REIGER PARK DELMORE EXTENSION 7
Basic Ecological Assessment

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Prepared for:
Urban Dynamics
Tel. No: (011) 482 4131
E-mail: henk@urbandynamics.co.za

On behalf of:

Reinco Park
DEVELOPMENT

Prepared by:

Strategic Environmental Focus
(Pty) Ltd
P.O. Box 74785
Lynnwood Ridge
0040
Tel. No: (012) 349-1307
Fax. No: (012) 349-1229
E-mail: sef@sefsa.co.za

S.E.F
STRATEGIC ENVIRONMENTAL FOCUS

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EXECUTIVE SUMMARY

Strategic Environmental Focus (Pty) Ltd was appointed by Urban Dynamics, to provide an ecological assessment report with a focus on sensitive flora and fauna of the described habitats on the property Reiger Park Delmore Extension 7.

In order to obtain a comprehensive understanding of floral and faunal community dynamics and the status of endemic, rare or threatened species in an area, ecological studies should ideally be replicated over several seasons and over a number of years. However, due to time constraints such long-term studies are not feasible as a single field survey was done on the 12th of August 2008. Consequently, the results of this report are based on data and observation collected during a day of field survey, a literature review and experience gained by the author through investigations of other areas similar to the study area in question.

The majority of the study area was heavily impacted on by historic anthropogenic activities like mining, construction and agriculture, with various surface and subsurface disturbances evident in the form of excavations, the football pitch, pipelines, road, building infrastructures and changes in the natural topography of the area. A distinct lack of primary grassland was evident within the study area, while the high density and number of alien and invasive species confirm the high levels of disturbances that have occurred on the study area. With the exception of the possible functional role of the very few grass patches, the rest of the study site can be considered as having a low conservation importance and ecological functioning, making them suitable for development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

1 INTRODUCTION

The increase in human demand for space and life-supporting resources is resulting in a rapid loss of natural open spaces in South Africa. When open space systems are rezoned for development, indigenous flora and fauna are replaced by alien and invasive species converting the environment to sterile landscapes with no dynamic propensity or ecological value (Wood *et al*, 1994).

In the Gauteng Province rapid expansion and the increase of development projects is resulting in the transformation and degradation of large tracts of natural land. Habitat transformation, fragmentation and destruction are the most serious threats to the survival of endangered plant, bird, mammal, reptile, amphibian and invertebrate species in the Gauteng Province (Pfab & Victor, 2002).

Historically, planning and developments did not include the natural environment and consequently lead to the wasteful exploitation, destruction and contamination of many natural environments within the Gauteng Province and in South Africa as a whole. In order to prevent further environmental degradation, developments should be planned in such a way, that they make the best possible use of natural resources and avoid degradation of the environment. It is therefore necessary to consider environmental factors during development planning. These environmental considerations should include studies relating to floral and faunal communities and their associated habitats, in order to identify and allocate the area's potential for conservation and development.

1.1 Project Description

Strategic Environmental Focus (Pty) Ltd was appointed by Urban Dynamics, to provide a basic ecological assessment report with a focus on sensitive flora and fauna of the described habitats on Reiger Park Delmore Extension 7.

1.2 Terms of Reference

The terms of reference for this assessment were as follows:

- To provide an indication of the relative conservation importance and ecological function of the study site in terms of flora and fauna;
- To assess the possible presence, or potential loss of general or sensitive habitats, open space as well as natural migration corridors;
- To assess the presence of Red Data species, medicinal plants, declared weeds, alien and invader plants;
- To assess the impacts of the proposed activity on the ecological integrity and sensitivity of the area; and
- To provide recommendations on ecological mitigation measures for the proposed development.

1.3 Limitations

Ideally, an ecological assessment should be carried out over a lengthy time period and should be replicated over several seasons. As some species only flower at certain periods of the year, it is necessary to undertake repetitive sampling to discover all the species within the study area. Due to the constraints of time, the data which was suppose to be collected over several seasons was collected and concluded from sample plots laid out on the study site during a single site visit.

Observations on sample plots, surveys of aerial and satellite imagery were used to assist in the compilation of the vegetation sensitivity map. Information about the study relied heavily on data from representative sections of natural grassland. However due to the presence of few conserved areas in the Soweto Highveld Grassland a high rate of grassland degradation and transformation, the process of comparing the study area with a benchmark site was not possible. Instead, published species lists from Mucina & Rutherford (2006) were relied upon for data comparison.

Faunal sampling was not undertaken during the present study, however floral assessment results (specifically the species composition) were used as an indication of disturbance and to identify possible faunal habitat within the study area.

2 BACKGROUND INFORMATION

2.1 Location

The Reiger Park Delmore Extension 7 is located within the Ekurhuleni Municipality, Gauteng. The property is located in a north-easterly direction from the intersection of Du Preez Street and the Lower Boksburg Street as shown in Figure 1.

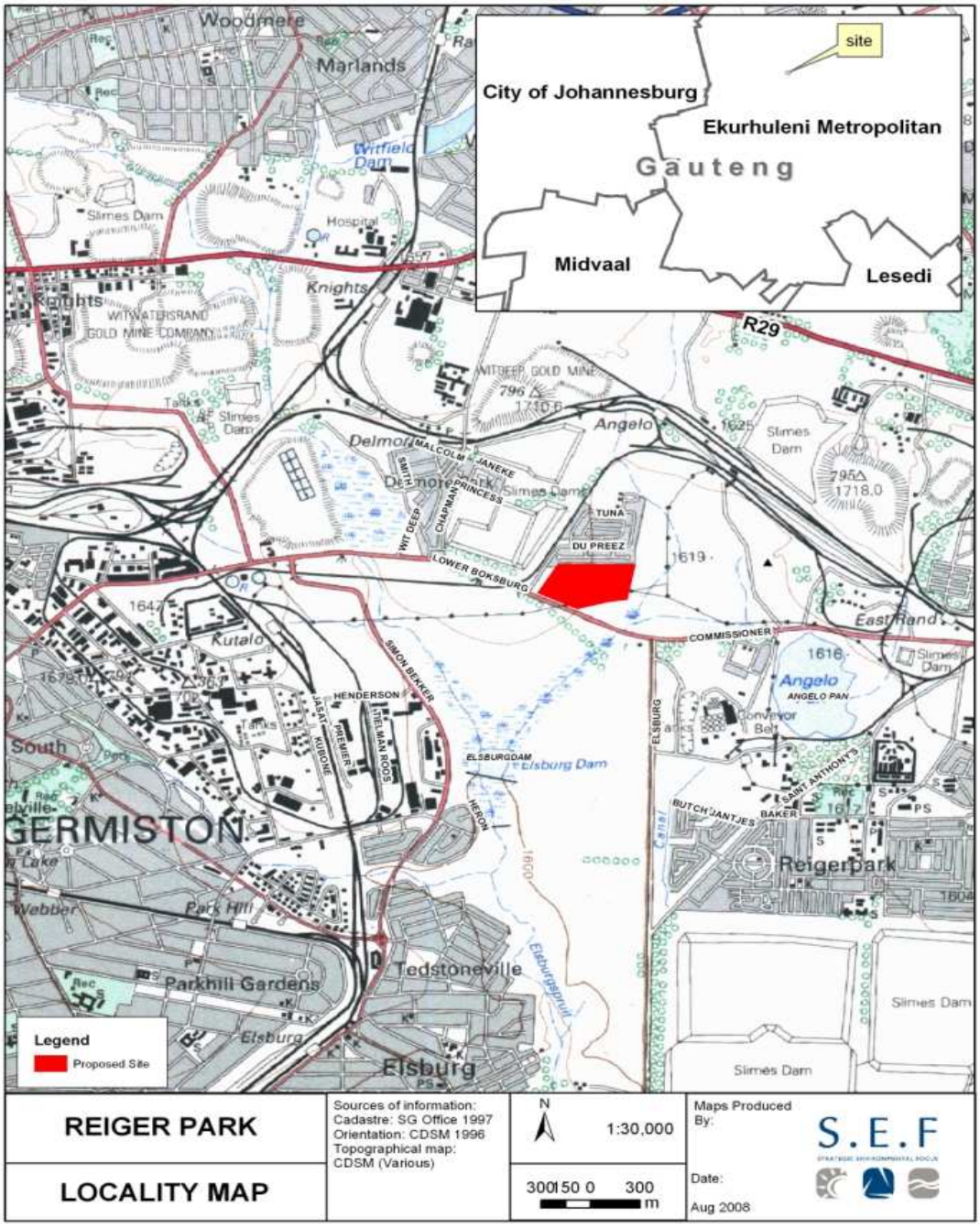

Figure 1: Locality map

2.2 Land Use

Land use on the Reiger Park Delmore Extension 7 includes informal residential areas, servitudes, alien tree plantations, illegal dumping of building rubble and household waste.

2.3 Climate

The Reiger Park Delmore Extension 7 has a typical Highveld climate characterised by warm, wet summers and cool dry winters. The mean annual rainfall is 700 mm/yr, and the temperatures range from -12˚C to 39˚C, with an mean annual temperature of 16˚C (Low & Rebelo, 1996).

2.4 Geology and Soil

The geology underlying the Reiger Park Delmore Extension 7 consists of quartzite, shale, tillite and sandstone yielding predominantly sandy soils. There are numerous areas that have been previously disturbed possibly due to historic mining, excavation and construction activities.

2.5 Regional Vegetation

The study site is located within the highly threatened Soweto Highveld Grassland Biome of South Africa, of which less than 2% is currently conserved (Le Roux, 2002). According to Acocks (1953), Reiger Park Delmore Extension 7 lies in Veld Type 52 (*Themeda* Veld) while Low and Rebelo (1996) define the vegetation type as the Moist Cool Highveld Grassland vegetation unit. More recently, Mucina and Rutherford (2006) further describe the vegetation types as the Soweto Highveld Grassland which will be adopted for this study. The Soweto Highveld Grasslands are a transitional vegetation unit between typical grasslands of the high inland plateau and the bushveld of the lower inland plateau. It is therefore an ecotone and forms the shift between two vegetation types. This makes the vegetation heterogeneous in composition, consisting of slightly different associations across its length.

The Soweto Highveld Grassland occurs on gentle to moderately undulating landscape on the Highveld plateau supporting short to medium density, tufted grassland dominated by *Themeda triandra*, and various other grasses such as *Elionurus muticus, Eragrostis racemosa, Heteropogon contortus* and *Tristachya leucothrix*. The characteristic grass and forb species of the area are *Andropogon appendiculatus, Brachiaria serrata, Cymbopogon pospischilii, Cynodon dactylon, Elionurus muticus, Eragrostis sp., Heteropogon contortus, Hyperhenia hirta, Themeda triandra, Tristachya leucothrix, Hermania depressa, Acalypha angustata, Haemanthus humilis* subsp*. Hirsutus* and *Rhynchosia totta* (Mucina & Rutherford, 2006).

3 METHODOLOGY

Earthsat satellite imagery (Google Earth, 2008), aerial photographs and topographical maps (scale 1:50 000) were used to delineate relatively homogeneous units within the study area. Transects were walked within the perceived habitat types on the site, concentrating on moving through environmental gradients in order to identify plant species and communities. This process was continued until a few to no new plant species were encountered in the area. Appendix 1 presents a more detailed description of the sampling method used during the field sampling process.

In the Reiger Park Delmore Extension 7 studies, a Geographic Information System (GIS) desktop exercise and literature review preceded the study site visit. Areas of perceived natural vegetation were identified from satellite imagery, aerial photographs and topographic maps groundtruthed upon arrival on site. The vegetation sampling exercise was then focused on identified areas of perceived natural vegetation during the study site visit. The adopted methodology comprised of scientific vegetation sampling (Mueller-Dombois & Ellenberg, 1974) method supplemented by photographic and physical attributes the sampling. When individuals could only be identified to family, genus level or were thought to be of threatened, a whole specimens was collected, bagged, labelled and location was recorded with a Global Positioning System (GPS) for later identification.

The data was analysed by undertaking the following:

- Comparison with Mucina and Rutherford (2006) species listed for the Soweto Highveld Grassland vegetation unit;
- Comparison of data between sample plots using statistical analysis; and
- Comparison of sample plots to derive dominant species composition and hence classify vegetation communities.

3.1 Ecological Sensitivity Rating

The final ecological sensitivity rating for Reiger Park Delmore Extension 7 was based on the ecological function and conservation importance of the study area. The relative ecological function (e.g. connectivity and presence of primary grasslands) of an area is based upon the inherent function of the system or portions of land. For example, highly sensitive or dynamic systems will be those systems contributing to ecosystem service (e.g. wetlands) or the total preservation of biodiversity. Secondly, it relates to the degree of ecological connectivity between systems within a landscape matrix. Ecosystems with a high degree of landscape connectivity among each other are perceived to be more sensitive.

On the other hand, ecological conservation importance relates to species diversity, endemism (unique species or unique processes) and the occurrence of threatened

species and species (or ecosystems) protected by legislation. The following categories were used to describe the ecological sensitivity of the study site:

High ecological function: Sensitive ecosystems with either low inherent resistance or resilience towards disturbance factors or highly dynamic systems considered to be stable and important for the maintenance of ecosystems integrity and offering ecosystem services (e.g. large pristine grasslands, wetlands and ridge systems). *These areas are not suitable for development;*
Medium ecological function: Relatively important ecosystems at gradients of intermediate disturbances. An area may also be considered to be of medium ecological function if it is directly adjacent to sensitive/pristine ecosystem. *These areas may be considered suitable for development, if mitigation measures are included*;
Low ecological function: Degraded and highly disturbed systems with no ecological function. *These areas are suitable for development.*
High conservation importance: Ecosystems with high species richness and usually provide suitable habitat for a number of threatened species. *These areas are usually termed 'no-go' areas and unsuitable for development, and should be protected*;
Medium conservation importance: Ecosystems with intermediate levels of species diversity without any threatened species. *These areas may be considered suitable for development, if mitigation measures are included*; and
Low conservation importance: Areas with little or no conservation potential and usually species poor (most species are usually alien). *These areas are considered suitable for development.*

3.2 Vegetation Species Occurrence

The probability of species occurring on site was classified into the following categories;
High probability of occurrence: species with an area of occupancy within the geographical locality of the study area and suitable habitat is present within the study area;
Medium probability of occurrence: species whose area of occupancy is adjacent to the study area but suitable habitat is found within the study area; and
Low probability of occurrence: species area of occupancy is adjacent to the study area and no suitable habitat is present within the study area.

4 RESULTS

4.1 Ecological Status of Vegetation

The ecological status of the Reiger Park Delmore Extension 7, vegetation was discussed in terms of species composition, ecological sensitivity and conservation importance. The vegetation species composition of Reiger Park Delmore Extension 7 was characterised by a low diversity in vegetation species occuring on the study site which can be attributed to high levels of disturbance on the study site resulting in low ecological sensitivity of the study area. The conservation status of the study site can be ranked as low as very little remnants of secondary grasslands present, however an increase of alien invasive species is evident.

4.2 Endemic Species Occurrence

The probability of endemic species occurrence on and around Reiger Park Delmore Extension 7 was ranked as low as there are no distinguishable areas of endemic species occupancy on the Reiger Park Delmore Extension 7 and adjacent areas. The absence of suitable habitat within the study site reduces the probability of both floral and faunal species occurrence. Based on these findings, the probability of species occurrence in and around the Reiger Park Delmore Extension 7 was determined and classified as low.

4.3 Ecological Function and Conservation Status

The Reiger Park Delmore Extension 7 was described as an area low ecological function due to the high levels of degradation. It is therefore suggested that the Reiger Park Delmore Extension 7 projects can be carried out on the study area with a low impact on the local and surrounding ecosystem functions. The study site was ranked as an area of low conservation importance. Reiger Park Delmore Extension 7 had a low conservation potential as it was species poor with a domination of alien and invasive vegetation species making the study site suitable for development.

4.4 Habitats Description

During the course of the field survey, numerous separate areas were delineated based on the homogeneity of their floral composition. The Study area was divided into two zones as according to the vegetation as illustrated by Figure 2, 3, 4 and 5 while a plant species list compiled from the field work is attached as Appendix 2.

4.4.1 Description of Habitats in Study Area

Two distinct vegetation zones (Zone 1 and Zone 2) supporting different plant communities were identified within the study area as illustrated by Figure 2.

Figure 2: Vegetation Zones

Zone 1: This portion was situated to the east of Du Preez Street and was observed to represent a heavily disturbed grassland site with evidence of alien and invasive plant species and domestic waste occupying approximately 80% of the study area. The upper most potion of Zone 1 had a significant number of planted *Rhus lancea* trees and *Cynodon dactlon* grass. Plant species diversity was extremely poor, as indicated by a few *Eragrostis sp*, *Pennisetum clandestinum* and mostly *Cynodon dactlon* grass species. While the forb component consisted mostly of a few pioneer species such as *Bidens pilosa* and *Tagetes minuta,* an alien grass species *Cortaderia selloana* was invading the area. The only other plant species noticed during the field visit were *Helichrysum caesipitatum, Gazania krebsiana* and *Indigofera* sp. formal housing units where situated on the northern boundary of Zone 1.

Figure 3: Vegetation in Zone 1

The remaining section of Zone 1 was located at the southern boundary along the lower Boksburg road and on eastern boundary adjacent to a medium density residential area. In this portion signs of human activity, through the dumping of domestic waste, excavations and movement of heavy machinery were evident. There was also an evident encroachment of the area by *Tagetes minuta* and other forbs with only one alien tree *Acacia baileyana* was identified in this area as shown in Figure 4. Due to the low species diversity and the disturbed nature of the site, the study area was described as an area of a low conservation importance and low ecological function. Figure 3 and 4 illustrated the vegetation of zone 1.

Figure 4: Domestic waste and weeds in Zone 1

Zone 2: Occupies approximately 15% of the study site and consists of a patch of secondary grassland dominated by *Hyperhenia*, *Eragrostis* and *Themeda* species. The grassland patch also showed signs of encroachment from *Tagetes minuta* forbs and high levels of disturbance in the form of foot path and domestic waste dumping. The presence of borrows and paths in the study area indicating of rodent activity while the high number of mole hills signal the possible presence of moles. Even with the occurrence of a patch of secondary grassland on the study site still gives the area a low conservation importance and ecological function with a low sensitivity classification.

Figure 5: Grassland patches in Zone 2

4.5 Red Data and Medicinal Floral species

South Africa has been recognised globally as a country with remarkable plant diversity and high levels of endemism. Almost 10% of the earth's plants are found within South Africa approximating to 23 420 species (Golding, 2002).

4.5.1 Red Data species

No Red Data species were observed during the field visit, this can be attributed to the presence of informal settlers who clear and harvest most of the available vegetation for fuel or to make room for cultivation.

4.5.2 Medicinal plants

The presences of a medium and high density residential area led to an increase in the use of medicinal plants, thereby decreasing the chances of such species being present on the study site. Table1 provides a list of Red and Orange Data floral species identified within the study area and their conservation status, while Appendix 2 lists plant species identified within the study site.

Table 1: Medicinal species observed on the study site

Species	Flowering Season	Suitable Habitat	Conservation Status
Acacia Karoo	March-May	Open savannas grasslands	Not Threatened
Eucomis autumnalis	Nov - April	Open grassland, marshes	Vulnerable
Habenaria barbertoni	Feb- March	In grassland on rocky hillsides	Vulnerable
Hypoxis hemerocallidae	Sep- March	Grassland and mixed woodland	Declining
Melolobium subspicatum	Oct - May	Grassland	Vulnerable

4.6 Declared weeds and invader plants

Alien and invasive species are a major threat to the ecological functioning of natural systems as well as the productive use of the land, and should ideally be removed if they are serving no ecological function. Appendix 2 lists possible occuring plant species according to declared weed or invader category and medicinal use. There are currently 198 alien species listed as declared weeds and invaders, and these have been divided into three categories (Henderson, 2001):

Category 1*:* Plants that are prohibited and must be controlled;

Category 2*:* Plants (commercially used plants) that may be grown in demarcated areas proving that there is a permit and that steps are taken to prevent their spread; and

Category 3*:* Plants (ornamentally used plants) that may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading there of, except within the flood line of watercourses and wetlands.

There were locations which were heavily infested by stands of the *Eucalyptus globulus, Tagetes minuta* and *Cynodon Dactylon*. The invasive plant species should be controlled to prevent further infestation and it is recommended that all category 1 alien and invasive species be removed. Table 2 presents the alien and invaders which where present on the study site.

Table 2: Alien and invasive species observed within the study area

Scientific Name	Common Name	Invader category
Acacia mearnsii	Black Wattle	Category 2
Arundo donax	Giant Reed	Declared weed Category 1
Cynodon dactylon	Couch Gras	Category 2
Datura stramonium	Thorn Apple	Declared weed Category 1
Eucalyptus globulus	Blue Gum	Category 2
Opuntia ficus indica	Sweet Prickly Pear	Category 1
Pennisetum clandestinum	Kikuyu Grass	Declared weed Category 2
Tagetes minuta	Tall Khakiweed	Declared weed Category 1

4.7 Faunal assessment

Reductions in fauna numbers and occurrence in the Gauteng Province can be attributed to the introduction of alien and invasive plants that do not offer a variation in plant communities, with most of the plant species being unpalatable. During the field survey very few faunal species were observed on the study site.

4.7.1 Avifauna Species

No Red Data bird species were identified on the study site during the site visit. However Appendix 3 provides a list of the Red Data bird species of the Gauteng province and the possibility of occurrence on the study site.

4.7.2 Invertebrates Species

No active searching of Red Data invertebrates was done during the field studies. Appendix 4 lists invertebrates of conservation importance within the Gauteng Province and their probability of occurrence within the study area. The conservation status of many invertebrates in the Gauteng Province is still in the process of being established with the 21 species listed as priority invertebrates for conservation.

4.7.3 Herpetofauna Species

No active searching of Red Data invertebrates was done during the field studies. However Appendix 5 lists the herpetofauna occuring within the Gauteng Province and their probability of occurrence within the study area.

4.7.4 Mammals Species

No Red data mammals were identified during the field studies. However Appendix 6 lists mammal species within the Gauteng Province and their probability of occurrence within the study area.

4.8 Conclusion

A large proportion of the study area was heavily impacted by historic anthropogenic activities, most of which probably occurred due to construction activities, domestic waste dumping and the mine dumps. Various surface and subsurface disturbances were still evident in the form of excavations, trenches, road and changes in the natural topography of the area. There was a distinct lack of primary grassland within the study area while the high density and number of alien and invasive species confirmed the level of disturbances that occurred in the past. These factors also limit the availability of natural habitat and refugia for different taxa. The study site is considered to have low conservation importance and low ecological functioning as it is heavily disturbed and degraded. The sensitivity map denotes the conservation importance and the ecological functionality of the study area in Figure 6.

Figure 6: Sensitivity Map

5 IMPACT DESCRIPTION, ASSESSMENT AND MITIGATION

Any development in a natural system will impact on the surrounding environment, usually in a negative way. The purpose of this phase of the project was therefore to identify and assess the significance of the impacts likely to arise during the construction and the operational phases of the project, and provide a short description of the mitigation required so as to limit the impact of the proposed development on the natural environment. Possible impacts associated with the proposed development and their sources are provided in Table 3(Construction phase) and Table 4(Operational phase).

Table 3: Possible impacts arising during construction phase

Possible impact	Source of impact
Increased stormwater runoff volume and velocity	Increase of hard impermeable surfaces and reduction of ground cover
Decreased biodiversity	Removal of vegetation for construction
Increased pollution	Activities of workforce

Table 4: Possible impacts arising during operation phase

Possible impact	Source of impact
Increase storm water drainage to the near by river system and increased pollution levels	Pavement, tarred surfaces, pollution and Households
Decreased biodiversity	Reduction of land vegetated land cover

5.1 Construction Phase

5.1.1 Increases stormwater runoff volume and velocity

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Medium	Definite	Moderate	Low	Medium

Description of Impact

The presence of bare soils without vegetation and the development of hard impermeable surfaces i.e. roads, parking areas and roofs, will result in an increase in stormwater runoff volume. This would, however, be of limited significance if the recommended mitigating measures are implemented.

5.1.2 Mitigation Measures

- Provide permeable surfaces and address increased runoff volumes at source; and
- Implement an ecologically-sensitive stormwater management plan during the construction phase.

5.1.3 Decreased Biodiversity

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Low	Highly Probable	Medium	Low	High

Description of Impact

The clearance of vegetation will reduce the biodiversity within the area. Human activities, which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can result in unsuitable habitats for flora and fauna. There is a possibility of introducing alien flora and fauna during the construction phase.

5.1.4 Mitigation Measures

- Minimising the loss of flora and fauna in areas that are not directly affected by the new development;
- Reduce the levels of disturbance on the area during construction;
- All construction areas should be suitably top soiled and vegetated as soon as is possible after construction; and
- Disturbed surfaces to be rehabilitated must be ripped, and the area must be backfilled with topsoil or overburden.

5.1.5 Increased pollution

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Medium	Probable	Medium	Low	Medium

Description of Impact

Hydrocarbon-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surrounds to be contaminated by raw sewage?

5.1.6 Mitigation Measures

- A walled concrete platform, dedicated store with adequate flooring or beamed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc.;
- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- Concrete and tar shall be mixed only in areas, which have been specially demarcated for this purpose with all concrete and tar that is spilled outside these areas shall be promptly removed by the Contractor and taken to an approved dumpsite;
- After all the concrete / tar mixing is complete all waste concrete / tar shall be removed from the batching area and disposed of at an approved dumpsite;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs must be informed immediately;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed and the construction site should be cleaned daily and litter removed; and
- Conduct ongoing staff awareness programs so as to reinforce the need to avoid littering;

5.2 Operational Phase

5.2.1 Altered hydrological regime

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Long	Low	Highly Probable	Low	Low	High

Description of Impact

The presence of hard impermeable surfaces i.e. roads, parking areas and roofs, will result in an increase in stormwater runoff volume and velocity. The increase of surface water runoff and the decrease of infiltration will result in an increase in erosion potential. This would however be of limited significance if the recommended mitigating measures are implemented.

5.2.2 Mitigation Measures

- Provide permeable surfaces to address increased runoff volumes at source and allow infiltration of the runoff; and
- Implement an ecologically-sensitive stormwater management plan that includes not allowing stormwater to be discharged directly into the identified buffer zone of the watercourse and drainage lines.

5.2.3 Altered biological composition

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Regional	Long term	Low	Probable	Low	Low	Medium

Description of Impact

The quantity and quality of nutrients entering into the aquatic ecosystem determines not only the number of organisms that can be supported by the stream, but also the type and complexity of the food web. The main nutrients entering mountain streams include plant material from the surrounding landscape, with little reliance on upstream sources. This has implications on the land management procedures, any alteration in the amount, timing and availability of plant material entering the stream may influence the response of the flora and fauna of the watercourse by altering the timing of food availability, as well as the quality and digestibility of food, thus influencing growth rates, timing of reproductive maturity and, ultimately, the species composition of the entire community.

5.2.4 Mitigation Measures

- Footprint size should be kept at a minimum so as to maintain as much natural vegetation cover as possible;
- Only vegetation indigenous to the area should be considered for landscaping purposes; and wastewater limit values applicable to discharge of wastewater into watercourses as stipulated by the Department of Water Affairs and Forestry should be strictly adhered to.

6 CONCLUSION AND RECOMMENDATIONS

There seems to be no areas of plant endemism within the proximity of the proposed development with evidence of disturbed and degraded portions within the study site. The study area presents a highly fragmented landscape that still shows remnants of a secondary grasslands which has since been destroyed due to mining, construction and human disturbances. A decrease in sensitive features is evident on towards the middle of the study area, as evident in the form of a patch of secondary grassland vegetation towards the middle of the study site. Overall the study site indicated high levels of disturbance which can be attributed to its proximity to a settlement making them vulnerable to human activities which are detrimental to ecosystem's integrity.

Other important recommendations which should be adhered to are the removal of the alien and invasive vegetation species from the study area as well as suing veld rehabilitation techniques in portions of the study site that will not be affected by the development. In general, it can be concluded that the majority of the site is suitable for development. However a large scale development with its associated footprint and impacts can only be possible under strict environmental protection guidelines. To ensure prevention of further habitat loss for present flora and fauna it is recommended that minimal destruction be subjected to the small portions of the remaining patches of primary grasslands as it causes irreversible damage to high biodiversity ecosystems within the Soweto Highveld Grassland Biome.

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8 GLOSSARY

Alien species: Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity.

Biodiversity: Biodiversity is the variability among living organisms from all sources including inter alia terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biome: A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.

Conservation: The management of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystem function and integrity.

Ecosystem: Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

Ecosystem services: Activities that help to maintain an ecosystem but are not directly part of energy flows and nutrient cycles. Examples include pollination, dispersal, population regulation, and provision of clean water and the maintenance of liveable climates (carbon sequestration).

Endangered: A taxon is endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Endemic: Occurring in a particular region, and nowhere else.

Environment: NEMA defines “environment” as “the surroundings within which humans exist and that are made up of the land, water and atmosphere of the earth; micro organisms, plant and animal life; any interrelationships among and between them and the physical, chemical aesthetic and cultural properties and conditions that influence human health and well-being”.

Forb: An herbaceous plant other than grasses

Habitat: Type of environment in which a plant or animal lives.

Indigenous: Any species of plant, shrub or tree that occurs naturally in South Africa

Invasive species: Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas

Rare species: Species, which have naturally small populations, and species, which have been reduced to small (often unstable) populations by man's activities.

Threatened species: Species which have naturally small populations and species which have been reduced to small (often unstable) populations by man's activities.

Red Data: A list of species, fauna and flora that require environmental protection. Based on the IUCN definitions.

Soil: A mixture of organic and inorganic substances, the composition and structure of the latter is derived from the parent rock material. Soil also contains bacteria, fungi, viruses and micro-arthropods, nematodes and worms.

Species diversity: A measure of the number and relative abundance of species (see biodiversity).

Species richness: The number of species in an area or habitat.

9 APPENDICES

Appendix 1: Descriptions regarding the methodology used during the assessment.

Estimation of optimal plot size

A number of plots that represent a given community were subjectively chosen. A list of all species encountered was compiled for each plot. An area that best represented the community was located and the minimal area for sampling was determined (the smallest area within which the species of the community were adequately represented). The minimal area was determined by a species-area curve.

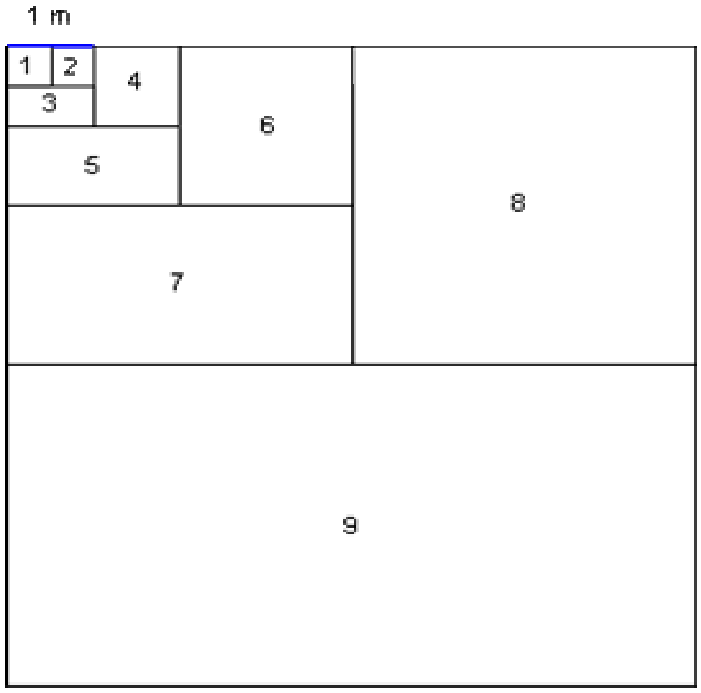

Figure 1: A system of nested plots for determining minimal area (Mueller-Dombois & Ellenberg, 1974).

A species-area curve was compiled by placing larger and larger plots on the ground in such a way that each larger plot encompassed all the smaller ones, an arrangement called nested plots (Barbour et al., 1987; Figure 2). As each larger plot was located, a list of additional species encountered was created. A point of 'diminishing return' was reached, beyond which increasing the plot area results in the addition of only a few more species. The point on the curve where the slope most rapidly approaches the horizontal is called the minimal area (Figure 4). Because this definition of minimal area is subjective, some define it instead as that area which contains some standard fraction of the total flora of a stand, for example, 95%. The most recently proposed solution is to plot the similarity between plots as plot size increases. Minimal area is thought by some ecologists to be an important community trait that is just as characteristic of a community type as the species that make it up.

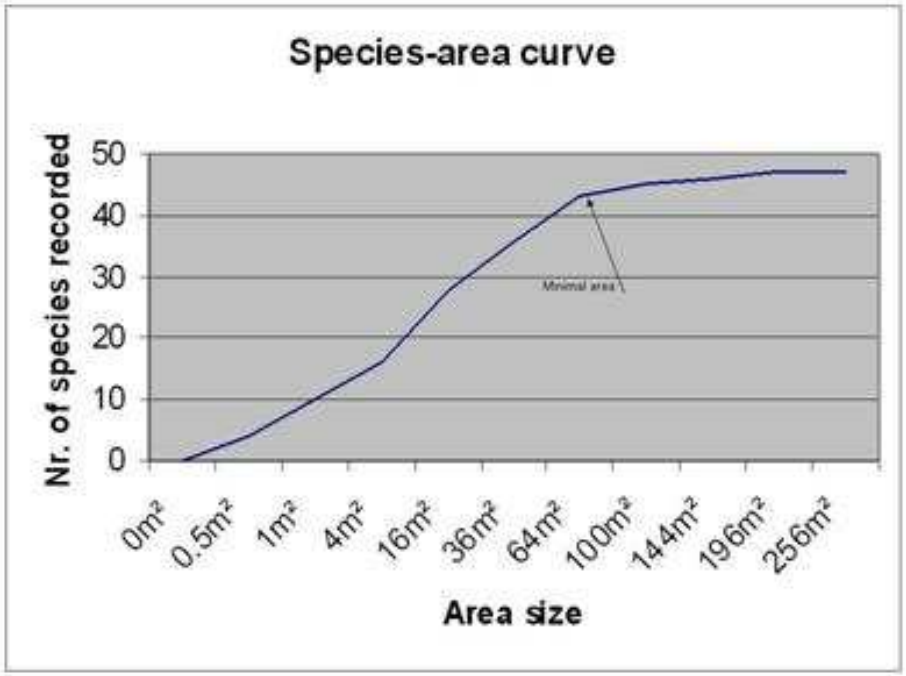

Figure 2: Species-area curve for the study area

Cover estimates

Cover was not measured precisely but is placed in one of seven categories by a visual estimate (Table 1). Braun-Blanquet and others recognise that plant cover is very heterogeneous from point to point and from time to time even within a small stand. The range of percentage points within each class allows for each observer's deviance from the correct cover percentage.

Table 1: Braun-Blanquet Cover classes (Mueller-Dombois & Ellenberg, 1974).

Class	Range of cover (%)	Mean
5	75-100	87.5
4	50-75	62.5
3	25-50	37.5
2b	13-25	19
2a	6-12	9
1	1-5	2.5
0	<1	0.1

NB: Individuals occurring only once; cover ignored and assumed to be insignificant.

Appendix 2: Plant species observed during the field survey

Scientific Name	Common English Name	Medicinal value	Declared plant & Status
*Acacia mearnsii**	Black Wattle	No	Category 2
*Agave sisalana**	Sisal	No	
Amaranthus hybridus	Pigweed	No	
Bidens pilosa	Black Jack	No	
Canna indica	Garden Canna	No	Category 1
*Cortaderia selloana**	Pampas Grass	No	Category
Cynodon dactylon	Couch Grass	No	
*Datura stramonium**	Common thorn Apple	No	Category 1
Eragrostis chloromelas	Curly Leaf	No	
Eragrostis curvula	Weeping love Grass	No	
Eragrostis gummiflua		No	
Eragrostis racemosa	Narrow heart love Grass	No	
Chloris Gayana	Rhodes Grass	No	
Eucalyptus sp.*	Gum Tree	No	Category 2
Hyparrhenia hirta	Common thatching Grass	No	
Hyparrhenia tamba	Blue thatching Grass	No	
Hypoxis rigidula var. *rigidula*	Silver-leaved Star flower	Yes	
Ledebouria revoluta	Common Ledebouria	Yes	
*Ligustrum ovalifolium**	Common Privet	No	Category 3
*Melia azedarach**	Syringa	No	Category 3
*Morus alba**	Common Mulberry	No	
Pennisetum clandestinum	Kikuyu Grass	No	
Phragmites australis	Common Reed	No	
*Pinus sp.**	Pine	No	
*Salix babylonica**	Weeping Willow	No	Category 2
*Solanum mauritianum**	Bugweed	No	Category 1
Seriphium plumosum	Bankrupt Bush	No	
*Tagetes minuta**	Tall Khakiweed	Yes	
Themeda triandra	Red Grass	No	
*Verbena tenuisecta**	Fine-leaved Verbena	No	
Vernonia oligocephala	Cape Vernonia	Yes	

* Denotes exotic and invasive plant species

Appendix 3: Avifauna that may occur on site, with their probability of occurrence indicated. Species observed or heard on site are highlighted.

Scientific Name	Common Name	Probability of occurrence	Status
Acridotheres tristis	**Common Myna**	**High**	
Acrocephalus baeticatus	African Reed-Warbler	High	
Acrocephalus gracilirostris	Lesser Swamp-Warbler	High	
Acrocephalus palustris	Marsh Warbler	Low	
Actitis hypoleucos	Common Sandpiper	Low	
Alopochen aegyptiacus	Egyptian Goose	Low	
Amadina erythrocephala	Red-headed Finch	Low	
Amandava subflava	Orange-breasted Waxbill	Low	
Amaurornis flavirostra	Black Crake	Low	
Anas erythrorhyncha	Red-billed Teal	Low	
Anas sparsa	African Black Duck	Low	
Anas undulata	Yellow-billed Duck	Low	
Anhinga rufa	African Darter	Low	
Anthus cinnamomeus	**African Pipit**	**High**	
Anthus leucophrys	Plain-backed Pipit	Low	
Anthus vaalensis	Buffy Pipit	Low	
Apus affinis	Little Swift	Low	
Apus barbatus	African Black Swift	Medium	
Apus caffer	White-rumped Swift	High	
Apus horus	Horus Swift	Medium	
Ardea cinerea	Grey Heron	Medium	
Ardea melanocephala	Black-headed Heron	Medium	
Asio capensis	Marsh Owl	Low	
Bostrychia hagedash	**Hadeda Ibis**	**Medium**	
Bradypterus baboecala	Little Rush-Warbler	High	
Bubo africanus	Spotted Eagle-Owl	Low	
Bubulcus ibis	Cattle Egret	Low	
Burhinus capensis	Spotted Thick-knee	Low	
Buteo buteo	Common Buzzard	Low	
Calandrella cinerea	Red-capped Lark	Medium	
Centropus burchelli	Burchell's Coucal	Low	
Ceryle rudis	Pied Kingfisher	Low	
Chalcomitra amethystina	Amethyst Sunbird	Low	

Charadrius pecuarius	Kittlitz's Plover	Low	
Charadrius tricollaris	Three-banded Plover	Low	
Chrysococcyx caprius	Diederick Cuckoo	Low	
Ciconia abdimii	Abdim's Stork	Low	
Ciconia ciconia	White Stork	Low	
Cinnyris talatala	White-bellied Sunbird	Low	
Cisticola aridulus	Desert Cisticola	Low	
Cisticola ayresii	Wing-snapping Cisticola	Low	
Cisticola fulvicapilla	Neddicky	Medium	
Cisticola juncidis	Zitting Cisticola	Low	
Cisticola textrix	Cloud Cisticola	Medium	
Cisticola tinniens	Levaillant's Cisticola	Low	
Colius striatus	Speckled Mousebird	Low	
Columba guinea	Speckled Pigeon	Low	
Columba livia	Rock Dove	Low	
Corvus albus	Pied Crow	High	
Corythaixoides concolor	Grey Go-away-bird	Medium	
Cossypha caffra	Cape Robin-Chat	Low	
Creatophora cinerea	Wattled Starling	Low	
Crex crex	Corn Crake	Low	
Crithagra atrogularis	Black-throated Canary	Low	
Crithagra mozambicus	Yellow-fronted Canary	Medium	
Cuculus solitarius	Red-chested Cuckoo	Low	
Cypsiurus parvus	African Palm-Swift	Medium	
Delichon urbica	Common House-Martin	Low	
Dendropicos fuscescens	Cardinal Woodpecker	Low	
Dicrurus adsimilis	Fork-tailed Drongo	Medium	
Egretta alba	Great Egret	Low	
Egretta garzetta	Little Egret	Low	
Elanus caeruleus	Black-shouldered Kite	High	
Estrilda astrild	Common Waxbill	Low	
Euplectes albonotatus	White-winged Widowbird	Medium	
Euplectes ardens	Red-collared Widowbird	Low	
Euplectes orix	Southern Red Bishop	Medium	
Euplectes progne	Long-tailed Widowbird	High	
Euplectus afer	Yellow-crowned Bishop	High	

Eupodotis [a.] afraoides	Northern Black Korhaan	High	
Falco amurensis	Amur Falcon	Medium	
Falco biarmicus	Lanner Falcon	Medium	NT
Falco naumanni	Lesser Kestrel	Medium	V
Fulica cristata	Red-knobbed Coot	Medium	
Gallinago nigripennis	African Snipe	Medium	
Gallinula chloropus	Common Moorhen	Medium	
Halcyon albiventris	Brown-hooded Kingfisher	Medium	
Hirundo abyssinica	Lesser Striped Swallow	Low	
Hirundo albigularis	White-throated Swallow	High	
Hirundo cucullata	Greater Striped Swallow	High	
Hirundo rustica	Barn Swallow	High	
Hirundo spilodera	South African Cliff-Swallow	Low	
Indicator minor	Lesser Honeyguide	Low	
Jynx ruficollis	Red-throated Wryneck	Low	
Lamprotornis nitens	Cape Glossy Starling	Low	
Lanius collaris	**Common Fiscal**	**High**	
Larus cirrocephalus	Grey-headed Gull	Low	
Lybius torquatus	Black-collared Barbet	Low	
Macronyx capensis	Cape Longclaw	High	
Megaceryle maximus	Giant Kingfisher	Low	
Merops apiaster	European Bee-eater	Low	
Milvus [m.] aegyptius	Yellow-billed Kite	High	
Mirafra [apiata] fasciolata	Eastern Clapper Lark	Medium	
Mirafra africana	Rufous-naped Lark	High	
Mirafra cheniana	Melodious Lark	Medium	NT
Motacilla capensis	Cape Wagtail	Medium	
Muscicapa striata	Spotted Flycatcher	Low	
Numida meleagris	Helmeted Guineafowl	High	
Nycticorax nycticorax	Black-crowned Night-Heron	Low	
Oenanthe pileata	Capped Wheatear	Med	
Ortygospiza atricollis	African Quailfinch	High	
Passer diffusus	Grey-headed Sparrow	Low	
Passer domesticus	House Sparrow	Medium	
Passer melanurus	Cape Sparrow	High	
Phalacrocorax [c.] lucidus	White-breasted Cormorant	Low	

Phalacrocorax africanus	Reed Cormorant	Low	
Phylloscopus trochilus	Willow Warbler	Low	
Platalea alba	African Spoonbill	Low	
Plegadis falcinellus	Glossy Ibis	Low	
Ploceus capensis	Cape Weaver	Low	
Ploceus velatus	Southern Masked-Weaver	High	
Prinia subflava	Tawny-flanked Prinia	Low	
Pternistes swainsonii	Swainson's Spurfowl	High	
Pycnonotus tricolor	Dark-capped Bulbul	Medium	
Quelea quelea	Red-billed Quelea	Medium	
Riparia paludicola	Brown-throated Martin	Low	
Riparia riparia	Sand Martin	Low	
Saxicola torquata	**African Stonechat**	**High**	
Scleroptila levaillantii	Red-winged Francolin	High	
Scopus umbretta	Hamerkop	Medium	
Sigelus silens	Fiscal Flycatcher	Low	
Spreo bicolor	Pied Starling	Medium	
Streptopelia capicola	**Cape Turtle-Dove**	**High**	
Streptopelia semitorquata	Red-eyed Dove	High	
Streptopelia senegalensis	Laughing Dove	High	
Telophorus zeylonus	Bokmakierie	Low	
Terpsiphone viridis	African Paradise-Flycatcher	Low	
Threskiornis aethiopicus	African Sacred Ibis	Medium	
Trachyphonus vaillantii	Crested Barbet	Low	
Tringa glareola	Wood Sandpiper	Low	
Turdus smithi	Karoo Thrush	Medium	
Tyto alba	Barn Owl	High	
Tyto capensis	African Grass Owl	Medium	V
Upupa africana	African Hoopoe	Medium	
Urocolius indicus	Red-faced Mousebird	Low	
Vanellus armatus	Blacksmith Lapwing	Low	
Vanellus coronatus	Crowned Lapwing	High	
Vanellus senegallus	African Wattled Lapwing	Low	
Vidua macroura	Pin-tailed Whydah	High	
Zosterops pallidus	Cape White-eye	Low	

E = Endangered, V = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient.

Appendix 4: Invertebrates species of conservation importance in the Gauteng Province (GDACE, 2006)

Species	Taxon	Probability of Occurrence
Aloeides dentatis	Butterfly	Low
Chrysoritis aureus	Butterfly	Low
Metisella meninx	Butterfly	Low
Gegenes hottentota	Butterfly	Low
Harpactirella flavipilosa	Baboon Spider	Low
Harpactira hamiltoni	Baboon Spider	Low
Pycnacantha tribulus	Spider	Low
Brachionopus pretoriae	Trapdoor Spider	Low
Idiops fryi	Trapdoor Spider	Low
Idiops pretoriae	Trapdoor Spider	Low
Idiops gunningi	Trapdoor Spider	Low
Homostola pardalina	Trapdoor Spider	Low
Homostola zebrina	Trapdoor Spider	Low
Galeosoma hirsutum	Trapdoor Spider	Low
Segregara monticola	Trapdoor Spider	Low
Segregara transvaalensis	Trapdoor Spider	Low
Ancylotrypa rufescens	Trapdoor Spider	Low
Ancylotrypa brevipalpis	Trapdoor Spider	Low
Ancylotrypa pretoriae	Trapdoor Spider	Low
Gorgyrella schreineri minor	Trapdoor Spider	Low
Stasimopus suffucus	Trapdoor Spider	Low
Stasimopus oculatus	Trapdoor Spider	Low
Calommata simoni	Trapdoor Spider	Low
Hadogenes gunningi	Scorpion	Low
Hadogenes gracilis	Scorpion	Low
Hadogenes longimanus	Scorpion	Medium
Opistophthalmus pugnax	Scorpion	Medium
Ichnestoma stobbiai	Fruit Chafer Beetle	Low
Trichocephala brincki	Fruit Chafer Beetle	Low

Appendix 5 Herpatofaunal species of conservation importance in the Gauteng Province (GDACE, 2006)

Scientific Name	Common Name	Probability of Occurrence
Reptiles		
Python sebae	African Rock Python	Low
Homoroselaps dorsalis	Striped Harlequin Snake	Low
Lygodactylus capensis	Cape Dwarf Gecko	Low
Trachylepis puntatissima	Speckled eyed Skink	Low
Lamprophis fuliginosus	Brown House Snake	Low
Duberria lutrix	Common Slug-eater	Low
Crotaphopeltis hotamboeia	Herald Snake	Low
Dasypeltis scabra	Rhombic Eggeater	Low
Lycodonomorphus rufulus	Brown water Snake.	Low
Amphibians		
Kassina senegalensis	Bubbling Kassina	Low
Semnodactylus waelii	Rattling Kassina	Low
Rana angolensis	Common River Frog	Low
Afrana fuscigula	Cape River Frog	Low
Strongylopus fasciatus	Striped Stream Frog	Low
Bufo gutturalis	Guttural Toad	Low
Tomopterna cryptotis	Striped Sand Frog	Low
Tomopterna natalensis	Natal Sand Frog	Low
Phrynobatrachus natalensis	Snoring Puddle Frog	Low
Cacosternum boettgeri	Common Caco	Low
Pyxicephalus adspersus	Giant Bullfrog	Low

Appendix 6: Mammalian species of Gauteng province

Scientific Name	Common Name	Habitat	Probability of occurrence	Status
Artidactyla/Perissodactyla/Proboscidea				
Sylvicapra grimmia	Common Duiker	Wide range of habitats	Low	
Carnivora				
Aonyx capensis	Cape Clawless Otter	Rivers, marshes, dams, lakkes, and dry stream beds with pools	Low	
Atilax paludinosus	Water Mongoose	Well watered areas, along rivers, around dams, estuaries and swamps	Low	
Canis mesomelas	Black-backed Jackal	Wide habitat tolerance; arid, savanna and well watered regions.	Low	
Cynictis penicillata	Yellow Mongoose	Open areas such as vleis and open grassland around waterholes	Low	
Galerella sanguinea	Slender Mongoose	Varied; widespread	Low	
Genneta genetta	Small-spotted Genet	Savanna to desert even rural gardens	Low	
Helogale parvula	Dwarf Mongoose	Open woodland and grassland savanna	Low	
Lutra maculicollis	Spotted-necked otter	Large rivers, lakes, dams, swamps, and dry rivers with large pools	Low	NT
Chiroptera				
Epomophorus wahlbergi	Wahlberg's Epauletted Fruit Bat	Forest and riverine woodland	Low	
Neoromicia capensis	Cape Serotine Bat	Variable but prefers savanna. Commonly enter houses and readily visits lights	Low	
Insectivora				

Amblysomus septentrionalis	Highveld Golden Mole	Marshes	Low	NT
Atelerix frontalis	South African Hedgehog	Variety of habitats, even suburban gardens	Low	NT
Chrysospalax villosus	Rough-haired Golden Mole	Grasslands, on the fringe of marshes	Low	CE
Crocidura cyanea	Reddish-grey Musk Shrew	Varied including grasslands; widespread	Low	DD
Crocidura fuscomurina	Tiny Musk Shrew	Thick vegetation, especially along rivers; widespread	Low	DD
Crocidura hirta	Lesser Red Musk Shrew	Varied; widespread	low	DD
Crocidura mariquensis	Swamp Musk Shrew	Grass along river banks and reedbeds; widespread	Low	V
Myoserex cafer	Dark-Footed forest Shrew	Well vegetated and moist area, in a wide range of habitats	Low	DD
Myosorex varius	Forest Shrew	Moist densely vegetated habitat	Low	DD
Neablysomus julianae	Juliana's Golden Mole	Sandy to sandy loam soils between rock outcrops. Prefers savanah	Low	V
Suncus infinitesesimus	Least Dwarf Shrew	Termite mounds	Low	DD
Suncus lixus	Greater Dwarf Shrew	Wide range of habitats	Low	DD
Suncus varilla	Lesser Dwarf Shrew	Termite mounds	Low	DD
Lagamorpha				
Lepus saxatilis	Scrub Hare	Savanna with grass cover; widespread	Medium	
Rodentia				
Cryptomys hottentotus	Common Mole Rat	Varied; Widespread	High	
Dasymys incomtus	Water Rat	Well vegetated and wet habitats	Low	NT
Dendromus melanotis	Grey Climbing Mouse	Stands of tall grasses (Hyparrhenia	Low	

		spp.) with bushes and other thick vegetation		
Dendromus mystacalis	Chestnut Climbing Mouse	Grassland, with coarse grasses such as hyparrhenia spp	High	
Hystrix africaeaustralis	Porcupine	Catholic, most habitat types	Low	
Lemniscomys rosalia	Single-striped Mouse	Grasslands; peripheral	Low	DD
Mastomys coucha	Multimammate Mouse	Wide habitat tolerance	Low	
Otomys angoniensis	Angoni Vlei Rat	Swampy areas; widespread	Low	
Otomys irroratus	Vlei Rat	Grasslands with wetlands	Low	
Pedetes capensis	Springhare	Compacted sandy soils	Medium	
Rhabdomys pumilo	Striped Mouse	Grassland; widespread	Medium	
Steatomys krebsii	Krebs' Fat Mouse	Sandy substrates and cultivate land	Low	
Tatera leucogaster	Bushveld Gerbil	Light sandy soils in open grassland to savanna woodland	Low	DD
Thallomys paedulcus	Tree Rat	Wide range of habitats	Low	
Thryonomys swinderianus	Greater Cane Rat	Reed-beds and other dense vegetation near water	Low	
Macroscelidea/Tubilidentata				
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	Areas with sandy soil	Low	DD
Orycteropus afer	Aardvark	Open woodland, scrub and grasslands with termites	Low	
E = Endangered, V = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient				