

**MAMMAL ASSESSMENT FOR A PROPOSED DUPLICATION OF THE  
VLAKFONTEIN – MAMELODI WATER SUPPLY PIPELINE THROUGH  
RIETVLEI NATURE RESERVE AND PARTS OF THE BRONBERG,  
GAUTENG PROVINCE**



## MAMMAL ASSESSMENT

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## **INDEPENDENCE**

The School of Animal, Plant and Environmental Sciences do hereby declare that they are independent (legally and financially) from the applicant.

A handwritten signature in black ink, appearing to read 'Ute Schwaibold', is written over a light pink rectangular background.

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Dr Ute Schwaibold

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## **1. The Project**

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Africon Engineering International approached Wits Enterprise to assist with a biodiversity assessment for a proposed Rand Water project involving the duplication of an existing water supply route within the existing Rand Water servitude. The existing alignment crosses two very sensitive areas and specialist studies in these areas need to be conducted.

### **Section 1: The Rietvlei Nature Reserve**

Route 1 is the proposed route and runs parallel to the existing alignment within the Rand Water servitude right through the Reserve. The length of this section is approximately 7.8 km long.

Route 2 (Alternative\_Option 2) is 8.84 km long. The alternative will enter the Reserve from the south, turn east parallel with Eskom distribution lines and then run to the north within the firebreak of the Reserve. It is said that the section that runs parallel with the distribution lines will impact on natural vegetation. The geology of this section also differs from the rest of the Reserve.

### **Section 2: The Bronberg Conservation Area**

The proposed alignment enters the conservation area to connect at the Bronberg Reservoir. Unfortunately alternatives cannot be considered in terms of the alignment, but alternative construction methods can be considered. GDACE has provided information regarding Red Data species in this quarter degree grid, and specialist studies should be done along the alignment by the relevant specialists.

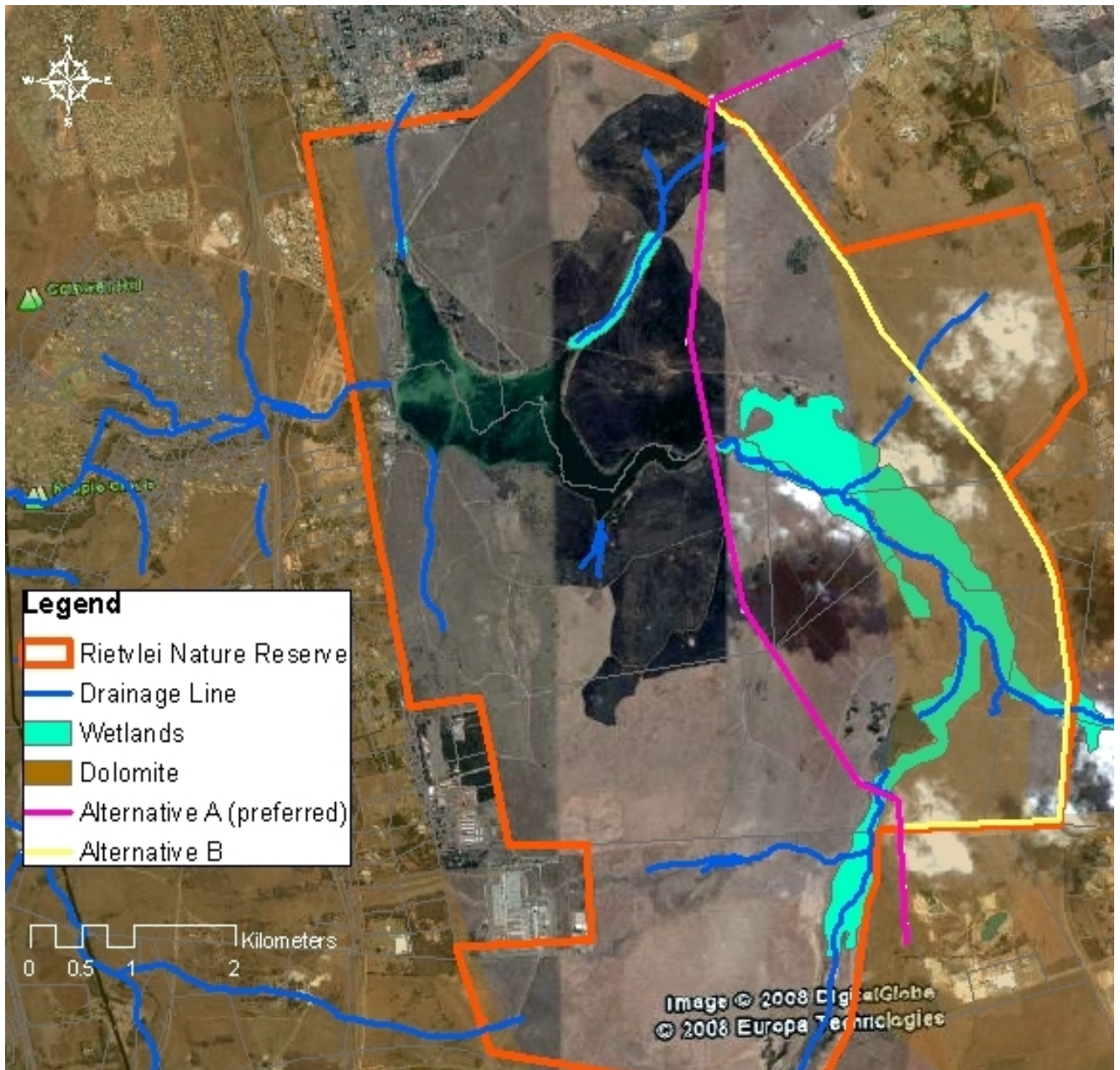
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## **2. Site Description**

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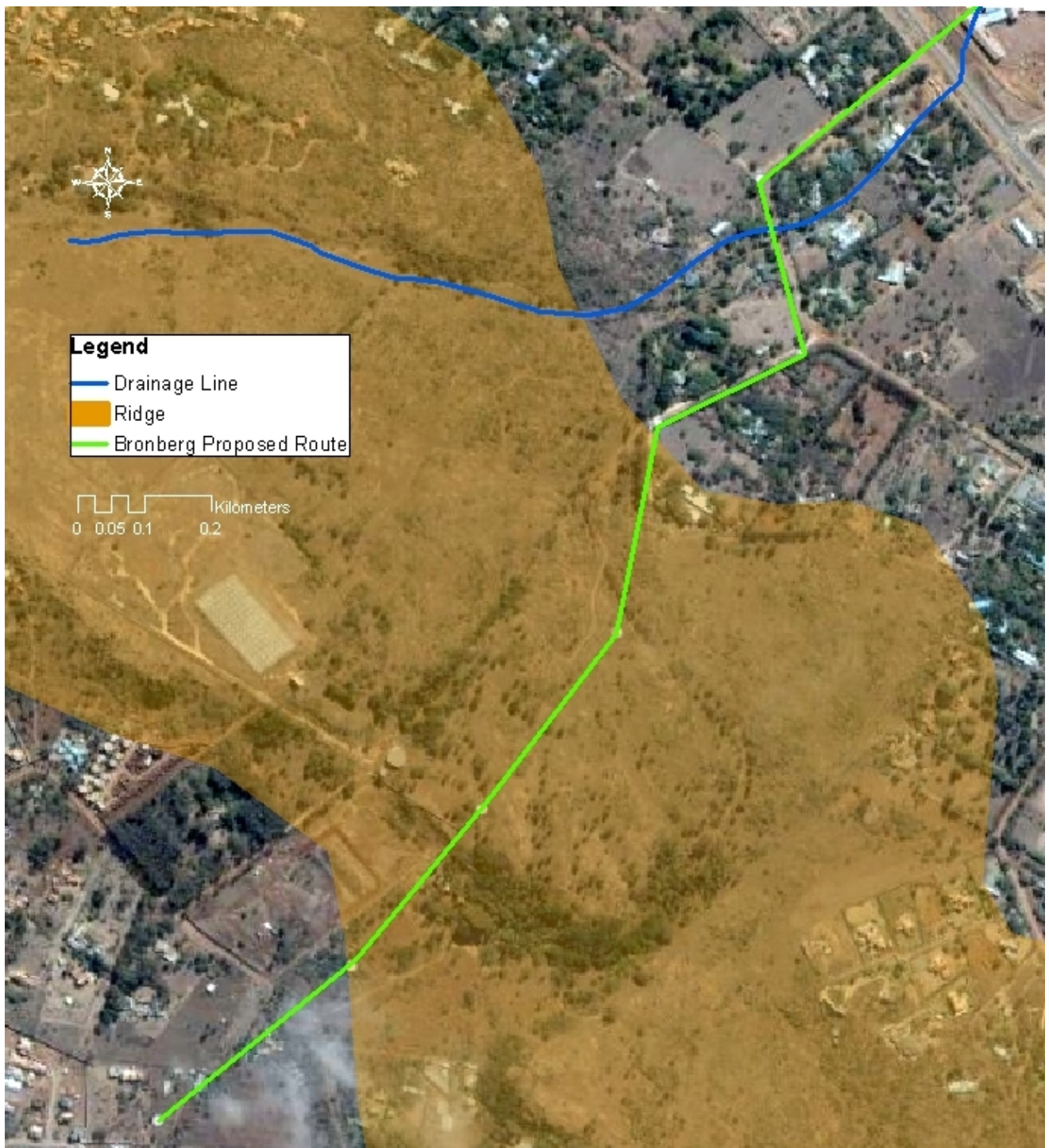
The study sites are situated on several Portions of the Farm Rietvallei 377-JR that form the Rietvlei Nature Reserve near Pretoria north of Johannesburg (S25°53'2.84"; E28°17'38.7") as well as across Portion 18 of the Farm Tweefontein 372-JR in the Bronberg Protected Area just south of Pretoria (S25°47'32.13"; E28°20'49.62") (Figure 1.2a and b). Based on GDACE's CPLAN information, the preferred Rietvlei route crosses a river and wetland system and has been highlighted for the possible presence of several Red Data vertebrates, invertebrates and plants. The second alternative runs across identified dolomite and cave systems, making it potentially unstable.





**Figure 2a. Preferred and alternative routes through Rietvlei Nature Reserve. Map also indicates sensitive areas as identified in CPLAN**





**Figure 2b. Proposed Route through the Bronberg Protected Area. Map also indicates sensitive areas as identified in CPLAN**

## **2.1 Regional Vegetation**

The study area falls within the Grassland Biome as classified by Rutherford and Westfall (1994). The Grassland Biome is found primarily on the high central plateau of South Africa, the inland regions of KwaZulu-Natal and the Eastern Cape. Tree species are limited due to frost, fire and grazing, which maintains the herbaceous grass and forb layer and ultimately prevents the establishment of tall woody plants (Tainton, 1999). It must be noted that this biome has an extremely high biodiversity, second only to the Fynbos Biome. According to

le Roux (2002) mammal species richness in the Grassland Biome is moderate, while endemism is high (44%). Of the species listed for this biome, around 10% are Red-Data listed.

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### 3. Methodology

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A mammal assessment based on the requirements listed in the terms of reference above was conducted by the following specialists:

Name	Qualification	Specialised in	Employer
Dr Ute Schwaibold	BSc/BSc Hons/PhD Zoology	Zoology (Mammals) Ecology SACNASP no 400263/07	Wits University
Dr Sarita Maree	PhD Zoology	Zoology (specialised in Golden Moles)	University of Pretoria

#### ***Mammals***

A desktop study was conducted to generate an expected checklist of mammals likely to occur in the region and to identify species that are of concern to conservation (Appendix 1). Fieldwork was limited to 2 days (20 November and 4 December 2008) active searching. The survey for both the Rietvlei and Bronberg routes involved walking the length of each route as well as investigating the areas within 50 meter on either side of the routes. When sensitive habitats were identified, these were surveyed more thoroughly regardless of proximity to the route. Random point checks were conducted throughout the surrounding grassland (up to 300m from the crossing point) to assess mammal presence in the greater area. Finally, a habitat assessment was also done to determine the likelihood of occurrence of Red Data mammals based on resources available on site. The presence of mammals was recorded and based predominantly on evidence of their occurrence (spoor, droppings, burrows, skulls, visual confirmation).

Due to time constraints limiting field work, the “precautionary principle” was applied. The species list compiled is based on information from recent literature (Taylor, 2000; Friedmann & Daly, 2004; Skinner and Chimimba, 2005).

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### 4. Results

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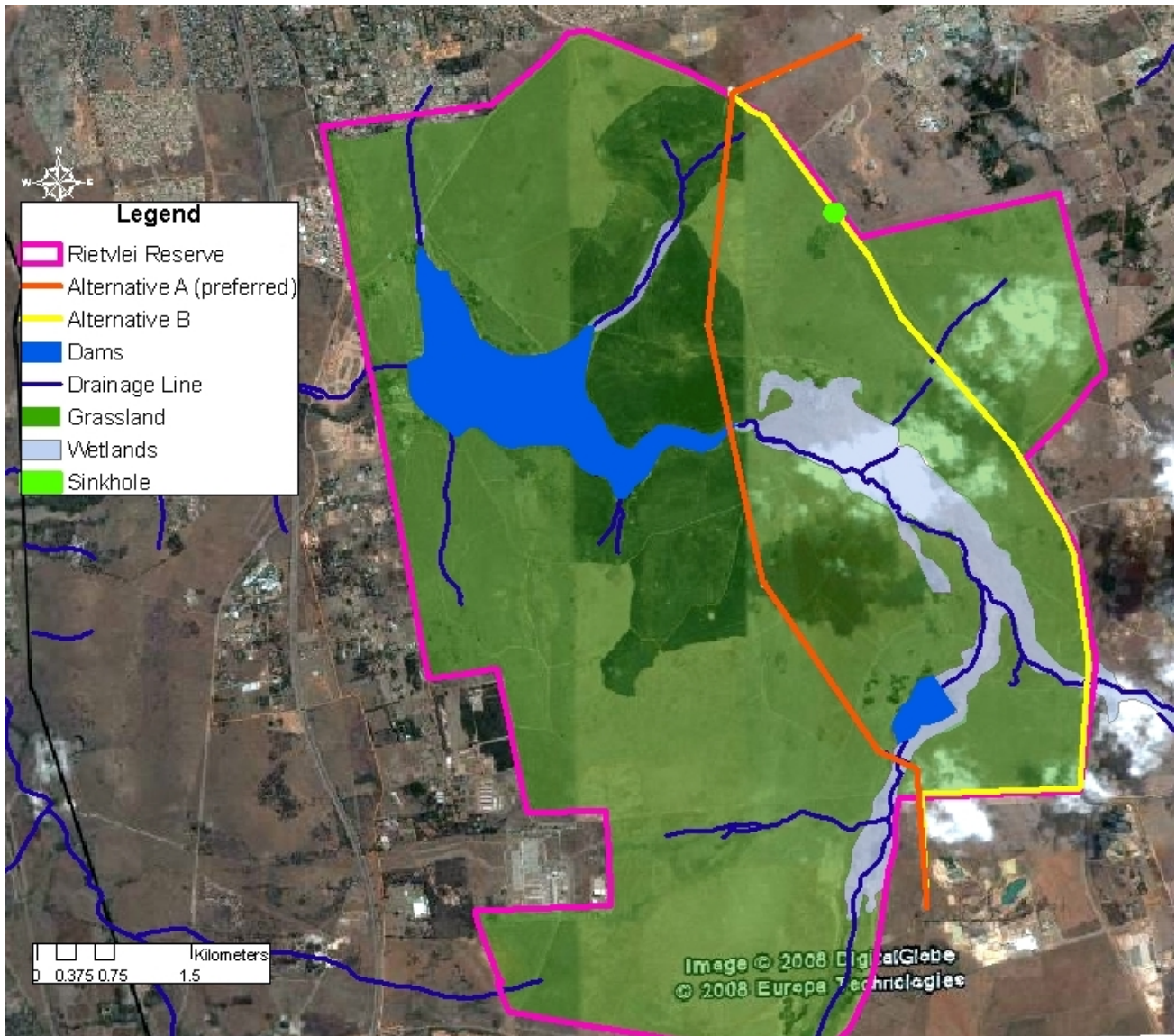
#### ***4.1 Habitat Assessment***

During the assessment the following major habitat categories were identified within the two sites (Figure 4.1a and 4.1b):

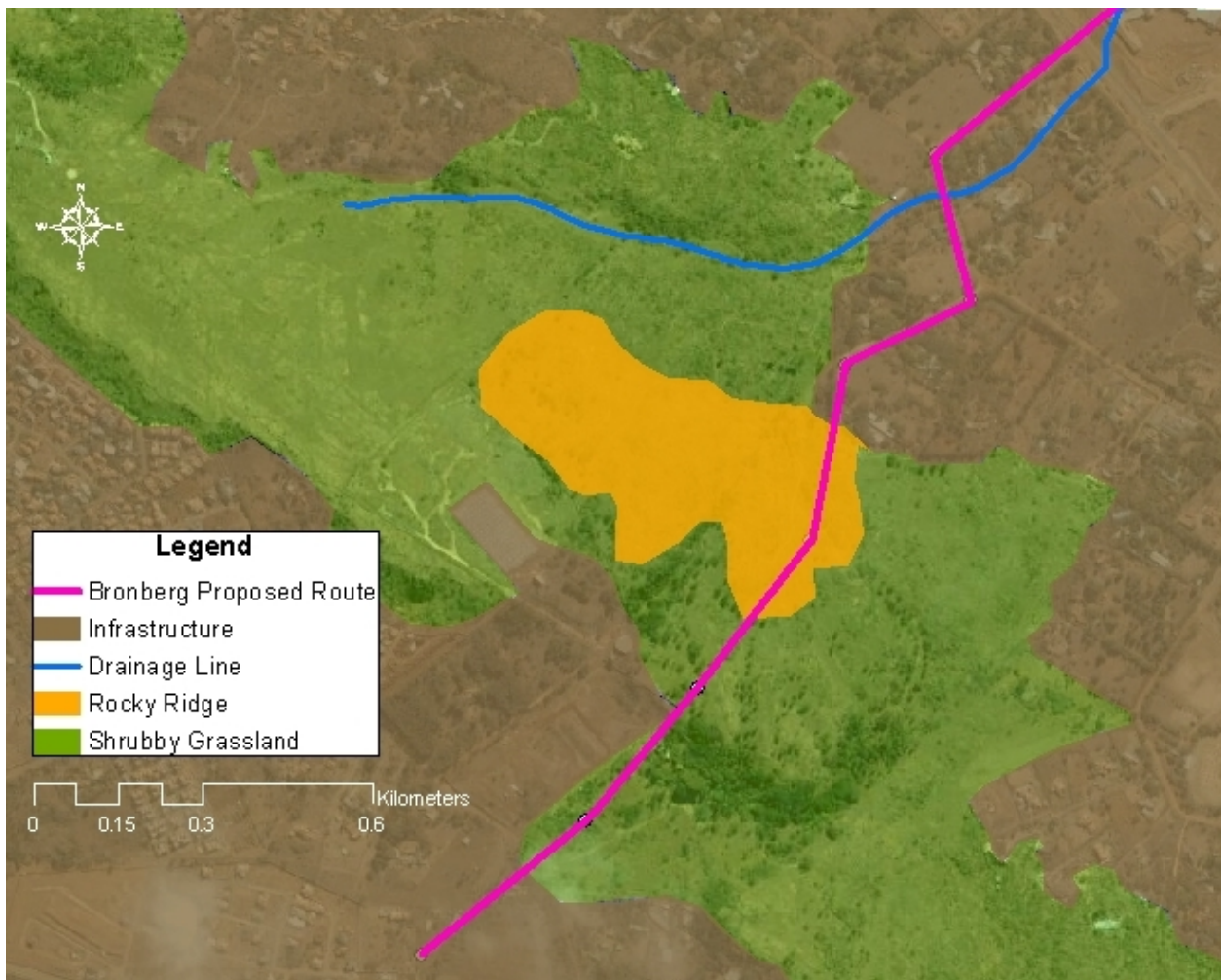
- Infrastructure – primarily Bronberg
- Drainage Line (permanent water) – Rietvlei



- Wetland (temporarily wet) – Wetland
- Dams - Rietvlei
- Grassland – Rietvlei
- Tree Clumps (scattered throughout Rietvlei) and Tree Lines (Bronberg)
- Shrubby Grassland – Bronberg; open grassland with scattered shrubs, tree clumps as well as rocky outcrops
- Sinkhole, possible caves (Rietvlei)



**Figure 4.1a. Broad habitat types identified at Rietvlei**



**Figure 4.1b. Broad habitat types identified at Bronberg**

While the preferred route through Rietvlei Nature Reserve crosses predominantly grassland with scattered shrubs, rocky outcrops, wetlands and moist grassland patches ideal for many Red Data species, the route proposed through the Bronberg crosses sensitive ridge habitat which has previously been highlighted for the possible presence of the critically endangered golden mole species.

#### **4.2 Mammals- Status Quo**

From the desktop study, 73 mammal species of small mammal were found to potentially occur on the Bronberg based on habitat requirements and other factors such as levels of disturbance on site. The presence of some species could be confirmed on site based on burrows and droppings (Table 4.2a). At Rietvlei Nature Reserve, 109 species were identified as potentially occurring on site (of which 52 are listed in Tshwane's guide book for the reserve and 18 were confirmed visually).

**Table 4.2a. Species confirmed (visual) at Rietvlei and Bronberg**

Species (and Order)	Common Name	Conservation Status	confirmed
<i>Rhabdomys pumilio</i>	Four-striped Grass Mouse	least concern	Rietvlei
<i>Otomys irroratus</i>	Vlei Rat	least concern	Rietvlei
<i>Hystrix africaeaustralis</i>	Cape Porcupine	least concern	Rietvlei
<i>Chrysospalax villosus</i>	Rough-haired Golden Mole	vulnerable	Rietvlei
<i>Raphicerus campestris</i>	Steenbok	least concern	Rietvlei
<i>Sylvicapra grimmia</i>	Common Duiker	least concern	Rietvlei
<i>Cynictis penicillata</i>	Yellow Mongoose	least concern	Rietvlei
<i>Ceratotherium simum</i>	White Rhinoceros	least concern	Rietvlei
<i>Equus burchellii</i>	Zebra	least concern	Rietvlei
<i>Hippopotamus amphibius</i>	Hippopotamus	least concern	Rietvlei
<i>Andidorcas marsupialis</i>	Springbok	least concern	Rietvlei
<i>Connochaetes gnou</i>	Black Wildebeest	least concern	Rietvlei
<i>Taurotragus oryx</i>	Eland	least concern	Rietvlei
<i>Alcelaphus buselaphus</i>	Red Hartebeest	least concern	Rietvlei
<i>Syncerus caffer</i>	African Buffalo	least concern	Rietvlei
<i>Cryptomys hottentotus</i>	African Molerat	least concern	Rietvlei
<i>Papio ursinus</i>	Chacma Baboon	least concern	Rietvlei
<i>Lepus saxatilis</i>	Scrub Hare	least concern	Rietvlei
<i>Pronolagus radensis</i>	Jameson's Red Rock Rabbit	least concern	Bronberg
<i>Neamblysomus julianae</i>	Juliana's Golden Mole	vulnerable	Bronberg

Of the species of concern to conservation, only one was confirmed (visually by the specialist) on either site and 17 others may/are likely to occur (Table 4.2b). Furthermore, several of the species likely to occur or even confirmed on these sites are protected under the National Environmental Management: Biodiversity Act of 2004 (Threatened and Protected Species Regulations; referred to as NEMBA) (Table 4.2c).

**Table 4.2b. Species of concern and their likelihood of occurrence**

Species (and Order)	Common Name	Conservation Status	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Chrysospalax villosus</i>	Rough-haired Golden Mole	vulnerable	confirmed (tunnels)	may occur
<i>Amblysomus septentrionalis</i>	Highveld Golden Mole	near threatened	may occur	may occur confirmed at Bronberg (tunnels)
<i>Neamblysomus julianae</i>	Juliana's Golden Mole	vulnerable	may occur	
<i>Dasymys incomtus</i>	Water Rat	near threatened	may occur near dams and wetland	unlikely to occur
<i>Mystromys albicaudatus</i>	White-tailed mouse	endangered	confirmed*	may occur
<i>Atelerix frontalis</i>	Southern African Hedgehog	near threatened	confirmed*	may occur

Species (and Order)	Common Name	Conservation Status	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Crocidura maquassiensis</i>	Maquassie Musk Shrew	vulnerable	may occur	may occur
<i>Miniopterus schreibersii</i>	Schreiber's Long-fingered Bat	near threatened	may occur	may occur
<i>Rhinolophus blasii</i>	Blasius' Horseshoe Bat	vulnerable	confirmed*	may occur
<i>Rhinolophus clivosus</i>	Geoffroy's Horseshoe Bat	near threatened	confirmed*	may occur
<i>Myotis welwitschii</i>	Welwitsch's Hairy Bat	near threatened	may occur	may occur
	Darling's Horseshoe Bat			
<i>Rhinolophus darlingi</i>	Bat	near threatened	confirmed*	may occur
<i>Mycotis tricolor</i>	Temminck's Hairy Bat	near threatened	may occur	may occur
<i>Pipistrellus rusticus</i>	Rusty Pipistrelle	near threatened	may occur	may occur
<i>Manis temminckii</i>	Ground Pangolin	vulnerable	confirmed*	unlikely to occur
<i>Hyaena brunnea</i>	Brown Hyaena	near threatened	confirmed*	unlikely to occur
<i>Lutra maculicollis</i>	Spotted-necked Otter	near threatened	may occur	unlikely to occur
<i>Mellivora capensis</i>	Honey Badger	near threatened	likely to occur	may occur
<i>Ourebia ourebi</i>	Oribi	endangered	confirmed*	unlikely to occur

**Table 4.2b. Species likely to occur that are protected under NEMBA**

Species (and Order)	Common Name	Conservation Status under NEMBA
<i>Chrysospalax villosus</i>	Rough-haired Golden Mole	critically endangered
<i>Ourebia ourebi</i>	Oribi	endangered
<i>Neamblysomus julianae</i>	Juliana's Golden Mole	vulnerable
<i>Manis temminckii</i>	Ground Pangolin	vulnerable
<i>Panthera pardus</i>	Leopard	vulnerable
<i>Aonyx capensis</i>	Cape Clawless Otter	protected
<i>Atelerix frontalis</i>	South African Hedgehog	protected
<i>Canis mesomelas</i>	Black-backed Jackal	protected
<i>Caracal caracal</i>	Caracal	protected
<i>Ceratotherium simum</i>	White Rhinoceros	protected
<i>Connochaetes gnou</i>	Black Wildebeest	protected
<i>Felis nigripes</i>	Black-footed Cat	protected
<i>Hyaena brunnea</i>	Brown Hyaena	protected
<i>Hystrix africaeustralis</i>	Porcupine	protected
<i>Leptailurus serval</i>	Serval	protected
<i>Lutra maculicollis</i>	Spotted-necked Otter	protected
<i>Mellivora capensis</i>	Honey Badger	protected
<i>Redunca arundinum</i>	Reedbuck	protected
<i>Sylvicapra grimmia</i>	Common Duiker	protected
<i>Vulpes chama</i>	Cape Fox	protected



#### **4.2.1 Red Data Mammals**

The **Rough-haired Golden Mole** is currently listed as 'Vulnerable' and was confirmed at Rietvlei and may well occur on the Bronberg due to the suitability of the substrate for tunneling.

**Juliana's Golden Mole** is currently listed as 'vulnerable', both nationally and globally. Based on incorrect estimates it was listed as 'critically endangered' globally in 1996 (IUCN). Its distribution suggests that its occurrence at Rietvlei Nature Reserve is quite possible. It was confirmed to occur on the Bronberg site during this site visit.

The **White-tailed Mouse** was previously listed as 'Vulnerable', both nationally and globally (IUCN, 1986; 1996) and its status has been upgraded to 'Endangered' due to high levels of afforestation in highland grasslands (Friedmann and Daly, 2004). It is confined mainly to the Highveld and montane grasslands, living in holes in the ground or cracks in the soil. Based on its habitat requirements, the White-tailed Mouse may well occur at Rietvlei Nature Reserve (has been confirmed in the guide book) and in the Bronberg.

The **Southern African Hedgehog** was previously listed as 'Rare' on a national level (IUCN, 1986), and of 'Least Concern' on a global level (IUCN, 1996). Although it is currently classified as 'Near Threatened', Friedmann and Daly (2004) suggest it is approaching a listing as 'Vulnerable'. The species is widespread within its distribution range and has recently been recorded at Rietvlei Nature Reserve. It requires dry habitats with good ground cover for nesting and is likely to occur on both the Rietvlei and Bronberg sites.

As the **Maquassie Musk Shrew** is a poor disperser, its distribution across South Africa is very patchy (Friedman and Day, 2004). It has recently been recorded in areas close to Rietvlei, however it prefers montane grassland habitats, rocky areas, coastal forests and gardens, suggesting that the habitat at the Bronberg may be more suitable for this species.

Six 'Near Threatened' and one 'Vulnerable' species of **bat** could occur on the sites proposed for the project, specifically the Bronberg site. Due to the presence of rocky areas and tall trees as well as the proximity to housing, these species may well occur in both areas. Furthermore, the sinkhole on alternative 2 at Rietvlei may provide cave habitat at its base (as known for most dolomite sinkholes). Most of these species are insectivores and while they may not roost on site, they may require this habitat for foraging.

Due to the vast number of termitaria on site, the presence of the 'Vulnerable' **Ground Pangolin** at Rietvlei Nature Reserve is possible, and the presence of larger water bodies on this site strengthens the likelihood of the occurrence of the 'Near-Threatened' **Water Rat** in the area.

The **Brown Hyena** is currently listed as 'Near Threatened' on a national level and globally it falls under a lower risk category according to the IUCN Red List categories (IUCN, 2001). Previously it was classified as 'Vulnerable' by the IUCN Conservation Monitoring Centre (1986-1994). It has recently been recorded at Rietvlei Nature Reserve and occurs in a wide range of habitats, including urban developments. During the day it requires holes or thick cover (Smithers, 2000). Due to its scavenging nature and habitat preference it may not occur at Bronberg.

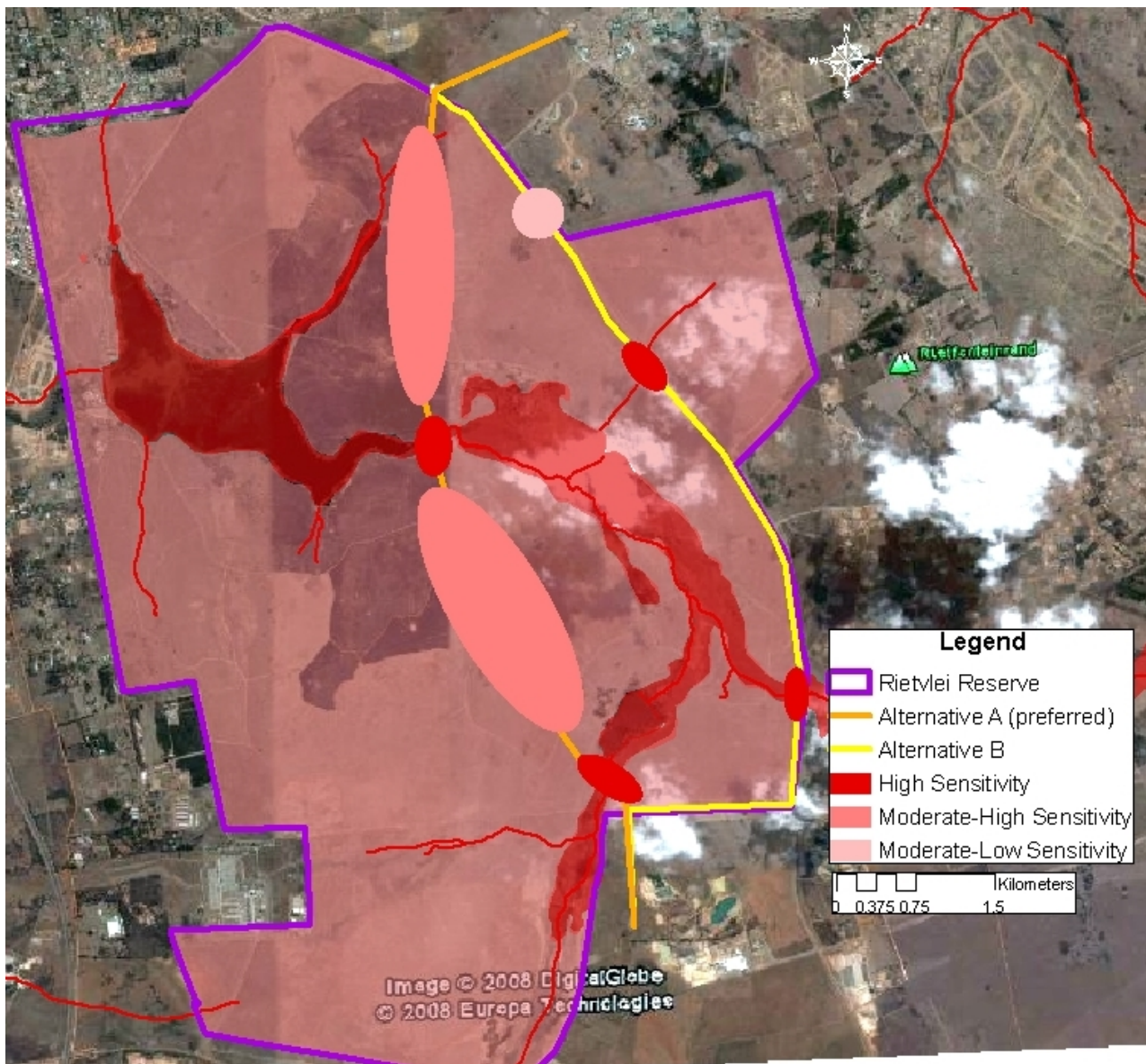
The **Spotted-necked Otter** is currently listed nationally as 'Near-Threatened' (Version 3.1) and was previously listed globally as 'Vulnerable' (2000). Its major threat is habitat loss (Friedman and Daly, 2004). This species is aquatic and dependent on large lakes and rivers. They are closely confined to their habitat and usually do not wander far from their water source (Skinner and Chimimba, 2005). As Rietvlei Dam is situated relatively central to Rietvlei Nature Reserve, it provides adequate habitat for this species, thus the spotted-necked otter is likely to occur on site.

The **Honey Badger**, currently listed nationally as "Near-Threatened" (Version 3.1) and previously identified as 'Vulnerable' (1986), occurs in a wide variety of habitats and use rock crevices for shelter, although they are able to excavate refuges or adapt disused burrows (Skinner and Chimimba, 2005). The habitat at both sites provides not only suitable rock crevices, but also suitable soils for burrowing, thus this species is very likely to occur on site.

The **Oribi** is currently listed as 'Endangered' according to the IUCN Red List Categories Version 3.1 (IUCN, 2001). However this classification applies only at a national level – the species is not Red Data listed globally (Friedmann and Daly, 2004). Previously the species was classified as 'Vulnerable' at national level (IUCN, 1986) and was placed in the 'Least Concern' category globally (IUCN, 1996). The Oribi prefers open grassland with a mosaic of short and tall grass, and avoids woodland areas. It is hunted for food and for sport, and its habitat is threatened by agricultural and urban development. As the habitat at Rietvlei Nature Reserve is predominantly savanna/grassland, the species may well occur there. It is further listed as occurring in the guide book provided by the reserve. It is however unlikely to occur at Bronberg.

#### **4.2.2 Sensitive habitats/areas suitable for Red Data species**

As Rietvlei Nature Reserve is an enclosed protected area with a large collection of species forming part of a well managed ecosystem, the entire reserve should be considered sensitive habitat. However, within this sensitive ecosystem, wetlands, dams and drainage lines are classified, for the purpose of this study, as highly sensitive (Figure 4.2.2a). These systems specifically will provide the best habitat for Red Data and protected species such as the African Clawless and Spotted-necked Otters, the water rat (should it occur here), as



**Figure 4.2.2a. Sensitive habitats for mammals identified at Rietvlei Nature Reserve**

well as most carnivores (some of which are Red Data listed) which will frequent these systems for drinkable water on a daily basis. The river and wetland crossings have been highlighted in this figure as this is where most damage could occur should this alternative be chosen, and care must be taken not to affect water flow or to block the passage of aquatic species such as the otters from one side of the pipeline to the other. Litter also accumulates quite regularly in culverts created to provide constant flow.

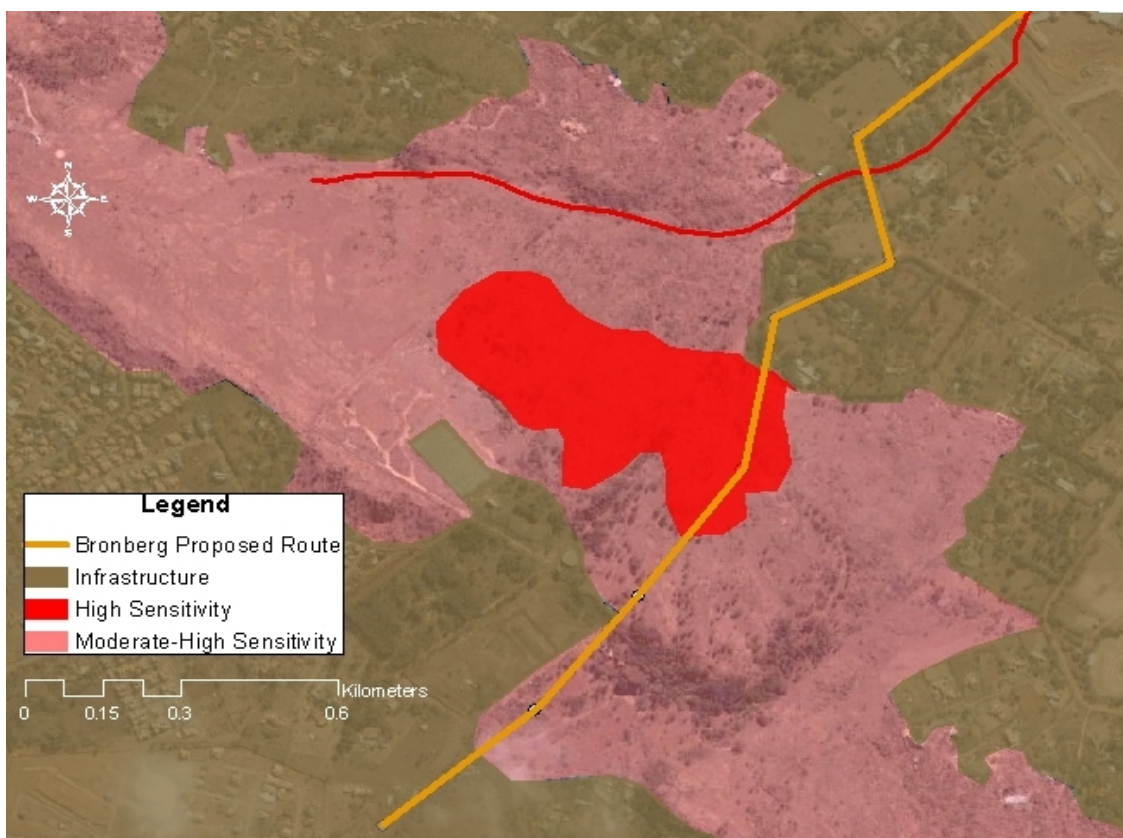
Second to the wetlands and water bodies is the sensitivity of the grassland plains (moderate-high sensitivity) – any disturbance running through this open area may act as a barrier for crossing for many species, which will be especially problematic during the breeding season. Also, the proposed pipeline runs relatively parallel and close to the drainage line, and both the project impact and the wetland will provide barriers for mammals, thus isolating them in a small patch between the two. Again, this must be avoided especially during the breeding season when food availability and territoriality play

a significant role. If the disturbance is of short enough duration and rehabilitation starts immediately after the impact, this may have a lesser effect on the populations.

Furthermore, the presence of rough-haired golden mole has been confirmed along the route (see report by S Maree), especially along the section between the two river crossings where golden mole burrows were located next to the pegs marking the proposed line. Moving the proposed pipeline further east towards the wetland may avoid the golden moles, however it will then impact on the wetland and affect species such as the otters.

Finally, the sinkhole identified along Alternative B has been highlighted as being of moderate to low sensitivity. The sinkhole is very deep, too deep to be able to confirm the presence of a cave at the bottom. The sides of the sinkhole ran straight down with no signs of crevices or possible nesting sites. It is thus unlikely that any species other than possibly bats may find suitable habitat here, hence I would suggest waiving the need for a 500m buffer from a mammal perspective. It is however essential that the stability of the sinkhole is not compromised.

Figure 4.2.2b indicates sensitive areas within the Bronberg site. While the entire Bronberg should be considered moderately-highly sensitive due to the presence of Juliana's Golden Mole (see report by S Maree), especially the ridge in the centre of this site is of high sensitivity as it will be most affected by the project. The presence of Juliana's Gooden Mole was confirmed here, and there is a significant likelihood of occurrence of several small species such as data deficient shrews based on the suitability of the habitat.



**Figure 4.2.2b. Sensitive habitats for mammals identified at Bronberg**



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## **5. Possible Impacts of the proposed development**

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In terms of mammals, the proposed project is likely to have a number of direct and indirect impacts on the species occurring in the area. While direct impacts include the death of small mammals (mainly during ground-breaking through vehicle traffic and front-end loaders), resulting in significant effects on the populations currently occurring on the site, these impacts are usually localised and short-term. However, indirect effects such as changes in habitat structure and fragmentation of habitats, while less obvious, may be of higher significance, as their effects can be more widespread and long-term and must be mitigated to lessen their effects.

The proposed pipeline, if not mitigated and rehabilitated adequately, will result in the permanent transformation of the habitat on certain parts of the site. Unfortunately, negative impacts cannot be totally avoided, but must be minimised by keeping the area of transformation to a minimum and rehabilitating the impact sites as best possible to ensure continuity of natural habitats with neighbouring sites.

### **5.1 Construction Phase**

The preconstruction and construction phases will involve the removal of topsoil and vegetation leading to the establishment of access roads and the underground pipeline. This process could possibly lead to:

- A reduction in suitable habitat for many animals through habitat destruction, specifically destruction of the wetlands being crossed, thus directly impacting the population in the demarcated area;
- Habitat fragmentation due to the barrier to movement posed by trenches, underground pipes, roads; this will especially affect small and aquatic mammals;
- Noise pollution and ground vibrations resulting from machinery;
- Intentional killing / hunting of animals by workers;
- Death of a proportion of small mammals by direct physical damage through front-end loaders and other earth moving equipment;
- An increase in runoff and pollution which may adversely affect the down-slope drainage line and wetland, as well as associated small mammals.

#### **5.1.1 Mitigation**

The negative effects of this phase can be partially mitigated by:

- Having a designated game ranger accompany the construction crew at Rietvlei Nature Reserve at all times to ensure safety of and prevent harassment of mammals; ensure the presence of an environmental officer at the Bronberg site for the same purpose;
- Selecting Alternative B at Rietvlei Nature Reserve which would lie within the existing fire break; this will significantly decrease disturbance of mammals as well

as practically eliminate the risk of habitat fragmentation as it would run along side an existing main road which marks the border of the reserve;

- Should alternative 2 be chosen, care must be taken not to further collapse existing sinkholes as the caves possibly occurring at the base of these are suitable habitat for bats, many of which are RD listed. Raising of the pipeline above-ground should be considered here;
- Keeping the area of disturbance to a minimum; possibly restricting the area of disturbance to a 20m corridor using at least danger tape to demarcate the corridor;
- Starting with clearing and topsoil removal from one end of the site towards the other to allow small mammals to flee the site;
- Not disturbing the movements of any animals intending to flee the impacted area;
- Prohibiting the intentional killing of mammal species through on-site supervision by an Environmental Officer (EO) or game ranger;
- If any rare or endangered species are located during construction by the EO, an ecologist or specialist must be contacted;
- Educating employees to minimise accidental killing of plant and animal species during construction;
- Relocating, with the assistance of an ecologist, mammals found during ground-breaking;
- Avoid ground clearing during spring/summer as mammals reproduce and disperse during this time; this should be planned for late autumn/early winter.
- Removal of all old materials and remaining soil stockpiles during and after construction. Construction material storage must occur within areas that are considered transformed (e.g. alien bush clumps).
- Access roads to the construction areas should be kept to a minimum, and where possible existing tracks must be used.
- Adequately manage storm water runoff, preferably start with the rehabilitation of the disturbed areas as soon as possible after construction.

#### **5.1.2 Mitigation specific to the areas suitable for Red Data species**

The Rietvlei site has several sensitive habitats that need to be considered. Alternative A (the preferred alternative) may well run parallel to the existing buried pipeline, but will be crossing two drainage lines associated with wetlands. Furthermore it will cross moist grassland where Rough-haired Golden Moles (Red Data listed) are confirmed (see report by S Marais). Creating a disturbance through the centre of the reserve, thereby transecting grassland areas used by large ungulates, will lead to short-term habitat fragmentation and it is essential that the timing of the disturbance does not coincide with breeding season, is short in duration and limited to a 20-30m stretch. It is further essential that rehabilitation of vegetation commences as soon as the pipe is covered with soil.

Where the pipeline crosses the drainage lines and wetlands it is recommended that the pipe runs above-ground with limited disturbance of water flow and mitigation to avoid sediment build-up where supporting structures will be placed into the wetland.

At the Bronberg site, which is highly sensitive due to the presence of Juliana's Golden Mole as well as several burrowing and rock-dwelling rodent species, a pipe below ground would result in significant damage to the rocky outcrop through which it is meant to run. It is suggested that an above-ground mounting of the pipeline be considered as this will cause less disturbance to burrowing rodents in the suitable sandy substrate, as well as the rocky ridge which provides good habitat not only for rodents but also for bats. Should a second alternative be possible, it would be suggested to run the pipeline along the existing tracks leading around the ridge (see section 6).

## **5.2 Operational Phase**

The only impacts from the proposed pipeline during the operational phase may be posed during routine checks (vehicle and human movement, impact is less significant) and a possible pipeline failure, which may release many liters of water into the drainage line and onto dry grassland. This impact will however be of less significance as long as repairs are done as soon as possible.

### **5.2.1 Mitigation**

Most mitigation measures for impacts encountered during this phase need to be implemented during construction and should form part of the design and planning phase. Should Alternative A be accepted, regular monitoring of culverts and flow passages under the pipeline must be done to avoid build-up of organic litter, plastic litter and sediment.

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## **6. Recommendations and Conclusion**

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Planning to run a water pipeline through a protected area is never an easy task, and it must be noted that, while the original pipeline runs through the same area, our legislation has changed to a point of recognising an area such as Rietvlei Nature Reserve and the Bronberg as worthy of protection. Both sites showed clear evidence of the presence of Red Data mammals, and especially Rietvlei Nature Reserve has a range of Red Data species on their list.

It is strongly suggested that, due to the nature of the sensitive areas within the reserve, the sinkhole and possible cave along the eastern border is of less significance to Red Data mammals, and Alternative B should be the preferred alternative as it reduces the impact on mammal populations due to disturbance, isolation and habitat fragmentation due to its

position within an already graded area (fire break) along the eastern boundary of the reserve.

With regards to the Bronberg, this site overall is not preferable for the routing of this pipeline. However, should it be positioned across this protected area, and above-ground construction would be most suitable to limit destruction of the rocky habitat and to allow passage for burrowing species to both sides of the pipeline.



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## 7. References

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## Appendix 1: Mammal species likely to occur at Bronberg and Rietvlei

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<b>Afrosoricidae</b>								
<i>Chrysospalax villosus</i>	Rough-haired Golden Mole	vulnerable	X		obs		confirmed (tunnels)	may occur
<i>Amblysomus septentrionalis</i>	Highveld Golden Mole	near threatened	X		ext	montane grassland and vleis	may occur	may occur
<i>Neamblysomus julianae</i>	Juliana's Golden Mole	vulnerable	X		obs	savanna biome, sandy soils with rocky outcrops	may occur	confirmed at Bronberg (tunnels)
<b>Macroscelidae</b>								
<i>Elephantulus myurus</i>	Eastern Rock Elephant-Shrew	least concern	X		ext	common; rock crevices	likely adjacent to both routes	very likely to occur
<b>Tubulidentata</b>								
<i>Orycteropus afer</i>	Aardvark	least concern	X		ext	associated with termitaria and ant hills	confirmed*	unlikely to occur
<b>Hyracoidea</b>								
<i>Procavia capensis</i>	Rock Hyrax	least concern	X		obs	common; rocky barren areas; rock outcrops and koppies	confirmed*	likely to occur
<b>Lagomorpha</b>								

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Lepus saxatilis</i>	Scrub Hare	least concern	X		obs	widespread; savanna and grassland (shrubs, tall grass); agricultural land;	confirmed throughout the reserve (droppings) likely to occur in parts of the reserve	likely to occur
<i>Pronolagus radensis</i>	Jameson's Red Rock Rabbit	least concern	X		obs	only found around rocky outcrops	confirmed	(droppings) unlikely to occur
<i>Lepus capensis</i>	Cape Hare	least concern				dry open grassland	confirmed*	
<b>Rodentia</b>								
<i>Aethomys ineptus</i>	Tete Veld Rat	least concern	X		obs	peripheral; rocky crevices, piles of boulders	may occur in parts of the reserve	likely to occur
<i>Cryptomys hottentotus</i>	African Molerat	least concern	X		obs	common; wide range of habitats	confirmed in parts of the reserve (tunnels)	likely to occur
<i>Dendromus melanotis</i>	Grey Climbing Mouse	least concern	X		obs	common; tall coarse grass, bushes	confirmed* likely to occur	may occur unlikely to occur
<i>Dendromus mesomelas</i>	Brants' Climbing Mouse	least concern	X			tall grass, near water		
<i>Dendromus mystacalis</i>	Lesser/chestnut Climbing Mouse	least concern	X		obs	peripheral; tall coarse grass; grassland	confirmed* may occur in parts of the reserve	may occur likely to occur
<i>Graphiurus murinus</i>	Woodland Dormouse	least concern	X		obs	common; woodland		

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Graphiurus platyops</i>	Rock Dormouse	data deficient	X		obs	rocky areas	may occur in pars of the reserve	likely to occur
<i>Xerus inauris</i>	Ground Squirrel	least concern	X		ext	open terraine, sparse bush,	may occur	unlikely to occur
<i>Hystrix africaeaustralis</i>	Cape Porcupine	least concern	X		obs	common; wide range of habitats	confirmed (quills)	may occur
<i>Lemniscomys rosalia</i>	Single-striped Grass Mouse	data deficient	X		obs	peripheral; savanna and grassland; good cover	likely to occur	may occur
<i>Mastomys coucha</i>	Southern Multimammate Mouse	least concern	X		obs	common; wide habitat tolerance	confirmed*	likely to occur
<i>Mastomys natalensis</i>	Natal multimammate Mouse	least concern	X			peripheral; wide habitat tolerance; arid scrub savanna and woodland	likely to occur	may occur
<i>Micaelamys namaquensis</i>	Namaqua Rock Mouse	least concern	X		obs	common rocky crevices, outcrops	may occur in pars of the reserve	likely to occur
<i>Mus indutus</i>	Desert Pygmy Mouse	least concern	X			common; moist to arid shrub savanna	confirmed*	may occur
<i>Otomys angoniensis</i>	Angoni Vlei Rat	least concern	X		obs	common; mesic grassland with good cover	likely to occur	may occur
<i>Otomys irroratus</i>	Vlei Rat	least concern	X		obs	common; grassland with good cover, bogs, marshes, swamps	confirmed (droppings)	may occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Pedetes capensis</i>	Springhare	least concern	X		obs	common; sandy hard soils, cultivated areas or open shrublands	confirmed*	may occur
<i>Rhabdomys pumilio</i>	Four-striped Grass Mouse	least concern	X		obs	common; grassland with good cover	confirmed (droppings and burrows)	may occur
<i>Tatera brantsii</i>	Highveld Gerbil	least concern	X		obs	common; grassland and shrub on sandy soil	confirmed*	may occur
<i>Tatera leucogaster</i>	Bushveld Gerbil	data deficient	X		obs	common; sandy soils	likely to occur	likely to occur
<i>Dasymys incomtus</i>	Water Rat	near threatened	X		ext	peripheral; swamps and wet areas along rivers and streams	may occur near dams and wetland	unlikely to occur
<i>Steatomys pratensis</i>	Fat Mouse	least concern			obs	peripheral; wide habitat tolerance	likely to occur	likely to occur
<i>Thallomys nigricauda</i>	Black-tailed Tree Rat	least concern				common; acacia woodlands and tree savanna; in shrubs in grassy areas	may occur	may occur
<i>Thallomys paedulcus</i>	Acacia Rat	least concern			ext	common; woodlands and tree savanna; in shrubs in grassy areas	may occur	may occur



Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Thryonomys swinderianus</i>	Greater Cane Rat	least concern	X		ext	common; seldom found far from water; moist swampy areas	may occur near dams and wetland	unlikely to occur
<i>Saccostomus campestris</i>	Pouched Mouse	least concern	X		obs	common; savanna and grassland, seed-eater	likely to occur	may occur
<i>Steatomys krebsii</i>	Krebs' Fat Mouse	least concern	X		obs	peripheral; wide habitat tolerance	may occur	may occur
<i>Mystromys albicaudatus</i>	White-tailed mouse	endangered	X		obs	grassland biome, good grass cover, rocky areas with good cover	confirmed*	may occur
<b>Primates</b>								
<i>Papio ursinus</i>	Chacma Baboon	least concern	X		obs	widespread; savanna and grassland, inhabits woodland edges	confirmed in the reserve	unlikely to occur
<i>Cercopithecus pygerythrus</i>	Vervet Monkey	least concern			ext	woody areas, riparian savanna , woodlands	confirmed*	unlikely to occur
<i>Galago moholi</i>	South African Galago	least concern	X		obs	arboreal; savanna and savanna woodland	confirmed*	may occur
<b>Eulipothyphla</b>								

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Atelerix frontalis</i>	Southern African Hedgehog	near threatened	X		obs	common; requires dry habitat with ground cover for nesting	confirmed*	may occur
<i>Crocidura cyanea</i>	Reddish-grey Musk Shrew	data deficient	X		obs	common; wide habitat tolerance	confirmed*	may occur
<i>Crocidura mariquensis</i>	Swamp Musk Shrew	data deficient	X		obs	common; damp areas, river banks, swamps/marshes	confirmed*	unlikely to occur
<i>Crocidura silacea</i>	Lesser Grey-brown Musk Shrew	data deficient	X		ext	common; wide habitat tolerance	confirmed*	may occur
<i>Crocidura fuscomurina</i>	Tiny Musk Shrew	data deficient	X		ext	common; wide habitat tolerance	likely to occur	may occur
<i>Suncus infinitesimus</i>	Least Dwarf Shrew	data deficient	X		obs	forest and grassland, savanna, mixed bushveld, termitaria	confirmed*	may occur
<i>Suncus varilla</i>	Lesser Dwarf Shrew	data deficient	X		obs	termite mounds; gardens, open savanna	confirmed*	may occur
<i>Crocidura hirta</i>	Lesser Red Musk Shrew	data deficient	X		obs	requires cover in form of logs or rock; prefers damp areas	confirmed*	may occur
<i>Crocidura maquassiensis</i>	Maquassie Musk Shrew	vulnerable	X				may occur	may occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Myosorex varius</i>	Forest Shrew	data deficient	X		obs	common; forest/dense vegetation; damp habitats; grasslands; burrows or uses rodent burrows	confirmed*	likely ot occur
<b>Chiroptera</b>								
<i>Miniopterus schreibersii</i>	Schreiber's Long-fingered Bat	near threatened	X	X	obs	common; prefers moister regions; roosts in caves, disused tunnels, mine shafts, under bridges and in trees, outbuildings and under roofs	may occur	may occur
<i>Neoromicia capensis</i>	Cape Serotine Bat	least concern	X	X	obs	widespread; urban areas; roosts in man-made structures, rock crevices, tree bark	confirmed*	may occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Epomophorus wahlbergi</i>	Wahlberg's Epauletted Fruit Bat	least concern	X	X	ext	peripheral; urban areas, roosts in eaves of houses/under bridges; savanna, roosts in tall trees with good cover	may occur	may occur
<i>Nycteris thebaica</i>	Egyptian/Common Slit-faced Bat	least concern	X	X	ext	widespread; open savanna woodland and coastal and riverine forest; roosts in caves, man-made structures, aardvark holes	confirmed*	may occur
<i>Rhinolophus blasii</i>	Blasius' Horseshoe Bat	vulnerable	X	X	obs	savanna habitats, roosts in caves; aerial insectivore	confirmed*	may occur
<i>Rhinolophus clivosus</i>	Geoffroy's Horseshoe Bat	near threatened	X	X	obs	peripheral; savanna woodlands and grassland; cave-dwellings, subterranean habitats, trees and eaves	confirmed*	may occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Tadarida aegyptiaca</i>	Egyptian Free-tailed Bat	least concern	X	X	obs	widespread; roosts in rock fissures and man-made structures; aerial insectivore	confirmed*	may occur
<i>Taphozous mauritanus</i>	Mauritian Tomb Bat	least concern	X	X	ext	peripheral; roosts on bark of trees under covering vegetation, under eaves of houses	confirmed*	may occur
<i>Myotis welwitschii</i>	Welwitsch's Hairy Bat	near threatened	X	X	ext		may occur	may occur
<i>Rhinolophus darlingi</i>	Darling's Horseshoe Bat	near threatened	X	X	obs		confirmed*	may occur
<i>Sauromys petrophilus</i>	Flatheaded free-tailed bat	least concern	X	X	ext	patchy distribution; savanna, roosts in rock fissures; aerial insectivore	may occur	may occur
<i>Scotophilus viridis</i>	Greenish Yellow House Bat	least concern	X		ext	peripheral; savanna; roosts in tree hollows and man-made structures; aerial insectivore	confirmed*	may occur



Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Scotophilus dinganii</i>	African Yellow Bat	least concern	X		obs	common; savanna and mixed bushveld; aerial insectivore, roosts in crevices	confirmed*	may occur
<i>Mycotis tricolor</i>	Temminck's Hairy Bat	near threatened	X	X	obs	savanna woodlands, drier areas, roosts in caves or tunnels	may occur	may occur
<i>Pipistrellus rusticus</i>	Rusty Pipistrelle	near threatened	X	X	obs	peripheral savanna; riparian forest; aerial insectivore, roosts in tree crevices	may occur	may occur
<i>Rhinolophus simulator</i>	Bushveld Horseshoe Bat	least concern	X	X	obs	peripheral; savanna and riverine savanna; aerial insectivore; cave-dwelling	confirmed*	may occur
<b>Pholidota</b>								
<i>Manis temminckii</i>	Ground Pangolin	vulnerable	X		obs	common in savanna areas; shrub, woodlands,	confirmed*	unlikely to occur
<b>Carnivora</b>								

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Aonyx capensis</i>	African Clawless Otter	least concern	X		obs	common; freshwater and marine; rivers/streams/creeks; ponds, agriculture ponds	confirmed*	unlikely to occur
<i>Civettictis civetta</i>	African Civet	least concern	X		ext		confirmed*	may occur
<i>Atilax paludinosus</i>	Marsh Mongoose	least concern	X		obs	common; freshwater and marine; permanent/seasonal freshwater lakes, and pools	confirmed*	unlikely to occur
<i>Canis mesomelas</i>	Black-backed Jackal	least concern	X		obs	common; savanna, grasaland	confirmed*	unlikely to occur
<i>Panthera pardus</i>	Leopard	least concern	X		obs	peripheral; savanna, grassland; usually associated with woodland	confirmed*	unlikely to occur
<i>Caracal caracal</i>	Caracal	least concern	X		obs	common; open shrubland and woodland; savanna and grassland	confirmed*	may occur
<i>Cynictis penicillata</i>	Yellow Mongoose	least concern	X		obs	common; savanna, shrubland, grassland	confirmed (visual)	unlikely to occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Felis nigripes</i>	Black-footed Cat	least concern			ext	common; grassland, shrubland	likely to occur	may occur
<i>Felis silvestris</i>	African Wild Cat	least concern	X		obs	common; broad habitat tolerance	likely to occur	may occur
<i>Galerella sanguinea</i>	Slender Mongoose	least concern	X		obs	common; savanna, grassland, urban areas	confirmed*	unlikely to occur
<i>Genetta genetta</i>	Small-spotted Genet	least concern	X		obs	common; open scrub and woodland; ; savanna, grassland, urban areas	confirmed*	may occur
<i>Genetta tigrina</i>	Large-spotted Genet	least concern	X		obs	common; open scrub and woodland; ; savanna, grassland, urban areas	confirmed*	may occur
<i>Helogale parvula</i>	Dwarf Mongoose	least concern	X		obs	common; prefers savannas	likely to occur	may occur
<i>Hyaena brunnea</i>	Brown Hyaena	near threatened	X		obs	common; dry habitats, shrublands, grasslands, urban areas	confirmed*	unlikely to occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Ichneumia albicauda</i>	White-tailed Mongoose	least concern	X		obs	common; savanna, grasslands, urban areas and rural gardens	confirmed*	may occur
<i>Ictonyx striatus</i>	Striped Polecat	least concern	X		obs		confirmed*	may occur
<i>Lutra maculicollis</i>	Spotted-necked Otter	near threatened	X		ext	fresh deep water, dense cover	may occur	unlikely to occur
<i>Mellivora capensis</i>	Honey Badger	near threatened	X		ext	common; savanna and grassland; commensural with humans	likely to occur	may occur
<i>Mungos mungo</i>	Banded Mongoose	least concern	X		obs	common, savanna; feeds on termite and beetle larvae	likely to occur	may occur
<i>Poecilogale albinucha</i>	African Striped Weasel	data deficient	X		obs	common; grassland, savanna; predator of rodents; burrowing	confirmed*	may occur
<i>Proteles cristatus</i>	Aardwolf	least concern	X		obs	common; pastureland; open savanna, grassland; associated with termites; burrowing	confirmed*	unlikely to occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Suricata suricata</i>	Suricate	least concern			obs	common; Savanna; Grassland	confirmed*	unlikely to occur
<i>Vulpes chama</i>	Cape Fox	least concern	X		obs	common; grassland, however more common in dry grassland and desert	confirmed*	unlikely to occur
<b>Perissodactyla</b>								
<i>Ceratotherium simum</i>	White Rhinoceros	least concern	X		ext	short grass, water, bush cover, flat terrain	confirmed (visual)	unlikely to occur
<i>Equus burchellii</i>	Zebra	least concern				savanna, open areas	confirmed (visual)	unlikely to occur
<b>Whippomorpha</b>								
<i>Hippopotamus amphibius</i>	Hippopotamus	least concern				water bodies	confirmed (visual)	unlikely to occur
<b>Ruminantia</b>								
<i>Andidorcas marsupialis</i>	Springbok	least concern	X		obs	widespread; arid regions, dry open grassland savanna	confirmed (visual)	unlikely to occur
<i>Connochaetes gnou</i>	Black Wildebeest	least concern	X		obs	common; grasslands, open areas with short grass; open plains	confirmed (visual)	unlikely to occur



Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Ourebia ourebi</i>	Oribi	endangered	X		obs	peripheral; open grassland;	confirmed*	unlikely to occur
<i>Pelea capreolus</i>	Grey Rhebok	least concern	X		ext	peripheral; rocky/mountainous terrain; ecotones	may occur	may occur
<i>Raphicerus campestris</i>	Steenbok	least concern	X		obs	widespread; savanna, shrubland, open grassland with some cover (high grass, shrubs)	confirmed (visual)	may occur
<i>Sylvicapra grimmia</i>	Common Duiker	least concern	X		obs	common; thickets, savanna, forest, grassland	confirmed (visual)	may occur
<i>Taurotragus oryx</i>	Eland	least concern	X		ext	common; prefers woodlands/woodland mosaics; also in arid grasslands/thickets and savannas	confirmed (visual)	unlikely to occur
<i>Alcelaphus buselaphus</i>	Red Hartebeest	least concern	X		obs	widespread; open grassland, arid shrub and savanna	confirmed (visual)	unlikely to occur

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Connochaetes taurinus</i> <i>Equus burchellii</i>	Blue Wildebeest Plains Zebra	least concern least concern	X		ext obs	common; open savanna woodlands, short grass	may occur	unlikely to occur
<i>Oreotragus oreotragus</i>	Klipspringer	least concern	X		ext	widespread; rocky outcrops, mountainous areas	likely to occur	may occur
<i>Redunca fulvorufula</i>	Mountain Reedbuck	least concern	X		ext	common; mountainous terrain, rocks/boulders for cover; grasslands	confirmed*	unlikely to occur
<i>Syncerus caffer</i>	African Buffalo	least concern	X			savanna, abundant grass and water	confirmed (visual)	unlikely to occur
<i>Redunca arundinum</i>	Reedbuck	least concern	X		ext	peripheral; tall grass savannas with herbaceous cover and woody plants; reedbeds; near water supply	confirmed*	unlikely to occur
<i>Damaliscus pygargus phillipsi</i>	Blesbok	least concern	X		obs	common; grasslands, short grass	confirmed*	unlikely to occur
<i>Kobus ellipsiprymnus</i>	Waterbuck	least concern					confirmed*	unlikely to occur
<b>Suiformes</b>								

Species (and Order)	Common Name	Conservation Status	Skinner & Chimimba, 2005	Taylor, 2000	Friedman & Daly, 2004	Habitat Requirements	Likelihood of occurrence Rietvlei	Likelihood of occurrence Bronberg
<i>Potamochoerus larvatus</i>	Bushpig	least concern				tall grass, thickets, forest	confirmed*	unlikely to occur
* confirmed in Rietvlei visitor's Guide; Ext = extent of range; Obs = observed								