Ecological Management Services

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ECOLOGICAL SURVEY FOR THE PROPOSED MANGANESE MINE ON THE PROPERTY LEHATING 741, NEAR BLACK ROCK, NORTHERN CAPE

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For
SLR Consulting (Africa) (Pty) Ltd (Pty)

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TABLE OF CONTENTS

1. INTRODUCTION & TERMS OF REFERENCE

Ecological Management Services was commissioned by SLR Consulting (Africa) (Pty) Ltd to undertake an ecological specialist survey of the proposed development site of a small underground Manganese mine on the property, Portion 1 of Lehating 741 which is located approximately 20km north of Hotazel in the Northern Cape. This survey included;

- a desktop and field investigation to identify and map different habitats in the proposed project area;
- identification of species to each habitat on the basis of fieldwork, professional experience and available research.
- The ranking of each habitat type based on conservation importance and ecological sensitivity;
- Identification of potential impacts on the ecology.

1.1. DETAILS OF SPECIALIST

Dr Natalie Birch

Qualifications:	BSc (Hons) Wildlife Management, Pretoria University PhD Botany (Rhodes University)
Dissertation:	Vegetation potential of natural rangelands in the mid Fish River Valley. Towards a sustainable and acceptable management system.
Research Interests:	My academic interests cover various areas dealing with ecological functioning, and wildlife management, with a special interest in the functioning and management of arid and semi arid rangelands.
Awards:	Grassland Society of Southern Africa award for: Outstanding research in Range and Forage Science (2001).
Associations:	Grassland Society of Southern Africa South African Council for Natural Scientific Professions

Declaration:

I Natalie Birch declare that I –

- act as the independent specialist in this study;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2010;
- will provide the competent authority with access to all information at my disposal regarding the study.

1.2. THE STUDY AREA

The area is located approximately 20km north of Hotazel, on the property Portion 1 of the farm Lehating 741, and includes the access road which crosses the property Portion 2 of the farm Wessels 227, within the John Taolo Gaetsewe District Municipality. The study area falls mostly within the land type Ah (ARC – Institute for Soil Climate & Water), a land-type being an area that is uniform with respect to terrain form, soil patterns and climate.

The geology within the Ah land type is broadly described as aeolian sand of Recent age with a few outcrops of Tertiary Kalahari beds (surface limestone, silcrete and sandstone) in the riverbeds. The soils are eutrophic red and yellow, sandy well drained soils with high base status. These soils are >/= 750 mm deep with less than 15% clay content.

In terms of land capability the area can be described as non-arable, low potential grazing land. The terrain consists of level plains with some relief and areas of rolling plains low dunes. Within the vicinity of the Kuruman River slopes of 6-8% occur. The grazing capacity for this area ranges between 26 -30 ha/LSU. The landcover of the property consists of woodland, degraded woodland and thicket.

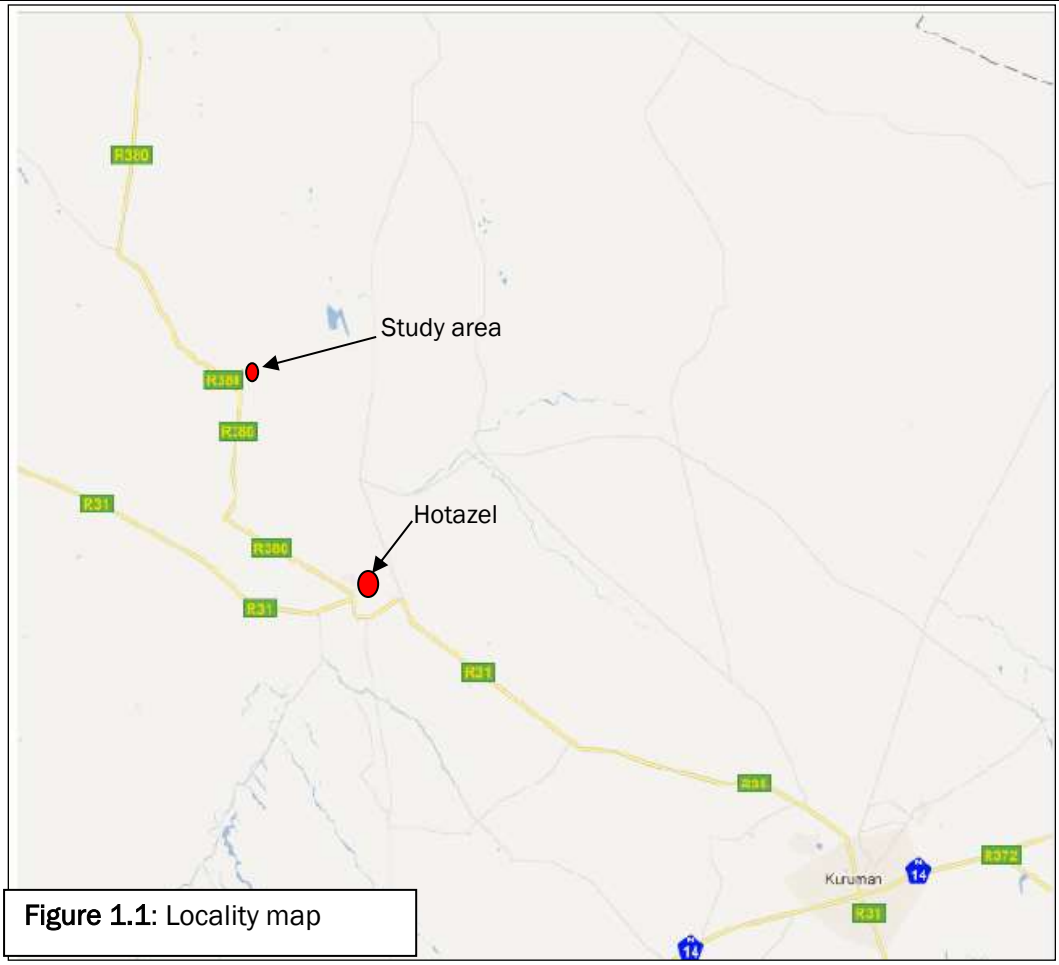


Figure 1.1: Locality map

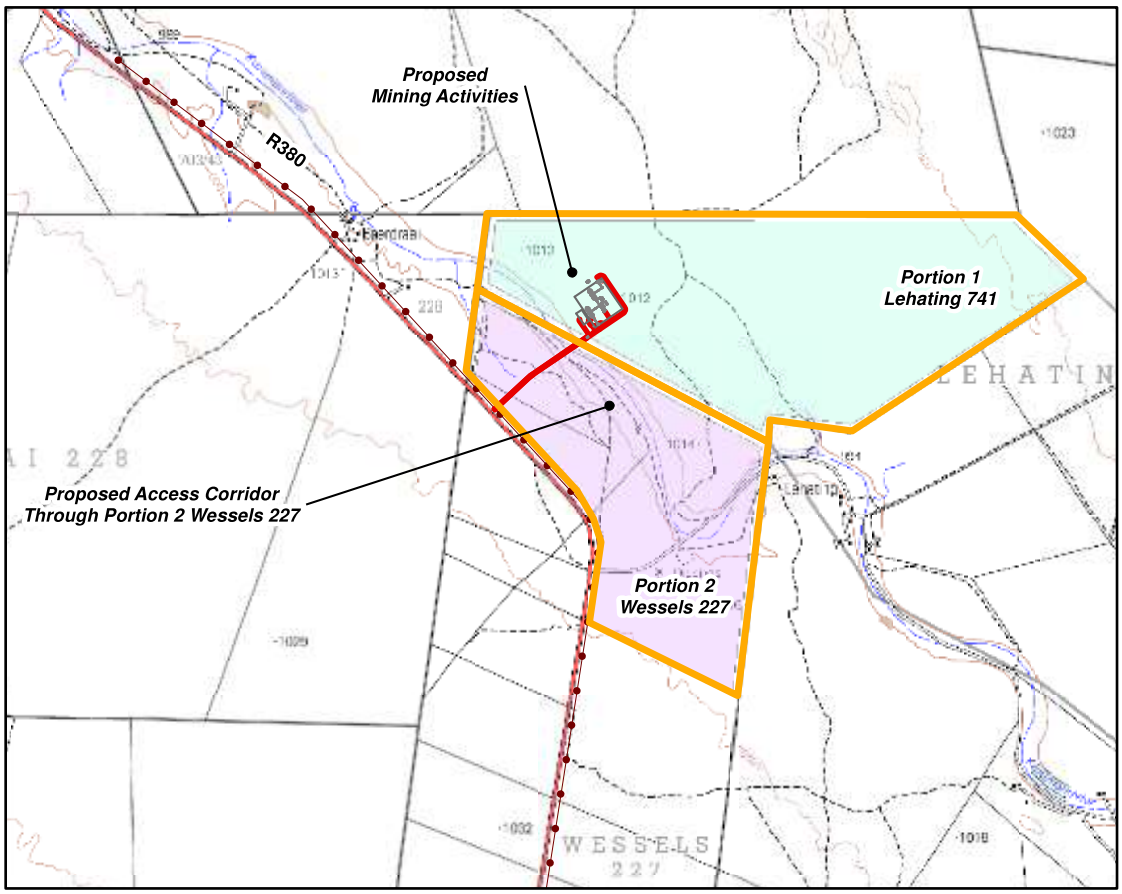


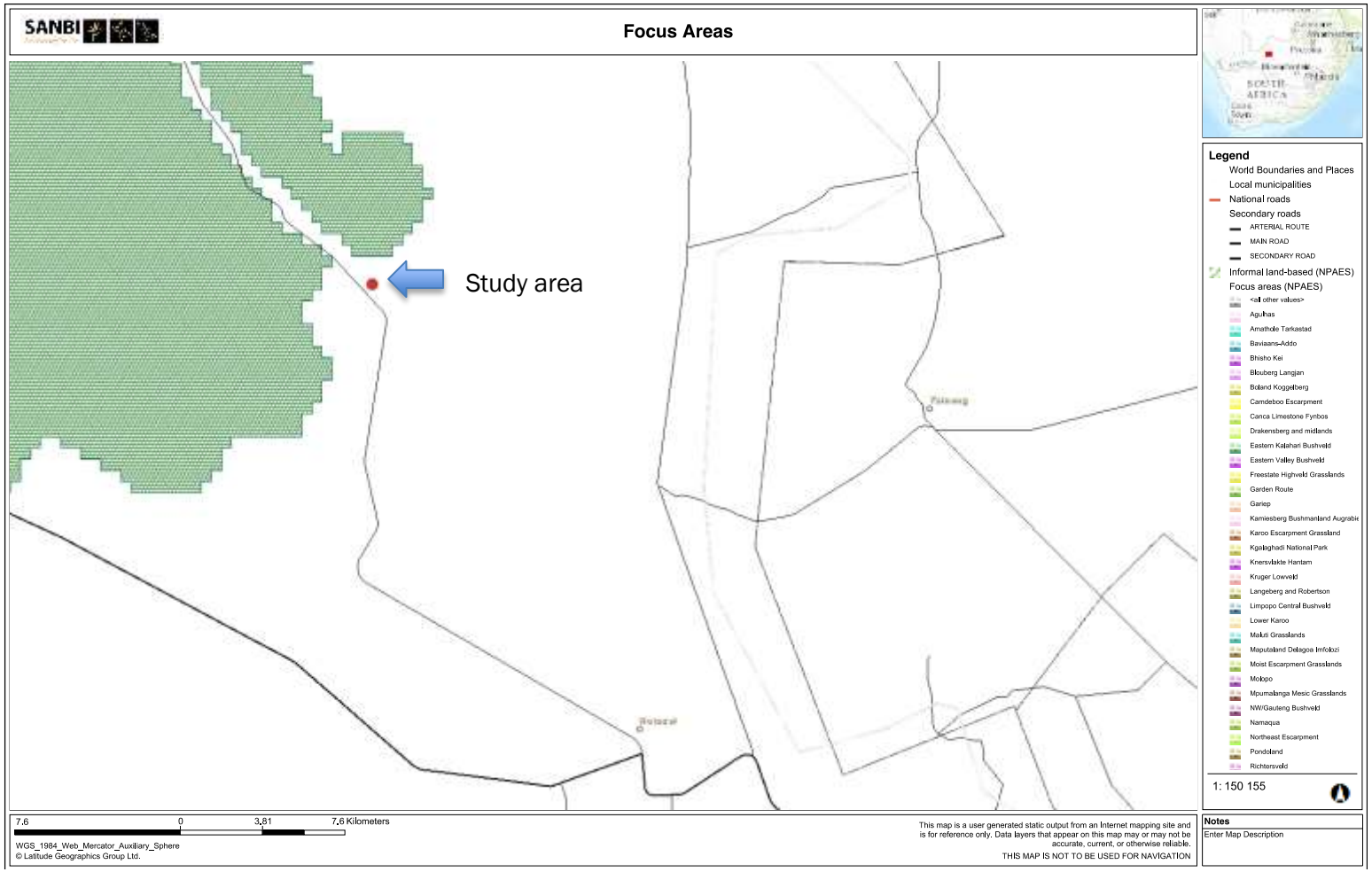
Figure 1.2: Borders of the study area the access road is shown in red.

1.2.1. FOCUS AREAS FOR PROTECTED AREA EXPANSION

Focus areas for land-based protected area expansion are large, intact and unfragmented areas of high importance for biodiversity representation and ecological persistence, suitable for the creation or expansion of large protected areas. The focus areas were identified through a systematic biodiversity planning process undertaken as part of the development of the National Protected Area Expansion Strategy 2008 (NPAES). They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES, and were designed with strong emphasis on climate change resilience and requirements for freshwater ecosystems.

The proposed mining area borders the area identified as a potential protected area for the eastern Kalahari bushveld. The boundary of the property is located approximately 500m from the boundary of the identified focus area.

Figure 1.3: Focus areas for land-based protected area expansion identified by the National Protected Area Expansion Strategy for the eastern Kalahari bushveld



2. METHODS

Flora

The fieldwork component of this survey was conducted during August 2011. A report was submitted in October 2011 and updated in July 2013. Aerial photographs & Satellite images were used to identify homogenous vegetation/habitat units within the proposed development area. These were then sampled on the ground with the aid of a GSP to navigate in order to characterise the species composition. The following quantitative data was collected:

- species composition,
- cover estimation of each species according to the Braun-Blanquet scale,
- vegetation height,
- amount of bare soil and rock cover,
- slope, aspect
- presence of biotic disturbances, e.g. grazing, animal burrows, etc.

Additional checklists of plant species were compiled by traversing a linear route and recording species as they were encountered.

Due to the brief duration of the survey the lack of seasonal coverage and the fact that the survey was conducted in winter, the species list obtained for the area cannot be regarded as comprehensive, but is nevertheless likely to include the majority of the dominant and common species present. To augment this data, the checklist of plant species for the study area was supplemented by including all species present in the National Herbarium PRECIS database that have been historically recorded in the 1:50 000 grids within the study area.

Searches were undertaken specifically for Red List plant species for the area including the current study area. Historical occurrences of Red List plant species were obtained from the South African National Biodiversity Institute for the quarter degree squares that includes the study area.

Fauna

The faunal study was undertaken as a desktop / literature survey combined with a field survey. The tasks included in each are given below.

Desktop/literature survey:

A desktop survey was undertaken to determine the red data reptile, amphibian, mammalian and bird species occurring in the quarter degree square 2722BB in which the proposed mining areas falls. The likelihood of red data species occurring on-site has been determined using the i) distribution maps in the red data reference books and ii) a comparison of the habitat described from the field survey.

Field survey:

The fieldwork component of this survey was conducted during August 2011. The habitats on-site were assessed to compare with habitat requirements of red data species determined during the literature survey. During the site visit the presence and identification of bird and mammal species was determined using the following methods / techniques:

- Identification by visual observation.
- Identification of bird and mammal calls.
- Identification of spoor.
- Identification of faeces.
- Presence of burrows and / or nests.

3. VEGETATION

The study area falls within the Kathu Bushveld and Southern Kalahari Mekgacha (Mucina & Rutherford 2006). The Kathu Bushveld which is described as an open savannah with *Acacia erioloba* and *Boscia albitrunca* as the prominent trees. The shrub layer is dominated by *A. mellifera, Diospyros lycioides* and *Lycium hirsutum* and the grass layer is described as being vary variable. The Southern Kalahari Mekgacha is typically found on the bottom of dry river beds. It is characterised by low shrublands in places with patches of taller shrublands on the banks of the river. Tall *Acacia erioloba* trees can form a dominant belt along some of the rivers.

3.1. PLANT COMMUNITY DESCRIPTION

The site consists of a mixture of vegetation that displays various slight structural changes and dominance in woody vegetation. Four vegetation communities can be defined within the area, however these communities show a very low beta diversity and are distinguished primarily on the composition of the dominant woody species within each community type.

Cynodon dactylon– Prosopis glandulosa shrubland

This vegetation type is found along the bottom of the dry river bed that runs through the area. It is an open grassy shrubland which in parts has been invaded by *Prosopis grandulosa*, other species found within this vegetation includes, *Acacia karoo, Searsia erosa, Giegeria ornativa*, *Ziziphus mucronata, Enneapogon cenchroides, Aristida stipitata, Cynodon dactylon, Cyperus margaritaceus* and *Eustachys paspaloides*.

Plate 3.1: The vegetation found within the dry river bed that runs through the study area

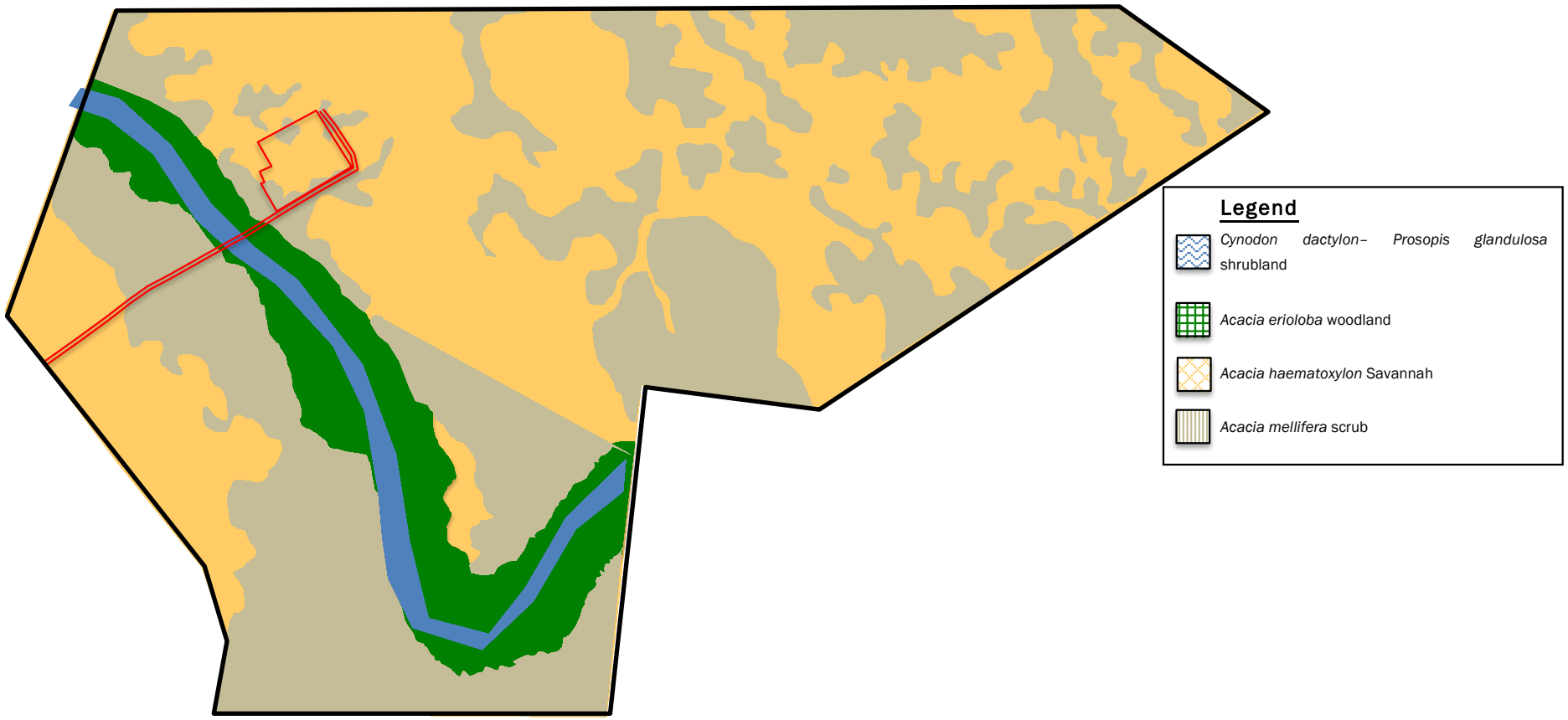


Figure 3.1: Vegetation distribution within the proposed mining area

Acacia erioloba Woodland

Acacia erioloba is the most prominent woody component within this vegetation type and it is covers the prominent dune which runs the length of the river within the study area. This vegetation is distinctive owing to the height of the tree layer which forms a distinct canopy coverage and three vegetation strata are evident within this vegetation unit. There is a prominent tree layer between 2.5m – 8m, a shrub layer, between 1.5m – 2.5m and a grass layer with an average height of 70cm. *Acacia erioloba, A hebeclada, Ziziphus muconata*, and *Grewia flava* are common within this vegetation unit. The grass layer contained species such as *Schmidtia kalihariensis, Centrapodia glauca, Eragrostis lehmanniana, Stipagrostis uniplumis,* and *Aristida congesta*. Other common species included *Tribulus zeyheri, Acanthosicyos naudinianus* and *Asparagus* spp.

Plate 3.2: The *Acacia erioloba* woodland within the study area

Acacia haematoxylon Savannah

This community has a moderate grass cover (50-60%), the shrub layer is moderately developed. *Acacia haematoxylon* is the dominant shrub species. The tree layer is poorly developed with individuals of *Acacia erioloba* occurring within the community. Common grass species include, *Schmidtia pappophoroides (*dominant*), Eragrostis lehmanniana*,, *Eragrostis micrantha*, *Stipagrostis uniplumis, Aristida adscensionis* and *Aristida vestita.* Other common species within this vegetation type included, *Indigofera alternans, Chrysopogon serrulatus, Cleome angustifolia,* and *Coelachyrum yemenicum*

Plate 3.3: *Acacia haematoxylon* savannah

Acacia mellifera Scrub

Acacia mellifera constitutes the dominant shrub species within this community. It is characterised by a high shrub density with a poor to moderate grass coverage (40 –60%) in some areas the *Acacia mellifera* forms impenetrable thickets. Other common shrub/tree species within this vegetation community include *Grewia flava, Acacia hebeclada, Acacia erioloba*, and *Ziziphus mucronata.* Common grass species include *Eragrostis lehmanniana, Aristida congesta, Pogonarthria squarrosa, Eragrostis chloromelas, Eragrostis echinochloidea, Aristida meridionalis, Schmidtia pappophoroides* and *Tragus racemosus*. Patches of this vegetation type have been over utilised and consequently karroid shrub vegetation also has invaded. Stands of *Rhigosum trichotomum* dispersed between the moderate grass cover can be observed within this vegetation community. Other species include, *Salsola patentipilosa, Polygala leptophylla, Chysocomma ciliata* and *Melolobium candicans*

Plate 3.4: *Acacia mellifera* scrub community within the study area

3.2. POPULATIONS OF SENSITIVE AND/OR THREATENED PLANT SPECIES

Other than *Acacia erioloba* (status declining[1]) no Red List plant species were recorded in the field during the current survey. Historical records of Red List plant species were consulted in order to determine the likelihood of any such species occurring in the study area. Lists of plant species previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute. The threatened species programme's database was consulted in order to obtain updated information on the conservation status of the plants in the area. There were no other species recorded on site or in the quarter degree grid that appear on the list.

The tree species occurring in the area that are protected in terms of the National Forests Act of 1998 (Act 84 of 1998) are *Acacia erioloba,* and *Acacia haematoxylon.* In order to remove protected trees an application must be submitted to DAFF and a permit obtained from DAFF prior to any removal. A number of protected plant species (occur on the property (these are marked with an * in the species list appendix 1) prior to the removal of these species a permit must be obtain from DENC .

Kathu bushveld is classified as least threatened (target 16%), however this vegetation type is not conserved in any statutory conservation areas and more than 1% has already been transformed. Threats are from mining and to a lesser extent heavy grazing pressure.

The Southern Kalahari Mekgacha is classified as least threatened. 18% of the target 24% is statutorily conserved in the Kgalagadi Transfrontier Park and the Molopo Nature Reserve. About 2% has been transformed by road building. Threats include heavy utilisation pressure from wild and domestic stock and invasion by *Prosopis* spp.

The study area falls within the Griqualand West Centre of Endemism (GWC) (Van Wyk & Smith, 2001). A centre of plant endemism is an area with high concentrations of plant species with very restricted distributions, known as endemics. Centres of endemism are important because it is these areas, which if conserved, would safeguard the greatest number of plant species. They are extremely vulnerable; relatively small disturbances in a centre of endemism may easily pose a serious threat to its many range-restricted species. The GWC is one of the 84 African centres of endemism and one of 14 centres in southern

[1] A taxon is Declining when it does not meet any of the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline in the population.

Africa, and these centres are of global conservation significance. The GWC is considered a priority in the Northern Cape, as the number of threats to the area is increasing rapidly and it has been little researched and is poorly understood. Furthermore, this centre of endemism is extremely poorly conserved, and is a national conservation priority.

Endemic species listed to occur within the study area include, *Selago mixta, Ruschia semidentata, Moraea longistyla,* and *Melolobium humile,*

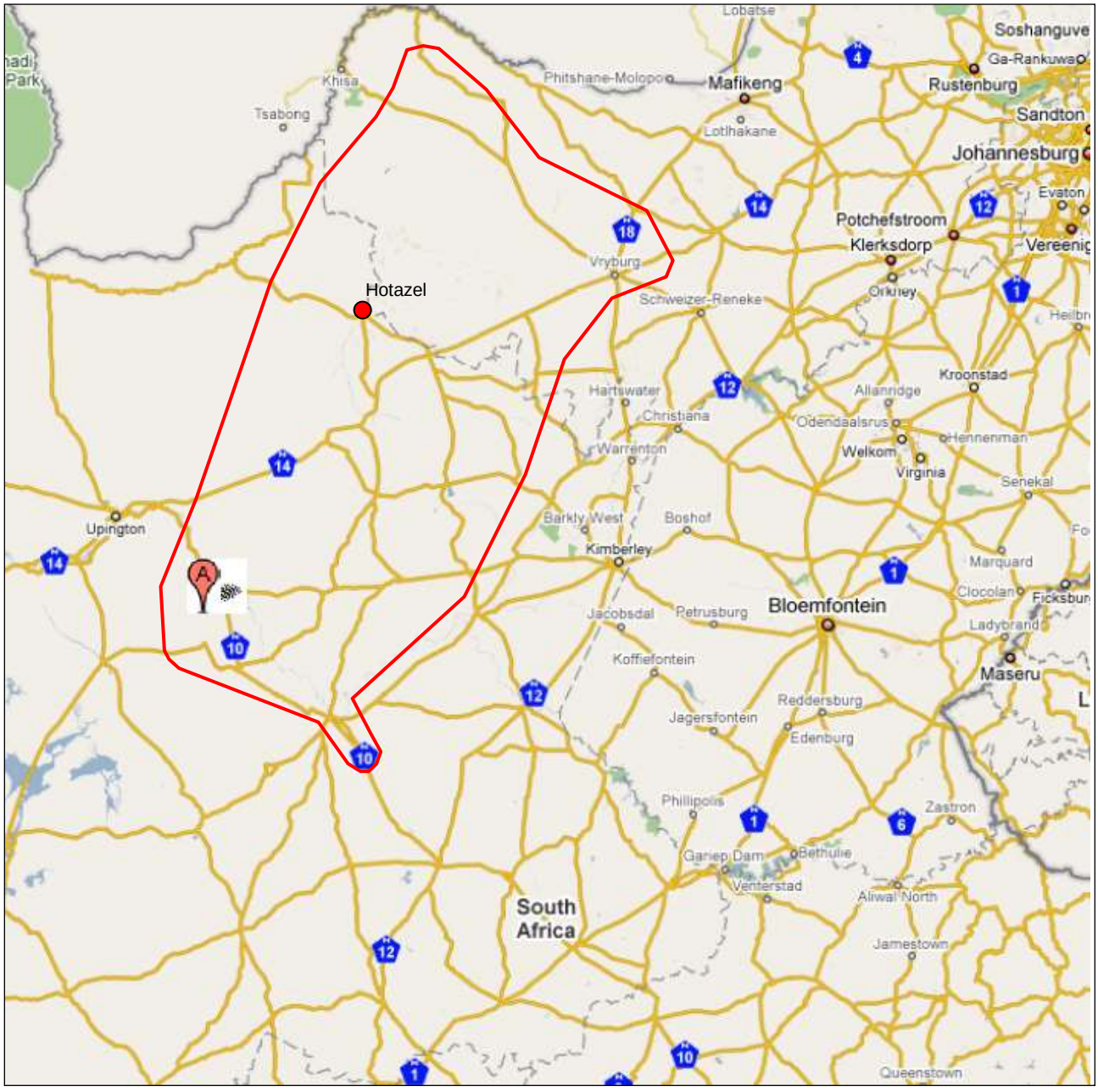


Figure 2.2: The approximate extent of the Griqualand West Center of Endemism (indicated in red).

3.3. ALIEN/INVASIVE SPECIES

Alien/invasive species are controlled in terms of Regulation 15 and Regulation 16 (R. 280 of 2001) of the Conservation of Agricultural Resources Act (No. 43 of 1993). Regulation 15 divides the plants into three categories as indicated below:

Category 1: Plants that must be removed and destroyed immediately.
These plants serve no economic purpose and possess characteristics that are harmful to humans, animals and the environment.

Category 2: Plants that may only be grown under controlled conditions.
These plants have certain useful qualities and are allowed in demarcated areas. In other areas they must be eradicated and controlled.

Category 3: Plants that may no longer be planted. Mostly ornamental plants. These are alien plants that have escaped from or are growing in gardens, but are proven to be invaders. No further planting is allowed. Existing plants may remain (except those within the flood line, 30 m from a watercourse or in a wetland) and must be prevented from spreading

Alien and alien invasive species recorded in and around the property are listed in the table below:

Species		Category
Prosopis cf. *glandulosa*	Mesquite	2
Prosopis velutina	Mesquite	2
Cymbopogon pospischilii	Mana grass	Not declared
Salsola kali	Prickly saltwort	Not declared

3.4. AREAS OF DISTURBANCE

Some areas within the property have already been disturbed by the prospecting activity, these areas are localised and restricted to roads that have been made in the veld and the immediate area around the drill sites.

Other types of disturbances are associated with farming practises, such as disturbances caused by grazing, and trampling effects.

4. TERRESTRIAL FAUNA

Very little evidence of wild faunal populations was evident on the property. General farming practices have an impact on wild faunal populations. Disturbances that alter the natural environment have two effects, namely, it may cause the loss of certain species due to the destruction of habitat. It may also cause the influx of species previously unable to colonise an area owing to lack of suitable habitat or because they have been excluded through competition.

A species checklist has been complied for the area and it is attached as appendix 1. It was not possible to compile a complete list of species present on the property during the field survey as it is important to note that many species that potentially occur on-site could not be identified due to the time of year when the survey was undertaken. However some observations were made during the site visit but emphasis was placed rather on the habitat in order to determine potential occurrence of species.

4.1. POPULATIONS OF SENSITIVE AND/OR THREATENED FAUNAL SPECIES

4.1.1. Reptiles Species of Conservation Concern

No red data terrapin, tortoises, snakes or lizards were identified as occurring in the quarter degree square 2722BB, based on the distribution maps available in the South African Red Data Book for reptiles (Branch, 1988) and The Southern African Reptile Conservation Assessment (SARCA). The conservation status was cross checked on the IUCN website to determine most recent status listing for these species.

4.1.2. Amphibians of Conservation Concern

No red data amphibians were identified as occurring in the quarter degree square 2722BB, based on the distribution maps available in the South African Red Data Book for amphibians (Minter *et al*., 2004) and the South African Frog Atlas project.

4.1.3. Birds of Conservation Concern

A list of all red data bird species occurring in the quarter degree square 2722BB was extrapolated from the Red Data Book of Birds (Barnes, 2000) with the distribution being confirmed in Roberts – Birds of Southern Africa, 7th edition (Hockey *et al.*, 2005). The

UUCN 3.1. status is also presented in the table. Based on an evaluation of the habitat requirements for these red data species, the potential of these species occurring either on-site or within 500m of the property boundary is provided in Table 4.1 below.

4.1.4. Mammals of Conservation Concern

A list of all red data mammal species occurring in the quarter degree square 2722BB was extrapolated from the Red Data Book for Mammals (EWT, 2004). Based on an evaluation of the habitat requirements for these red data species (EWT, 2004; Skinner and Chimimba, 2005), the potential of these species occurring either on-site or within 500m of the property boundary is provided in Table 4.2 below.

Table 4.1: Bird species of conservation concern identified as occurring in the quarter degree square 2722BB and the potential for occurrence on the proposed prospecting site.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS	SUITABLE HABITAT REQUIREMENTS[2]	POTENTIAL FOR OCCURRENCE ON-SITE
Martial Eagle	*Polemaetus bellicosus*	Vulnerable *Near Threatened**	Woodland, savannah or grassland with clumps of large trees or power pylons for nest sites	High – Nesting habitat in the *Acacia* Savannah
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable *Endangered**	Requires semi-arid dwarf shrublands, occasionally visiting the southern Kalahari.	Medium – Moderate to high shrub density throughout the site. .
Secretarybird	*Sagittarius serpentarius*	Near threatened *Vulnerable**	Requires open grassland with scattered trees, shrubland, open *Acacia* Savannah.	High – Patches of open savannah will accommodate this species.
African Whitebacked Vulture	*Gyps africanus*	Vulnerable *Endangered**	Savannah and bushveld. Nest in tall trees (*Acacia erioloba*).	High -No nest sites were recorded within the planned development area. However the presence of large *Acacia erioloba* trees (in the *Acacia erioloba woodland)* presents ideal nesting habitat for these birds.
Kori Bustard	*Ardeotis kori*	Vulnerable	Dry thornveld grassland, arid scrub	Medium – Moderate to high shrub

[2] Habitat requirements determined using the following reference material: Harrison *et al.*, 1997a; Harrison *et al.*, 1997b; Barnes, 2000; Hockey *et al.*, 2005

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS	SUITABLE HABITAT REQUIREMENTS[2]	POTENTIAL FOR OCCURRENCE ON-SITE
		*Least Concern**	requires the cover of some trees	density throughout the site
Black stork	*Ciconia bigra*	Near threatened *Least Concern**	Marshes, dams rivers and estuaries breeds in mountainous regions	**Low** – No suitable habitat on site, may occur during periods where standing water is present
Lesser Kestrel	*Falco naumanni*	Vulnerable *Least Concern**	Open semi arid grasslands, usually avoids wooded areas.	**Low:** - Area too densely wooded for ideal habitat.

**The IUCN 3.1. status*

Table 4.2: Mammal species of conservation concern identified as occurring in the quarter degree square 2722BB and the potential for occurrence on the proposed prospecting site.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS	SUITABLE HABITAT ON-SITE[3]	POTENTIAL FOR OCCURRENCE ON-SITE
Dent's Horseshoe Bat	*Rhinolophus denti*	Near threatened	**Limited** – Requires *substantial* cover such as caves and rock crevices.	**Very little** – Roosting habitat in the form of rock crevices may be available in the old mining area adjacent to the site. However, as the landscape in the area is flat sand veld and does not offer suitable roosting habitat for this species, it is unlikely that this species would have colonised

[3] Habitat requirements determined using the following reference material: Skinner and Smithers, 1990; EWT, 2004; Skinner and Chimimba, 2005

				the adjacent mining areas.
Honey badger	*Mellivora capensis*	Near threatened	**High** – As they are catholic in habitat requirements, they are likely to occur on-site.	**High**– Suitable habitat within the study area.
Schreiber's long-fingered bat	*Miniopterus schreibersii*	Near threatened	**Limited** – Suitable cover such as caves and mine adits determines distribution.	**Very little** – No caves or mine adits occur on-site. In addition, as the landscape in the area is generally flat sand veld and does not offer suitable roosting habitat for this species, it is unlikely that this species would have colonised the area.
South African Hedgehog	*Atelerix frontalis*	Near threatened	**High –** Require ample groundcover and dry places for nesting.	**High** to **Medium** – Suitable habitat available.

5. SITE SENSITIVITY

5.1. SITE SENSITIVITY

The classification of areas into different sensitivity classes is based on information collected at various levels. This includes the national conservation status of the vegetation, the presence of species of special concern and the condition of the vegetation

Vegetation types can be categorised according to their conservation status which is in turn, assessed according to the degree of the transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the national vegetation map (Mucina & Rutherford 2006) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 5.1 as determined by best available scientific approaches.

habitat remaining (%)

80-100	Least threatened	LT
60-80	vulnerable	VU
*BT -60	endangered	EN
0-*BT	Critically endangered	CR

Table 5.1: Determining ecosystem status (from Driver *et al* 2005).
**BT = biodiversity target (minimum conservation required)*

The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al* 2005).

The national status is based on 1996 National Landcover data (Fairbanks *et al* 2000) and is, therefore out of date. Additional transformation has taken place since 1996 and it is for this reason updated transformation information is often required to improve the conservation assessment. Although it is listed that 1% of Kathu Bushveld has been transformed (this figure is probably higher given the threats from mining) and this vegetation type is not statutorily conserved however it is classified as Least Threatened.

On a local scale the various habitat types or vegetation communities may have varying degrees of sensitivity or conservation value owing to their particular species composition of habitat structure.

Sensitivity of habitats and sites within the study area were assessed using a combination of criteria as follows:

	Criterion	Definition
1	Conservation status of untransformed habitats occurring in the study area	The extent of each vegetation type occurring within the study area that is conserved and/or transformed relative to a targeted amount required for conservation
2	Presence and number of Red Data species and other species of special concern	Presence or potential presence of Red Data species within habitats
3	Within-habitat species richness of flora and the between-habitat (beta) diversity of the site	Presence or potential presence of Red Data Species within habitats.
4	The type or nature of topography of the site, ie presence of ridges koppies etc	Steepness and/or nature of topography in the study area.
5	The type and nature of important ecological processes on site, especially hydrological processes, ie wetlands drainage lines etc.	Habitats and/or terrain features that represent ecological processes such as water-flow migration routes etc.

In order to advise the impact assessment and the proposed mitigation, a sensitivity map has been generated using the above criteria to guide the compilation of this map. The map includes areas of LOW, MODERATE, and HIGH sensitivity that are defined as follows

- Low sensitivity areas do not contain significant habitat for species of special concern. The vegetation communities are well represented within the surrounding area. Development in these areas will not have a significant environmental impact.
- Moderate sensitivity areas: The vegetation and habitats in these areas include some species of conservation concern or habitat for species of conservation concern. The communities are represented in surrounding areas but are not widely represented. Development in these areas will have a significant environmental impact.

- High sensitivity areas include habitat for species of conservation concern and threatened vegetation communities. Contains habitats and/or terrain features that represent important ecological processes and habitats (ADEs) No development should be allowed.

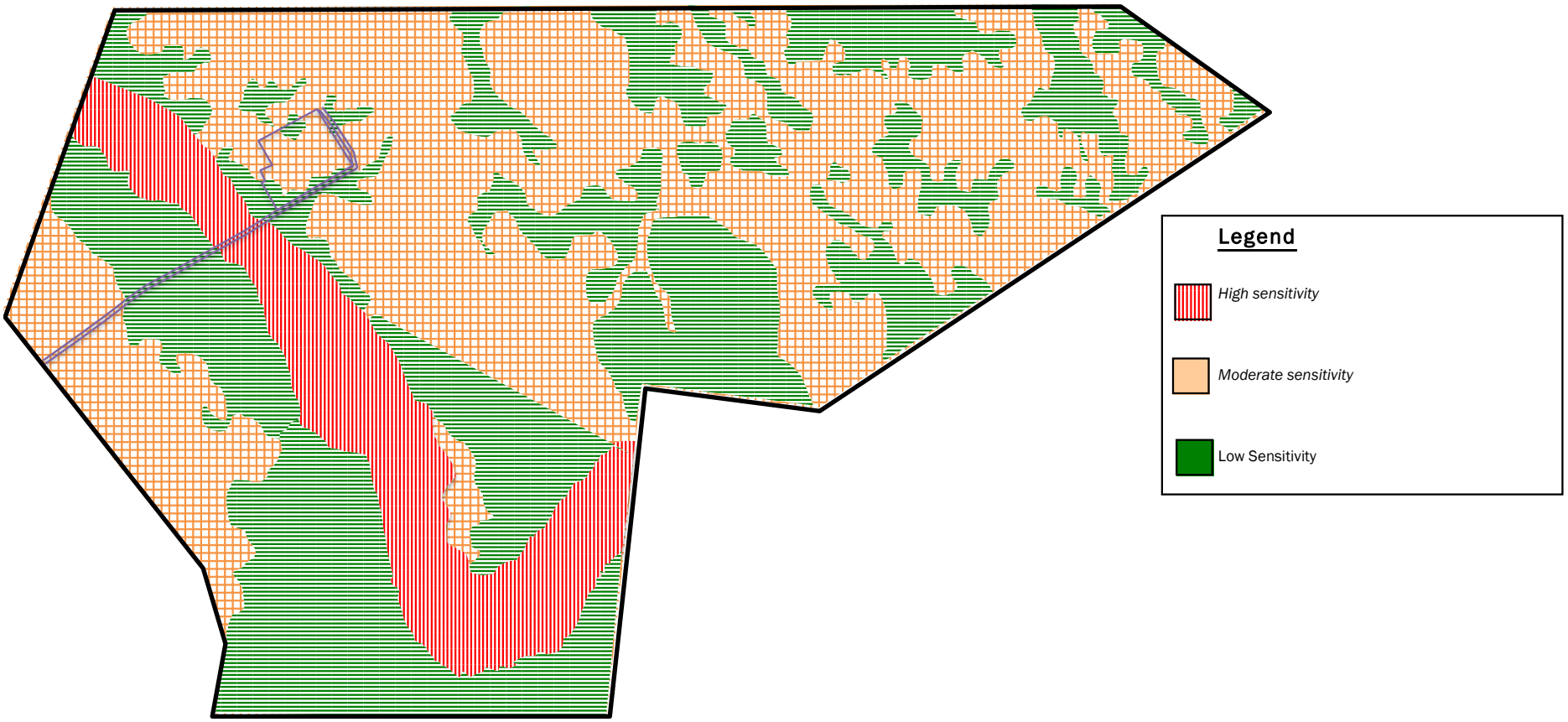


Figure 6.1: Site sensitivity map

6. POTENTIAL IMPACTS

6.1. VEGETATION AND FLORISTICS

6.1.1. Loss of natural vegetation

The vegetation in the path of mining and within the infrastructure areas will be completely and permanently removed. This causes vegetation fragmentation and habitat disturbance in the landscape. This disturbance destroys primary vegetation and allows secondary pioneer species or invasive plants to enter and re-colonise disturbed areas. As primary vegetation is more functional in an ecosystem, this could irreversibly transform the vegetation characteristics in the area. The vegetation within the study area consists of primary vegetation in a moderate condition.

6.1.2. Loss of Red data and/or protected floral species

The removal of *Acacia erioloba* and *Acacia haematoxylon* trees not only results in a loss of the species richness in the area but has impacts on the ecosystem function of the area.

Acacia erioloba largely grow in clusters. The establishment of these assemblages within the microhabitat is slow, and may take decades, so established trees, are needed to facilitate their existence. These trees are also important as nesting and as perching sites. Tree rats (*Thallomys paedulcus*), sociable weavers (*Philetarius socius*) and many species of raptors and vultures have been found to nest preferentially in large trees. Other data collected in the southeastern Kalahari suggests that most other cup-nesting bird species also preferentially select larger trees as nest sites. Holes within large, dead or dying trees are crucial for hole nesting species (e.g. African Hoopoe *Upupa epops*, Scimitarbilled woodhoopoe *Rhinopomastus cyanomelas*), and the densities of these species appear to be governed by the densities of camelthorns

Acacia haematoxylon has a narrow distribution range and the *A. haematoxylon* woodlands in the area around Kuruman are not well conserved and are under threat from activities such as mining. Thus the loss of these trees will have a significant impact.

Aquifer dependent ecosystems (ADEs) are ecosystems which depend on groundwater in, or discharging from, an aquifer. They are distinctive because of their connection to the aquifer and would be fundamentally altered in terms of their structure and functions if groundwater was no longer available. ADEs found on Kalahari sands are characterised by the abundance of *Acacia erioloba*, a species which is sensitive to changes in depth to

the water table as well as *Acacia haematoxylon, Acacia karroo, Rhus lancea, Tamarix usneoides,* and *Euclea pseudebenus.* There is a growing body of research which has found that these trees - singly, in stands and as gallery forests - are keystone ecosystems. These deep-rooted species are thought to act as nutrient pumps but it is equally likely that they are providing water to shallower-rooted plants via hydraulic lift. ADEs particularly in arid ecosystems provide habitats for an array of species and are considered important in ecological processors by making available resources for the biodiversity in an area that would otherwise not be available.

A high rainfall year is needed to stimulate seed germination and promote seedling recruitment in groundwater dependent phreatophytes such as *Acacia erioloba*. The rainfall wets the profile down to the water table to the extent that rapid root growth by the seedlings enables them to reach the capillary fringe above the water table before the soil layers above it dry out. The young plants are then no longer vulnerable to variations in rainfall. A seedling only 25 cm high can have roots longer than 320 cm suggesting that a large portion of their growth energy is directed to root development, in order to enable the plants to become drought resistant as soon as possible (saplings are more vulnerable to drought owing to rooting systems being unable to reach far moister soils than larger trees, although, their rooting systems are deep enough to perhaps enable them to escape moderately dry periods).

Very little research in the Kalahari has focused on water consumption by the various types of vegetation and on the partitioning of transpired water between water that is extracted from different depths of the unsaturated zone and that which originates from the saturated zone. Thus it is very difficult to predict the extent to which altering the water levels in the aquifers may impact on these ecosystems.

In terms of dewatering, larger trees will be most at risk because they are less flexible in root growth. Small trees are more flexible because they can grow down to the depths necessary. However, for big trees, a sudden drop in the water table can effectively put them into a situation where they can't reach the water. The effects of dewatering have been studied in Namibia (with a plant ecophysiologist, Prof William Stock from the University of Cape Town). His findings suggests that although trees may sometimes have very deep roots, it does not mean that "adult" trees can lower their roots any more in response to a drop in the water level. Although camel thorns have very deep recorded root depths, extending their roots so deep is not necessarily what they "prefer" to do and that they only extent their roots down as far as necessary.

This would suggest that the dewatering as a result of mining would have the greatest negative impact on large trees within the study area and that these negative impacts would be exacerbated during periods of drought which could result in large scale mortalities of large trees in particular and the destruction of the aquifer dependent ecosystem.

This proposed site falls within the Griqualand West Centre of Endemism. A significant amount of mining is taking place and this is a cause for concern because this centre of endemism is under researched and not well understood thus vital aspects may be lost or disturbed because of a lack of fundamental knowledge which could assist in protecting this centre of endemism. The cumulative affects of mining in this area exacerbate the potential risk of losing information and/or ecosystem function owing to a lack of basic research information within this area.

6.1.3. Introduction or spread of alien species

The disturbance associated with mining and associated infrastructure may lead to the introduction of alien plants species or the further spread of existing alien species within the area. Invasive species are now regarded as the second-leading threat to imperilled species, behind only habitat destruction. Invasive species affect our natural biodiversity in a number of ways. They may compete directly with natural species for food or space, may compete indirectly by changing the food web or physical environment, or hybridize with indigenous species. Rare species with limited ranges and restricted habitat requirements are often particularly vulnerable to the influence of these alien invaders. Invasive plants have claimed about 8 percent or 10 million hectares of land suitable for agricultural use in South Africa. These invasive alien plants steal about seven percent of South Africa's water bulk every year.

6.2. FAUNA

6.2.1. Fragmentation of habitat

Termite mounds, burrows, nests and vegetation on which small mammals, insects, amphibians and reptiles are heavily reliant will be destroyed during clearing activities associated with mining, causing the permanent displacement of these animals.

During the construction & operational phases of mining vegetation will be cleared this has the effect of creating unnatural open space through the vegetation and the matrix of the landscape. Due to this cleared open space, some species that habitually seek out protective cover for movement across the landscape may be prevented from moving

across this open space due to the fear of predation. For smaller species, it limits movement and restricts access to foraging sites. This results in reduced population density of prey species (invertebrates and/or smaller birds and/or smaller mammals and/or herpetofauna) which then reduces the food availability for predators (invertebrates and/or smaller birds and/or smaller mammals and/or herpetofauna). The area surrounding the proposed mine site has already been disturbed and altered and the removal of more natural vegetation results in a cumulative impact which significantly increases the significance of habitat fragmentation.

6.2.2. Intentional/accidental killing of fauna

Smaller fauna will inevitably be killed during land clearing activities, as these activities will destroy their habitat. In addition to unintentional killing of fauna, some faunal species, particularly herpetofaunal species, are often intentionally killed as they are thought to be dangerous. Large exposed excavations could result in some faunal species falling in and being killed or being unable to escape from the excavation ultimately leading to death.

6.2.3. Anthropogenic disturbances

Anthropogenic disturbances include aspects such as the on-site waste generation, vibrations caused by earth moving equipment, campfires and illumination of the site and camps. These aspects will impact on invertebrate species more than any other faunal species. These anthropogenic disturbances impact on the way invertebrates forage. For example; some invertebrates use vibrations caused by their prey to locate and catch them. Vibrations caused by earth moving equipment will make this impossible.

6.2.4. Loss of faunal species of conservation concern

A number of faunal species of conservation concern have the potential to occur in the area and the loss of habitat could result in a reduction in number or loss of the species from the area. Although important habitat for these animals would still remain within the surrounding area the increase in the loss of natural vegetation and habitat fragmentation from surrounding mining results in a cumulative impact which significantly increases the magnitude of this potential impact.

7. RECOMMENDATIONS AND CONCLUSION

Mining of this area will result in the clearing of vegetation and the destruction of the natural habitat within the mining area. The significance of the impacts will also be affected by the success of the mitigation measures implemented and the rehabilitation programme for the mining area.

The planned mine will have a relatively small direct impact to the surface biodiversity as the surface area of disturbance will be relatively small. However the cumulative impact of increased mining in the area may have a much wider impact to the surface biodiversity indirectly owing to impacts that may occur to the underground water system. Changes to the aquifers on which the surface ecosystem are dependent could potentially impact on individual species as well as entire ADEs, the affects of which could potentially transcend the boundaries of the mining area. The severity of this impact would depend on the extent of disturbance to the aquifers, the dependence of the ecosystem on the aquifer and other environmental factors such as rainfall. It is therefore important to undertake comprehensive groundwater impact modelling as part of the groundwater specialist study to confirm the extent of the aquifers in the area and how they are connected as well as to determine the extent to which the surface ecosystems are dependent on the aquifers.

The continued clearing of *Acacia erioloba* and *Acacia haematoxylon* woodlands in the region is a cause for concern as the exact extent of this resource is unknown. Thus it is unclear as to how much development this vegetation type can sustain without being irreversibly damaged resulting in a loss of biodiversity within the Northern Cape. The cumulative affects of development in this area exacerbate the potential risk of losing information and/or ecosystem function owing to a lack of basic research information within this area

Recommendations to mitigate the impacts to the ecology include but are not limited to

- All cleared areas should be re-seeded once the topsoil has been replaced with a seed mixture reflecting the natural vegetation as is currently found (harvesting of seed from similar areas within the study area should be undertaken). This may be used in conjunction with a commercially available mix as this will ensure a good vegetation coverage and soil stability. Species such as *Stipagrostis* are good sand binders and aid in stabilising the substrate and are present within the study area.
- Pods of *Acacia erioloba*, and *Acacia haematoxylon* should be collected from the area in order to aid in the re-establishment of these species. These seeds do

however require artificial scarring/acid washing in order to aid in germination. The establishment of these trees will form a pivotal part in the rehabilitation of this area post mining as *A. erioloba* increases habitat heterogeneity. A. erioloba increases species richness by providing habitats and services for a variety of plants, reptiles, birds and mammals. Evidence also suggests that A. erioloba obtains nitrogen from deep ground water and then cycles nutrients from great depths, making them available above ground. High nutrient levels and shade of the subcanopy microhabitat increase survivorship of shade tolerant fleshy fruited plants. This microhabitat enables a suite of species, not adapted to conditions, to exist in this environment, thus enriching overall biodiversity. These plants provide a valuable food resource for a number of bird and mammal species.

- Adequate buffer zones will have to be implemented in order to protect the areas of high sensitivity that abut the mining areas. Containing the disturbance to the smallest footprint possible will aid in protecting the surrounding areas. Clearing of the natural vegetation should be kept to a minimum, where possible corridors of natural vegetation should be retained within the development area.
- Prior to the clearing of the protected floral species the relevant permits must be obtained from the relevant authorities (see section 3.2)
- A comprehensive monitoring programme of the protected trees within the area must be undertaken
- A comprehensive alien invasive eradication programme should be drawn up and implemented.

However it is likely that even with comprehensive mitigation measures in place there still exits the potential that the impacts to the biodiversity will be significant. It is therefore recommended that a biodiversity offset be undertaken by the project proponent in order to offset the residual impacts to the biodiversity.

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APPENDIX 1

PLANT SPECIES LIST

Species	Status	SA endemic
*Acacia erioloba**	Declining	No
*Acacia haematoxylon**	LC	No
Acacia hebeclada	LC	No
Acacia karroo	LC	No
Acanthosicyos naudinianus (Sond.) C.Jeffrey	LC	No
Asparagus spp		
Anthephora argentea Gooss.	LC	No
Aristida adscensionis L.	LC	No
Aristida congesta Roem. & Schult.	LC	No
Aristida congesta Roem. & Schult. subsp. congesta	LC	No
Aristida meridionalis	LC	No
Aristida stipitata Hack. subsp. Spicata	LC	No
Aristida vestita Thunb.	LC	No
Berkheya ferox O.Hoffm. var. tomentosa Roessler	LC	No
Brachiaria marlothii (Hack.) Stent	LC	No
Centrapodia glauca	LC	No
Chrysocomma ciliata	LC	No
Chrysopogon serrulatus Trin.	LC	No
Cleome angustifolia Forssk. subsp.	LC	No
Coelachyrum yemenicum (Schweinf.) S.M.Phillips	LC	No
Corbichonia rubriviolacea (Friedrich) C.Jeffrey	LC	No
Crotalaria virgultalis Burch. ex DC.	LC	No
Cullen tomentosum (Thunb.) J.W.Grimes	LC	No
Cymbopogon pospischilii (K.Schum.) C.E.Hubb.	NE	No
Cynodon dactylon (L.) Pers.	LC	No
Cyperus margaritaceus Vahl var. margaritaceus	LC	No
Dimorphotheca zeyheri Sond.	LC	No
Enneapogon cenchroides	LC	No
Enneapogon desvauxii P.Beauv.	LC	No
Eragrotis chloromelas	LC	No
Eragrostis echinochloidea Stapf	LC	No
Eragrostis lehmanniana Nees var. lehmanniana	LC	No
Eragrostis micrantha	LC	No
Eragrostis pallens Hack.	LC	No
Eragrostis trichophora Coss. & Durieu	LC	No
Eustachys paspaloides (Vahl) Lanza & Mattei	LC	No
Fingerhuthia africana Lehm.	LC	No
Geigeria ornativa O.Hoffm. subsp. ornativa	LC	No
Gisekia pharnacioides L. var. pharnacioides	LC	No
Grewia flava DC.	LC	No
*Harpagophytum procumbens (Burch.) DC. ex Meisn.**		No
Hermbstaedtia fleckii (Schinz) Baker & C.B.Clarke	LC	No
Indigastrum argyraeum (Eckl. & Zeyh.) Schrire	LC	No
Indigofera alternans DC. var. alternans	LC	No
Indigofera hololeuca Benth. ex Harv.	LC	No
Limeum myosotis H.Walter var. myosotis	LC	No
Megaloprotachne albescens C.E.Hubb.	LC	No
Melolobium candicans (E.Mey.) Eckl. & Zeyh.	LC	No
Melolobium humile Eckl. & Zeyh.	LC	Yes

Merremia verecunda Rendle	LC	No
Monechma genistifolium (Engl.)	LC	No
*Moraea longistyla (Goldblatt) Goldblatt**	LC	Yes
*Moraea pallida (Baker) Goldblatt**	LC	No
Oxygonum delagoense Kuntze	LC	No
Panicum coloratum L.		No
Pentzia calcarea Kies	LC	No
Pogonarthria squarrosa (Roem. & Schult.) Pilg.	LC	No
Polygala leptophylla Burch. var. leptophylla	LC	No
Polygala seminuda Harv.	LC	No
Prosopis glandulosa Torr. var. glandulosa	NE	No
Prosopis velutina Wooton	NE	No
Pupalia lappacea var. velutina	LC	No
Rhigosum trichotomum	LC	No
Riccia albolimbata S.W.Arnell		No
*Ruschia semidentata**	LC	Yes
Salsola kali L.	NE	No
Salsola patentipilosa Botsch.	LC	Yes
Schmidtia kalahariensis Stent	LC	No
Schmidtia pappaphoroides	Lc	No
Searsia dregeana (Sond.) Moffett	LC	No
Searsia erosa (Thunb.) Moffett	LC	No
Selago mixta Hilliard	LC	Yes
Sericorema remotiflora (Hook.f.) Lopr.	LC	No
Setaria verticillata (L.) P.Beauv.	LC	No
Sporobolus fimbriatus (Trin.) Nees	LC	No
Stachys spathulata Burch. ex Benth.	LC	No
Stipagrostis ciliata (Desf.) De Winter var. capensis	LC	No
Stipagrostis uniplumis	LC	No
Striga gesnerioides (Willd.) Vatke	LC	No
Tephrosia burchellii Burtt Davy	LC	No
Thesium hystrix A.W.Hill	LC	No
Tragus racemosus (L.) All.	LC	No
Tribulus zeyheri	LC	No
Tricholaena monachne (Trin.) Stapf & C.E.Hubb.	LC	No
Ziziphus mucronata		

FAUNAL SPECIES CHECK LIST

REPTILES		
Family Name	**Species Name**	**Common Name**
Agamidae	*Agama aculeata subsp. aculeata*	Ground agama
Lacertidae	*Heliobolus lugubris*	Bushveld Lizard
Lacertidae	*Pedioplanis lineoocellata*	Spotted Sand lizard
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Gecko
Lacertidae	*Heliobolus lugubris*	Bushveld Lizard
Lacertidae	*Pedioplanis lineoocellata*	Spotted Sand Lizard
Lacertidae	*Pedioplanis namaquensis*	Namaqua Sand Lizard
AMPHIBIANS		
Family Name	**Species Name**	**Common Name**
Bufonidae	*Amietophrynus poweri*	Power’s Toad
Hyperoliidae	*Kassina senegalensis*	Senegal kassina
Pyxicephalidae	*Cacosternum boettgeri*	Common Dainty Frog
Pyxicephalidae	*Tomopterna cryptotis*	Common Sand Frog
BIRDS		
Family Name	**Species Name**	**Common Name**

Alaudidae	*Calendulauda africanoides*	Fawn-coloured Lark
Alaudidae	*Calendulauda sabota*	Sabota Lark
Alaudidae	*Chersomanes albofasciata*	Spike-heeled Lark
Alaudidae	*Eremopterix verticalis*	Grey-backed Sparrowlark
Alaudidae	*Mirafra apiata*	Cape Clapper Lark
Anatidae	*Anas erythrorhyncha*	Red-billed Teal
Anatidae	*Anas undulata*	Yellow-billed Duck
Anatidae	*Dendrocygna viduata*	White-faced Duck
Apodidae	*Apus affinis*	Little Swift
Bucerotidae	*Tockus leucomelas*	Southern Yellow-billed Hornbill
Bucerotidae	*Tockus nasutus*	African Grey Hornbill
Burhinidae	*Burhinus capensis*	Spotted Thick-knee
Capitonidae	*Tricholaema leucomelas*	Acacia Pied Barbet
Charadriidae	*Charadrius tricollaris*	Three-banded Plover
Charadriidae	*Vanellus armatus*	Blacksmith Lapwing
Charadriidae	*Vanellus coronatus*	Crowned Lapwing
Ciconiidae	*Ciconia nigra*	Black Stork
Coliidae	*Colius colius*	White-backed Mousebird
Coliidae	*Urocolius indicus*	Red-faced Mousebird
Coraciidae	*Coracias caudatus*	Lilac-breasted Roller
Coraciidae	*Coracias naevius*	Purple Roller
Cuculidae	*Chrysococcyx caprius*	Diderick Cuckoo
Dicruridae	*Dicrurus adsimilis*	Fork-tailed Drongo
Estrildidae	*Amadina erythrocephala*	Red-headed Finch
Estrildidae	*Estrilda astrild*	Common Waxbill
Estrildidae	*Estrilda erythronotos*	Black-faced Waxbill
Estrildidae	*Granatina granatina*	Violet-eared Waxbill
Estrildidae	*Pytilia melba*	Green-winged Pytilia
Falconidae	*Falco naumanni*	Lesser Kestrel
Falconidae	*Falco rupicoloides*	Greater Kestrel
Fringillidae	*Crithagra atrogularis*	Black-throated Canary
Fringillidae	*Crithagra flaviventris*	Yellow Canary
Fringillidae	*Emberiza flaviventris*	Golden-breasted Bunting
Fringillidae	*Emberiza impetuani*	Lark-like Bunting
Glareolidae	*Cursorius rufus*	Burchell's Courser
Halcyonidae	*Alcedo cristata*	Malachite Kingfisher
Hirundinidae	*Hirundo albigularis*	White-throated Swallow
Hirundinidae	*Hirundo cucullata*	Greater Striped Swallow
Hirundinidae	*Hirundo fuligula*	Rock Martin
Hirundinidae	*Hirundo rustica*	Barn Swallow
Hirundinidae	*Hirundo semirufa*	Red-breasted Swallow
Hirundinidae	*Hirundo spilodera*	South African Cliff-Swallow
Hirundinidae	*Riparia paludicola*	Brown-throated Martin
Laniidae	*Lanius collaris*	Common Fiscal
Laniidae	*Lanius collurio*	Red-backed Shrike
Laniidae	*Lanius minor*	Lesser Grey Shrike
Malaconotidae	*Laniarius atrococcineus*	Crimson-breasted Shrike
Malaconotidae	*Tchagra australis*	Brown-crowned Tchagra
Malaconotidae	*Telophorus zeylonus*	Bokmakierie
Meropidae	*Merops apiaster*	European Bee-eater
Meropidae	*Merops hirundineus*	Swallow-tailed Bee-eater
Motacillidae	*Anthus cinnamomeus*	African Pipit
Motacillidae	*Motacilla capensis*	Cape Wagtail
Muscicapidae	*Batis pririt*	Pririt Batis
Muscicapidae	*Bradornis infuscatus*	Chat Flycatcher
Muscicapidae	*Bradornis mariquensis*	Marico Flycatcher
Muscicapidae	*Sigelus silens*	Fiscal Flycatcher
Nectariniidae	*Cinnyris mariquensis*	Marico Sunbird

Numididae	*Numida meleagris*	Helmeted Guineafowl
Otididae	*Eupodotis afra*	Southern Black Korhaan
Otididae	*Lophotis ruficrista*	Red-crested Korhaan
Paridae	*Parus cinerascens*	Ashy Tit
Phalacrocoracidae	*Phalacrocorax africanus*	Reed Cormorant
Phasianidae	*Pternistis adspersus*	Red-billed Spurfowl
Phoeniculidae	*Rhinopomastus cyanomelas*	Common Scimitarbill
Plataleidae	*Platalea alba*	African Spoonbill
Plataleidae	*Plegadis falcinellus*	Glossy Ibis
Plataleidae	*Threskiornis aethiopicus*	African Sacred Ibis
Podicipedidae	*Tachybaptus ruficollis*	Little Grebe
Pteroclididae	*Pterocles bicinctus*	Double-banded Sandgrouse
Pteroclididae	*Pterocles burchelli*	Burchell's Sandgrouse
Pteroclididae	*Pterocles namaqua*	Namaqua Sandgrouse
Pycnonotidae	*Pycnonotus nigricans*	African Red-eyed Bulbul
Rallidae	*Fulica cristata*	Red-knobbed Coot
Rallidae	*Gallinula chloropus*	Common Moorhen
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper
Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper
Scolopacidae	*Gallinago nigripennis*	African Snipe
Scopidae	*Scopus umbretta*	Hamerkop
Strigidae	*Bubo lacteus*	Verreaux's Eagle-Owl
Strigidae	*Glaucidium perlatum*	Pearl-spotted Owlet
Struthionidae	*Struthio camelus*	Common Ostrich
Sturnidae	*Creatophora cinerea*	Wattled Starling
Sturnidae	*Lamprotornis nitens*	Cape Glossy Starling
Sturnidae	*Onychognathus nabouroup*	Pale-winged Starling
Timaliidae	*Turdoides bicolor*	Southern Pied Babbler
Viduidae	*Vidua regia*	Shaft-tailed Whydah
Sylviidae	*Acrocephalus baeticatus*	African Reed-Warbler
Ardeidae	*Ardea cinerea*	Grey Heron
Ardeidae	*Ardea melanocephala*	Black-headed Heron
Turdidae	*Cercomela familiaris*	Familiar Chat
Turdidae	*Cercotrichas paena*	Kalahari Scrub-Robin
Sylviidae	*Cisticola aridulus*	Desert Cisticola
Sylviidae	*Cisticola tinniens*	Levaillant's Cisticola
Columbidae	*Columba guinea*	Speckled Pigeon
Ardeidae	*Egretta garzetta*	Little Egret
Accipitridae	*Elanus caeruleus*	Black-shouldered Kite
Sylviidae	*Eremomela icteropygialis*	Yellow-bellied Eremomela
Falconidae	*Falco rupicolus*	Rock Kestrel
Accipitridae	*Melierax canorus*	Southern Pale Chanting Goshawk
Accipitridae	*Melierax gabar*	Gabar Goshawk
Turdidae	*Myrmecocichla formicivora*	Ant-eating Chat
Ardeidae	*Nycticorax nycticorax*	Black-crowned Night-Heron
Columbidae	*Oena capensis*	Namaqua Dove
Turdidae	*Oenanthe pileata*	Capped Wheatear
Sylviidae	*Parisoma subcaeruleum*	Chestnut-vented Tit-Babbler
Ploceidae	*Passer diffusus*	Southern Grey-headed Sparrow
Ploceidae	*Passer domesticus*	House Sparrow
Ploceidae	*Passer melanurus*	Cape Sparrow
Ploceidae	*Philetairus socius*	Sociable Weaver
Ploceidae	*Plocepasser mahali*	White-browed Sparrow-Weaver
Ploceidae	*Ploceus velatus*	Southern Masked-Weaver
Accipitridae	*Polemaetus bellicosus*	Martial Eagle
Sylviidae	*Prinia flavicans*	Black-chested Prinia
Ploceidae	*Quelea quelea*	Red-billed Quelea

Ploceidae	*Sporopipes squamifrons*	Scaly-feathered Finch
Columbidae	*Streptopelia capicola*	Cape Turtle-Dove
Columbidae	*Streptopelia senegalensis*	Laughing Dove
Sylviidae	*Sylvia borin*	Garden Warbler
Sylviidae	*Sylvietta rufescens*	Long-billed Crombec
INVERTEBRATES		
Family Name	**Species Name**	**Common Name**
Hesperiidae	*Leucochitonea levubu*	White-cloaked Skipper butterfly
Hesperiidae	*Pelopidas mathias*	Lesser Millets Skipper butterfly
Lycaenidae	*Azanus jesous jesous*	Topaz spotted blue butterfly
Lycaenidae	*Cigaritis phanes*	Silver bar butterfly
Pieridae	*Catopsilia florella*	African Migrant butterfly
Pieridae	*Colotis agoye bowkeri*	Speckled Sulphur tip butterfly
Pieridae	*Colotis subfasciatus subfasciatus*	Lemon tip butterfly
Lycaenidae	*Aloeides gowani*	Gowan's copper butterfly
Pieridae	*Eurema brigitta subsp. brigitta*	Small grass yellow butterfly
MAMMALS		
Family Name	**Species Name**	**Common Name**
Suidae	*Phacochoerus africanus*	Warthog
Bovidae	*Raphicerus campestris*	Steenbok
Hespestidae	*Cynictis penicillata*	Yellow Mongoose
Orycteropdidae	*Orycteropus afer*	Aardvark
Muridae	*Thallomys nigricauda*	Black tailed tree rat