	Low	Low	Medium
Operational Phase								
Alternative 1	Negative-impacting on rivers and riparian habitat due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local	Permanent	Low	Improbable	Low	Low	Medium
Alternative 2				Medium	Probable	Medium	Low	Medium
Alternative 3				Low	Improbable	Low	Low	Medium

6.2.2.5 Impacts on Pristine Patches of Grassland Habitat

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative- Impacting on pristine patches of grassland due to the physical damage as a result of construction and erection activities	Local	Short term if mitigated	Low	Improbable	Low	Low	Medium
Alternative 2		Local		Low	Improbable	Low	Low	Medium
Alternative 3		Local		Low	Improbable	Low	Low	Medium
Operational Phase								
Alternative 1	Negative- impacting on pristine patches of grassland due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local	Long term	Low	Improbable	Low	Low	Medium
Alternative 2				Low	Improbable	Low	Low	Medium
Alternative 3				Low	Improbable	Low	Low	Medium

6.2.2.6 Impacts on Faunal Species

Activity	Nature of impact	Extent of impact	Duration of impact	Severity of impact	Probability of impact	Significance without mitigation	Significance with mitigation	Level of confidence
Construction Phase								
Alternative 1	Negative- Impacting on fauna due to the physical damage to habitat as a result of construction and erection activities	Local	Short term if mitigated	Medium	Probable	Medium	Low	Medium
Alternative 2		Local		Medium	Probable	Medium	Low	Medium
Alternative 3		Local		Medium	Probable	Medium	Low	Medium
Operational Phase								
Alternative 1	Negative- impacting on fauna due to existence of servitude and other service or temporary roads, the presence of pylon foundations and footblocks	Local but could be regional and national for some bird species	Long term	Medium	Probable	Medium	Low	Medium
Alternative 2				Medium	Probable	Medium	Low	Medium
Alternative 3				Medium	Probable	Medium	Low	Medium

7 RECOMMENDATIONS AND MITIGATION MEASURES

7.1 ALTERNATIVE ROUTE OPTIONS

7.1.1 Recommended Power Line Route

Different categories of sensitive areas have been pointed out (Figures 2,3,4 and 5 of Appendix I). Route options should be considered to avoid these areas where possible. Provision should be made to shift the locality of some pylon positions on the final planned route to avoid any significant impact on any of these sensitive areas, especially along water courses. Considering the proposed alternatives, route alternative no 1 as proposed by the client will have the least coincidence with sensitive biological features as indicated by this report and is therefore the recommended option (Figure 8 of Appendix I).

7.1.2 Access Roads

Since the major direct impact on the environment is likely to be the construction of access roads for, and the construction of pylons, care should be exercised to plan the route so that existing roads may be used as far as possible.

7.2 LEGISLATION AND POLICIES

The following policies and legislation should be considered in the process of planning a route for the new proposed power line:

a) National Biodiversity Conservation Plan; which has the goal to conserve and manage terrestrial and aquatic biodiversity to ensure sustainable and equitable benefits to the people of South Africa, now and in the future.
b) National Grasslands Biodiversity Programme; 15 priority clusters identified within the Grassland Biome.

c) Gauteng Conservation Plan; landscape features associated with ecological processes that are essential for the maintenance and generation of biodiversity in sensitive areas and that require sensitive management.
d) All acts relating to the conservation of biodiversity e.g. Environment Conservation Act (Act No. 73 of 1989) and The National Environmental Biodiversity Act (Act No. 10 of 2004) etc.

8 REFERENCES

Acocks, J. P. H. (1988). Veld types of South Africa. Memoirs of the Botanical Survey of South Africa No.57. Government Printer, Pretoria.

Bredenkamp, G., Granger, J.E. & van Rooyen, N. (1996.) Moist Sandy Highveld Grassland. In: Low, A.B. & Robelo, A.G. (eds) *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Brownlie, S. 2005. *Guideline for involving biodiversity specialists in EIA processes: Edition 1.*CSIR Report No ENV-S-C 2005 053 C. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning, Cape Town.

Du Preez, L.H. and Cook, C.L. 2004. Conservation status and threats. Pp. 300-303 in L.R. Minter, M.Burger, Harrison. J.A., Braack, H.H. Bishop, P.J. & Kloepfer, D. eds. *Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland.* SI/MAB Series#9. Smithsonian Insituteion, Washington, DC.

Mucina L. and Rutherford M.C. (eds). (2007). National Vegetation Maps of South Africa.

O'Connor TG & Bredenkamp GJ 1997. Grassland. In: Cowling RM, Richardson DM & Pierce SM (eds). *Vegetation of South Africa*. Cambridge University Press, Cambridge

Palgraves, K.C. (1984). Trees of Southern Africa, 2nd ed. Struik Publications, Cape Town.

OTHER SOURCES

Ekurhuleni SoER, 2003

National Biodiversity Implementation Plan

Grasslands Project Progress Report, August 2006

Gauteng Conservation Plan version 2

South Africa's National Biodiversity and Action Plan

National Grassland Biodiversity Programme

Tshwane Integrated Environmental Policy

Urban Development and Biodiversity in Gauteng: Workshop Proceedings

APPENDIX I

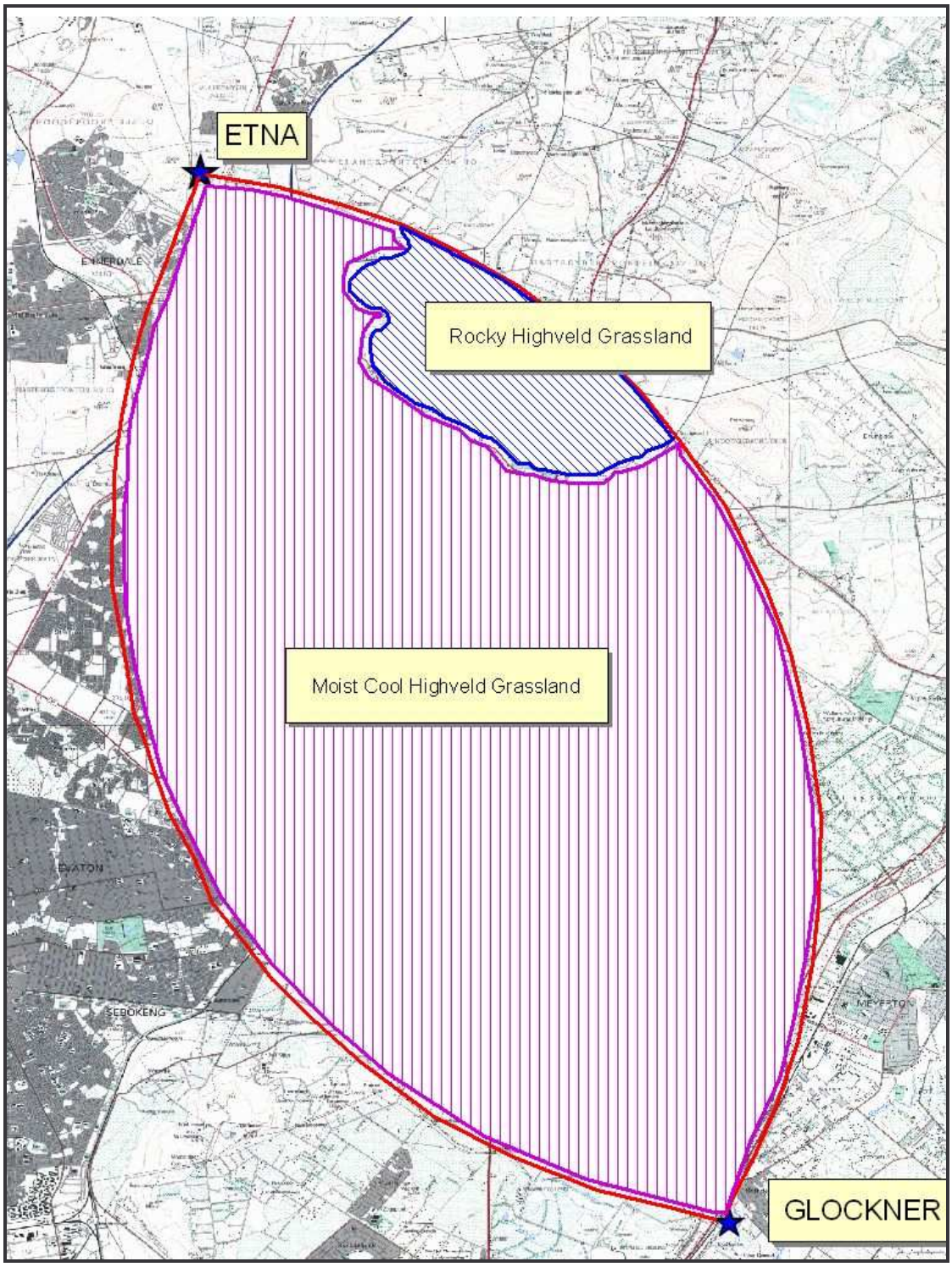

Figure 1. Distribution of vegetation types in the study area

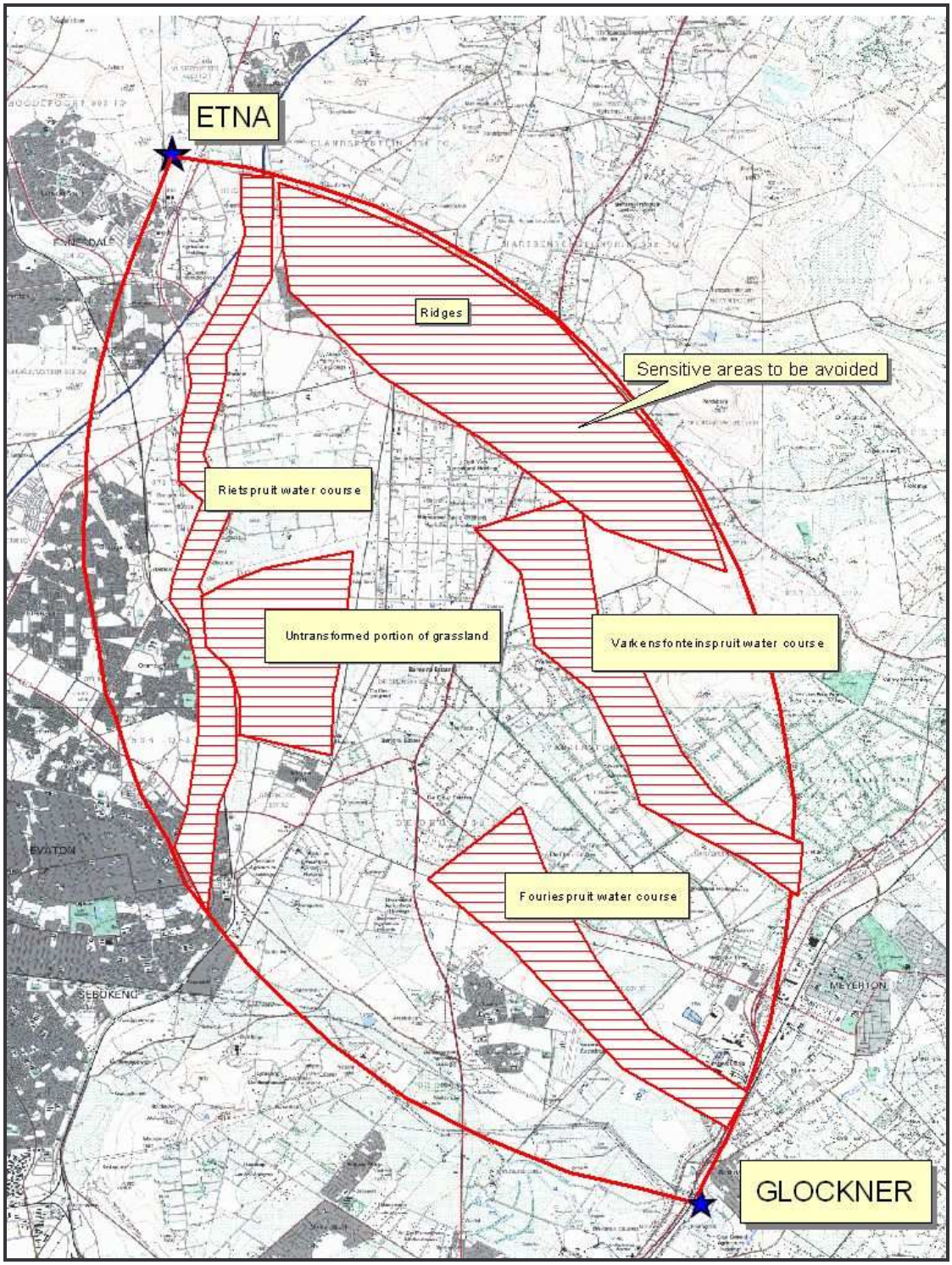

Figure 2. General sensitive areas including ridges and water courses.

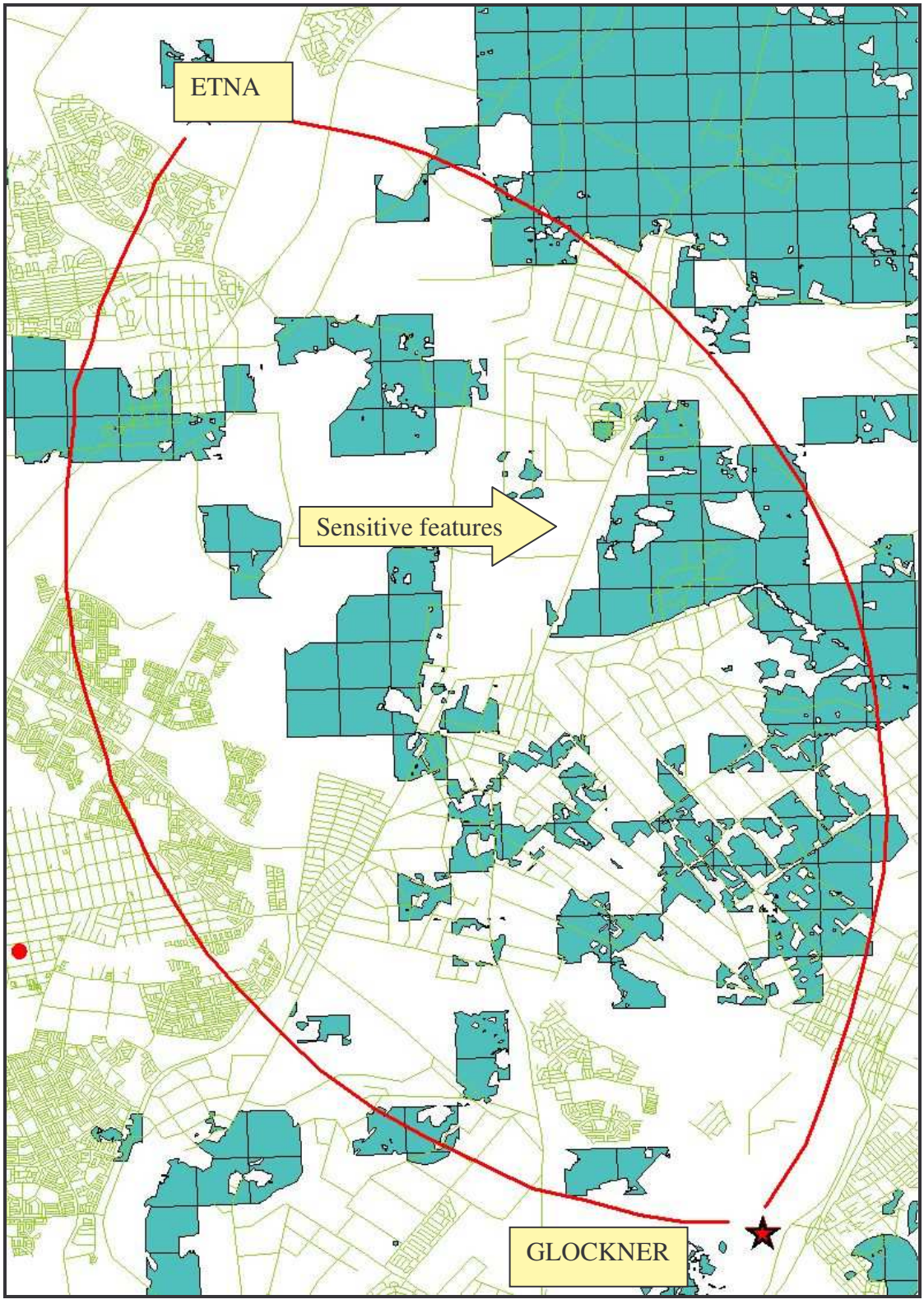

Figure 3. Sensitive features as identified by the Gauteng Conservation Plan

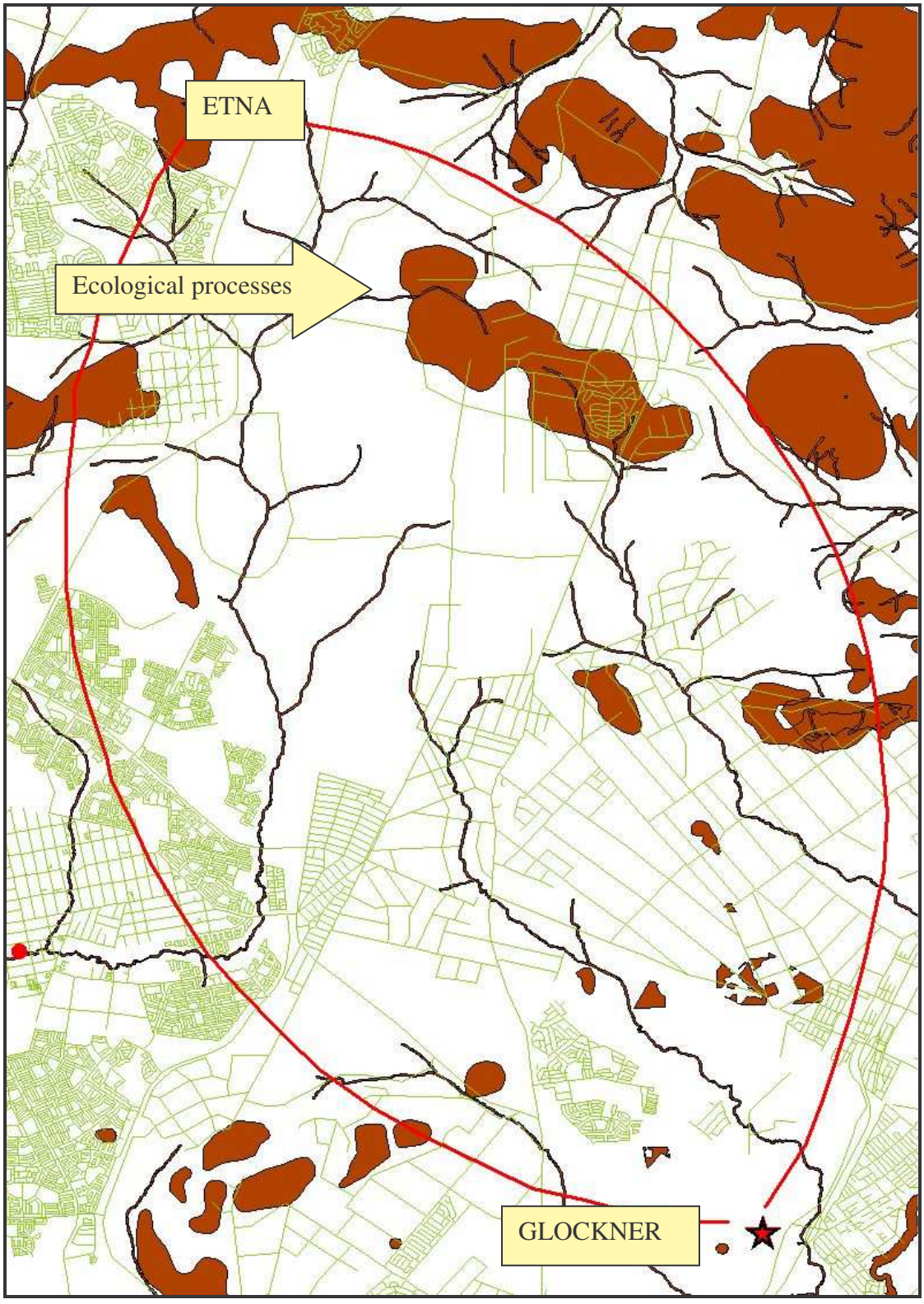

Figure 4. Ecological processes as identified by the Gauteng Conservation Plan

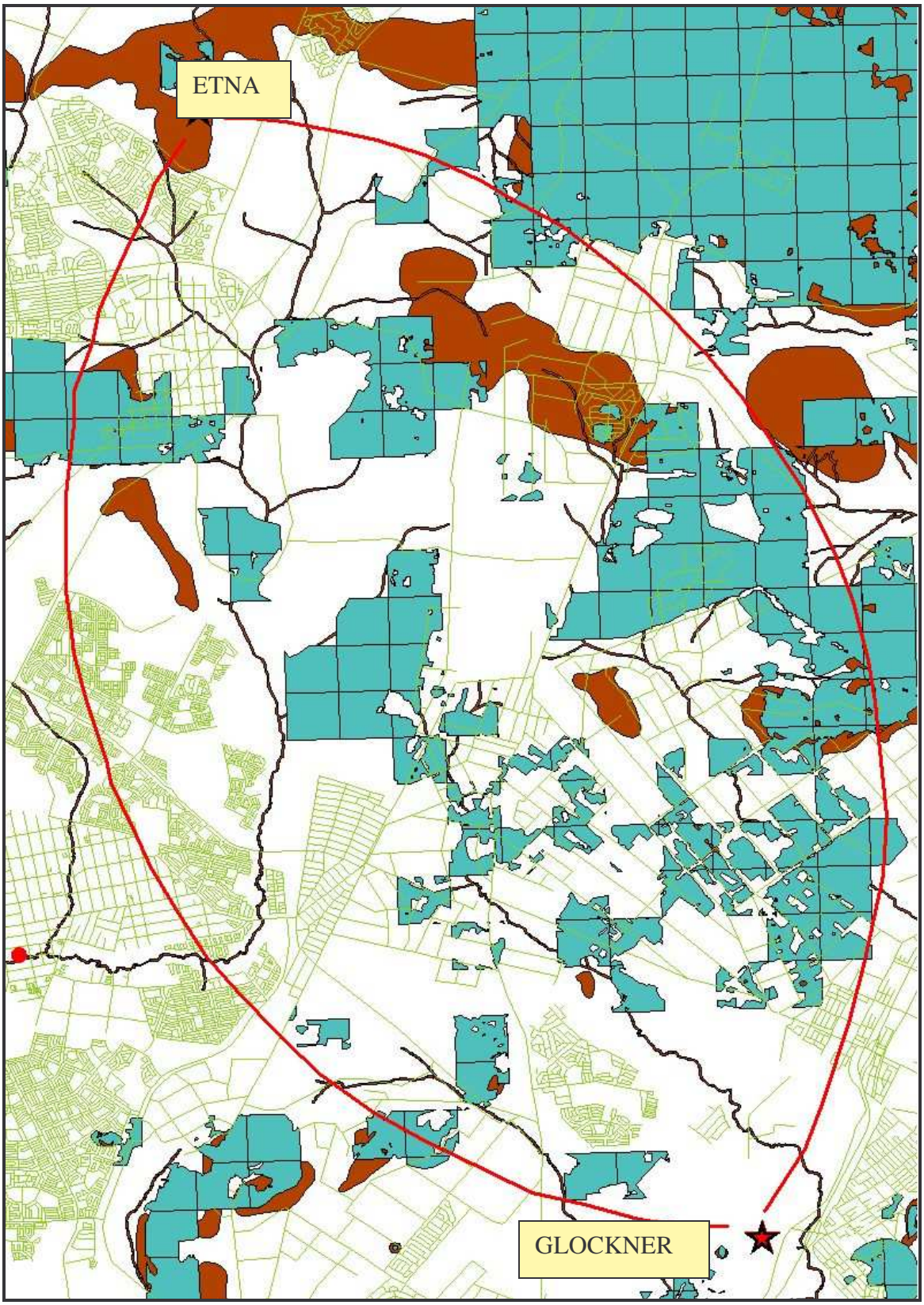

Figure 5. Sensitive features and ecological processes combined.

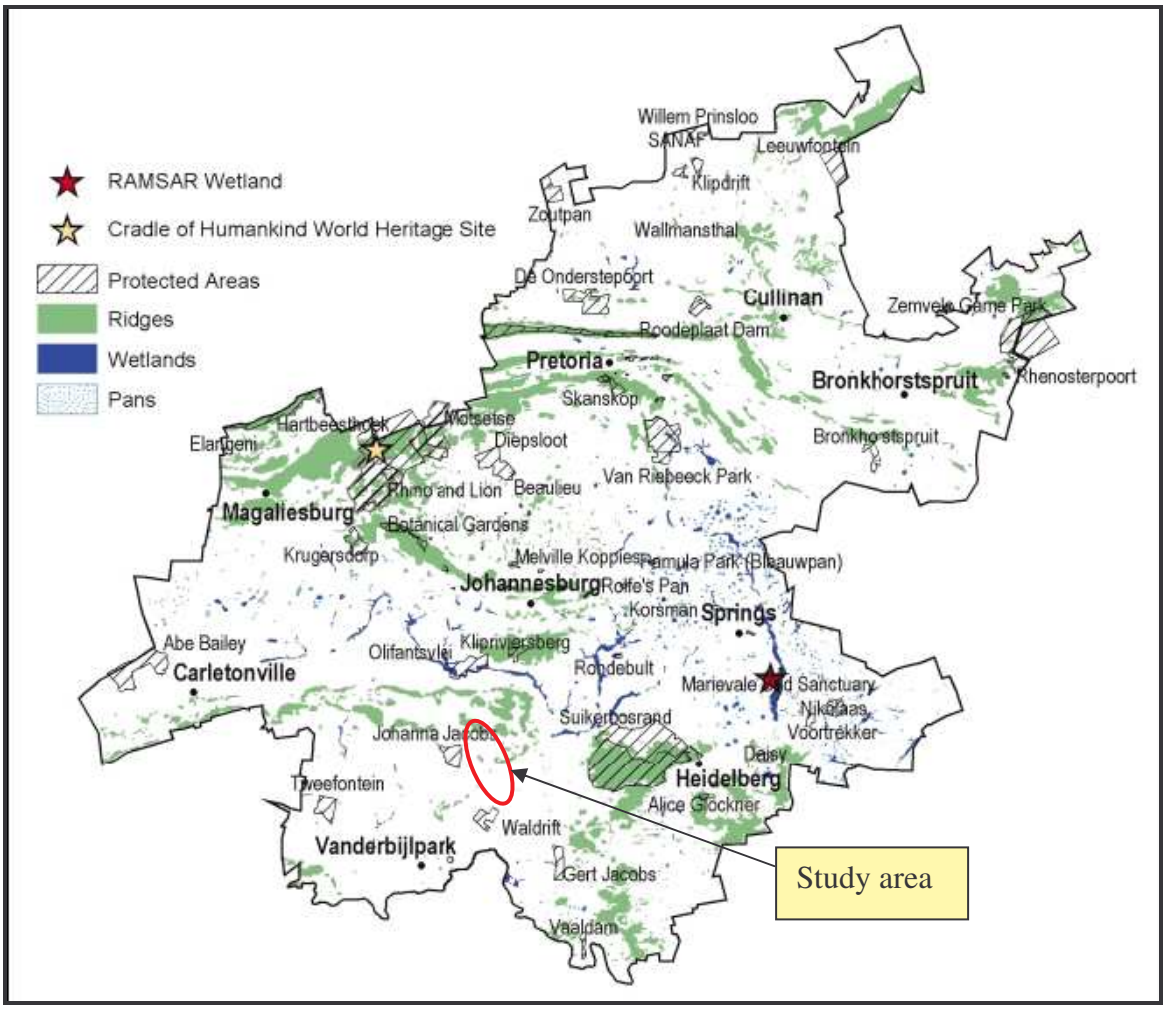

Figure 6. Locality of the study area with sensitive areas demarcated according to the Gauteng Conservation Plan.

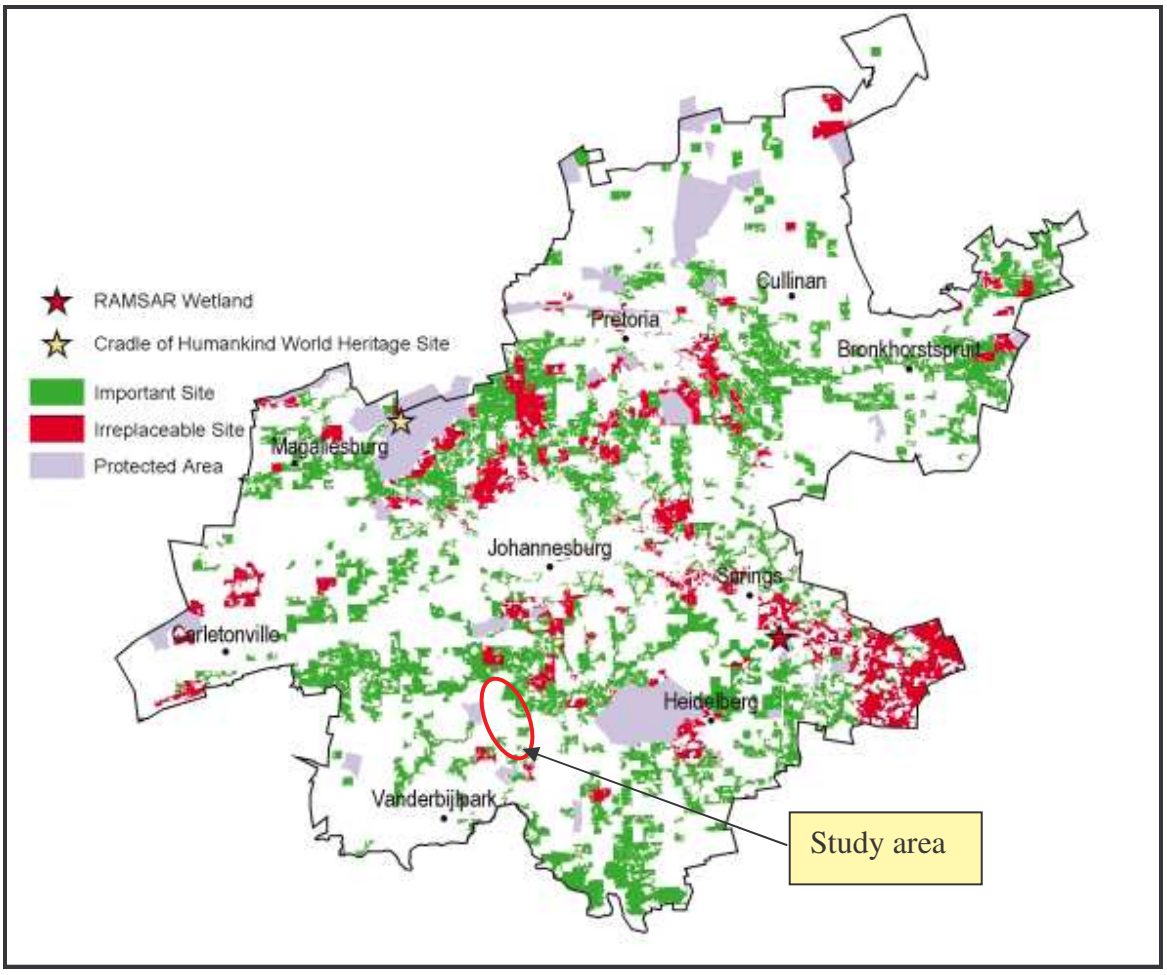

Figure 7. The location of the study area with important sites as indicated by the Gauteng Conservation Plan.

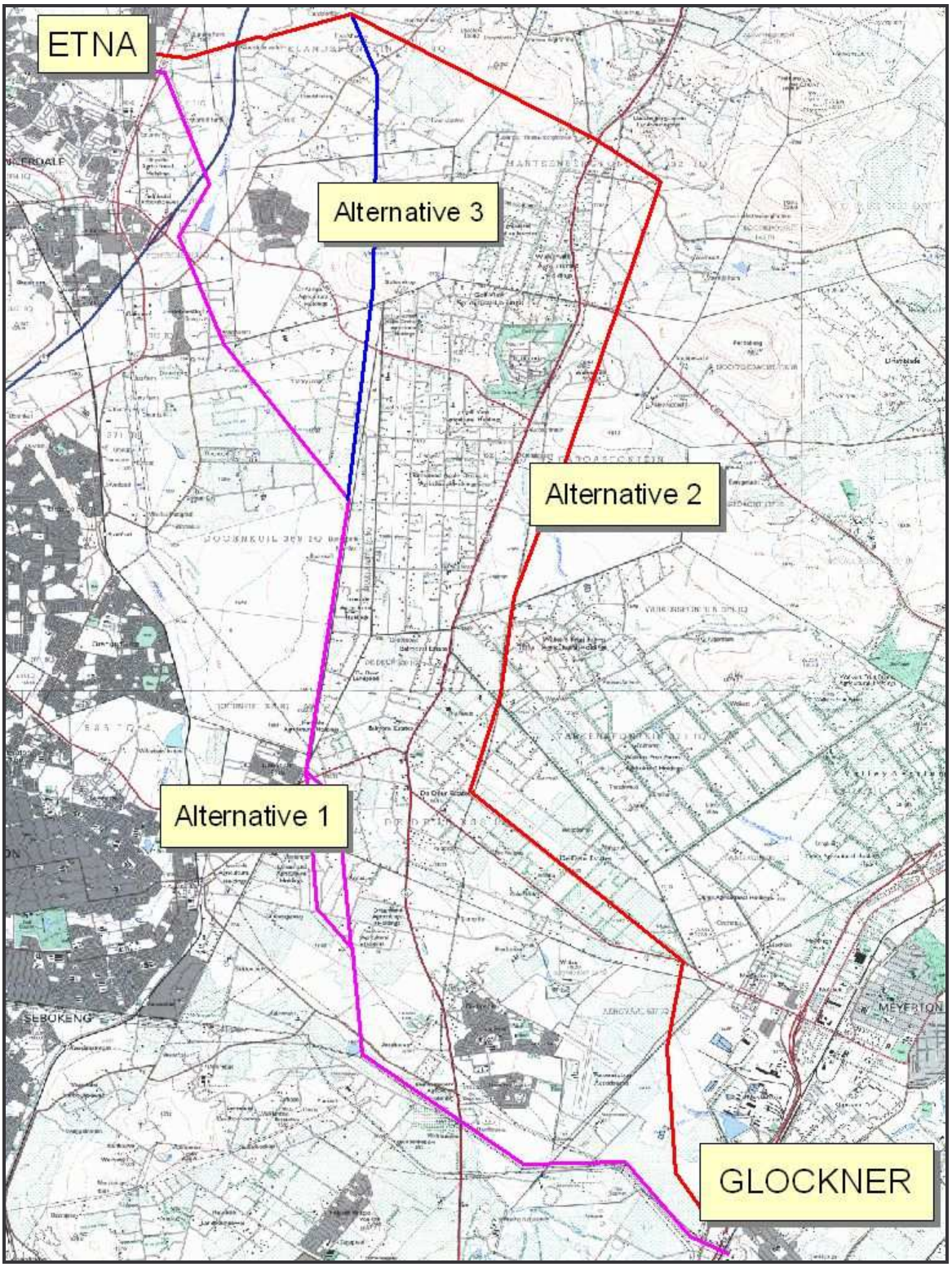

Figure 8. Position of the three proposed alternative routes

APPENDIX II

HOURLY WIND ANALYSIS DATA REQUESTED 1992 to 2006
0438784 3 VEREENIGING Lat:-26.5670 Lon:27.9500 Height:1479 m

Wind speed is measured in m/s
1 m/s = 1.944 knots = 3.6
km/h
Wind direction is reported as the direction from which the wind blows

Frequency of winds as a percentage from each direction

MON	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
JAN	11	8	10	11	12	7	3	2	2	2	2	3	5	4	5	7
FEB	10	7	11	12	13	6	4	2	2	2	3	3	4	3	4	7
MAR	11	6	11	10	8	5	3	2	3	2	3	3	4	3	5	9
APR	14	6	6	5	5	2	2	2	3	3	4	4	6	4	7	14
MAY	14	3	3	3	3	2	2	2	3	3	5	5	6	4	7	16
JUN	15	3	4	3	3	1	1	2	3	3	6	5	7	5	9	17
JUL	13	4	4	4	4	2	2	2	3	3	5	4	6	5	9	17
AUG	16	6	6	4	3	1	1	1	3	4	5	5	5	5	9	16
SEP	16	7	6	5	4	1	1	1	2	3	4	4	7	5	10	15
OCT	15	9	8	7	6	2	2	2	3	3	4	3	6	6	8	11
NOV	16	9	9	8	6	3	2	2	2	2	3	4	6	5	7	11
DEC	14	10	10	8	8	5	2	1	2	2	2	3	5	6	8	10
YR	14	6	7	7	6	3	2	2	3	3	4	4	6	5	7	13

Average Wind Speed (m/s) per direction

MON	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
JAN	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
FEB	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
MAR	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
APR	3	3	3	3	3	3	3	3	2	3	3	3	4	3	3	3
MAY	2	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
JUN	3	3	3	3	3	3	2	2	2	3	3	3	4	3	3	3
JUL	3	3	4	4	4	3	3	2	2	3	3	3	4	3	3	3
AUG	3	3	4	4	3	3	3	2	3	3	3	3	4	3	4	3
SEP	4	4	4	4	5	4	3	3	3	3	3	4	4	4	4	4
OCT	4	4	4	5	5	4	3	3	3	3	3	4	4	4	4	4
NOV	4	4	4	4	4	4	3	3	3	3	3	4	4	4	4	4
DEC	4	4	4	4	3	4	3	3	3	3	3	3	4	4	4	4
YR	3	3	4	4	4	3	3	3	3	3	3	3	4	3	3	3

Percentage Frequency of Wind per wind speed class (m/s)

MON	0 -1.0	1.1-1.5	1.6-3.5	3.6-5.5	5.6-8.0	> 8.0
JAN	6.4	10.3	50.6	25.1	7.1	0.6
FEB	9.2	11.8	52.2	22.2	4.2	0.4
MAR	11.1	14.2	52.7	18.3	3.5	0.2
APR	13.1	13.4	51	16	5.4	1.1
MAY	17.7	12.7	52.1	12.9	4	0.6
JUN	13.9	12.9	49.5	17.5	5.2	1
JUL	13.3	12.2	48.8	16.9	6.9	1.8
AUG	9.3	10.5	49.5	19.3	8.4	3
SEP	7.4	7.8	44.2	23.7	12.9	4
OCT	5	6.2	40.6	27.2	16.3	4.6
NOV	5.6	8	40.8	27.8	15.3	2.5
DEC	4.7	7.5	42.5	30.8	12.9	1.5
YR	9.7	10.6	47.9	21.5	8.5	1.8

Climate Number	Statin Name	Month	Ave Max Temp (°C)	Ave Min Temp (°C)
0438784 3	VEREENIGING	1992/02	32.3	15.2
0438784 3	VEREENIGING	1992/03	28.6	12.1
0438784 3	VEREENIGING	1992/04	26.6	8.6
0438784 3	VEREENIGING	1992/05	23.0	2.9
0438784 3	VEREENIGING	1992/06	20.2	0.8
0438784 3	VEREENIGING	1992/07	19.4	0.2
0438784 3	VEREENIGING	1992/08	20.2	3.9
0438784 3	VEREENIGING	1992/09	**	**
0438784 3	VEREENIGING	1992/10	28.4	12.4
0438784 3	VEREENIGING	1992/11	25.6	12.4
0438784 3	VEREENIGING	1992/12	27.7	15.1
0438784 3	VEREENIGING	1993/01	29.4	15.2
0438784 3	VEREENIGING	1993/02	25.9	14.3
0438784 3	VEREENIGING	1993/03	25.3	13.0
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0438784 3	VEREENIGING	1993/06	18.1	-1.2
0438784 3	VEREENIGING	1993/07	19.7	1.3
0438784 3	VEREENIGING	1993/08	21.4	3.0
0438784 3	VEREENIGING	1993/09	28.0	8.6
0438784 3	VEREENIGING	1993/10	25.0	13.1
0438784 3	VEREENIGING	1993/11	25.4	13.1
0438784 3	VEREENIGING	1993/12	27.5	15.3
0438784 3	VEREENIGING	1994/01	25.8	14.5
0438784 3	VEREENIGING	1994/02	25.6	14.4
0438784 3	VEREENIGING	1994/03	26.8	12.0
0438784 3	VEREENIGING	1994/04	25.4	8.2
0438784 3	VEREENIGING	1994/05	22.7	1.6
0438784 3	VEREENIGING	1994/06	18.1	-0.5
0438784 3	VEREENIGING	1994/07	18.1	-2.9
0438784 3	VEREENIGING	1994/08	21.6	2.8
0438784 3	VEREENIGING	1994/09	27.0	7.4
0438784 3	VEREENIGING	1994/10	26.3	10.3
0438784 3	VEREENIGING	1994/11	27.6	14.2
0438784 3	VEREENIGING	1994/12	29.7	15.4
0438784 3	VEREENIGING	1995/01	30.0	16.3
0438784 3	VEREENIGING	1995/02	30.6	15.6
0438784 3	VEREENIGING	1995/03	27.2	13.5
0438784 3	VEREENIGING	1995/04	24.0	8.7
0438784 3	VEREENIGING	1995/05	20.2	4.3
0438784 3	VEREENIGING	1995/06	18.8	-1.4
0438784 3	VEREENIGING	1995/07	19.7	0.6
0438784 3	VEREENIGING	1995/08	22.3	3.8
0438784 3	VEREENIGING	1995/09	27.2	8.5
0438784 3	VEREENIGING	1995/10	27.0	11.6
0438784 3	VEREENIGING	1995/11	26.6	14.0
0438784 3	VEREENIGING	1995/12	25.8	12.7
0438784 3	VEREENIGING	1996/01	27.6	15.4

0438784 3	VEREENIGING	1996/02	25.8	15.1
0438784 3	VEREENIGING	1996/03	26.0	11.0
0438784 3	VEREENIGING	1996/04	22.2	8.0
0438784 3	VEREENIGING	1996/05	20.0	5.1
0438784 3	VEREENIGING	1996/06	18.9	-0.2
0438784 3	VEREENIGING	1996/07	16.3	0.4
0438784 3	VEREENIGING	1996/08	19.9	4.2
0438784 3	VEREENIGING	1996/09	25.3	7.2
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0438784 3	VEREENIGING	1997/04	21.9	6.7
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0438784 3	VEREENIGING	1998/01	27.5	14.9
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0438784 3	VEREENIGING	1998/07	20.5	1.7
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0438784 3	VEREENIGING	1999/01	28.3	15.6
0438784 3	VEREENIGING	1999/02	30.3	15.2
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0438784 3	VEREENIGING	1999/04	26.3	10.2
0438784 3	VEREENIGING	1999/05	21.9	5.3
0438784 3	VEREENIGING	1999/06	19.9	0.6
0438784 3	VEREENIGING	1999/07	19.7	2.1
0438784 3	VEREENIGING	1999/08	21.8	3.1
0438784 3	VEREENIGING	1999/09	24.1	7.6
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0438784 3	VEREENIGING	2000/01	25.7	14.9
0438784 3	VEREENIGING	2000/02	26.0	16.0
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0438784 3	VEREENIGING	2002/03	28.1	13.4
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0438784 3	VEREENIGING	2003/08	20.4	3.1
0438784 3	VEREENIGING	2003/09	26.1	9.4
0438784 3	VEREENIGING	2003/10	27.6	12.6
0438784 3	VEREENIGING	2003/11	27.8	14.4
0438784 3	VEREENIGING	2003/12	30.4	14.8
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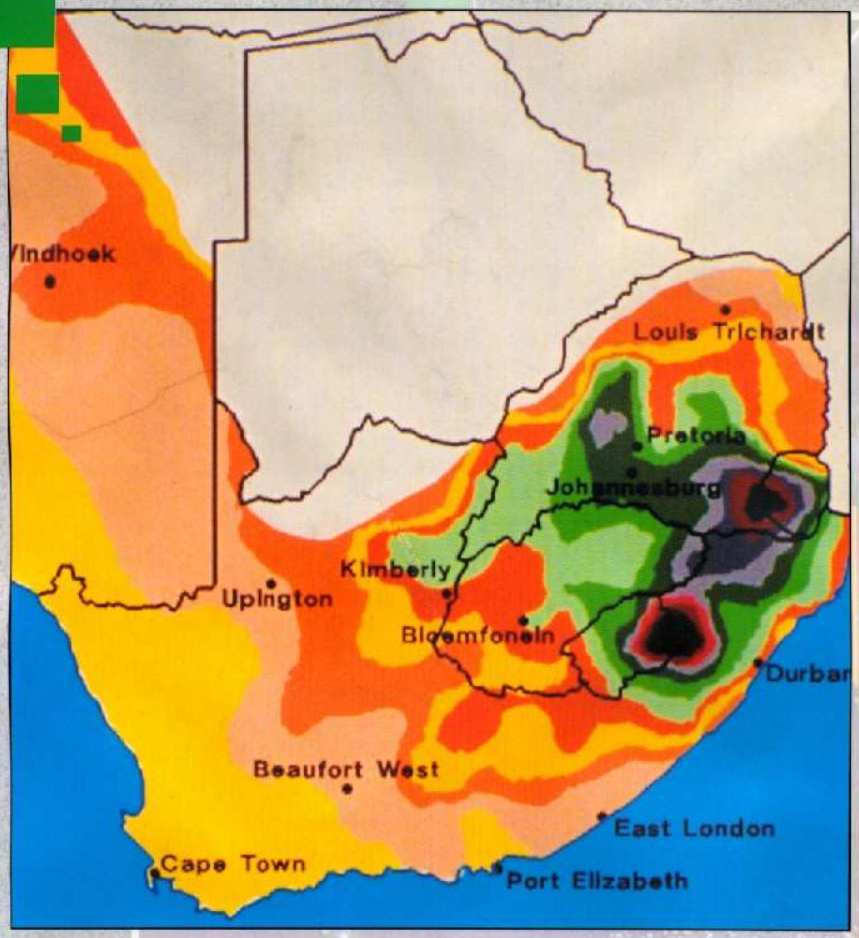
0438784 3	VEREENIGING	2004/02	26.0	14.0
0438784 3	VEREENIGING	2004/03	23.7	11.4
0438784 3	VEREENIGING	2004/04	22.9	6.8
0438784 3	VEREENIGING	2004/05	22.0	1.5
0438784 3	VEREENIGING	2004/06	17.3	-2.0

0438784 3	VEREENIGING	2004/07	16.6	-2.3
0438784 3	VEREENIGING	2004/08	22.0	3.8
0438784 3	VEREENIGING	2004/09	22.2	5.6
0438784 3	VEREENIGING	2004/10	26.3	9.4
0438784 3	VEREENIGING	2004/11	29.6	12.3
0438784 3	VEREENIGING	2004/12	26.6	11.0
0438784 3	VEREENIGING	2005/01	26.0	9.4
0438784 3	VEREENIGING	2005/02	26.9	8.6
0438784 3	VEREENIGING	2005/03	25.7	11.2
0438784 3	VEREENIGING	2005/04	23.1	9.8
0438784 3	VEREENIGING	2005/05	22.6	4.1
0438784 3	VEREENIGING	2005/06	21.4	2.5
0438784 3	VEREENIGING	2005/07	20.7	0.1
0438784 3	VEREENIGING	2005/08	24.1	5.7
0438784 3	VEREENIGING	2005/09	28.2	8.9
0438784 3	VEREENIGING	2005/10	29.1	12.8
0438784 3	VEREENIGING	2005/11	28.5	14.4
0438784 3	VEREENIGING	2005/12	28.8	14.7
0438784 3	VEREENIGING	2006/01	27.1	16.8
0438784 3	VEREENIGING	2006/02	26.6	16.2
0438784 3	VEREENIGING	2006/03	24.1	12.8
0438784 3	VEREENIGING	2006/04	23.0	8.9
0438784 3	VEREENIGING	2006/05	18.9	2.2
0438784 3	VEREENIGING	2006/06	18.9	-0.2
0438784 3	VEREENIGING	2006/07	21.2	2.2
0438784 3	VEREENIGING	2006/08	19.5	3.7
0438784 3	VEREENIGING	2006/09	24.9	7.3
0438784 3	VEREENIGING	2006/10	28.0	13.0
0438784 3	VEREENIGING	2006/11	26.6	13.5
0438784 3	VEREENIGING	2006/12	28.7	15.8

Year	Month	Day	Event	Place	Latitude	Longitude	Height (m)	Thunderstorm Activity
1905	10	21	TORNADO	JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM
1929	10	06	TORNADO	JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM
1935	02		TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1947	01	16	TORNADO	POTCHEFSTROOM	-26.7330	27.0670	1349	THUNDERSTORM
1948	11	26	TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1948	12	17	TORNADO	VEREENIGING	-26.5670	27.9500	1479	THUNDERSTORM
1951	01	13	TORNADO	JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM
1952	05	01	TORNADO	MALMESBURY	-33.4670	18.7170	102	THUNDERSTORM
1952	11	30	TORNADO	ALBERTYNSVILLE - JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM
1952	12	02	TORNADO	SPRINGS	-26.2000	28.4330	1592	THUNDERSTORM
1954	05	21	TORNADO	BENONI	-30.0500	26.2400	1650	THUNDERSTORM
1954	11	14	TORNADO	ORANJEVILLE - VAAL DAM	-26.98	28.22	1444	THUNDERSTORM
1958	01	29	TORNADO	BENONI	-30.0500	26.2400	1650	THUNDERSTORM
1958	03	24	TORNADO	SPRINGS	-26.2000	28.4330	1592	THUNDERSTORM
1958	12	22	TORNADO	BARRAGE	-26.75	27.68	1433	THUNDERSTORM
1959	09	12	TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1959	10	30	TORNADO	EIKENHOF	-27.60	27.88	1539	THUNDERSTORM
1964	01	02	TORNADO	BENONI	-30.0500	26.2400	1650	THUNDERSTORM
1966	10	13	TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1967	05	31	TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1971	04	05	TORNADO	ROODEPOORT	-25.7330	29.8170	1737	THUNDERSTORM
1993	10	25	TORNADO	FLORIDA	-26.1670	27.9170	1585	THUNDERSTORM
1995	12	22	TORNADO	JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM
2000	04	16	TORNADO	JOHANNESBURG	-26.1500	28.2300	1695	THUNDERSTORM

Lightning Ground-Flash Density Map



Flashes /km²/yr

0-1	3-4	6-7	9-10
1-2	4-5	7-8	10-12
2-3	5-6	8-9	12-14

The values supplied in the list on the right are representative of the number of lightning flashes to ground per square kilometre per year.

Aberdeen	1,8
Aliwal North	5,3
Barberton	7,5
Beaufort West	1,7
Belfast	7,3
Benoni	7,5
Bergville	6,3
Bethlehem	8,4
Bloemfontein	5,2
Boksburg	7,5
Brits	6,0
Butterworth	0,9
Caledon	0,2
Cape Town	0,3
Carnarvon	1,1
Carolina	9,0
Cedara	8,0
Ceres	0,2
Colesberg	3,0
Cradock	5,8
Doornfontein	7,3
Dundee	9,2
Durban	4,4
East London	1,6
Empangeni	4,1
Ermelo	9,0
Ficksburg	5,3
George	1,5
Germiston	7,5
Giant's Castle	13,0
Gobabeb	0,2
Graaff-Reinet	2,5
Grahamstown	1,4
Harding	5,5
Harrismith	9,4
Heidelberg (C)	8,0
Johannesburg	7,5
Keetmanshoop	1,2
Kimberley	4,8
King William's Town	1,1
Knysna	0,4
Krugersdorp	7,0
Ladysmith (N)	8,0
Lichtenburg	5,5
Louis Trichardt	1,5
Luderitz	0,4
Lydenburg	5,0
Matikeng	5,6
Mbabane	3,4
Mmabatho	5,6
Molteno	1,6
Mooirivier	6,9
Mossel Bay	0,5
Nelspruit	2,7
Nylstroom	7,0
Oshakati	2,3
Oudtshoorn	0,5
Paarl	0,2
Pietermaritzburg	7,0
Pietersburg	3,6
Piet Retief	11,7
Port Alfred	1,4
Port Elizabeth	0,9
Potchefstroom	7,0
Pretoria	7,5
Prieska	3,0
Richards Bay	5,2
Riversdale	0,2
Rustenburg	5,1
Sabie	3,2
Schweizer Reneke	5,6
Sishen	3,4
Skukuza	2,3
Springbok	0,6
Standerton	7,6
Stellenbosch	0,3
Sutherland	0,9
Swakopmund	0,5
Thabazimbi	2,1
Tsumeb	4,0
Umtata	3,0
Upington	2,2
Vereeniging	7,5
Villiersdorp	0,4
Vryburg	3,0
Vryheid	8,9
Walvis Bay	0,2
Warmbad	7,5
Windhoek	2,3
Witbank	7,5

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Lightning Flash Density Map for 1 January to 31 December 2006