BASELINE STUDY: VERTEBRATE FAUNA AND FLORA ASSOCIATED WITH THE CRATON MINING & EXPLORATION PROJECT – ML197, HOCHVELD/STEINHAUSEN AREA

SPECIALIST CONTRIBUTION:

Prepared by:

Peter L Cunningham

Environment and Wildlife Consulting Namibia

P. O. Box 417
Karasburg
Namibia
Telephone: +264-61-254550
Telefax: +264-61-254550
Mobile: +264 81-3004080
E-mail: pckkwrc@yahoo.co.uk

Prepared for:

Ms Jessica Bezuidenhout

Environmental Compliance Consultancy

Windhoek
Namibia
Mobile: +264 81-2627872
www.enviroconsultants.co.za
E-mail: jessica@enviroconsultants.co.za

CONTENTS

Vertebrate fauna associated with the Craton Mining & Exploration Project - ML197; Hochveld/Steinhausen area

1	**Introduction**	1
2	**Methods**	3
2.1	**Literature review**	3
2.2	**Field survey**	3
3	**Results**	5
3.1	**Reptile Diversity**	5
3.2	**Amphibian Diversity**	11
3.3	**Mammal Diversity**	15
3.4	**Avian Diversity**	22
3.5	**Tree and Shrub Diversity**	33
3.6	**Grass Diversity**	42
3.7	**Other Species**	50
3.8	**Important Species**	54
3.9	**Important Areas**	57
4	**Alternative Sites and Routes**	59
5	**Impact Assessment**	62
5.1	**Introduction**	62
5.2	**Faunal Disturbance**	62
5.3	**Floral Disturbance**	66
5.4	**Impacts – Methods**	70
5.5	**Assessment: Construction, Operational, Decommissioning Phase's**	72
5.6	**Impacts: Construction, Operational, Decommissioning Phase's**	73
6	**Conclusion**	78
7	**References**	79

1 Introduction

A desktop study (i.e., literature review) was conducted between 6 and 10 March 2023 on the vertebrate fauna (e.g., reptiles, amphibians, mammals and birds) and flora (larger trees and shrubs and grasses) expected to occur in the general Hochveld/Steinhausen area. This was followed by a rapid site assessment between 14 and 16 March 2023 to determine actual vertebrate fauna and flora (including unique habitats) at the proposed development areas. The aim was to determine the vertebrate fauna and flora potentially impacted should active mining operations proceed (Figures 1 and 2).

This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general Hochveld/Steinhausen area and commonly referred to as the Highland Savannah (Giess 1971) or the area referred to by Mendelsohn *et al.* (2022) as the Highland Shrubland. The vegetation structure is classified as shrubs and low trees in the Highland Savannah while the average plant production is viewed as high with the variation in plant production estimated at low (5-10%) to medium (10-15%) (Mendelsohn *et al.* 2022).

Areas of special ecological importance throughout Namibia include mountains and inselbergs with the Auas Mountains viewed as an area of special ecological importance with highly restricted range species (Curtis and Barnard 1998). The mountains around Windhoek have over 500 species of which 7% are viewed as endemic (Burke 2007). The Mountain Savannah with its unique vegetation types is wholly unprotected (Barnard 1998). More broadly speaking, the Savannah Biome – of which the Craton ML197 forms part of – is underrepresented in the protected area network in Namibia covering 37% of the land area, but only 7.5% of the biome (Barnard 1998).

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and fygies (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species – approximately 687 species in total – are manly associated with the Kaokoveld (northwestern) and the succulent Karoo (southwestern) Namibia. The major threats to the floral diversity in Namibia are:

1). Conversion of the land to agriculture (with associated problems) and,
2). poorly considered development (Maggs 1998, Mendelsohn *et al.* 2002).

Highland Savannah

The Highland Savannah, although varied, is classified by *Combretum apiculatum* subsp. *apiculatum* and *Acacia hereroensis*, *Acacia reficiens* and *Acacia erubescens* amongst others (Giess 1971). Little is known of the flora of the Auas Mountains although located close to Windhoek (Maggs 1998). Simmons (1998) puts the plant endemism in the general Windhoek area at between 61 and 70 species depending on the locality. The overall plant diversity (all species - “higher” plants) in the general area is “high” and estimated at 400-499 species (Jarvis *et al.* 2022). Plant endemism is also “high” with >35 species expected from the general area while the actual Auas Mountains south of Windhoek have >500 species (Jarvis *et al.* 2022). Of the >500 species expected in the area at least 7% are Namibian endemics (Burke 2007). Burke (2007) indicates that the vegetation of the Auas Mountains is unique and have species reminiscent of the highland plateau grasslands in central South Africa and the Drakensberg (e.g., *Themeda triandra*) and the fynbos (e.g., *Passerina montana*) and succulents from the Northern Cape and South-western Namibia (e.g., *Crassula* and *Ebracteola* species). Furthermore, Jarvis *et al.* (2022) views the grazing and browse as good in the general area with the risk of farming viewed as low and the tourism potential of this area also viewed as high.

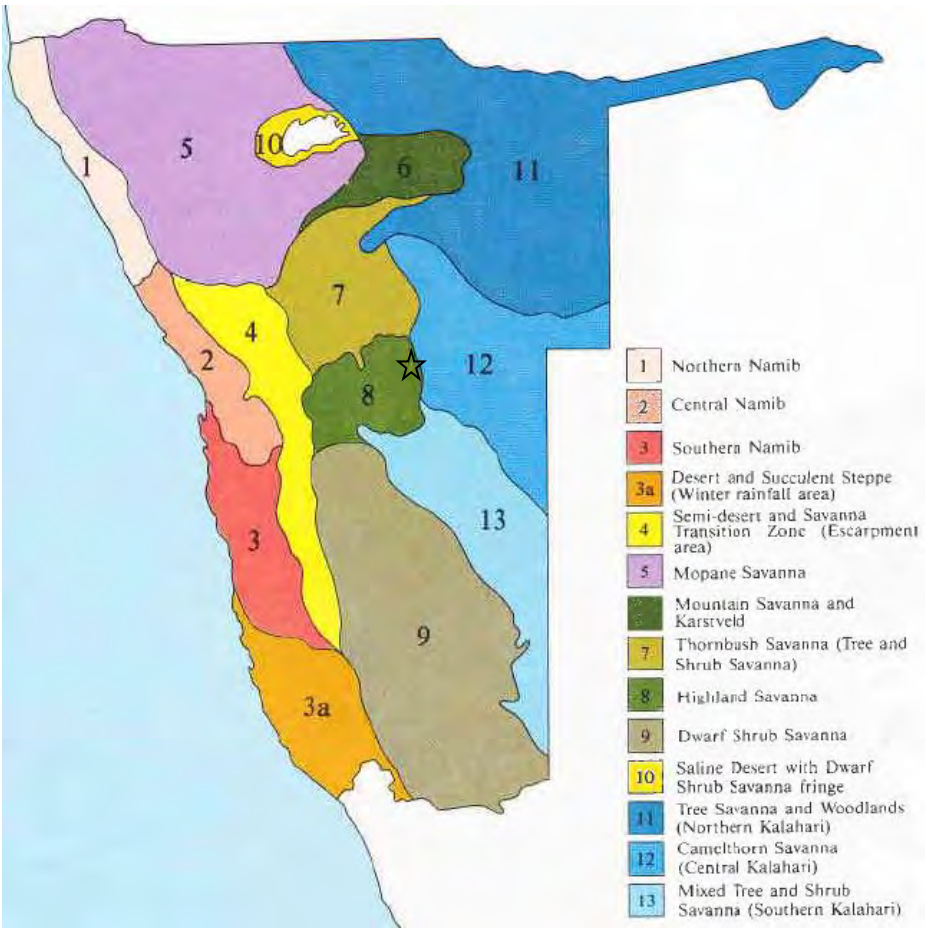

Figure 1. The Craton ML197 falls within the Highland Savannah vegetation type – See black star (Source: Giess 1971).

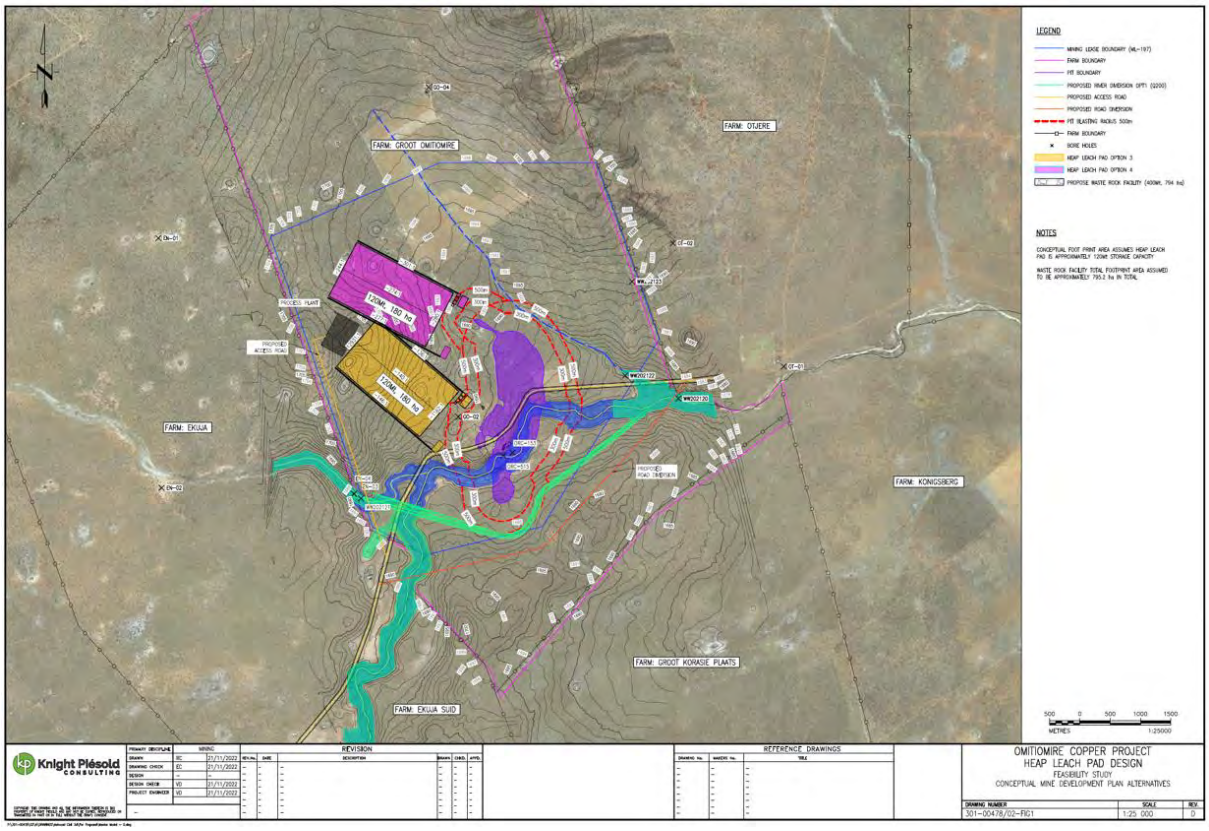

Figure 2. The Craton ML197 Project Site: (2 x Heap Leach Options – yellow & pink), Plant (black), Pit (purple), proposed River Diversion (light green) and the proposed Road Diversion (orange). The existing river and road passing through the envisaged pit area is indicated in blue and yellow, respectively (Source: Knight Piesold).

The Hochveld/Steinhausen area in general is regarded as "average" in overall (all terrestrial species) diversity and endemism (Mendelsohn *et al.* 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "high" with 7-8 species expected – e.g., gemsbok, hartebeest and kudu have highest densities in this area – while the overall diversity of large carnivorous mammals (large predators) is viewed as "average" with 3-4 species expected – e.g., cheetah and leopard have highest densities in this area (Mendelsohn *et al.* 2002).

The overall plant diversity (all species) in the general Hochveld/Steinhausen area is estimated at between 100-399 species and the Auas Mountains to the southwest have >500 species (Jarvis *et al.* 2022). These estimates are limited to "higher" plants as information regarding "lower" plants is sparse. The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in "unique" habitat – often transition zones – e.g., mountains, inselbergs, etc. Plant endemism, other than the Auas Mountains, is viewed as "low" – with between 2-5 endemics expected from the general area (Jarvis *et al.* 2022). Furthermore, Mendelsohn *et al.* (2002) views the availability of hardwoods as average and the grazing as good and the browse as average to good in the general area. Bush thickening (encroachment) is patchy in the general Hochveld/Steinhausen area with *Acacia mellifera* (black thorn) the dominant problem species with densities of 2,000-3,000 plants/ha (Bester 1996, Cunningham 1998, Mendelsohn *et al.* 2002).

The estimated value of game production in the general area is viewed as >N$4,000/km^2/year while the estimated livestock production is viewed as N$5,000-20,000/km^2/year (Jarvis *et al.* 2022).

The area does not fall within a Communal Conservancy with the closest being Ovitoto to the east of Okahandja and northwest of Hochveld/Steinhausen while there are large Freehold (i.e., commercial) Conservancies in the general area with the Hochveld, Omitara and Seeis being the closest (MEFT/NACSO 2021, See: www.nacso.org.na).

It is estimated that at least 62 species of reptile, 11 amphibian, 82 mammal, 213 birds, 60-81 larger trees and shrubs and up to 101 grass species occur in the general/immediate Hochveld/Steinhausen area of which a high proportion are endemics (e.g., reptiles – 25.8%).

2 Methods

2.1 Literature review

A comprehensive and intensive literature review (i.e., desktop study) regarding the reptiles, amphibians, mammals, birds, larger trees and shrubs (>1m in height) and grasses that could potentially occur in the general Hochveld/Steinhausen area (including the Craton ML197 project area) was conducted using as many references as manageable. A list of the references consulted can be viewed in the Reference section (Page 79).

2.2 Field Survey

Vertebrate fauna

According to the original ToR, a rapid fieldwork assessment to determine the actual faunal diversity would include the following:

- Small mammal transects to determine small mammal diversity in the area
- Assess larger mammal presence in the area
- Reptile and amphibian transects to determine reptile and amphibian diversity in the area
- Bird transects to determine avian diversity in the area
- Tree/shrub transects to determine diversity in the area
- Grass transects to determine diversity in the area

Reptiles
Diurnal reptile transects were conducted along various transects throughout the proposed development area and were not conducted in rigid straight lines but focused on the habitat viewed as most suitable for reptiles. Reptiles observed were either caught by hand or by using an active capture technique called 'reptile noosing' where an extendable fishing rod was fitted with a soft thread noose, positioned over the unsuspecting head of an individual and pulled tight. This technique does not result in the death or injury of the caught specimen. Species caught were identified *in situ*, photographed and released unharmed at the point of capture. No nocturnal transects were conducted due to the dense grass cover and high grass biomass which would make observing reptiles virtually impossible together with a high fire risk using a handheld gas lantern under these circumstances.

Amphibians
Amphibians were searched for in areas deemed suitable habitat – e.g., Black Nossob River and other ephemeral drainage lines, dams, pans, etc. – with species encountered identified *in situ*.

Mammals
Small mammal trapping was conducted by active trapping using collapsible aluminium Sherman traps baited with peanut butter and oats. Traps were set at 3 sites throughout the area with between 11 and 20 traps placed 20m apart for 2 nights (i.e., potential maximum of 42 captures) in habitats viewed as potentially suitable for small mammals in the area and/or potentially affected by the proposed mining developments.

Assessing larger mammals from the area was conducted by traversing the area by vehicle following permissible tracks and on foot throughout the area and included actual sightings, tracks, scats and other signs – e.g., burrows, scrapes, carcasses, etc.

Birds
Bird transects (variable lengths, directions and times) were conducted by vehicle following permissible tracks and on foot throughout the area during daylight hours using binoculars to identify and confirm species.

Flora
According to the original Terms of Reference (ToR), fieldwork to determine the actual floral diversity was to include the following:

- Trees and shrubs – species composition
- Grasses – species composition
- Other species

Trees and shrubs
All the trees and shrubs encountered in the proposed development areas were identified whilst conducting the fieldwork in the area – i.e., identification was not limited to transects

only. Trees and shrubs species composition was quantified. The transect lengths varied according to the terrain and were conducted in the proposed development areas as well as the general surrounding area.

Grasses
All the grasses encountered in the proposed development areas were identified whilst conducting the fieldwork in the area – i.e., identification was not limited to transects only. Grass species composition was quantified. The transect lengths varied according to the terrain and were conducted in the proposed development areas as well as the general surrounding area.

Other species
Other species – i.e., bulbs, herbs, etc. – were also identified whenever encountered throughout the area.

The focus of the fieldwork was on the "key target areas" – i.e., proposed infrastructure options (e.g., Plant, Heap Leach Options), pit area, drainage line diversion, road diversion, etc. – see Figure 2.

3 Results

3.1 Reptile Diversity

Reptile diversity known and/or expected to occur in the Hochveld/Steinhausen area, including species confirmed during the fieldwork as well as the authors confirmed records (and farm staff sightings) during other studies from the general area, is presented in Table 1.

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continent's species diversity (Griffin 1998a). At least 22% or 55 species of Namibian lizards are classified as endemic. The occurrence of reptiles of "conservation concern" includes about 67% of Namibian reptiles (Griffin 1998a). Emergency grazing and large-scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998a). The overall reptile diversity and endemism in the general Hochveld/Steinhausen area is estimated at between 61-70 species and 1-8 species, respectively (Jarvis *et al.* 2022). Griffin (1998a) presents figures of between 1-10 and 3-4 for endemic lizards and snakes, respectively, from the general area, while the closest protected areas, the Daan Viljoen (Windhoek) and Von Bach (Okahandja) Game Parks, have an estimated 79 and 76 species, respectively.

At least 62 species of reptiles are expected to occur in the general area with 16 species being endemic – i.e., 25.8% endemic. One species is classified as rare (*Rhinotyphlops lalandei*), 4 species are classified as vulnerable and protected game (*Stigmochelys pardalis*, *Psammobates oculiferus, Python natalensis* and *Varanus albigularis*), 1 species is classified as insufficiently known and 3 species as perripheral. The IUCN (2022) classifies 57 species as least concern (a few species have not yet been assessed by the IUCN Red List) while CITES classifies 7 species as either Appendix 2 and/or 3, respectively.

The 62 species expected to occur in the general area consist of at least 2 tortoises (both vulnerable and protected game), 1 terrapin, 29 snakes (3 blind, 1 thread, 1 python, 1 burrowing asp, 1 purple-glossed, 2 quill snouted and 20 typical snakes) of which 6 species (20.7%) are endemic, 1 species insufficiently known/rare (*Rhinotyphlops lalandei*) and 1 species as vulnerable/protected game (*Python natalensis*), 3 worm lizards, 8 skinks (1 endemic), 6 Old World lizards (2 endemic), 1 girdled lizard (endemic), 1 monitor, 2 agamas, 1 chamaelon and 8 geckos (6 endemic – i.e., 75% endemic).

Table 1. Reptile diversity expected (literature study) and confirmed (fieldwork - √) including author's confirmed records (and farm staff sightings - √#) from other studies conducted from the general area (See: Cunningham 2013).

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status		
				SARDB	IUCN	CITES
TORTOISES AND TERRAPINS						
Stigmochelys pardalis	Leopard Tortoise	√	Vulnerable; Peripheral; Protected Game		LC	C2
Psammobates oculiferus	Kalahari Tent Tortoise	√	Vulnerable; Protected Game			C2
Pelomedusa (galeata) subrufa	Marsh/Helmeted Terrapin	√#	Secure		LC	C3
SNAKES						
Blind Snakes						
Rhinotyphlops boylei	Boyle's Beaked Bland Snake		Endemic; Secure		LC	
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake		Insufficiently known; Rare?		LC	
Rhinotyphlops schinzi	Schinz's Beaked Blind Snake		Endemic; Secure	P	LC	
Thread Snakes						
Leptotyphlops scutifrons	Peters' Thread Snake	√	Secure		LC	
Pythons						
Python natalensis	Southern African Python	√#	Vulnerable; Peripheral; Protected Game	V	LC	C2
Burrowing Snakes						
Atractaspis bibronii	Bibron's Burrowing Asp		Secure		LC	
Purple-glossed Snakes						
Amblyodipsas ventrimaculata	Kalahari Purple-glossed Snake					
Quill Snouted Snakes			Secure		LC	
Xenocalamus bicolour bicolor	Bicoloured Quill-snouted Snake					
Xenocalamus mechowii	Elongate Quill-snouted Snake		Secure		LC	
Typical Snakes			Secure		LC	
Boaedon (Lamprophis) fuliginosus	Brown House Snake					
Lycophidion capense	Cape Wolf Snake				LC	
Pseudaspis cana	Mole Snake		Secure		LC	
Prosymna bivittata	Two-striped Shovel-snout		Secure		LC	
Hemirhagerrhis viperinus	Viperine Bark Snake		Endemic; Secure		LC	
Dipsina multimaculata	Dwarf Beaked Snake		Endemic; Secure		LC	
Psammophylax tritaeniatus	Striped Skaapsteker		Secure		LC	
Psammophis notostictus	Karoo Sand Snake		Secure		LC	

Psammophis leightoni trinasalis	Namib Sand Snake		Secure		LC	
Dasypeltis scabra	Common/Rhombic Egg Eater		Secure		LC	
Telescopus semiannulatus semiannulatus	Eastern Tiger Snake		Secure		LC	
Dispholidus typus	Boomslang		Secure		LC	
Aspidelaps lubricus infuscatus	Coral Snake		Secure		LC	
Aspidelaps scutatus scutatus	Shield-nose Snake	√#	Secure		LC	
Elapsoidea sundewallii	Sundevall's Garter Snake		Endemic; Secure		LC	
Naja (annulifera) anchietae	Snouted Cobra	√	Secure		LC	
Naya nigricincta	Black-necked Spitting Cobra	√#	Endemic; Secure		LC	
Dendroaspis polylepis	Black Mamba	√#	Secure		LC	
Bitis arietans	Puff Adder	√#	Secure		LC	
Bitis caudalis	Horned Adder		Secure		LC	
WORM LIZARDS						
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard		Secure		LC	
Monopeltis infuscata	Dusky Spade-snouted Worm Lizard		Secure		LC	
Dalophia pistillum	Blunt-tailed Worm Lizard		Secure	P	LC	
LIZARDS						
Skinks						
Acontias (percivali) occidentalis	Percival's Legless Skink					
Lygosoma sundevallii	Sundevall's Writhing Skink		Secure		LC	
Trachylepis capensis	Cape Skink		Secure		LC	
Trachylepis occidentalis	Western Three-striped Skink		Secure		LC	
Trachylepis spilogaster	Kalahari Tree Skink		Endemic; Secure		LC	
Trachylepis striata wahlbergi	Striped Skink		Secure		LC	
Trachylepis sulcata	Western Rock Skink		Secure		LC	
Trachylepis variegata punctulata	Variegated Skink		Secure		LC	
Old World Lizards						
Heliobolus lugubris	Bushveld Lizard		Secure		LC	
Meroles squamulosus (Ichnotropis squamulose)	Common Rough-scaled Lizard		Secure		LC	
Nucras intertexta	Spotted Sandveld Lizard		Endemic; Secure		LC	
Nucras holubi	Holub's Sandveld Lizard		Secure		LC	
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard		Endemic; Secure		LC	
Pedioplanis namaquensis	Namaqua Sand Lizard	√	Secure		LC	
Girdled Lizards						
Karusasaurus (Cordylus) jordani	Jordan's Girdled Lizard		Endemic; Secure		LC	C2
Monitors						
Varanus albigularis	Rock or White-throated Monitor	√#	Vulnerable; Peripheral;	S to V	LC	C2

		Protected Game		
Agamas				
Agama achuleata	Ground Agama	Secure		
Agama anchietae	Anchietae's Agama	Secure	LC	
Chameleons				
Chamaeleo dilepis	Flap-neck Chameleon	Secure	LC	C2
Geckos				
Chondrodactylus angulifer angulifer	Giant Ground Gecko	Endemic; Secure	LC	
Lygodactylus bradfieldi	Bradfield's Dwarf Gecko	Endemic; Secure	LC	
Narudasia festiva	Festive Gecko	Endemic; Secure	LC	
Pachydactylus bicolor	Velvety Thick-toed Gecko	Endemic; Secure	LC	
Pachydactylus capensis	Cape Thick-toed Gecko	Endemic; Secure	LC	
Pachydactylus turneri	Turner's Thick-toed Gecko	Secure		
Pachydactylus punctatus	Speckled Thick-toed Gecko	Secure	LC	
Ptenopus garrulus garrulus	Common Barking Gecko	Endemic; Secure	LC	

Namibian conservation and legal status according to the Nature Conservation Ordinance No 4 of 1975
Endemic – includes Southern African Status (Branch 1998)
SARDB (2004): S to V – Safe to Vulnerable; V – Vulnerable; P – Peripheral
IUCN (2022): LC – Least Concern [All other species not yet assessed]
CITES: CITES Appendix 2/3 species

Source for literature review: Alexander and Marais (2007), Branch (1998), Branch (2008), Bonin *et al.* (2006), Boycott and Bourquin (2000), Broadley (1983), Buys and Buys (1983), Cunningham (2006), Cunningham (2013), Griffin (2003), Hebbard (n.d.), IUCN (2022), Marais (1992), SARDB (2004), Tolley and Burger (2007)

Tortoises (both species being vulnetrable and protected game), snakes (29 species with 6 species being endemic) and geckos (8 species with 6 species being endemic) are the most important groups. Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a). Geckos expected and/or known to occur in the general area have the highest occurrence of endemics (75%) of all the reptiles in this area. Griffin (1998a) confirms the importance of the gecko fauna in Namibia.

Tortoises are viewed as the group of reptiles most under threat in Namibia (Griffin 1998a) making *Stigmochelys pardalis* and *Psammobates oculiferus* probably the most important reptiles expected in the area followed by the python (*P. natalensis*) and *Varanus albigularis*. All the above-mentioned species are either consumed as food or indiscriminately killed when encountered – e.g., *Python natalensis*. Delalande's Beaked Blind Snake (*Rhinotyphlops lalandei*) is classified as insufficiently known, probably rare (Griffin 2003) making it another important species potentially occurring in the general area.

During the fieldwork only 5 species were confirmed from the area which included 2 tortoises, 2 snakes and 1 3 Old World lizard (Figures 3-6). Furthermore, another 7 species which include 1 terapin, 1 python, 4 typical snakes and 1 monitor, were confirmed by the farm staff interviewed and identified by Cunningham (2013) from the general area – i.e., 12 species confirmed from the area – See Table 1.

Since reptiles are an understudied group of animals, especially in Namibia, it is expected that more species may be in the general area than presented in Table 1.

Figure 3. *Stigmochelys pardalis* (leopard tortoise) – vulnerable, peripheral, protected game – observed in the Heap Leach Option 3 area.

Figure 4. *Psammobates oculiferus* (Kalahari tent tortoise) – vulnerable, protected game – observed on the general area.

Figure 5. *Naja (annulifera) anchietae* (snouted cobra) – secure – observed in the Pit area.

Figure 6. *Leptotyphlops scutifrons* (Peters' thread snake) – secure – observed in the alternate road area.

The most important species expected to occur in the general area (See Table 1) are viewed as the tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; *Varanus albigularis* and some of the endemic and little-known gecko species – e.g., *Pachydactylus* species. Tortoises, snakes and monitor lizards are routinely killed for food or as perceived threats. Other important species are those viewed as "rare" – i.e., *Rhinotyphlops lalandei* although very little is known about this species.

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique reptiles are expected to be exclusively associated with this area. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on reptiles potentially occurring in the area.

3.2 Amphibian Diversity

Amphibian diversity known and/or expected to occur in the Hochveld/Steinhausen area, including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 2.

Amphibians are declining throughout the world due to various factors of which much has been ascribed to habitat destruction. Basic species lists for various habitats are not always available with Namibia being no exception in this regard while the basic ecology of most species is also unknown. Approximately 4,000 species of amphibians are known worldwide with just over 200 species known from southern Africa and at least 57 species expected to occur in Namibia. Griffin (1998b) puts this figure at 50 recorded species and a final species richness of approximately 65 species, 6 of which are endemic to Namibia. This "low" number of amphibians from Namibia is not only as a result of the generally marginal desert habitat, but also due to Namibia being under studied and under collected. Most amphibians require water to breed and are therefore associated with the permanent water bodies, mainly in northeast Namibia.

Table 2. Amphibian diversity expected (literature study) and confirmed (fieldwork - √) including author's confirmed records (and farm staff sightings - √#) from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International Status: IUCN
Rain Frogs				
Breviceps adspersus	Bushveld Rain Frog	√#		LC
Toads				
Amietophrynus poweri	Western Olive Toad			LC
Kassinas				
Kassina senegalensis	Bubbling Kassina			LC
Rubber Frog				
Phrynomantis annectens	Marbled Rubber Frog		Endemic	LC
Phrynomantis bifasciatus	Banded Rubber Frog			LC
Puddle Frog				
Phrynobatrachus mababiensis	Dwarf Puddle Frog			LC
Phrynobatrachus natalensis	Snoring Puddle Frog			LC
Cacos				
Cacosternum boettgeri	Boettger's Caco			LC
Bullfrogs				
Pyxicephalus adspersus	Giant Bullfrog	√#	Near Threatened	LC
Sand Frogs				
Tomopterna tandyi	Tandy's Sand Frog			LC
Platannas				
Xenopus laevis	Common Platanna			LC

Endemic – (Griffin 1998b)
Near threatened – (Du Preez and Carruthers 2009)
IUCN (2022): LC – Least Concern

Source for literature review: Carruthers (2001), Channing (2001), Channing and Griffin (1993), Du Preez and Carruthers (2009), IUCN (2022), Passmore and Carruthers (1995), SARDB (2004)

According to Jarvis *et al.* (2022), the overall frog diversity in the general Hochveld/Steinhausen area is estimated at between 9-12 species. Griffin (1998b) puts the species richness in the general area at 10-14 species, while the closest protected areas, the Daan Viljoen (Windhoek) and Von Bach (Okahandja) Game Parks, have an estimated 13 and 11 species, respectively.

According to the literature, at least 11 species of amphibians can occur in suitable habitat in the general area. The area is underrepresented, with 2 rubber and puddle frogs, respectively and 1 species each for rain, toad, kassina, caco, bullfrog, sand and platanna known and/or expected (i.e., potentially found in suitable habitat) to occur in the area. Of these, 1 species is endemic (*Phrynomantis annectens*) (Griffin 1998b) and 1 species classified as near threatened (*Pyxicephalus adspersus*) due to habitat loss and development (Du Preez and Carruthers 2009) – i.e. 18.2% of amphibians of conservation value from the general area. *Pyxicephalus adspersus* is more common in northern Namibia where their numbers are also declining due to overutilization as food by humans (M. Griffin pers. com.).

The most important species are the endemic *Phrynomantis annectens* although it is widespread in Namibia and not exclusively associated with the ML197 area. The Otjivero Dam to the south in the vicinity of Omitara and temporary pools in the Black Nossob River, and its tributaries, are viewed as potential amphibian habitat in the general area. Other potential habitats in the area include farm reservoirs and earth dams although the latter are also dependant on localised showers and temporary of nature.

During the fieldwork standing surface water was observed in small artificial ground dams and as overflow around some farm reservoirs – i.e., likely amphibian breeding habitat (Figure 7) – although no surface water was observed in the Black Nossob River and ephemeral pans throughout the area (Figures 8 & 9). However, no tadpoles and/or amphibians were observed in any of these potential habitats although *Phrynomantis annectens* occurs in large numbers in the ephemeral pans when flooded (H. Derks *Pers. com.*) while *Breviceps adspersus* have been observed further to the east (Pers. obs.).

Figure 7. A farm reservoir with overflow around it serve as potential amphibian, albeit artificial.

Figure 8. Black Nossob River as potential amphibian habitat during the rainy season.

Figure 9. Ephemeral pans throughout the area are habitat to *Pyxicephalus adspersus* (giant bulfrog) – near threatened – and viewed as important habitat to be avoided as far as possible.

Important species include the 2 endemics – *Poyntonophrynus hoeschi* and *Phrynomantis annectens* and *Pyxicephalus adspersus* which are classified as "near threatened" in southern Africa (Du Preez and Carruthers 2009). The latter species numbers are decreasing throughout its range in Namibia mainly due to being targeted as food (Griffin *pers. com*). Although *Phrynomantis annectens* are known to occur in the various ephemeral pans throughout the ML197, they occur widespread throughout Namibia and are not exclusively associated with the ML197 area.

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique amphibians are expected to be exclusively associated with this area. However, the ephemeral pans are viewed as important habitat for *Phrynomantis annectens* and should be avoided and/or incorporated within the proposed mine infrastructures as far as possible. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

3.3 Mammal Diversity

Mammal diversity known and/or expected to occur in the Hochveld/Steinhausen area, including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 3.

Namibia is well endowed with mammal diversity with at least 250 species occurring in the country. These include the well known big and hairy as well as a legion of smaller and lesser-known species. Currently 14 mammal species are considered endemic to Namibia of which 11 species are rodents and small carnivores of which very little is known. Most endemic mammals are associated with the Namib and escarpment with 60% of these rock-dwelling (Griffin 1998c). According to Griffin (1998c) the endemic mammal fauna is best characterized by the endemic rodent family *Petromuridae* (Dassie rat) and the rodent genera *Gerbillurus* and *Petromyscus*.

Overall terrestrial diversity and endemism – all species – is classified as “average” and “high”, respectively, in the area (Mendelsohn *et al.* 2002). The overall mammal diversity in the general area is estimated at between 61-75 species with 1-2 species being endemic to the area (Jarvis *et al.* 2022). Griffin (1998c) puts the species richness distribution of endemics also between 5-6 species in the general area while the closest protected areas, the Daan Viljoen (Windhoek) and Von Bach (Okahandja) Game Parks, have an estimated 65 and 60 species, respectively.

According to the literature at least 82 species of mammals are known and/or expected to occur in the general area of which 3 species (3.7%) are classified as endemic. The Namibian legislation classifies 2 species as rare (*Atelerix frontalis angolae*, *Felis nigripes*), 9 species as vulnerable (*Galago moholi*, *Smutsia (Manis) temminckii*, *Proteles cristatus*, *Hyaena brunnea*, *Acinonyx jubatus*, *Felis silvestris*, *Otocyon megalotis, Vulpes chama*, *Tragelaphus oryx*), 1 species as specially protected game, 11 species as protected game, 7 species as insufficiently known, 1 species as indeterminate, 5 species as peripheral, 4 species as huntable game and 4 species as problem animals. The Red List for Namibian carnivores classifies 1 species as endangered (*Acinonyx jubatus*), 2 species as vulnerable (*Panthera pardus*, *Felis nigripes*) and 1 species as near threatened (*Parahyaena (Hyaena) brunnea*) (NCE, LCMAN, MEFT 2022). At least 29.3% (24 species) of the mammalian fauna that occur or are expected to occur in general area are represented by rodents of which 3 species (12.5%) are endemic. This is followed by bats with 25.6% (21 species) species although 3 species listed by Monadjem *et al.* (2010) are not listed by Griffin (2005) while 1 species is listed as insufficiently known and carnivores with 22% (18 species) of which 1 species (5.6%) is viewed as rare. The 3 species of bat not listed – i.e., according to Monadjem *et al.* (2010) – potentially occur in the general Hochveld/Steinhausen area according to a habitat modelling programme although not yet actually confirmed.

The IUCN (2022) lists 4 species as vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Felis nigripes*) and 2 species as near threatened (*Eidolon helvum, Parahyaena (Hyaena) brunnea*). The SARDB (2004) lists 1 species as rare, 3 species as vulnerable, 10 species as near threatened and 8 species as data deficient while CITES lisdts 8 species as either Appendix 1 (3 species) or Appendix II (5 species). The House Mouse (*Mus musculus*) is viewed as an invasive alien species to the area.

Table 3. Mammal diversity expected (literature study) and confirmed (fieldwork - √) including author's confirmed records (and farm staff sightings - √#) from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Red List – Namibia (carnivores)	Namibian conservation and legal status	International Status		
					SARDB	IUCN	CITES
Elephant Shrews							
Elephantulus intufi	Bushveld Elephant-shrew			Secure	DD		
Aardvark							
Orycteropus afer	Aardvark	√		Secure; Protected Game			
Shrews							
Crocidura fuscomurina	Tiny Musk Shrew			Secure	DD		
Crocidura cyanea	Reddish-grey Musk Shrew			Secure	DD		
Crocidura hirta	Lesser Red Musk Shrew			Secure	DD		
Hyrax							
Procavia capensis	Rock Hyrax	√		Secure; Problem animal			
Bats							
Eidolon helvum	African Straw-coloured Fruit Bat			Secure; Migrant		NT	
Hipposideros caffer	Sundevall's Roundleaf Bat			Secure	DD		
Macronycteris (Hipposideros) gigas	Giant Leaf-nosed Bat			Not listed			
Macronycteris (Hipposideros) vittatus	Striped Leaf-nosed Bat			Not listed			
Rhinolophus clivosus	Geoffroy's Horseshoe Bat			Secure	NT		
Rhinolophus darlingi	Darling's Horseshoe Bat			Secure; Peripheral	NT		
Rhinolophus denti	Dent's Horseshoe Bat			Secure	NT; DD		
Rhinolophus fumigatus	Rüppell's Horseshoe Bat			Secure	NT		
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat			Not Listed			
Taphozous mauritianus	Mauritian Tomb Bat			Secure			
Nycteris thebaica	Egyptian Slit-faced Bat			Secure			
Chaerephon nigeriae	Nigerian Free-tailed Bat			Secure			
Tadarida aegyptiaca	Egyptian Free-tailed Bat			Secure			
Miniopterus natalensis	Natal Long-fingered Bat			Secure	NT		
Eptesicus hottentotus	Long-tailed Serotine Bat			Secure			
Laephotis botswanae	Botswana Long-eared Bat			Secure	V		
Neoromicia capensis	Cape Serotine Bat			Secure			
Neoromicia zuluensis	Zulu Serotine			Secure			
Pipistrellus reuppellii	Rűppel's Pipistrelle			Insufficiently Known; Peripheral			

Pipistrellus rusticus	Rusty Pipistrelle		Secure	NT	
Scotophilus dinganii	Yellow-bellied House Bat		Secure		
Hares and Rabbits					
Lepus saxatilis	Scrub Hare	√	Secure		
Rodents					
Molerat					
Cryptomys damarensis	Damaraland Mole-Rat	√	Secure		
Porcupine					
Hystrix africaeaustralis	Cape Porcupine		Secure		
Rats and Mice					
Petromys typicus	Dassie Rat		Endemic; Secure	NT	
Pedetes capensis	Springhare		Secure		
Xerus inaurus	South African Ground Squirrel	√	Secure		
Graphiurus platyops	Rock Dormouse		Endemic; Secure	DD	
Graphiurus murinus	Woodland Dormouse		Secure		
Rhabdomys pumilio	Four-striped Grass Mouse		Secure		
Mus indutus	Desert Pygmy Mouse		Secure		
Mastomys coucha	Southern Multimammate Mouse		Secure		
Thallomys paedulcus	Acacia Rat		Secure		
Thallomys nigricauda	Black-tailed Tree Rat		Secure		
Aethomys chrysophilus	Red Veld Rat		Secure		
Micaelamys (*Aethomys*) *namaquensis*	Namaqua Rock Mouse		Secure		
Desmodillus auricularis	Cape Short-tailed Gerbil		Secure		
Gerbillurus paeba	Hairy-footed Gerbil		Insufficiently Known		
Tatera leucogaster	Bushveld Gerbil	√	Secure	DD	
Tatera brantsii	Highveld Gerbil		Secure		
Saccostomus campestris	Pouched Mouse	√	Secure		
Malacothrix typica	Gerbil Mouse		Secure		
Petromyscus collinus	Pygmy Rock Mouse		Endemic; Secure		
Mus musculus	House Mouse		Invasive alien		
Primates					
Galago moholi	South African Galago		Vulnerable; Protected Game		C2
Papio ursinus	Chacma Baboon	√	Secure; Problem animal		C2
Hedgehog					
Atelerix frontalis angolae	Southern African Hedgehog		Insufficiently Known; Rare; Protected Game	Rare; NT	
Pangolin					

Smutsia (Manis) temminckii	Ground Pangolin	√#		Vulnerable; Peripheral; Protected Game	V	V	C2
Carnivores							
Proteles cristatus	Aardwolf			Insufficiently Known; (Vulnerable?); Peripheral			
Parahyaena (Hyaena) brunnea	Brown Hyena	√#	NT	Insufficiently Known; (Vulnerable?); Peripheral	NT	NT	
Acinonyx jubatus	Cheetah	√#	E	Vulnerable; Protected Game	V	V	C1
Panthera pardus	Leopard	√#	V	Secure?; Peripheral; Protected Game		V	C1
Caracal caracal	Caracal			Secure; Problem Animal			C2
Felis silvestris	African Wild Cat			Vulnerable			C2
Felis nigripes	Black-footed Cat		V	Indeterminate; Rare		V	C1
Genetta genetta	Small Spotted Genet			Secure			
Suricata suricatta	Suricate			Secure			
Cynictis penicillata	Yellow Mongoose			Secure			
Galerella sanguinea	Slender Mongoose			Secure			
Mungos mungo	Banded Mongoose			Secure			
Helogale parvula	Dwarf Mongoose			Secure			
Otocyon megalotis	Bat-eared Fox	√		Vulnerable?; Peripheral			
Vulpes chama	Cape Fox			Vulnerable?			
Canis mesomelas	Black-backed Jackal	√		Secure; Problem animal			
Mellivora capensis	Honey Badger/Ratel			Secure; Protected Game	NT		
Ictonyx striatus	Striped Polecat			Secure			
Pigs							
Phacochoerus africanus	Common Warthog	√		Secure; Huntable Game			
Antelopes							
Tragelaphus strepsiceros	Greater Kudu	√		Secure; Huntable Game			
Tragelaphus oryx	Eland	√#		Insufficiently Known; Vulnerable?; Protected Game			
Alcelaphus buselaphus	Red Hartebeest	√		Secure; Protected Game			
Oryx gazella	Gemsbok	√		Secure; Huntable game			
Sylvicapra grimmia	Common Duiker			Secure			
Antidorcas marsupialis	Springbok	√		Secure; Huntable game			
Madoqua damarensis	Damara Dik-dik			Insufficiently Known; Protected Game			
Raphicerus campestris	Steenbok	√		Secure; Protected Game			
Oreotragus oreotragus	Klipspringer			Secure; Specially Protected Game			

SARDB (2004): R – Rare, E – Endangered, V – Vulnerable, NT – Near Threatened, DD – Data Deficient
IUCN (2022): V – Vulnerable, NT – Near Threatened. All other species not listed are viewed as “Least Concern” by IUCN (2022)
CITES: CITES Appendix 1/2 species

Red List – Namibia (carnivores): E – Endangered; V – Vulnerable; NT – Near Threatened. All other species are classified as LC – Least Concern
*Monadjem *et al.* (2010)

Source for literature review: De Graaff (1981), Griffin and Coetzee (2005), Estes (1995), Frost (2014), IUCN (2022), Joubert and Mostert (1975), Monadjem *et al.* (2010), NCE, LCMAN, MEFT (2022), SARDB (2004), Skinner and Smithers (1990), Skinner and Chimimba (2005), Stander and Hanssen (2003) and Taylor (2000)

Mus musculus are generally known as casual pests and not viewed as problematic although they are known carriers of "plague" and can cause economic losses.

The most important species from the general area are all the endemics as well as those classified by the Namibian legislation as rare (*Atelerix frontalis angolae*, *Felis nigripes*) and vulnerable (*Galago moholi*, *Smutsia (Manis) temminckii*, *Proteles cristatus*, *Parahyaena (Hyaena) brunnea*, *Acinonyx jubatus*, *Felis silvestris*, *Otocyon megalotis, Vulpes chama*, *Tragelaphus oryx*); carnivores classified by the Red List (Namibia) as endcangered (*Acinonyx jubatus*), vulnerable (*Panthera pardus*, *Felis nigripes*) and near threatened (*Parahyaena (Hyaena) brunnea*) as well as those classified by the IUCN (2022) as vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Felis nigripes*) and near threatened (*Eidolon helvum, Parahyaena (Hyaena) brunnea*). The various bats – many listed as vulnerable and near threatened (IUCN 2022, SARDB 2004) – are potentially also important as these are understudied, and little known throughout Namibia. The important carnivores classified as vulnerable and near threatened by the IUCN (2022) are often indiscriminately persecuted as stock thieves in Namibia.

Habitat alteration and overutilization are the two primary processes threatening most mammals (Griffin 1998c) with species probably underrepresented in the abovementioned table for the general area being the bats and rodents, as these groups have not been well documented from the central/eastern part of Namibia.

During the fieldwork only 16 species of mammals were confirmed (i.e., actually captured, observed and or other evidence – e.g., tracks, scats, etc. See Figure 10) to occur in the ML197 Project area while another 5 species were confirmed by the farm staff – i.e., 21 species confirmed for the area. Other species observed and/or occurring on the farms include blue wildebeest, black wildebeest, blesbuck, common impala, giraffe, lechwe, Burchel's zebra, waterbuck, etc. (Figure 11) although these were introduced and do not occur naturally in the general area and consequently excluded in Table 3 (the farms are operated as a hunting farm unit).

Figure 10. Evidence of *Cryptomys damarensis* (Damaraland mole rat) were observed throughout the sandy areas.

Figure 11. Subadult waterbuck (*Kobus ellipsiprymnus*) males observed in the area.

A total of 42 Sherman small mammal traps (Figure 12) were set for 2 nights at 3 sites throughout the area (Table 4). This resulted in 6 captures of 2 species – *Saccostomus campestris* and *Tatera leucogaster* – i.e., 14.3% capture success (Figures 13-14).

Table 4. Small mammals trap sites.

Number	Date	Traps	Area	Habitat	Coordinates		Captures	Species
1	14/3/2023	20	Black Nossob River	Ephemeral river	21 50 13.1	17 55 48.2	1	*Saccostomus campestris*
2	15/3/2023	11	Heap Leach & Plant	Sandy plains	21 49 36.3	17 55 17.4	4	*Tatera leucogaster*
							1	*Saccostomus campestris*
3	15/3/2023	11	Pit	Sandy plains	21 49 33.2	17 55 59.7	0	
		42					**6**	

Figure 12. Sherman collapsible small mammal traps were baited and used to trap rodents at various sites in different habitats.

Figure 13. *Saccostomus campestris* (pouched mouse) capture in the Black Nossob River and sandy plain habitat.

Figure 14. *Tatera leucogaster* (bushveld gerbil) captured in sandy plain habitat.

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique mammals are expected to be exclusively associated with this area. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on mammals potentially occurring in the area.

3.4 Avian Diversity

Bird diversity known and/or expected to occur in the Hochveld/Steinhausen area, including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 5.

Although Namibia's avifauna is comparatively sparse compared to the high rainfall equatorial areas elsewhere in Africa, approximately 658 species have already been recorded with a diverse and unique group of arid endemics (Brown *et al.* 1998, Maclean 1985). Fourteen species of birds are endemic or near endemic to Namibia with most Namibian endemics occurring in the savannas (30%) of which ten species occur in a north-south belt of dry savannah in central Namibia (Brown *et al.* 1998).

Bird diversity and endemism is viewed as "high" in the general Hochveld/Steinhausen area with 141-170 species, of which 5-7 species being endemic (Jarvis *et al.* 2022). Simmons (1998a) suggests 1-6 endemic species and a "average" ranking for southern African endemics and "average" ranking for red data birds expected from the general area. Although the Hochveld/Steinhausen area is not classified as an Important Birding Area (IBA) in Namibia (Jarvis *et al.* 2022; Simmons 1998a) the closest such IBA sites are located to the west (Namib-Naukluft Park); north (WaterbergPlateau Park) and south (Hardap Recreational Resort) of the ML197. However, the Otjivera Dam at Omitara may be an important site for aquatic birds in the general area.

At least 213 species of terrestrial ["breeding residents"] birds occur and/or could occur in the general area at any time (Hockey *et al.* 2006, Maclean 1985, Tarboton 2001). All the migrant and aquatic species have been excluded here. Eight of the 14 Namibian endemics

Table 5. Avian diversity expected (literature study) and confirmed (fieldwork - √) including author's confirmed records (and farm staff sightings - √#) from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN
Struthio camelus	Common Ostrich				
Scleroptila levaillantoides	Orange River Francolin			Near endemic	
Pternistis adspersus	Red-billed Spurfowl	√		Near endemic	
Pternistis swainsonii	Swainson's Spurfowl	√			
Coturnix coturnix	Common Quail				
Coturnix delegorguei	Harlequin Quail				
Numida meleagris	Helmeted Guineafowl	√			
Turnix sylvaticus	Kurrichane Buttonquail				
Indicator minor	Lesser Honeyguide				
Campethera bennettii	Bennett's Woodpecker				
Campethera abingoni	Golden-tailed Woodpecker				
Dendropicos fuscescens	Cardinal Woodpecker				
Dendropicos namaquus	Bearded Woodpecker				
Tricholaema leucomelas	Acacia Pied Barbet	√		Near endemic	
Tockus monteiri	Monteiro's Hornbill		Endemic		
Tockus erythrorhynchus	Red-billed Hornbill				
Tockus damarensis	Damara Hornbill		Endemic	Near endemic	
Tockus leucomelas	Southern Yellow-billed Hornbill	√		Near endemic	
Tockus nasutus	African Grey Hornbill	√			
Upupa africana	African Hoopoe				
Phoeniculus purpureus	Green Wood-Hoopoe				
Phoeniculus damarensis	Violet Wood-Hoopoe		E; Endemic		
Rhinopomastus cyanomelas	Common Scimitarbill	√			
Coracias caudatus	Lilac-breasted Roller	√			
Coracias naevius	Purple Roller	√			
Merops hirundineus	Swallow-tailed Bee-eater	√			
Colius colius	White-backed Mousebird	√		Endemic	
Urocolius indicus	Red-faced Mousebird				
Poicephalus rueppellii	Rüppell's Parrot		NT; Endemic	Near endemic	

Agapornis roseicollis	Rosy-faced Lovebird	√	Endemic	Near endemic	
Cypsiurus parvus	African Palm Swift				
Tachymarptis melba	Alpine Swift				
Apus bradfieldi	Bradfield's Swift			Near endemic	
Apus affinis	Little Swift	√			
Apus caffer	White-rumped Swift				
Corythaixoides concolor	Grey Go-away-bird	√			
Tyto alba	Barn Owl				
Otus senegalensis	African Scops-Owl				
Ptilopsis granti	Southern White-faced Scops-Owl				
Bubo africanus	Spotted Eagle Owl				
Bubo lacteus	Verreaux's Eagle-Owl	√			
Glaucidium perlatum	Pearl-spotted Owlet				
Glaucidium capense	African Barred Owlet				
Caprimulgus pectoralis	Fiery-necked Nightjar				
Caprimulgus tristigma	Freckled Nightjar				
Caprimulgus rufigena	Rufous-cheeked Nightjar				
Columba livia	Rock Dove				
Columba guinea	Speckled Pigeon				
Streptopelia capicola	Cape Turtle Dove	√			
Streptopelia senegalensis	Laughing Dove	√			
Turtur chalcospilos	Emerald-spotted Wood-Dove				
Oena capensis	Namaqua Dove	√			
Neotis ludwigii	Ludwig's Bustard		E	Near endemic	E
Ardeotis kori	Kori Bustard		NT		NT
Lophotis ruficrista	Red-crested Korhaan	√		Near endemic	
Afrotis afraoides	Northern Black Korhaan	√		Endemic	
Pterocles namaqua	Namaqua Sandgrouse			Near endemic	
Pterocles bicinctus	Double-banded Sandgrouse			Near endemic	
Pterocles burchelli	Burchell's Sandgrouse	√		Near endemic	
Burhinus capensis	Spotted Thick-knee				
Vanellus armatus	Blacksmith Lapwing				
Vanellus coronatus	Crowned Lapwing	√			
Rhinoptilus africanus	Double-banded Courser				
Rhinoptilus chalcopterus	Bronze-winged Courser				
Cursorius rufus	Burchell's Courser			Near endemic	
Cursorius temminckii	Temminck's Courser				

Elanus caeruleus	Black-shouldered Kite	√			
Haliaeetus vocifer	African Fish-Eagle		V		
Gyps africanus	White-backed Vulture	√	E		CE
Aegypius tracheliotos	Lappet-faced Vulture	√	V		E
Circaetus pectoralis	Black-chested Snake-Eagle	√			
Circaetus cinereus	Brown Snake-Eagle	√			
Terathopius ecaudatus	Bateleur		E		E
Circus maurus	Black Harrier		E	Vulnerable	E
Polyboroides typus	African Harrier-Hawk				
Melierax canorus	Southern Pale Chanting Goshawk	√		Near endemic	
Melierax gabar	Gabar Goshawk				
Accipiter badius	Shikra				
Accipiter minullus	Little Sparrowhawk				
Accipter ovampensis	Owambo Sparrowhawk				
Buteo augur	Augur Buzzard				
Buteo rufofuscus	Jackal Buzzard			Endemic	
Aquila rapax	Tawny Eagle	√	E		V
Aquila verreauxii	Verreaux's Eagle		NT		
Aquila spilogaster	African Hawk-Eagle				
Aquila pennatus	Booted Eagle		V		
Aquila wahlbergi	Wahlberg's Eagle				
Polemaetus bellicosus	Martial Eagle		E		E
Sagittarius serpentarius	Secretarybird		V		E
Polihierax semitorquatus	Pygmy Falcon				
Falco rupicolus	Rock Kestrel	√			
Falco rupicoloides	Greater Kestrel				
Falco biarmicus	Lanner Falcon				
Falco peregrinus	Peregrine Falcon		NT		
Egretta garzetta	Little Egret				
Ardea cinerea	Grey Heron				
Ardea melanocephala	Black-headed Heron				
Bubulcus ibis	Cattle Egret	√			
Scopus umbretta	Hamerkop				
Ciconia nigra	Black Stork		E		
Ephippiorhynchus senegalensis	Saddle-billed Stork		E		
Leptoptilos crumeniferus	Marabou Stork	√	NT		
Dicrurus adsimilis	Fork-tailed Drongo	√			

Terpsiphone viridis	African Paradise-Flycatcher			
Nilaus afer	Brubru			
Tchagra australis	Brown-crowned Tchagra			
Laniarius atrococcineus	Crimson-breasted Shrike	√		Near endemic
Telophorus zeylonus	Bokmakierie			Near endemic
Lanioturdus torquatus	White-tailed Shrike		Endemic	Near endemic
Batis pririt	Pririt Batis			Near endemic
Corvus capensis	Cape Crow			
Corvus albus	Pied Crow			
Lanius collaris	Common Fiscal	√		
Eurocephalus anguitimens	Southern White-crowned Shrike			Near endemic
Anthoscopus minutes	Cape Penduline Tit			Near endemic
Parus carpi	Carp's Tit		Endemic	Near endemic
Parus cinerascens	Ashy Tit			Endemic
Riparia paludicola	Brown-throated Martin			
Riparia cincta	Banded Martin	√		
Hirundu albigularis	White-throated Swallow			
Hirundo dimidiata	Pearl-breasted Swallow			
Hirundo cucullata	Greater Striped Swallow	√		
Hirundo semirufa	Red-breasted Swallow			
Hirundo spiloderna	South African Cliff-Swallow			
Hirundo fuligula	Rock Martin	√		
Pycnonotus nigricans	African Red-eyed Bulbul	√		Near endemic
Achaetps pycnopygius	Rockrunner		Endemic	Near endemic
Sylvietta rufescens	Long-billed Crombec			
Eremomela icteropygialis	Yellow-bellied Eremomela			
Eremomela usticollis	Burnt-necked Eremomela			
Acrocephalus baeticatus	African Reed-Warbler			
Acrocephalus gracilirostris	Lesser Swamp Warbler			
Turdoides bicolor	Southern Pied Babbler			Endemic
Parisoma subcaeruleum	Chestnut-vented Tit-Babbler			Near endemic
Zosterops pallidus	Orange River White-eye			Endemic
Cisticola chiniana	Rattling Cisticola			
Cisticola rufilatus	Tinkling Cisticola			
Cisticola subruficapilla	Grey-backed Cisticola			Near endemic
Cisticola juncidis	Zitting Cisticola			
Cisticola jaridulus	Desert Cisticola			

Prinia flavicans	Black-chested Prinia		
Malcorus pectoralis	Rufous-eared Warbler		Endemic
Camaroptera brevicaudata	Grey-backed Camaroptera		
Calamonastes fasciolatus	Barren Wren-Warbler		Near endemic
Mirafra passerina	Monotonous Lark		
Mirafra africana	Rufous-naped Lark		
Mirafra fasciolata	Eastern Clapper Lark		Near endemic
Mirafra sabota	Sabota Lark		
Calendulauda africanoides	Fawn-coloured Lark		Near endemic
Chersomanes albofasciata	Spike-heeled Lark		Near endemic
Certhilauda subcoronata	Karoo Long-billed Lark		Endemic
Eremopterix leucotis	Chestnut-backed Sparrowlark		
Eremopterix verticalis	Grey-backed Sparrowlark		Near endemic
Calandrella cinerea	Red-capped Lark		
Alauda starki	Stark's Lark		Near endemic
Spizocorys conirostris	Pink-billed Lark		
Monticola brevipes	Short-toed Rock Thrush		
Psophocichla litsitsirupa	Groundscraper Thrush		
Bradornis infuscatus	Chat Flycatcher		Near endemic
Melaenornis mariquensis	Marico Flycatcher	√	Near endemic
Muscicapa striata	Spotted Flycatcher		
Cercotrichas leucophrys	White-browed Scrub-Robin		
Cercotrichas paena	Kalahari Scrub-Robin	√	
Oenanthe monticola	Mountain Wheatear		Near endemic
Oenanthe pileata	Capped Wheatear		
Cercomela schlegelii	Karoo Chat		Near endemic
Cercomela familiaris	Familiar Chat		
Myrmecocichla formicivora	Ant-eating Chat		Endemic
Onychognathus nabouroup	Pale-winged Starling		Near endemic
Lamprotornis nitens	Cape Glossy Starling	√	
Lamprotornis australis	Burchell's Starling	√	
Cinnyricinclus leucogaster	Violet-backed Starling		
Creatophora cinerea	Wattled Starling	√	
Chalcomitra senegalensis	Scarlet-chested Sunbird		
Nectarinia fusca	Dusky Sunbird		Near endemic
Cinnyris mariquensis	Marico Sunbird		
Bualornis niger	Red-billed Buffalo-Weaver	√	

Sporopipes squamifrons	Scaly-feathered Finch	√	Near endemic
Plocepasser mahali	White-browed Sparrow-Weaver	√	
Philetairus socius	Sociable Weaver	√	Endemic
Ploceus intermedius	Lesser Masked-Weaver		
Ploceus velatus	Southern Masked-Weaver	√	
Ploceus rubiginosus	Chestnut Weaver		
Quelea quelea	Red-billed Quelea		
Euplectes afer	Yellow-crowned Bishop		
Euplectes orix	Southern Red Bishop		
Ortygospiza atricollis	African Quailfinch		
Amadina erythrocephala	Red-headed Finch		Near endemic
Estrilda erythronotos	Black-faced Waxbill		
Estrilda astrild	Common Waxbill		
Granatina granatina	Violet-eared Waxbill	√	
Uraeginthus angolensis	Blue Waxbill		
Pytilia melba	Green-winged Pytilia		
Vidua macroura	Pin-tailed Whydah		
Vidua paradisaea	Long-tailed Paradise-Whydah		
Vidua regia	Shaft-tailed Whydah	√	
Passer domesticus	House Sparrow		
Passer motitensis	Great Sparrow		Near endemic
Passer melanurus	Cape Sparrow		Near endemic
Passer griseus	Southern Grey-headed Sparrow		
Motacilla aguimp	African Pied Wagtail		
Motacilla capensis	Cape Wagtail	√	
Anthus cinnamomeus	African Pipit		
Anthus vaalensis	Buffy Pipit		
Anthus similes	Long-billed Pipit		
Serinus alario	Black-headed Canary		Endemic
Crithagra atrogulariis	Black-throated Canary		
Serinus flaviventris	Yellow Canary	√	Near endemic
Serinus albogularis	White-throated Canary		Near endemic
Emberiza impetuani	Lark-like Bunting	√	Near endemic
Emberiza tahapisi	Cinnamon-breasted Bunting		
Emberiza capensis	Cape Bunting		Near endemic
Emberiza flaviventris	Golden-breasted Bunting		

This table excludes migratory birds (e.g., Petrel, Albatross, Skua, etc.), aquatic species (e.g., ducks, etc.) and species breeding extralimital (e.g., stints, sandpipers, etc.) and rather focuses on birds that are breeding residents or can be found in the area during any time of the year. This would imply that many more birds (e.g., Palaearctic migrants) could occur in the area depending on "favourable" environmental conditions.
Namibian status: E – Endangered, V- Vulnerable, NT – Near Threatened (Simmons *et al.* 2015)
Southern African status: Hockey *et al.* (2006)
IUCN (2022): CE – Critically Endangered, E – Endangered, V- Vulnerable, NT – Near Threatened. All other species not listed are viewed as "Least Concern" by IUCN (2022)

Source for literature review: Brown *et al.* (1998), Hockey *et al.* (2006), IUCN (2022), Komen (n.d.), Little and Crowe (2011), Maclean (1985), Peacock (2015), Simmons *et al.* (2015), Tarboton (2001)

are expected to occur in the general area (57.1% of all Namibian endemic species or 3.8% of all the species expected to occur in the area).

Fifty-eight (27.2% of all the birds expected) species have a southern African conservation rating with 11 species classified as endemic (19% of southern African endemics or 5.2% of all the birds expected) and 47 species classified as near endemic (81% of southern African endemics or 22.1% of all the birds expected) (Hockey *et al.* 2006).

Simmons *et al.* (2015) classify 9 species as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, bateleur, black harrier, tawny eagle, martial eagle, black stork, saddle-billed stork), 4 species as vulnerable (African fish-eagle, lappet-faced vulture, booted eagle, secretarybird) and 5 species as near threatened (Rüppell's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) from Namibia.

The IUCN (2022) classifies 1 species as critically endangered (white-backed vulture), 6 species as endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), 1 species as vulnerable (tawny eagle) and 1 species as near threatened (kori bustard).

During the fieldwork only 54 species of birds were confirmed (i.e., observed) to occur in the general ML197 Project area. Another 3 species (common swift, European bee eater, Egyptian goose) were also confirmed from the area, but excluded from Table 5, as these are either migrant or aquatic species – i.e., 57 species in total confirmed from the Project area. The most important species confirmed from the area during the fieldwork are white-backed vulture (E), lappet-faced vulture (V), tawny eagle (E) and marabou stork (NT) (Namibian conservation status indicated) (Figures 15-17).

A few other important species not included in Table 5, as these are aquatic and/or other species not viewed as breeding residents, but nevertheless important species and may pass through occasionally (especially when pans are flooded) include maccoa duck (NT), Cape vulture (CE), pallid harrier (NT), red-footed falcon (NT), black-necked grebe (NT) and great white pelican (V).

The most important species expected to occur in the general area are viewed as all the Namibian endemics, especially *Poicephalus rueppellii* (Rűppel's parrot) and the violet woodhoopoe (*Phoeniculus damarensis*). The violet woodhoopoe has the lowest estimated population size (±2,000 individuals) of all the Namibia endemics and known to be associated with large trees along ephemeral drainage lines, such as the Black Nossob River riparian vegetation. All the species classified by the IUCN (2022) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard) as well as those classified by Simmons *et al.* (2015) from Namibia as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard). As raptors are often mercilessly persecuted as perceived livestock predators (e.g., Verraux's eagle, martial eagle, etc.) or succumb as collateral damage in problem animal poisoning incidents (e.g., various vulture species), they are viewed as important species in the area. As white-backed vulture and lappet-faced vulture are known to breed in the general area albeit not in the ML197 Project area (H. Derks *pers.com.*), such nesting sites, should these be established and/or located in future, are viewed as extremely important and should be avoided at all costs.

Figure 15. White-backed vulture (Critically endangered, IUCN 2022 & Endangered, Simmons *et al.* 2015) observed in the area and although are known to nest in the general area, no nests were observed in the immediate ML197 Project area.

Figure 16. Lappet-faved vulture (Endangered, IUCN 2022 & Vulnerable, Simmons *et al.* 2015) observed in the area and although are known to nest in the general area, no nests were observed in the immediate ML197 Project area.

Figure 17. Marabou stork (Near threatened, Simmons *et al.* 2015) observed in the area and although are known to nest in the general area, no nests were observed in the immediate ML197 Project area.

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique birds are expected to be exclusively associated with this area. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on birds potentially occurring in the area.

3.5 Tree and Shrub Diversity

It is estimated that at least 60-81 species of larger trees and shrubs (>1m in height) – Coats Palgrave 1983 [81 spp.], Curtis and Mannheimer 2005 [80 spp.], Mannheimer and Curtis 2009 [76 spp.], Mannheimer and Curtis 2018 [69 spp.], Van Wyk and Van Wyk 1997 [60 spp.]) – occur in the general Hochveld/Steinhausen area.

The trees and shrubs known, and/or expected to occur in the general area (derived from Mannheimer and Curtis 2018) is presented in Table 6 below. Species indicated are know from the quarter-degree square distribution principle used and don't necessarily occur throughout the entire area. Some species indicated to possibly occur in the area according to Coats Palgrave (1983) and Van Wyk and Van Wyk (1997) is excluded here.

A total of 69 species of larger species of trees and shrubs are known and/or expected to occur in the general ML197 area. Two species of trees and shrubs (2.9%) expected to occur in the general Hochveld/Steinhausen area are classified as endemic, 1 species as near endemic (1.4%), 9 species (13%) are protected by the Forest Act No 12. of 2001, 1 species (1.4%) are protected under the Nature Conservation Ordinance No. 4 of 1975 while 1 species (1.4%) is classified as CITES Appendix 2 species. All the trees with some kind of conservation and/or protected status are viewed as important in the general Hochveld/Steinhausen area. The most important species are viewed as *Erythrina decora* and *Manuleopsis dinteri* (See Table 6).

Only 21 species of larger trees and shrubs were identified in the ML197 area with 9, 8 and 17 species identified in the following proposed development areas – Black Nossob River, River

& Road diversion area, Heap leach, Pit & Plant area, respectively (Although not included in Table 6, 2 more species – i.e., *Asparagus* spp. And *Leucosphaera bainesii* – were observed in the Black Nossob River and River and Heap Leach, Pit & Plant areas & Road diversion area, resepectively.

The most important protected species (including endemic/near endemic, etc.) are viewed as:

Black Nossob River

- *Acacia erioloba* and *Ziziphus mucronata*

River & Road diversion area

- *Acacia erioloba*

Heap leach, Pit & Plant area

- *Acacia erioloba* and *Ziziphus mucronata*

[Although African species of Acacia have undergone a name change and grouped into two distinct genera – i.e., Vachellia and Senegalia – which are clearly separated based on several morphological, anatomical & biochemical attributes (e.g., Vachellia has capitate inflorescences (round, head-like flowers) and spinescent stipules (thorns) while Senegalia has spicate inflorescences (flowers in spikes) and the stipules are non-spinescent), the International Code of Nomenclature for algae, fungi, and plants is not prescriptive and I stick to Acacia throughout]

Table 6. Tree and shrub diversity expected (literature study) and confirmed (fieldwork - √) from the general area. The trees and shrubs known, and/or expected to occur in the general area (derived from Mannheimer and Curtis 2018).

Species expected: Scientific name	ML197 area	Black Nossob River	River & Road Diversion	Heap Leach, Pit & Plant	Namibian conservation and legal status
Acacia ataxacantha					
Acacia erioloba	√		√	√	Protected (F#)
Acacia erubescens					
Acacia fleckii					
Acacia hebeclada	√	√	√	√	
Acacia hereroensis	√			√	
Acacia karroo	√	√	√	√	
Acacia luederitzii					
Acacia mellifera	√		√	√	
Acacia reficiens					
Acacia senegal					
Acacia tortilis					
Albizia anthelmintica					Protected (F#)
Aloe litoralis					NC, C2
Boscia albitrunca					Protected (F#)
Boscia foetida					
Catophractes alexandri					
Combretum apiculatum					
Combretum hereroense					
Commiphora africana					
Commiphora angolensis					
Commiphora glandulosa					
Commiphora pyracanthoides					
Commiphora tenuipetiolata					
Croton gratissimus					
Dichrostachys cinerea	√			√	
Diospyros lycioides	√			√	
Ehretia alba					
Erythrina decora					Protected (F#), End
Elephantorrhiza elephantina	√			√	

Elephantorrhiza suffruticosa					
Euclea undulata					
Faidherbia albida					Protected (F#)
Ficus cordata					Protected (F#)
Ficus ilicina					
Grewia bicolor					
Grewia flava	√	√		√	
Grewia flavescens					
Grewia retinervis					
Grewia tenax					
Gymnosporia senegalensis					
Laggera decurrens	√	√			
Lycium bosciifolium	√		√	√	
Lycium cinereum					
Lycium eenii	√	√			
Lycium hirsutum					
Maerua juncea					
Maerua schinzii					Protected (F#)
Manuleopsis dinteri					End
Montinia caryophyllacea					
Mundulea sericea					
Obetia carruthersiana					N-end
Olea europaea					
Ozoroa crassinervia					
Ozoroa paniculosa					
Pechuel-Loeschea leubnitziae					
Phaeoptilum spinosum	√			√	
Rhighozum brevispinosum	√	√			
Rhigozum trichotomum					
Searsia ciliata	√			√	
Searsia lancea	√	√			Protected (F#)
Searsia marlothii	√			√	
Searsia pyroides					
Searsia teninervis					
Steganotaenia araliacea					
Tarchonanthus camphoratus	√	√	√	√	
Terminalia sericea	√			√	
Vernonia cinerascens	√			√	

Ziziphus mucronata	√	√	√	√	Protected (F#)

End & N-end = Endemic & Near-endemic (Mannheimer and Curtis 2018)
F# – Forest Act No. 12 of 2001
NC – Nature Conservation Ordinance No. 4 of 1975
C2 – CITES Appendix 2 species

Source for literature review: Coats Palgrave (1983), Curtis and Mannheimer (2005), Loots (2005), Mannheimer and Curtis (2009), Mannheimer and Curtis (2018), Rothmann (2004), Steyn (2003), Van Wyk and Van Wyk (1997)

Black Nossob River

Seven species of larger trees and shrubs were encountered along transects conducted along the Black Nossob River totalling 1,000m. *Acacia karroo* (41%) and *Ziziphus mucronata* (40%) were the most dominant tree/shrub species observed during the fieldwork along the Black Nossob River habitat (Figure 18). *Ziziphus mucronata* (buffalo thorn) is a protected species and although not exclusively associated with the Black Nossob River and/or ML107 area, these trees not only stabilise the riparian riverbanks, but a source of food to a variety of browsers and birds and are usually some of the largerst trees in the area which consequently serve as habitat to a miriad of vertebrate species (e.g., cavity dwellers, perching/roosting/nesting sites, etc.) (Figure 19). They should not unnecessarily be destroyed. Permits would also be required to remove these species.

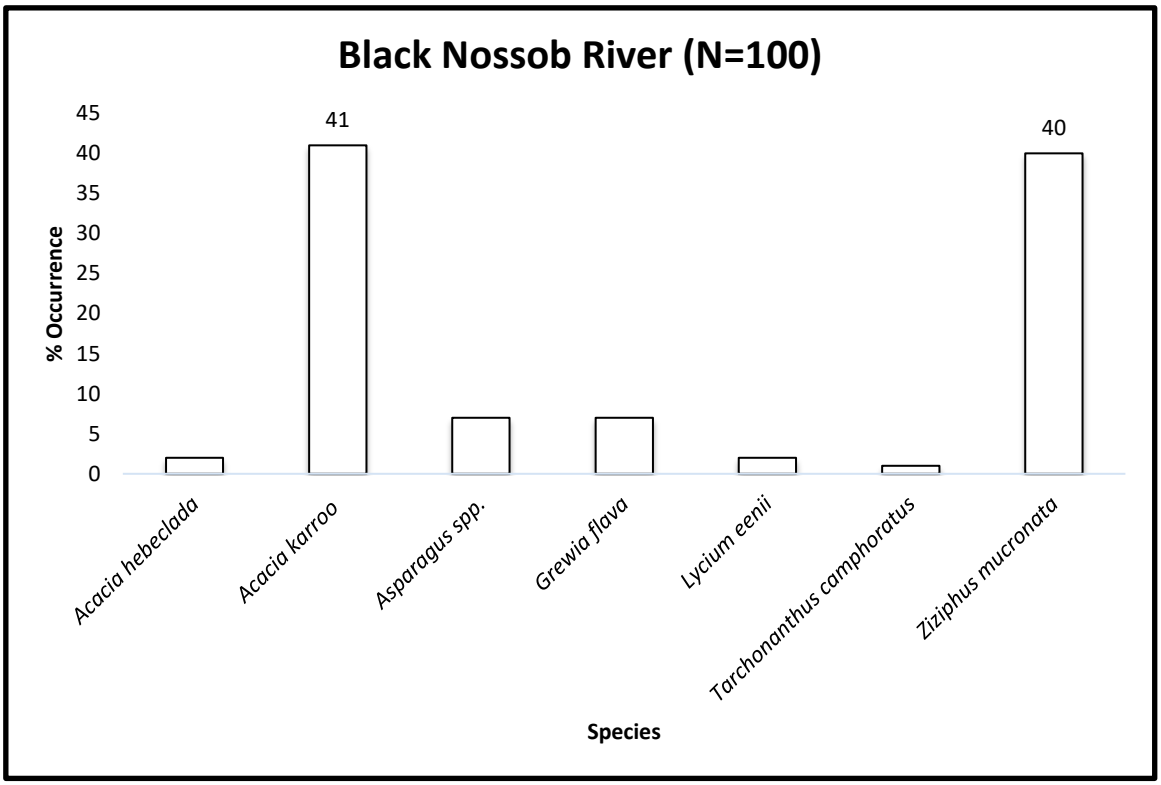

Figure 18. Tree and shrub species composition along various transects (total length – 1,000m @ 10m intervals) in the Black Nossob River habitat (N=100 points).

Figure 19. Large *Ziziphus mucronata* (buffalo thorn) – protected F – on the banks of the Black Nossob River in the ML197 area.

River & Road Diversion area

Eight species of larger trees and shrubs were encountered along various transects conducted in the proposed River and Road Diversion area to the south of the Black Nossob River totalling 1,000m. *Acacia hebeclada* (30%), *Tarchonanthus camphoratus* (27%) and *Leucosphaera bainesii* (20%) were the most dominant species observed during the fieldwork in this habitat (Figures 20 & 21). *Acacia* species account for 37% of the tree/shrub species composition in this area while protected species – *Acacia erioloba* (2%) and *Ziziphus mucronata* (2%) – account for 4%. The protected species are widespread throughout Namibia and not exclusively associated with the ML197 Project area. Permits would also be required to remove these species. However, as this habitat is erosion prone (i.e., soil capping and signs of erosion evident in area), all unnecessary activities should be avoided in this habitat as far as possible.

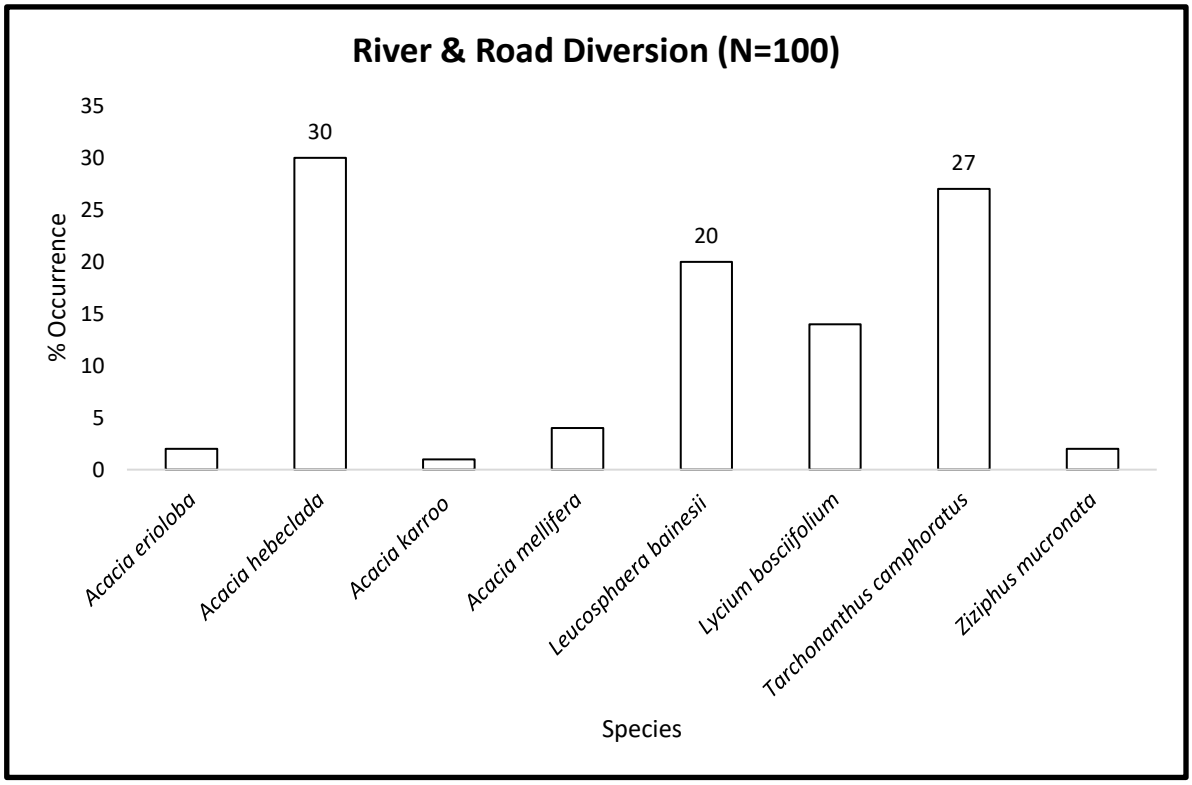

Figure 20. Tree and shrub species composition along various transects (total length – 1,000m @ 10m intervals) in the River & Road Diversion habitat (N=100 points).

Figure 21. Open area dominated by short *Acacia hebeclada* (candelpod) and *Tarchonanthus camphoratus* (camphor bush) trees/shrubs in the proposed River and Road Diversion habitat in the ML197 area. Fire damage has also stunted the growth in this area.

Heap Leach, Pit & Plant areas

Thirteen species of larger trees and shrubs were encountered along various transects totalling 1,500m in this habitat. *Tarchonanthus camphoratus* (38.6%), *Acacia hebeclada* (15.3%) and *Acacia erioloba* (14%) were the most dominant species observed during the fieldwork in this habitat (Figure 22). *Acacia* species account for 30.9% of the tree/shrub

species composition in this area while protected species – *Acacia erioloba* (14%) and *Ziziphus mucronata* (12%) (Figure 23) – account for 26%. However, the protected species are widespread throughout Namibia and not exclusively associated with the ML197 Project area. Permits would also be required to remove these species.

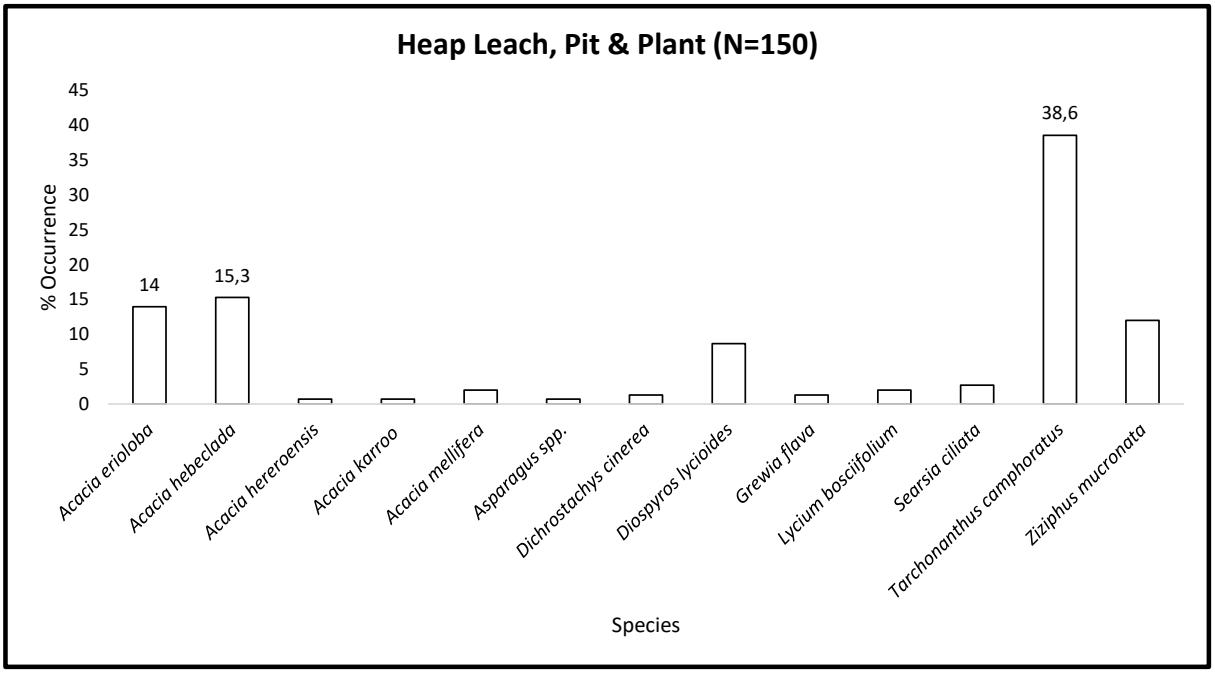

Figure 22. Tree and shrub species composition along various transects (total length – 1,500m @ 10m intervals) in the Heap Leach, Pit & Plant habitat (N=150 points).

Figure 23. Open area dominated by *Tarchonanthus camphoratus* (camphor bush), *Acacia hebeclada* (candelpod) and *Acacia erioloba* (camel thorn) trees/shrubs in the proposed Heap Leach Options, Pit & Plant habitat in the ML197 area.

The protected and/or unique species identified during the fieldwork throughout the proposed ML197 Project areas occur widespread throughout Namibia and not limited to the development area. However, unique habitats such as the Black Nossob River and

ephemeral pan habitats have larger specimens which often serve as habitat for a variety of species – e.g., raptor breeding sites, bark and cavity dwelling species (bats, birds and reptiles), etc. – and stabilise riverbanks while ephemeral pan habitats are important for amphibians and aquatic bird species.

Figure 24 indicates the tree/shrub species composition as determined for the Black Nossob River, River & Road Diversion and Heap Leach Options, Pit & Plant areas for comparative purposes. From this figure it is evident that *Acacia hebeclada* (candelpod), *Acacia karroo* (sweet thorn), *Tarchonanthus camphoratus* (camphor bush) and *Ziziphus mucrtonata* (buffalo thorn) are the most widespread and dominant species throughout the ML197 Project area.

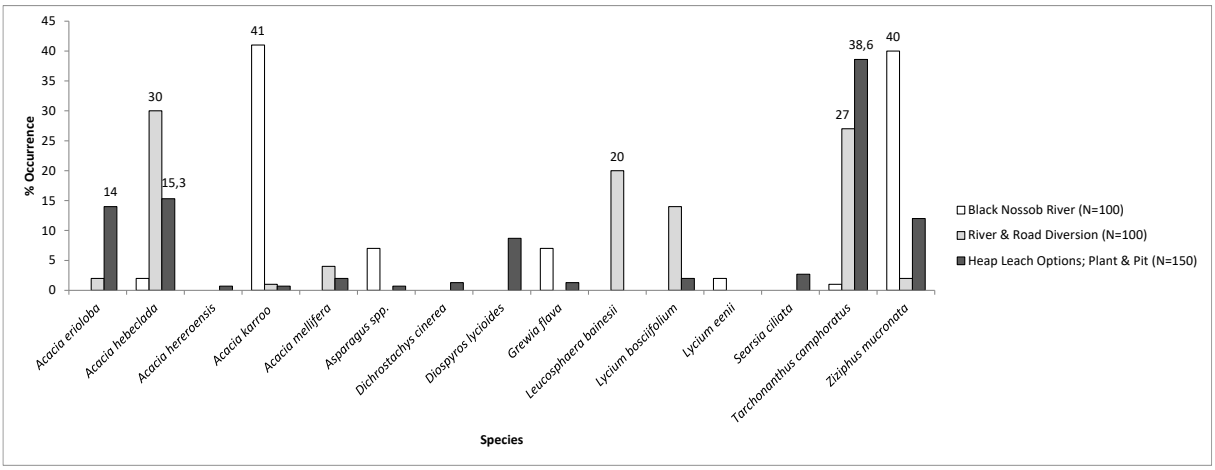

Figure 24. Tree/shrub species composition along various transects within the proposed development areas (Black Nossob River [N=100], River & Road Diversion [N=100], Heap Leach Options, Pit & Plant [N=150]) in the ML197 area.

Tree and shrub densities were determined for the Heap Leach Options, Pit & Plant area in twenty 10x10m field quadrates. The mean number of trees/shrubs per 10m² at the two sites selected was 3.5 (median) with a range between 2 and 7 trees/shrubs 10m², respectively. This can be converted to 350 trees/shrubs per hectare indicating that the area is open although there are patches of dense *Tarchonanthus camphoratus* in places, indicating the first signs of bush thickening, and should be monitored (Bester 1996, Cunningham 1998).

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique larger trees/shrubs are expected to be exclusively associated with this area. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on larger trees/shrubs potentially occurring in the area.

3.6 Grass Diversity

It is estimated that up to 101 grasses – 10 to 90 species – (Burke 2007 [10 spp.], Van Rooyen 2001 [35 spp.], Müller 2007 [90 spp.], Müller 1984 [38 spp.], Van Oudshoorn 1999 [50 spp.]) occur in the general Hochveld/Steinhausen area.

Of the 101 grasses are expected in the general area, 4 species are viewed as endemic (*Eragrostis omahekensis*, *Eragrostis scopelophila*, *Pennisetum foermeranum* and *Setaria finite*). *Pennisetum foermeranum* is associated with rocky mountainous terrain and consequently only expected is such suitable habitat. *Eragrostis omahekensis* is virtually only found on disturbed soils – e.g., close to watering points – while *Eragrostis scopelophila* is associated with mountainous areas under trees and shrubs. The endemic *Setaria finita* is

associated with drainage lines in the general area; never very common and probably the grass species most likely to be affected most by development in the area.

Thirty species of grasses were identified in the ML197 area with 7, 3 and 10 species identified in the following proposed development areas – Black Nossob River, River & Road diversion area, Heap leach, Pit & Plant area, respectively (Although not included in Table 7, 1 more species – i.e., *Bothriochloa radicans* (smelly grass) – was observed in the Black Nossob River.

The most important grass species (climax species) are viewed as:

Black Nossob River

- *Panicum maximum and Bothriochloa radicans*

River & Road diversion area

- *Eragrostis trichophora*

Heap leach, Pit & Plant area

- *Brachiaria nigropedata* and *Schmidtia pappophoroides*

Table 7. Grass diversity expected (literature study) and confirmed (fieldwork - √) from the general ML197 Project area (derived from [1]Müller 1984, [2]Van Oudtshoorn 1999, [3]Burke 2007, [4]Van Rooyen 2001 and [5]Müller 2007).

Species: Scientific name	ML197 area	Black Nossob River	River & Road Diversion	Heap Leach, Pit & Plant	Namibian conservation and legal status	Ecological Status	Grazing Value
[2,5]*Andropogon chinensis*						Decreaser	High
[1]*Andropogon schinzii*						Decreaser	High
[5]*Anthephora argentea*							
[1,2,3,5]*Anthephora pubescens*	√					Decreaser	High
[1,5]*Anthephora schinzii*						?	Low
[1,2,4,5]*Aristida adscensionis*	√	√	√	√		Increaser 2	Low
[1,2,4,5]*Aristida congesta*	√			√		Increaser 2	Low
[2,5]*Aristida stipitata*	√					Increaser 2	Low
[1,5]*Aristida effusa*						?	Low
[1]*Aristida engleri*						?	Low
[2,3,4,5]*Aristida meridionalis*	√					Increaser 3	Low
[2,5]*Aristida rhiniochloa*						Increaser 2	Low
[5]*Aristida stipoides*						?	Low
[2]*Brachiaria deflexa*						Increaser 2	Average
[5]*Brachiaria glomerata*						?	Average
[5]*Brachiaria marlothii*	√					Increaser 2	Low
[3,5]*Brachiaria nigropedata*	√			√		Decreaser	High
[1,2,4, 5]*Cenchrus ciliaris*	√					Decreaser	High
[2,4,5]*Centropodia glauca*						Decreaser	High
[2,3,5]*Chloris virgata*	√					Increaser 2	Average
[2,5]*Cymbopogon (excavatus) caesius*						Increaser 1	Low
[5]*Cymbopogon pospischilii*	√					Increaser 1	Low
[2,5]*Cynodon dactylon*	√	√				Increaser 2	High
[1,2,5]*Dactyloctenium aegyptium*						Increaser 2	Average
[1,5]*Danthoniopsis ramosa*						?	Average
[2,4]*Dichanthium annulatum*						Decreaser	High
[2,5]*Digitaria eriantha*						Decreaser	High
[5]*Digitaria seriata*						Decreaser	High
[5]*Digitaria velutina*						Increaser 2	Low

[2,4]*Diplachne fusca*						Decreaser	High
[5]*Echinochloa holubii*						Increaser 2	Average
[2]*Eleusine coracana*						Increaser 2	Low
[5]*Elionurus muticus*						Increaser 3	Low
[2,3,4,5]*Enneapogon cenchroides*	√		√			Increaser 2	Average
[2,4,5]*Enneapogon desvauxii*						Intermediate	Average
[1,2,4,5]*Enneapogon scaber*						?	Low
[2,5]*Enneapogon scoparius*						Increaser 3	Low
[1,5]*Entoplocamia aristulata*						?	Average
[4,5]*Eragrostis annulata*						?	Low
[1,2,4,5]*Eragrostis bicolor*						?	Low
[2,4,5]*Eragrostis biflora*						Increaser 2	Low
[2]*Eragrostis cilianensis*						Increaser 2	Low
[5]*Eragrostis cylindriflora*						Increaser 2	Low
[5]*Eragrostis dinteri*						Increaser 2	Average
[1,2,4,5]*Eragrostis echinochloidea*	√					Increaser 2	Average
[1,2,4,5]*Eragrostis lehmanniana*	√			√		Increaser 2	Average
[1,2,5]*Eragrostis nindensis*	√					Increaser 2	Average
[5]*Eragrostis omahekensis*					Endemic	Increaser 2	Low
[1,4,5]*Eragrostis porosa*	√	√				Increaser 2	Low
[5]*Eragrostis rigidior*						Increaser 2	Average
[2,4,5]*Eragrostis rotifer*	√	√		√		?	Average
[1,5]*Eragrostis scopelophila*					Endemic	Decreaser	Average
[3,5]*Eragrostis superba*	√					Increaser 2	Average
[1,2,5]*Eragrostis trichophora*	√	√	√	√		Increaser 2	Average
[1,4,5]*Eragrostis truncata*						?	Average
[2,5]*Eragrostis viscosa*						Increaser 2	Low
[2,4,5]*Fingerhuthia africana*						Decreaser	Average
[2,3,5]*Heteropogon contortus*						Increaser 2	Average
[1,2,3,5]*Hyparrhenia hirta*						Increaser 1	Average
[5]*Leptochloa fusca*						?	Average
[2,5]*Melinis repens*	√			√		Increaser 2	Low
[1,5]*Microchloa caffra*						Increaser 2	Low
[1,5]*Monelytrum leuderitzianum*						?	Low
[4,5]*Oropetium capense*						Increaser 2	Low
[1,5]*Panicum arbusculum*						Decreaser	High
[1,2,4,5]*Panicum coloratum*						Decreaser	High

[1,5]*Panicum lanipes*					?	High
[2,5]*Panicum maximum*	√	√			Decreaser	High
[5]*Panicum novemnerve*					?	Low
[5]*Panicum repens*	√				Decreaser	High
[5]*Panicum stapfianum*					Decreaser	High
[1,5]*Pennisetum foermeranum*				Endemic	?	Low
[5]*Pogonarthria fleckii*	√		√		Increaser 2	Low
[5]*Pogonarthria squarrosa*					Increaser 2	Low
[1]*Rhynchelytrum villosum*					Increaser 2	Average
[1,2,4,5]*Schmidtia kalahariensis*					Increaser 2	Low
[2,3,5]*Schmidtia pappophoroides*	√		√		Decreaser	High
[1,5]*Setaria finita*				Endemic	?	Low
[2]*Setaria incrassata*					Decreaser	High
[2,4,5]*Setaria verticillata*	√				Increaser 2	Average
[5]*Sorghum bicolor*					?	High
[4]*Sporobolus coromandelianus*					Increaser 2	Low
[2,5]*Sporobolus festivus*					Increaser 2	Low
[1,5]*Sporobolus fimbriatus*	√				Decreaser	High
[2,5]*Sporobolus ioclados*					Increaser 2	Average
[4]*Sporobolus rangei*					Increaser 2	Average
[1,2,4,5]*Stipagrostis ciliata*					Decreaser	High
[5]*Stipagrostis giessii*					?	Average
[1,2,3,5]*Stipagrostis hirtigluma*					Increaser 2	Low
[2,5]*Stipagrostis namaquensis*					?	Average
[1,2,4,5]*Stipagrostis obtusa*					Decreaser	High
[1,2,4,5]*Stipagrostis uniplumis*	√		√		Increaser 2	Average
[1,2,5]*Themeda triandra*					Decreaser	High
[2,5]*Tragus berteronianus*	√				Increaser 2	Low
[4,5]*Tragus racemosus*					Increaser 2	Low
[1,4,5]*Triraphis purpurea*					Increaser 1	Low
[1,5]*Triraphis ramosissima*					?	High
[5]*Urochloa brachyura*	√				?	Average
[4,5]*Urochloa oligotricha*					Decreaser	High
[2,5]*Urochloa panicoides*					Increaser 2	High
[5]*Urochloa trichopus*					?	Low

Endemic – (Müller 2007)
? – not classified in literature, but often similar to other species within the genus

Source for literature review: Burke 2007, Müller 1984, Müller 2007, Van Oudtshoorn 1999, Van Rooyen 2001

Black Nossob River

Seven species of grasses were encountered along transects conducted along the Black Nossob River totalling 200m. *Cynodon dactylon* (32%), *Eragrostis trichophora* (26.5%) and *Eragrostis rotifer* (12.5%) were the most dominant grass species observed during the fieldwork along the Black Nossob River habitat (Figure 25).

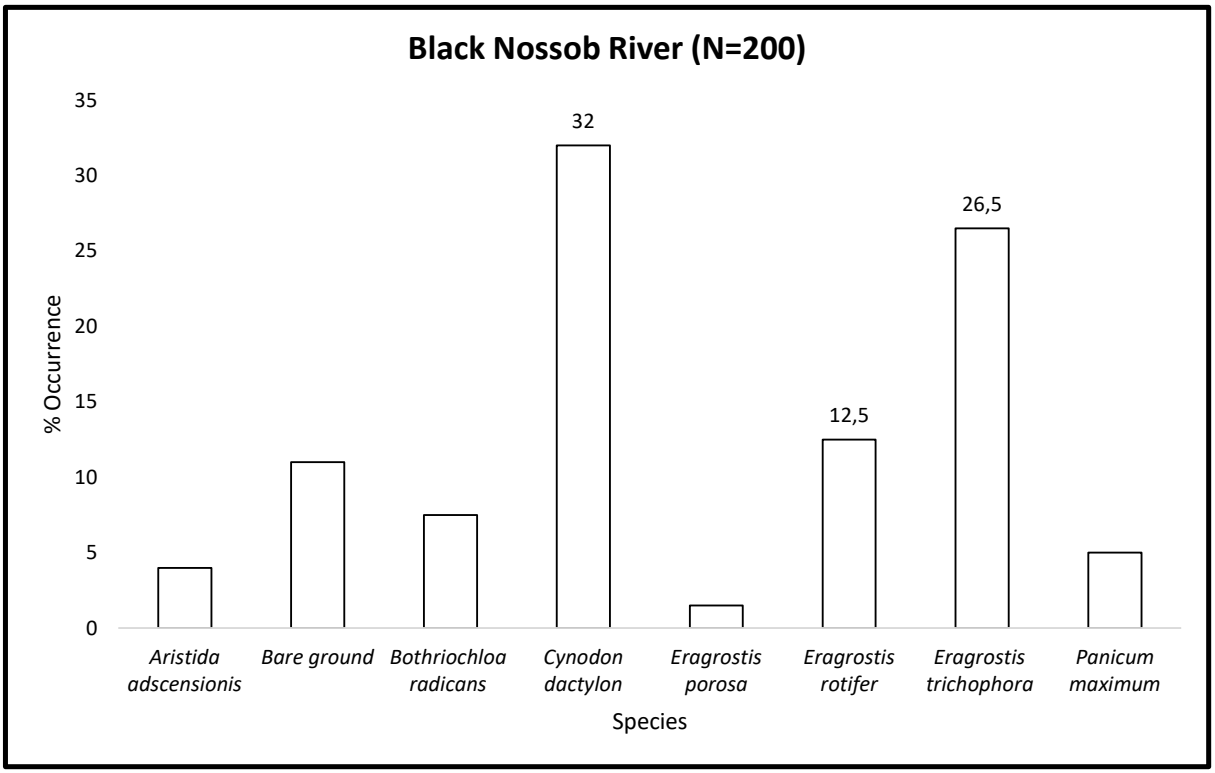

Figure 25. Grass species composition along various transects (total length – 200m @ 1m intervals) in the Black Nossob River habitat (N=200 points).

River & Road Diversion area

Three species of grasses were encountered along transects conducted along the River & Road Diversion area totalling 200m. *Eragrostis trichophora* (62%) was the most dominant grass species observed during the fieldwork along the River & Road Diversion habitat (Figure 26).

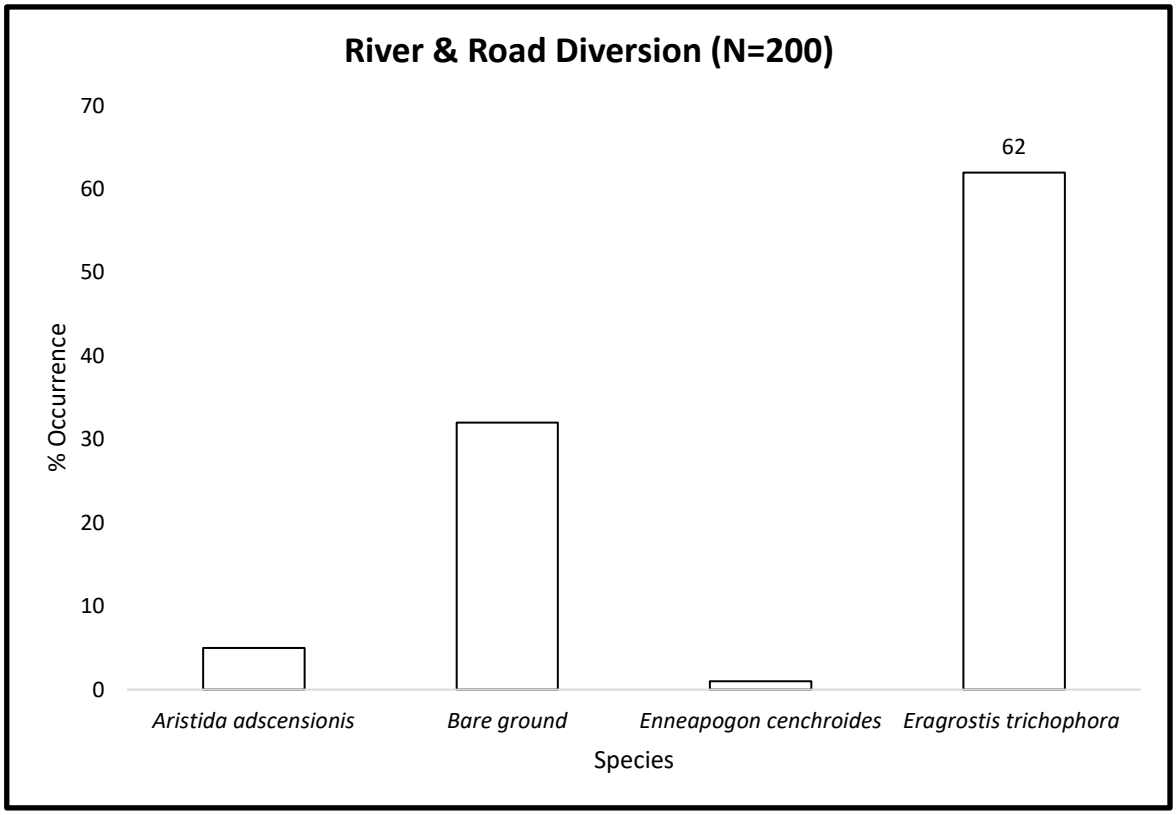

Figure 26. Grass species composition along various transects (total length – 200m @ 1m intervals) in the Heap Leach, Pit & Plant areas habitat (N=200 points).

Heap Leach, Pit & Plant areas

Ten species of grasses were encountered along transects conducted along the Heap Leach, Pit & Plant areas totalling 400m. *Eragrostis lehmanniana* (37.4%), *Stipagrostis uniplumis* (22.7%) and *Eragrostis trichophora* (20%) were the most dominant grass species observed during the fieldwork along the Heap Leach, Pit & Plant areas (Figure 27).

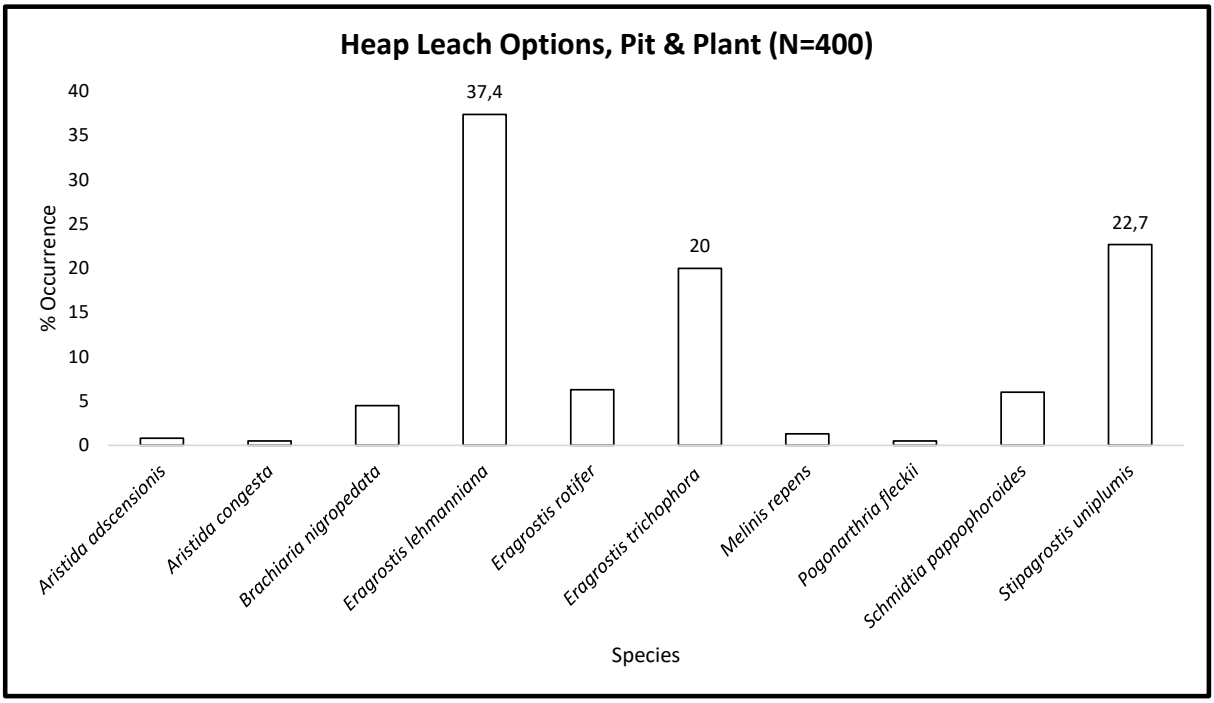

Figure 27. Grass species composition along various transects (total length – 400m @ 1m intervals) in the Heap Leach, Pit & Plant areas habitat (N=400 points).

Figure 28 indicates the grass species composition as determined for the Black Nossob River, River & Road Diversion and Heap Leach Options, Pit & Plant areas for comparative purposes. From this figure it is evident that *Eragrostis* species (*Eragrostis lehmanniana*, *Eragrostis trichophora*) are the most widespread and dominant species throughout the ML197 Project area.

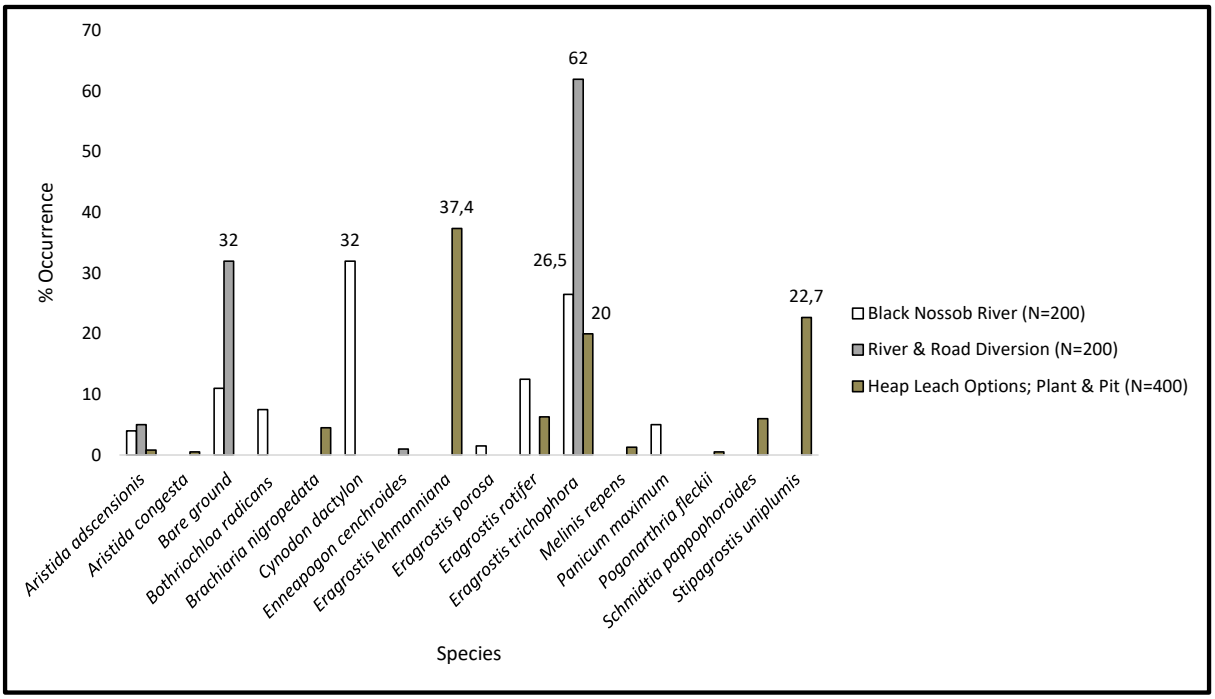

Figure 28. Grass species composition along various transects within the proposed development areas (Black Nossob River [N=200], River & Road Diversion [N=200], Heap Leach Options, Pit & Plant [N=400]) in the ML197 area.

The ML197 project area has been heavily impacted due to current/past mining activities (e.g., prospecting pit) and old and existing farm infrastructures and none of the unique grasses are expected to be exclusively associated with this area. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on grasses potentially occurring in the area.

3.7 Other Species

Other species observed throughout the proposed development area included the following herbs, etc. (Table 8). This list is not comprehensive – i.e., many more species are known and/or expected to occur in the area, but not necessarily within the ML197 Project area.

The most important species is viewed as the endemic *Barleria lanceoloata* (Mannheimer 2012).

Table 8. Other species – bulbs, herbs, etc. – confirmed in various habitats during the fieldwork throughout the ML197 Project area.

Species	ML197 area	Black Nossob River	River & Road Diversion	Heap Leach, Pit & Plant	Status
Acrotome fleckii	√			√	
Aerva leucura	√	√			
Albuca spp.	√			√	
Alternanthera pungens	√	√			Alien spp.

Asparagus spp.	√	√		√	
Barleria lanceolata	√			√	End
Bidens bipinnata	√	√			Alien spp.
Boophone disticha	√			√	
Cleome rubella	√	√			
Coccinia rehmannii	√			√	
Commelina livingstonii	√	√			
Commicarpus pentandrus	√			√	
Cucumis africanus	√			√	
Cyperus fulgens	√		√	√	
Cyperus schinzii	√			√	
Geigeria pectidia	√		√	√	
Gisekia africana	√			√	
Gomphrena celosioides	√			√	
Gomphocarpus fruticosus	√	√			
Guilleminea densa	√			√	Alien spp.
Hebenstretia integrifolia	√	√			
Helichrysum spp.	√			√	
Hermbstaedtia odorata	√	√			
Ingigophera alternans	√			√	
Ipomoea holubii	√			√	
Leonotis ocymifolia	√	√			
Leucas pechuelii	√			√	
Leucosphaera bainesii	√		√	√	
Limeum argute-carinatum	√			√	
Limeum fennestratum	√	√		√	
Nidorella resedifolia	√	√			
Ocimum americanum	√			√	
Peliostomum leucorrhizum	√			√	
Pergularia daemia	√			√	
Persicaria lapathifolia	√		√	√	Alien spp.
Selago spp.	√	√			
Solanum lichtensteinii	√	√		√	
Talinum caffrum	√	√			
Tribulus terrestris	√	√		√	

Invasive alien species

Invasive alien species (Figures 29-33) were associated with and/or spread from various farming activities – e.g., kraal, farmstead, etc. – and include:

- *Cereus jamacaru* (queen-of-the-night)
- *Datura innoxia* (thorn apple)
- *Eucalyptus* spp. (Australian gum spp.)
- *Melia azedarach* (syringa)
- *Schinus mole* (pepper tree)

These above-mentioned species have already started invading the area, especially away from old homestead ruins (e.g., *Cereus jamacaru*) and old kraal systems (*Datura innoxia*) and should be eradicated where/when encountered.

Figure 29. *Cereus jamacaru* (queen-of-the-night) observed invading areas away from its originally planted area as an ornamental around an old farmstead, now in ruins, adjasent the Black Nossob River.

Figure 30. *Datura innoxia* (thorn apple) observed at an old cattle kraal in the area.

Figure 31. *Eucalyptus* spp. (Australian gum spp.) at the old farmhouse ruin in the Pit area.

Figure 32. *Melia azedarach* (syringa) observed at the old farmstead.

Figure 33. *Schinus mole* (pepper tree) – foreground – and *Melia azedarach* (syringa) – background – observed at the old farmstead.

3.8 Important Species

Reptiles
The most important species expected to occur in the general area (See Table 1) are viewed as the tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. natalensis*; *Varanus albigularis* and some of the endemic and little-known gecko species – e.g., *Pachydactylus* species. Tortoises, snakes and monitor lizards are routinely killed for food or as perceived threats. Other important species are those viewed as "rare" – i.e., *Rhinotyphlops lalandei* although very little is known about this species.

Amphibians
Important species include the 2 endemics – *Poyntonophrynus hoeschi* and *Phrynomantis annectens* and *Pyxicephalus adspersus* which are classified as "near threatened" in southern Africa (Du Preez and Carruthers 2009). The latter species numbers are decreasing throughout its range in Namibia mainly due to being targeted as food (Griffin *pers. com*) (See Table 2).

Mammals
The most important species from the general area are all the endemics as well as those classified by the Namibian legislation as rare (*Atelerix frontalis angolae*, *Felis nigripes*) and vulnerable (*Galago moholi*, *Smutsia (Manis) temminckii*, *Proteles cristatus*, *Hyaena brunnea*, *Acinonyx jubatus*, *Felis silvestris*, *Otocyon megalotis, Vulpes chama*, *Tragelaphus oryx*) as well as those classified by the IUCN (2022) as vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Felis nigripes*) and near threatened (*Eidolon helvum, Parahyaena (Hyaena) brunnea*).

The various bats – many listed as vulnerable and near threatened (IUCN 2022, SARDB 2004) – are potentially also important as these are understudied, and little known throughout Namibia. The important carnivores classified as vulnerable and near threatened by the IUCN (2022) are often indiscriminately persecuted as stock thieves in Namibia (See Table 3).
.

Birds

The most important species expected to occur in the general area are viewed as all the Namibian endemics, especially *Poicephalus rueppellii* (Rűppel's parrot) and the violet woodhoopoe (*Phoeniculus damarensis*). The violet woodhoopoe has the lowest estimated population size (±2,000 individuals) of all the Namibia endemics and known to be associated with large trees along ephemeral drainage lines, such as the Black Nossob River riparian vegetation. All the species classified by the IUCN (2022) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard) as well as those classified by Simmons *et al.* (2015) from Namibia as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard). As raptors are often mercilessly persecuted as perceived livestock predators (e.g., Verraux's eagle, martial eagle, etc.) or succumb as collateral damage in problem animal poisoning incidents (e.g., various vulture species), they are viewed as important species in the area (See Table 4).

As white-backed vulture and lappet-faced vulture are known to breed in the general area albeit not in the ML197 Project area (H. Derks *pers.com.*), such nesting sites, should these be established and/or located in future, are viewed as extremely important and should be avoided at all costs.

Flora

Trees/shrubs and Grasses

A total of 69 species of larger species of trees and shrubs are known and/or expected to occur in the general ML197 area. Two species of trees and shrubs (2.9%) expected to occur in the general Hochveld/Steinhausen area are classified as endemic, 1 species as near endemic (1.4%), 9 species (13%) are protected by the Forest Act No 12. of 2001, 1 species (1.4%) are protected under the Nature Conservation Ordinance No. 4 of 1975 while 1 species (1.4%) is classified as CITES Appendix 2 species. All the trees with some kind of conservation and/or protected status are viewed as important in the general Hochveld/Steinhausen area. The most important species are viewed as *Erythrina decora* and *Manuleopsis dinteri* (See Table 6).

Of the 101 grasses are expected in the general area, 4 species are viewed as endemic (*Eragrostis omahekensis*, *Eragrostis scopelophila*, *Pennisetum foermeranum* and *Setaria finite*). *Pennisetum foermeranum* is associated with rocky mountainous terrain and consequently only expected is such suitable habitat. *Eragrostis omahekensis* is virtually only found on disturbed soils – e.g., close to watering points – while *Eragrostis scopelophila* is associated with mountainous areas under trees and shrubs. The endemic *Setaria finita* is associated with drainage lines in the general area; never very common and probably the grass species most likely to be affected most by development in the area (See Table 7).

Important plant species known and/or expected from the general Hochveld/Steinhausen area and included in the Red Data Book for Namibia include at least 8 species of which 2 species is listed as rare (*Anisopappus pseudopinnatifidus*, *Ceropegia pachystelma* subsp. *pachystelma*) and 1 species as near threatened (*Ceropegia mafekingensis*) (Table 9) (Loots 2005). All the species included in Table 9 are viewed as important, especially *Anisopappus pseudopinnatifidus* and *Ceropegia pachystelma* subsp. *pachystelma*, both species only known from 2 subpopulations and locations (restricted range) on deep sandy soils in the general area although there are currently no known threats (Loots 2004).

Table 9. Important species – i.e., Red Data spp. – known to occur in the general Hochveld/Steinhausen area according to Loots (2004).

Species: Scientific name	Conservation status

Anisopappus pseudopinnatifidus	Endemic; R
Brachystelma schinzii	Endemic; LC
Brachystelma schultzei	LC
Ceropegia dinteri	Endemic; NC; LC
Ceropegia mafekingensis	NC; NT
Ceropegia pachystelma subsp. *pachystelma*	NC; R
Eulophia hereroensis	NC; C2; LC
Lithops pseudotruncatella subsp. *pseudotruncatella*	Endemic; NC; LC

Endemic (Loots 2005)
NC – Nature Conservation Ordinance No. 4 of 1975
R – Rare; NT – Near Threatened; LC – Least Concern (Loots 2005)
C2 – CITES Appendix 2 spp.

Other

Aloes

Aloes are protected throughout Namibia with 2 other aloe species not included in Table 6, but which potentially occur in the general area, and viewed as important are *Aloe hereroensis* and *A. zebrina* (Rothmann 2004).

Amaryllis

There are an estimated 260 members of the Amaryllidaceae family in southern Africa with several taxa in urgent need of conservation (especially associated habitats). In the Savanna Biome in Namibia there are an estimated 32 species of which 8 species potentially occur in the general area (*Ammocharis nerinoides*, *Crinum lugardiae*, *C. crassicaule*, *C. carolo-schmidtii*, *C. minimum*, *Nerine laticoma* subsp. *laticoma*, *N. pusilla*, *Pancratiun tenuifolium*) (Duncan *et al.* 2020).

Commiphora

Many endemic Commiphora species are found throughout Namibia with Steyn (2003) indicating that *Commiphora glaucescens* (not included in the Table 6) potentially also occurring in the general area. *Commiphora* species have economic potential (i.e., resin properties used in the perfume industry – e.g., *C. wildii*) making them an important species (Nott and Curtis 2006).

Euphorbias

At least 47 species of Euphorbia occur throughout Namibia of which 4 species are listed as rare, 1 endangered, 1 vulnerable and 1 near threatened (Möller and Becker 2019). Euphorbia species known/expected to occur in the general area include at least 2 species (*Euphorbia pseudoduseimata, E. monteiroi*).

Lithops

Lithops species – all protected (See Nature Conservation Ordinance No. 4 of 1975) – are also known to occur in the general area and often difficult to observe, especially during the dry season when their aboveground structures wither. Lithop species klnown and/or expected to occur in the general area include *Lithops pseudotruncatella* subsp. *Pseudotruncatella* (Cole and Cole 2005, Earle and Round n.d.).

Ferns

At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general area include at least 10 indigenous species (*Azolla pinnata*, *Cheilanthes dinteri*, *Marselia aegyptiaca*, *M. coromandelina*, *M. farinosa*, *M. macrocarpa*, *M. unicornis*, *M. vera*, *Ophioglossum polyphyllum* and *Pellaea calomelanos*) (Crouch *et al.* 2011). The general area is undercollected with more species probably occurring in the general area than presented above.

Lichens

The overall diversity of lichens is poorly known from Namibia, especially the coastal areas and statistics on endemicity is even sparser (Craven 1998). More than 100 species are expected to occur in the Namib Desert with the majority being uniquely related to the coastal fog belt (Wirth 2010) while inselbergs are important – e.g., Waterberg have an estimated 140 species (Craven and Marais 1989). Lichen diversity is related to air humidity and generally decreases inland form the Namibian coast (Schults and Rambold 2007). Off road driving is the biggest threat to these lichens which are often rare and unique to Namibia. To indicate how poorly known lichens are from Namibia, the recent publication by Schultz *et al.* (2009) indicating that 37 of the 39 lichen species collected during BIOTA surveys in the early/mid 2000's was new to science (i.e., new species), is a case in point.

Other species with commercial potential that could occur in the general Hochveld/Steinhausen area include *Harpagophytum procumbens* (Devil's claw) – harvested for medicinal purposes and often over-exploited – *Citrullus lanatus* (Tsamma melon) which potentially has a huge economic benefit – and *Tylosema esculentum* (morama bean) – potential for food oils (Mendelsohn *et al.* 2002, Jarvis *et al.* 2022).

3.9 Important Areas

The most important areas in the ML197 Project area are:

1. Black Nossob River

The Black Nossob River is important habitat to larger trees, especially *Ziziphus mucronata*, which serve as habitat to a variety of unique vertebrate fauna (e.g., various bats, raptors, reptiles, etc.), stabilise riverbanks (erosion control) and food to a variety of species (e.g., browsers, birds). (See Table 6, Figure 34).

Figure 34. The Black Nossob River habitat, with its large trees, many of which are protected species (e.g., *Ziziphus mucronate*), serve as habitat to a variety of unique vertebrate fauna (e.g., various bats, raptors and vultures, etc.).

2. Ephemeral pans

The various ephemeral pans are important habitat, mainly for amphibians, although the larger trees associated with such features serve as habitat to a variety of vertebrate fauna (Figures 35-36).

At least 6 ephemeral pans are located within the general ML197 Project area (5 pans to the north and 1 panbd to the south of the gravel road):
North
1. S21°49'33.4"; E17°55'36.0"
2. S21°49'19.8"; E17°55'32.8"
3. S21°49'30.8"; E17°55'08.3"
4. S21°49'45.0"; E17°55'56.5"
5. S21°49'48.3"; E17°55'29.1"

South
1. S21°49'40.4"; E17°56'55.9"

Figure 35. Ephemeral pans are important habitat, mainly for amphibians and usually surrounded by large trees, which serve as habitat to a variety of unique vertebrate fauna (e.g., various bats, raptors, reptiles, etc.).

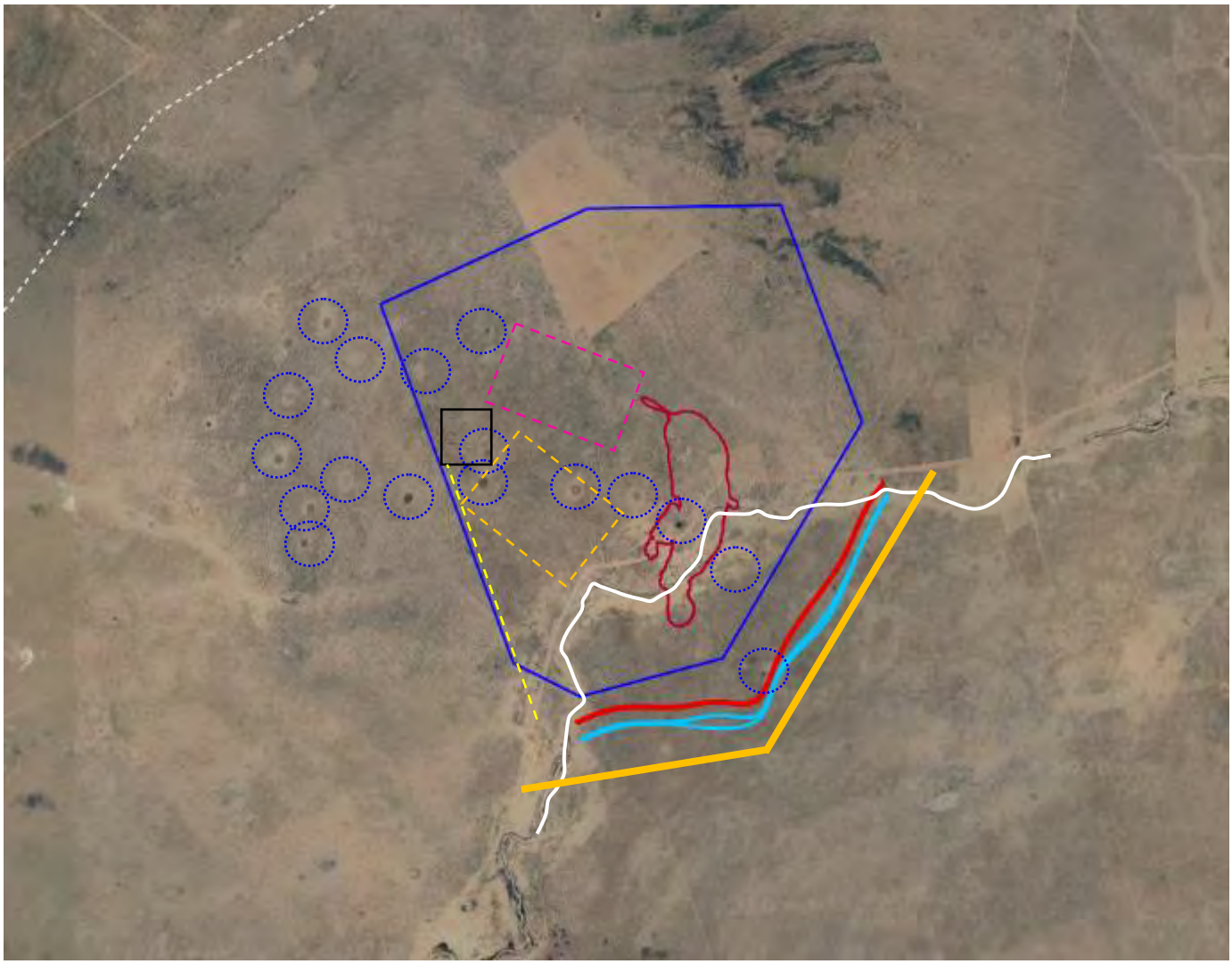

Figure 36. The most important habitats in the immediate ML197 Project area are the Black Nossob River (solid white line) and various ephemeral pans (dotted blue circles). Also indicated are the ML outline (solid dark blue line); Pit (solid burgundy line); 2 x River Diversion options (solid light blue & red lines); Road Diversion (solid orange line); Heap Leach Options 3 (hashed orange rectangle) & 4 (hashed pink rectangle); Plant (black square) and Plant Access Route (dashed yellow line) (See Figure 2 for the actual site layout).

4 Alternative sites and routes

Black Nossob River

The ephemeral Black Nossob River would have to be diverted as the proposed mine pit would be located directly in the path of the river (Figure 36). Two alternative options suggested include:

1) Diversion 1 to the south – Red Line; and
2) Diversion 2 to the south – Light Blue Line.

Options 1 & 2: Diverting the ephemeral Black Nossob River to the south (both Options 1 & 2) would result in a loss of the existing riparian habitat along this section of the river with a high density of large *Acacia karroo* (sweet thorn) and *Ziziphus mucronata* (buffalo thorn) – protected – trees/shrubs (41% & 40% of the species composition, respectively). Although this loss of riparian habitat would be permanent, this is a relatively short section of the river (i.e., 3-4km) and the dominant tree/shrub species along this section of the river occur

widespread throughout Namibia – i.e., not exclusively associated with the Black Nossob River and/or this section of this river. The proposed southerly route(s) would traverse a relatively open fire-prone area with a low density of trees/shrubs not viewed as particularly unique floristically and with no unique habitats. One small ephemeral pan occurs along the proposed route, and it is suggested that this pan be avoided (See Figure 36) – i.e., either River Diversion Options 1 or 2 would be acceptable, should the ephemeral pan in the area be avoided.

However, the general area adjasent the southern bank of the Black Nossob River in this section of the ML197 Project area, is erosion prone with soil capping and erosion evident (Figures 37-39). This is probably caused by long term overgrazing and/or high densities of domestic stock in the past close to the homestead as well as current wildlife accessing the Black Nossob River habitat from the inland areas. The alternative river option envisaged along this section should take cognicance of this potential problem and minimise heavy vehicle activities in these areas once the alternative chanel has been created as well as monitor erosion throughout as this could lead to downstream flood and siltation issues.

It is suggested that gabian walls and gabian 'weir-like' structures be placed along this section of the diversion chanel to prevent and/or minimise flooding; slow down streamflow and siltation.

Figure 37. Erosion gullies along the southern bank and adjasent area of the Black Nossob River.

Figure 38. The general area is open; soil capped and sparsely vegetated, dominated by low *Acacia hebeclada*, *Tarchonanthus camphoratus* and *Leucosphaera bainesii* trees/shrubs.

Figure 39. Soil capped areas which would increase erosion, probably caused by past continuous grazing practices of domestic stock close to the original farmstead.

A positive impact would be that it would create another, albeit artificial, type of wetland habitat favouring various species over time, especially once becoming established with riparian vegetation. Trees and shrubs, currently dominating the Black Nossob River (See Section 5.5; Figure 20), should be planted along this artificial canal to encourage rehabilitation of this habitat.

Ranking the various options, from best to worse ecological cases scenarios, is suggested as:

Option 1 = Option 2

Road Diversion

Except for a small ephemeral pan – See Figure 36 – the proposed location of the Road Diversion does not negatively impact on any unique habitats.

However, the Road Diversion should avoid the pan while all erosion related issues applicable to the River Diversion section immediately above would be relevant – i.e., erosion related issues. Furthermore, the areas where the new road would cross the Black Nossob River (e.g., bridge sections) would have to be at right angles with appropriate height, structure, etc.

Heap Leach Options

The proposed location of the 2 x Heap Leach options – See Figures 2 & 36 – is located to the north of the Black Nossob River area. Option 4 is expected to have the least impact on the overall ecology of the area, especially if/when avoiding the ephemeral pans, as it does negatively impact on any unique habitats. Option 3 would result in the destruction of at least 3 pans which are viewed as sensitive habitats. Ranking the options, from best to worse ecological cases scenarios, is suggested as:

Option 4 – Option 3

Plant

Except for a small ephemeral pan – See Figure 36 – the proposed location of the Plant does not negatively impact on any unique habitats.

However, the Plant layout should be designed to avoid the pan as far as possible.

Pit

The proposed Pit area would result in the destruction of at least 3 pans and part of the Black Nossob River – i.e., the Pit layout is related to the underground ore body.

However, the Pit layout should be designed to avoid sernsitive areas as far as possible, especially if new evidence of the ore body becomes available during excavations, etc.

Access route

The proposed location of the Plant Access Route does not negatively impact on any unique habitats.

5 Envisaged impacts

5.1 Introduction

All developments change or are destructive to the local fauna and flora to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development – i.e., development, once initiated, may have a different effect on the fauna and flora as originally predicted. Thus, continuing monitoring of such impacts during the development phase(s) is imperative.

5.2 Faunal disturbance

Faunal disturbance with the proposed mining activities would be localised. The following table indicates the potential/envisaged impacts expected regarding faunal disturbance (which is obviously closely linked to habitat destruction):

Description	Faunal disturbance will vary depending on the scale/intensity of the development operation and associated and inevitable infrastructure.

Extent	**1.** Black Nossob River - Localised disruption/destruction of the habitat and thus consequently vertebrate fauna associated directly with the actual area destroyed. This, however, would be relatively small area – depending on scale/intensity of operations – with localised implications. **2.** River & Road Diversions - Localised disruption/destruction of the habitat and thus consequently vertebrate fauna associated directly with the actual sites. This, however, would be relatively small areas – depending on scale/intensity of operations – with localised implications. **3.** Heap Leach Options - Localised disruption/destruction of the habitat and thus consequently vertebrate fauna associated directly with the actual sites. This, however, would be relatively small areas – depending on scale/intensity of operations – with localised implications. **4.** Plant - Localised disruption/destruction of the habitat and thus consequently vertebrate fauna associated directly with the actual site. This, however, would be relatively small area – depending on scale/intensity of operations – with localised implications. **5.** Access route(s) - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual route. This, however, would be a relatively small area with localised implications.
Duration	**1.** Black Nossob River - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications. **2.** River & Road Diversions - The duration of the impact is expected to be permanent at the site(s). This, however, would be relatively small area(s) with localised implications. **3.** Heap Leach Options - The duration of the impact is expected to be permanent at the site(s). This, however, would be relatively small area(s) with localised implications. **4.** Plant - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications. **5.** Access route(s) - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications.
Intensity	**1.** Black Nossob River - The actual site where Pit would be located would be permanently altered. This, however, would be relatively small area with localised implications. **2.** River & Road Diversions - The actual sites where construction of the route(s) would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. **3.** Heap Leach Options - The actual site where construction of the Heap Leach(s) would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. **4.** Plant - The actual site where construction of the Plant would be located would be permanently altered. This, however, would be relatively small area with localised implications. **5.** Access route(s) - The actual site where construction of the route would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. The areas adjacent the mining site(s) and other associated infrastructure should not be significantly affected. This, however, would depend on control over the contractors during the road building, construction phase(s) and prospecting/mining phase(s), but should be limited to localised implications. Areas not directly affected by the mining and associated infrastructure, although within the immediate area, would be affected minimally. This would include dust, noise, light and other associated disturbances in the area, but be limited to the mining and construction periods.

Mitigation	**General** **1.** Limit the development to actual sites to be mined/developed and avoid affecting adjacent areas, especially more portions of the Black Nossob River and various pans, throughout the entire area. **2.** Avoid development and associated infrastructure in sensitive areas – e.g., Black Nossob River and ephemeral pans in the immediate area (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various vertebrate fauna species. **3.** Remove (e.g., capture) unique fauna and sensitive fauna before commencing with the development activities and/or species serendipitously located during this period and relocate to a less sensitive/disturbed sites in the immediate area. **4.** Prevent and discourage the setting of snares (poaching), illegal collecting of veld foods (e.g., tortoises, etc.), indiscriminate killing of perceived dangerous species (e.g. snakes, etc.) and collecting of wood as this would diminish and negatively affect the local fauna – especially during the development phase(s). **5.** Attempt to avoid the removal of bigger trees during the development phase(s) – especially with the development of alternative Road and Plant access route [roads do not have to be in a straight line] – as these serve as habitat for a myriad of fauna. **6.** Prevent and discourage fires – especially during the development phase(s) – as this could easily cause runaway veld fires affecting the local fauna, but also causing problems (e.g., loss of grazing, wildligfe and domestic stock mortalities, etc.) for the neighbouring farmers. **7.** Rehabilitation of the disturbed areas – i.e., initial development access route "scars" and associated tracks; alternative River as well as associated mining infrastructures, etc. Preferably workers should be transported in/out to the construction sites daily to avoid excess damage to the local environment (e.g., fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company's environmental integrity, but also show true local commitment to the environment. **8.** Prevent domestic pets – e.g., cats and dogs – accompanying the workers during the construction phase as cats decimate the local fauna and interbreed and transmit diseases to the indigenous African wildcat and black footed cats in the area. Dogs often cause problems when bonding on hunting expeditions thus negatively affecting the local fauna. The indiscriminate and wanton killing of the local fauna by such pets should be avoided at all costs. **9.** Initiate a suitable waste removal system (i.e., remove to closest municipal dump site and not store on site) as this often attracts wildlife – e.g., baboons and black-backed jackal, crows, etc. – which may result in human-wildlife conflict issues. **10.** Educate/inform contractors and staff on protected species (See Tables 1 to 5) to avoid and the consequences of illegal collection of such species. **11.** Investigate the idea of employing an Environmental Officer during the construction phase(s) to ensure compliance and minimise the overall impact on the fauna and the environment. **Tracks** **12.** Avoid placing access routes (roads and tracks) trough sensitive areas –

	e.g., pans. This would minimise the effect on localised potentially sensitive habitats in the area. **13.** Avoid driving randomly through the area (i.e., "track discipline"), but rather stick to permanently placed roads/tracks – especially during the construction phase. This would minimise the effect on localised potentially sensitive habitats in the area. **14.** Stick to speed limits of maximum 30km/h as this would result in fewer faunal road mortalities. Speed humps could also be used to ensure the speed limit. Lower speeds would also minimise dust pollution. **15.** Implement erosion control. – i.e., avoid constructing tracks up steep gradients; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards and adjacent the Black Nossob River area are easily eroded, and further development may exacerbate this problem. Avoid construction within 100m of the main drainage line(s) to minimise erosion problems as well as preserving the riparian associated flora and fauna. **Black Nossob River** **16.** Limit destruction to the smallest section of the river as far as possible. **River & Road Diversions** **17.** Avoid the destruction of the small ephemeral pan in the area (See Section 4; Figure 36). **18.** Stabilise the River Diversion with gabians to avoid/limit erosion. **19.** Slow runoff along the diversion section with 'weir-like' gabians to to avoid/limit erosion. **20.** Rehabilitate River Diversion by re-vegetating section with indigenous species – e.g., *Acacia karroo*, *Ziziphus mucronata*. **Heap Leach Options** **21.** Option 4 is preferred over Option 3 (See Section 4; Figures 2 & 36). **22.** Avoid the ephemeral pans in the area as far as possible. **Plant** **23.** Avoid the ephemeral pans in the area as far as possible. **Access route** **24.** Avoid destroying the large *Acacia erioloba* (camel thorn) trees aliong this route as well as the ephemeral pans in the area as far as possible.
Frequency of occurrence	Expected to be a "once off" issue affecting the selected site(s). Further prospecting and associated road construction (should this become necessary/evident during the mining operations) including power line and water pipeline construction activities throughout the area would however increase the frequency of occurrence.
Probability	Definite (100%) negative impact on fauna is expected in the actual mining areas as well as along the access route(s), infrastructure development sites and river diversion site(s). This, however, would be much localised and cover only a small area(s) and should avoid sensitive areas – See various alternative options [Section 4; Figure 36]. Highly Probable (75%) negative impact on fauna is expected in the general areas especially during the construction and mining phase(s) as a result of

	noise, increased activities, etc. Probable (50%) negative impact on fauna is expected from the infrastructure (roads/tracks/buildings, etc.). Precautionary principle (e.g., avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g., Black Nossob River, ephemeral pans) with associated fauna would bear the brunt of this proposed development but be limited in extent and only permanent at the actual mining site(s) and access routes and infrastructure sites.
Legal requirements	Fauna related: Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN and SARDB Habitat – Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES
Degree of confidence in predictions	As an ecologist I am sure of the above-mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local fauna in the area.

5.3 Floral disturbance

Floral disturbance with the mining would be localised. The following table indicates the potential/envisaged impacts expected regarding floral disturbance (which is obviously closely linked to habitat destruction):

Description	Floral disturbance will vary depending on the scale/intensity of the development operation and associated and inevitable infrastructure.
Extent	**1.** Black Nossob River - Localised disruption/destruction of the habitat and thus consequently flora, especially large tree species, associated directly with the actual area destroyed. This, however, would be relatively small area – depending on scale/intensity of operations – with localised implications. **2.** River & Road Diversions - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual sites. This, however, would be relatively small areas – depending on scale/intensity of operations – with localised implications. **3.** Heap Leach Options - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual sites. This, however, would be relatively small areas – depending on scale/intensity of operations – with localised implications. **4.** Plant - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual site. This, however, would be relatively small area – depending on scale/intensity of operations – with localised implications. **5.** Access route(s) - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual route. This, however, would be a relatively small area with localised implications.

Duration	**1.** Black Nossob River - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications. **2.** River & Road Diversions - The duration of the impact is expected to be permanent at the site(s). This, however, would be relatively small area(s) with localised implications. **3.** Heap Leach Options - The duration of the impact is expected to be permanent at the site(s). This, however, would be relatively small area(s) with localised implications. **4.** Plant - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications. **5.** Access route(s) - The duration of the impact is expected to be permanent at the site. This, however, would be relatively small area with localised implications.
Intensity	**1.** Black Nossob River - The actual site where Pit would be located would be permanently altered. This, however, would be relatively small area with localised implications. **2.** River & Road Diversions - The actual sites where construction of the route(s) would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. **3.** Heap Leach Options - The actual site where construction of the Heap Leach(s) would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. **4.** Plant - The actual site where construction of the Plant would be located would be permanently altered. This, however, would be relatively small area with localised implications. **5.** Access route(s) - The actual site where construction of the route would be located would be permanently altered. This, however, would be relatively small area(s) with localised implications. The areas adjacent the mining site(s) and other associated infrastructure should not be significantly affected. This, however, would depend on control over the contractors during the road building, construction phase(s) and prospecting/mining phase(s), but should be limited to localised implications. Areas not directly affected by the prospecting/mining and associated infrastructure although within the immediate area would be affected minimally. This would include dust and other associated disturbances in the area but is limited to the prospecting/mining and construction periods.
Mitigation	**General** **1.** Limit the development to actual sites to be mined and avoid affecting adjacent areas, especially the Black Naossob River and pans, throughout the entire area. **2.** Avoid development and associated infrastructure in sensitive areas – e.g., Balack Nossob River and pans (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various vertebrate fauna species. **3.** Remove unique and sensitive flora (e.g., *Aloe* spp., etc. – See 3.9) before commencing with the development activities and relocate to a less sensitive/disturbed sites in the immediate area. **4.** Prevent and discourage the collecting of firewood as dead wood has an important ecological role – especially during the development phase(s). Such collecting of firewood, especially for economic reasons, often leads to abuses – e.g., chopping down of live and/or protected tree species such as *Acacia erioloba*, etc. which is good quality wood. **5.** Attempt to avoid the removal of bigger trees during the development

	phase(s) – especially with the development of access routes – as these serve as habitat for a myriad of fauna. Avoid the destruction of larger trees associated with the ephemeral pans. **6.** Prevent and discourage fires – especially during the development phase(s) – as this could easily cause runaway veld fires causing problems (e.g., loss of grazing, wildlife and domestic stock mortalities, etc.) for the neighbouring farmers. **7.** Rehabilitation of the disturbed areas – i.e., initial development access route "scars" and associated tracks as well as associated mining/prospecting infrastructures. Preferably workers should be transported in/out to the construction sites daily to avoid excess damage to the local environment (e.g., fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company's environmental integrity, but also show true local commitment to the environment. **8.** Prevent the planting of potentially invasive alien plant species (e.g., *Tecoma stans*, *Pennisetum setaceum*, etc.) for ornamental purposes as part of the landscaping – e.g., office buildings, plant site, access gate, etc. Alien species often "escape" and become invasive causing further ecological damage as is evident from previous human habitation in the area (i.e., invasive aliens on site include *Cereus jamacaru, Eucalyptus* spp., etc. – See Section 3.7; Figures 29-33). **9.** Eradicate – destroy – all invasive alien plants encountered on site – e.g., *Cereus jamacaru, Eucalyptus* spp., etc. – See Section 3.7; Figures 29-33). This would ensure that the spread is limited and show environmental commitment. **10.** Incorporate indigenous vegetation – especially the protected species e.g., *Acacia erioloba, Ziziphus mucronata*, etc. – into the overall landscaping. Indigenous species require less water and overall maintenance. **11.** Educate/inform contractors and staff on protected species (See Table 6 and Section 3.8) to avoid and the consequences of illegal collection of such species. **12.** Investigate the idea of employing an Environmental Officer during the construction phase(s) to ensure compliance and minimise the overall impact on the flora and the environment. **Tracks** **13.** Avoid placing access routes (roads and tracks) trough sensitive areas – e.g., over pans. This would minimise the effect on localised potentially sensitive flora and habitats in the area. **14.** Avoid driving randomly through the area (i.e., "track discipline"), but rather stick to permanently placed roads/tracks – especially during the construction phase. This would minimise the effect on localised potentially sensitive flora and habitats in the area. **15.** Stick to speed limits of maximum 30km/h as this would result in less dust pollution. Speed humps could also be used to ensure the speed limit. **16.** Implement erosion control. – i.e., avoid constructing tracks up steep gradients; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards and adjacent the drainage line(s) are easily eroded and further development may exacerbate this problem. Avoid construction within 100m of the main drainage line(s) to

	minimise erosion problems as well as preserving the riparian associated flora and fauna. **Black Nossob River** **17.** Limit destruction to the smallest section of the river (i.e., riparian vegetation) as far as possible. **River & Road Diversions** **18.** Avoid the destruction of the small ephemeral pan and surrounding pan vegetation in the area (See Section 4; Figure 36). **19.** Stabilise the River Diversion with gabians to avoid/limit erosion. **20.** Slow runoff along the diversion section with 'weir-like' gabians to to avoid/limit erosion. **21.** Rehabilitate River Diversion by re-vegetating section with indigenous species – e.g., *Acacia karroo*, *Ziziphus mucronata*. **Heap Leach Options** **22.** Option 4 is preferred over Option 3 (See Section 4; Figures 2 & 36). **23.** Avoid the ephemeral pans in the area as far as possible. **24.** Terrace the Heaps and cover with soil to facilitate stabilisation and rehabilitation. **Plant** **25.** Avoid the ephemeral pans in the area as far as possible. **Access route** **26.** Avoid destroying the large *Acacia erioloba* (camel thorn) trees aliong this route as well as the ephemeral pans in the area as far as possible.
Frequency of occurrence	Expected to be a "once off" issue affecting the selected site(s). Further prospecting and associated road construction (should this become necessary/evident during the mining operations) including power line and water pipeline construction activities throughout the area would however increase the frequency of occurrence.
Probability	Definite (100%) negative impact on flora is expected in the actual mining areas as well as along the access route(s), infrastructure development sites and river diversion site(s). This, however, would be much localised and cover only a small area(s) and should avoid sensitive areas – See various alternative options [Section 4; Figure 36]. Highly Probable (75%) negative impact on flora is expected in the general areas especially during the construction and mining phase(s) as a result of dust, increased activities, etc. Probable (50%) negative impact on flora is expected from the infrastructure (roads/tracks/buildings, etc.). Precautionary principle (e.g., avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.

Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g., Black Nossob River, ephemeral pans) with associated flora would bear the brunt of this proposed development but be limited in extent and only permanent at the actual mining site(s) and access routes and infrastructure sites.
Legal requirements	Flora & Habitat related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN, Red Data Book (Namibian plants)
Degree of confidence in predictions	As an ecologist I am sure of the above-mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local flora in the area.

5.4 Impacts – Methods

The construction and operation of the proposed new mine in the ML197 area would result in various impacts on the vertebrate fauna and flora and can be placed into three categories:

Direct Impacts: These are directly as a result of the construction of the proposed development – i.e., ML197 Project – and include general habitat destruction and the destruction of species of conservation concern.

Indirect Impacts: These are not directly associated with the proposed development, but potentially affect species of conservation concern recorded within the general area and include impacts as a result of changes in the hydrology, etc. and affect species rather on a population level.

Cumulative Impacts: These are impacts that the proposed development will have from a broad area perspective by considering land-use and transformation of natural habitat in areas surrounding the site (i.e., considering past, present and anticipated changes to biodiversity).

Mitigation measures are not always straightforward and/or easy to implement, but should be based on the following steps as mitigation hierarchy:

Step 1: Avoid/prevent loss to biodiversity and ecosystem services: The project location, layout and phasing should avoid negative impacts on biodiversity. Areas of high biodiversity should be identified prior to development activities to avoid negative impacts;

Step 2: Minimise impacts on biodiversity and ecosystem services: The project location, layout, and phasing should minimise the negative impacts on biodiversity;

Step 3: Rehabilitation – concurrently, progressively and on cessation of the activity: Rehabilitation should attempt to return the affected area(s) to pre-development natural state; and

Step 4: Offset significant residual negative impacts on biodiversity or ecosystem services: This refers to the compensation for the remaining and unavoidable negative impacts on biodiversity.

Assessment Criteria
The environmental impacts are assessed with and without mitigation measures and the results are presented in impact tables summarising the assessment. Mitigation and management actions are recommended to enhance positive impacts and minimising negative impacts.

The following risk assessment was used to determine the significance of impacts.

Significance = (Magnitude + Duration + Scale) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts are rated as high, medium or low significance on the following basis:

High environmental significance = 60-100 points
Medium environmental significance = 30-59 points
Low environmental significance = 0-29 points

Magnitude (M)
[Description & Numerical value]
Very high = 10
High = 8
Moderate = 6
Low = 4
Minor = 2

Duration (D)
[Description & Numerical value]
Permanent = 5
Long-term (ceases at end of operation) = 4
Medium-term = 3
Short-term = 2
Immediate = 1

Scale (S)
[Description & Numerical value]
International = 5
National = 4
Regional = 3
Local = 2
Site = 1
None = 0

Probability (P)
[Description & Numerical value]
Definite (or unknown) = 5
High = 4
Medium = 3
Low = 2
Improbable = 1
None = 0

The following criteria against which these activities are assessed are presented below.

Nature of the Impact
This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Scale of the Impact
A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, national or international scale.

Duration of the Impact
This provides an indication of whether the lifespan of the impact would be immediate, short term (0-5 years), medium term (6-15 years), long term (cesses at end of operational phase) or permanent.

Probability of Occurrence
This describes the probability of the impact occurring. This is rated as none, improbable (low likelihood), low, medium, high and definite.

Significance
This describes the degree of significance for the predicted impact based on the available information and level of knowledge and expertise – i.e., High, Medium and Low.

5.5 Assessment: Construction, Operational and Decommissioning Phases

The proposed new ML197 Project development in the Hochveld/Steinhausen would include the construction of the following:

- Diversion of the Black Nossob River – southwards;
- Diversion of the M53 gravel road – southwards;
- Mine pit;
- Mine infrastructures – Heap Leach, Plant; and
- Mine access route.

The impacts that the construction and operation of the proposed new mine project may have on the vertebrate fauna and flora recorded throughout the general area were based on a comprehensive literature review and rapid field assessment.

Possible impacts and their sources that this development is likely to have on the biodiversity and ecology (vertebrate fauna and flora) are provided for the construction phase (Table 10), operational phase (Table 11) and decommissioning phase (Table 12).

Table 10. Impacts expected to occur during the Construction Phase.

Impact - Description	Impact - Source	Affected Area
Destruction of vertebrate fauna, especially protected spp.	Ground clearing for mine, infrastructures, access route, road & river diversion	Project area
Destruction of vegetation, especially protected tree/shrub spp.	Ground clearing for mine, infrastructures, access route, road & river diversion	Project area

Destruction of sensitive habitats	Ground clearing for mine, infrastructures, access route, road & river diversion	Project area
Soil erosion issues	Mechanised clearing activities & river diversion	Project area
Introduction & spread of invasive alien plant spp.	Ground clearing activities & habitat change	Project area

Table 11. Impacts expected to occur during the Operational Phase.

Impact - Description	Impact - Source	Affected Area
Destruction of vertebrate fauna, especially protected spp.	Vehicle movement	Project area
Soil erosion issues	Vehicle movement & river diversion	Project area
Introduction & spread of invasive alien plant spp.	Vehicle movement	Project area

Table 12. Impacts expected to occur during the Decommissioning Phase.

Impact - Description	Impact - Source	Affected Area
Destruction of vertebrate fauna, especially protected spp.	Vehicle movement	Project area
Soil erosion issues	Vehicle movement & river diversion	Project area
Introduction & spread of invasive alien plant spp.	Vehicle movement	Project area

5.6 Impacts: Construction, Operational and Decommissioning Phases

The following impact tables describe the impacts that are expected to occur during the Construction, Operational and Decommissioning Phases:

CONSTRUCTION PHASE:

1. Destruction of vertebrate fauna, especially protected species

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Local (2)	Permanent (5)	Very high (10)	Definate (5)	High (85)	Definate
With Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High

Description of Impact: *The land clearing activities by mechanical methods, at the various development areas would result in numerous protected species, being eradicated and/or dispersed (See Tables 1-5). Vertebrate fauna (e.g., especially sedentary, slow moving and ground nesting species; various cavity dwellers such as bats, gallago, hornbills, parrots, various reptiles, etc.; various avifauna using vegetation in affected areas for perching/roosting/breeding, etc.) associated with the area, especially the old/large tree specimens associated with the Black Nossob River, would be killed and/or displaced.*

Mitigation Measures:

- *Remove important slow-moving species such as tortoise, chameleon, etc. prior to construction activities as well as when serendipitously encountered throughout the proposed development areas;*
- *Maintain and enforce track discipline;*
- *Avoid all areas not directly targeted for the various mining infrastructures;*
- *Avoid trees with raptor nests (especially white-backed vulture & lappet-faced vulture as these bird numbers is declining dramatically throughout their range and are classified as critically endangered and endangered by the IUCN 2022, respectively);*
- *Include large/old tree specimens as part of the landscaping at the Plant site;*
- *Redirect Black Nossob River – both Options 1 or 2 would have similar impact on the vertebrate fauna;*
- *Redirect Road (M53) – adjust layout slightly to prevent the destruction of the ephemeral pan in area (See Figure 36);*
- *Heap Leach Options – Option 4 would have the least impact on the vertebrate fauna;*
- *Plant – adjust layout slightly to prevent the destruction of the ephemeral pans in area (See Figure 36); and*
- *Access route – adjust layout slightly to prevent the destruction of the ephemeral pans in area and large Acacia erioloba (camel thorn) – protected spp. – trees (See Figure 36).*

2. Destruction of vegetation, especially protected tree/shrub species

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Local (2)	Permanent (5)	Very high (10)	Definate (5)	High (85)	Definate
With Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High

Description of Impact: *The land clearing activities by mechanical methods, at the various development areas would result in numerous protected tree species, being eradicated (See Table 6). Vertebrate fauna (e.g., cavity dwellers such as bats, gallago, hornbills, parrots, various reptiles, etc. including various raptors e.g. eagles, vultures using such trees as perching/roosting/breeding) associated with these trees, especially the old/large specimens, would be killed and/or displaced.*

Mitigation Measures:

- *Remove unique species which are easy to transplant and relocate such as Aloe spp. prior to construction activities as well as when serendipitously encountered throughout the proposed development areas;*
- *Maintain and enforce track discipline;*
- *Avoid all areas not directly targeted for the various mining infrastructures;*

- *Avoid trees with raptor nests (especially white-backed vulture & lappet-faced vulture as these bird numbers is declining dramatically throughout their range and are classified as critically endangered and endangered by the IUCN 2022, respectively);*
- *Include large/old tree specimens as part of the landscaping at the Plant site;*
- *Redirect Black Nossob River – both Options 1 and 2 would have similar impact on the flora;*
- *Redirect Road (M53) – adjust layout slightly to prevent the destruction of the ephemeral pan in area (See Figure 36);*
- *Heap Leach Options – Option 4 would have the least impact on the flora;*
- *Plant – adjust layout slightly to prevent the destruction of the ephemeral pans in area (See Figure 36); and*
- *Access route – adjust layout slightly to prevent the destruction of the ephemeral pans in area and large Acacia erioloba (camel thorn) – protected spp. – trees (See Figure 36).*

3. Destruction of sensitive habitats

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Regional (3)	Permanent (5)	Very high (10)	Definate (5)	High (90)	Definate
With Mitigations	Site (1)	Long term (4)	Low (4)	High (4)	Low (24)	High

Description of Impact: *The land clearing activities by mechanical methods, at the various development areas would result in some sensitive habitats being destroyed and/or detrimentally affected (See Section 3.9). Vertebrate fauna associated with these sensitive habitats, would be killed and/or displaced.*

Mitigation Measures:

- *Limit the development to actual sites to be mined and avoid affecting adjacent areas, especially ephemeral pans, throughout the entire area;*
- *Avoid development and associated infrastructure in sensitive areas – e.g., ephemeral pans in the immediate area (See Section 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various vertebrate fauna and flora species;*
- *Maintain and enforce track discipline;*
- *Avoid trees with raptor nests (especially white-backed vulture & lappet-faced vulture as these bird numbers is declining dramatically throughout their range and are classified as critically endangered and endangered by the IUCN 2022, respectively);*
- *Include large/old tree specimens as part of the landscaping at the Plant site;*
- *Redirect Black Nossob River – both Options 1 and 2 would have similar impact on the general ecology/sensitive habitats;*
- *Redirect Road (M53) – adjust layout slightly to prevent the destruction of the ephemeral pan in area (See Figure 36);*
- *Heap Leach Options – Option 4 would have the least impact on the general ecology/sensitive habitats;*
- *Plant – adjust layout slightly to prevent the destruction of the ephemeral pans in area (See Figure 36); and*
- *Access route – adjust layout slightly to prevent the destruction of the ephemeral pans in area and large Acacia erioloba (camel thorn) – protected spp. – trees (See Figure 36).*

4. Soil erosion issues

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High
With Mitigations	Site (1)	Short term (2)	Minor (2)	Low (2)	Low (10)	High

Description of Impact: *The land clearing activities by mechanical methods, at the various development areas would result in erosion issues, especially with the proposed redirection of the Black Nossob River. The erodible (soil capped) areas to the south of the Black Nossob River are prone to erosion.*

Mitigation Measures:

- *Avoid clear felling of vegetation in areas viewed as erosion prone – i.e., soil capped area south of the Black Nossob River;*
- *Reroute or limit the size of or avoid access route(s) in areas viewed as erosion prone – i.e., soil capped area south of the Black Nossob River*
- *Where new tracks have to be made off the main routes, the routes should be selected causing minimal damage to the environment – e.g., use the same tracks; cross drainage lines at right angles; avoid placing tracks within drainage lines; avoid collateral damage (i.e. select routes that do not require the unnecessary removal of trees/shrubs, especially protected species);*
- *Rehabilitate all new tracks created;*
- *Implement erosion control measures related to the proposed River Diversion – e.g., gabians along canal, gabians as 'weir-like' structures in canal, etc.*
- *Redirect Black Nossob River – both Options 1 and 2 would have similar erosion issues as the area is erosion prone;*
- *Redirect Road (M53) – ensure erosion control along this route as the area is erosion prone;*
- *Heap Leach Options – sandy soils in this area are not erosion prone;*
- *Plant – sandy soils in this area are not erosion prone; and*
- *Access route – sandy soils in this area are not erosion prone.*

5. Invasion and spread of invasive alien plant species

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High
With Mitigations	No (0)	Immediate (1)	Minor (2)	Low (2)	Low (6)	High

Description of Impact: *Soil disturbances by mechanical methods, at the various development areas would favour invasive alien plant species becoming established. Invasive alien plant species, already present in the area (See Section 3.7), would flourish in the disturbed areas and could also inadvertently be transported into the area as seed on the various vehicles accessing the mine site and access route.*

Mitigation Measures:

- *Limit land clearing activities to the actual mine site and infrastructures area so as to prevent random soil disturbances favouring invasive alien plant species;*
- *Remove and destroy all invasive alien plants encountered in the project area (See Section 3.7; Figures 29-33); and*
- *Ensure that vehicles accessing the route are free of vegetation, especially if contractors are used which also use their vehicles in urban areas.*

OPERATIONAL PHASE:

6. Destruction of vertebrate fauna, especially protected spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Local (2)	Long term (4)	High (8)	High (4)	Medium (56)	High
With Mitigations	Site (1)	Short term (2)	Minor (2)	High (4)	Low (20)	High

Description of Impact: *Typical mine operations, including continuous vehicle movement along the various access routes, would result in the continued destruction of vertebrate fauna (i.e., especially slow-moving species).*

Mitigation Measures:

- *Capture, remove and relocate all vertebrate fauna that may enter the various mine infrastructures to similar habitat in the general area;*
- *Maintain and enforce track discipline;*
- *Place speed humps along access routes to minimise wildlife mortalities.*

7. Soil erosion issues

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Regional (3)	Long term (4)	Very high (10)	Definate (5)	High (85)	High
With Mitigations	Site (1)	Short term (2)	Moderate (6)	Medium (3)	Low (27)	High

Description of Impact: *Typical mine operations, including continuous vehicle movement along the various access routes, would result in continued erosion issues if not continuously maintained. The proposed redirection of the Black Nossob River would result in continued erosion issues if not continuously maintained.*

Mitigation Measures:

- *Implement and maintain erosion control measures where applicable along the access route – i.e., use the same tracks; cross drainage lines at right angles;*
- *Construct permanent non-gravel roads along vehicle route(s) most often used;*
- *Rehabilitate eroded areas annually – i.e., after the rainy season (during winter months);*
- *Maintain track discipline – i.e., no offroad driving; speed control; use the same track, etc.; and*
- *Ensure the continuous maintenance of the redirected Black Nossob River – i.e., after the rainy season (during winter months).*

8. Introduction & spread of invasive alien plant spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High
With Mitigations	Site (1)	Short term (2)	Minor (2)	Low (2)	Low (10)	High

Description of Impact: *Invasive alien plant species would become established on disturbed areas and could also inadvertently continuously be transported into the area as seed on the various vehicles accessing the mining site.*

Mitigation Measures:

- *Remove and destroy all invasive alien plants encountered throughout the mine project area; and*
- *Ensure that vehicles accessing the project area are free of vegetation, especially if contractors are used which also use their vehicles in urban areas.*

DECOMMISSIONING PHASE:

9. Destruction of vertebrate fauna, especially protected spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Medium term (3)	Low (4)	High (4)	Medium (32)	High
With Mitigations	None (0)	Short term (2)	Minor (2)	High (4)	Low (16)	High

Description of Impact: *Typical mine closure operations, including some vehicle movement along the various access routes, would result in some destruction of vertebrate fauna (i.e., especially slow moving species).*

Mitigation Measures:

- *Avoid nocturnal vehicle movement; and*
- *Maintain and enforce track discipline.*

10. Soil erosion issues

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Regional (3)	Long term (4)	High (8)	High (4)	High (60)	High
With Mitigations	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	High

Description of Impact: *Typical mine operations, including some vehicle movement along the various access routes, would result in some erosion issues if not continuously maintained. The proposed redirection of the Black Nossob River would result in continued erosion issues if not continuously maintained.*

Mitigation Measures:

- *Rehabilitate eroded areas annually – i.e., after the rainy season (during winter months);*
- *Maintain track discipline – i.e., no offroad driving; speed control; use the same track, etc.; and*
- *Ensure the continuous maintenance of the redirected Black Nossob River – i.e., after the rainy season (during winter months).*

11. Introduction & spread of invasive alien plant spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Short term (2)	Low (4)	High (4)	Low (28)	High
With Mitigations	None (0)	Immediate (1)	Minor (2)	Low (2)	Low (6)	High

Description of Impact: *Invasive alien plant species would become established on disturbed areas and could also inadvertently continuously be transported into the area as seed on the various vehicles accessing the mining site.*

Mitigation Measures:

- *Remove and destroy all invasive alien plants encountered throughout the mine project area; and*
- *Ensure that vehicles accessing the project area are free of vegetation, especially if contractors are used which also use their vehicles in urban areas.*

6 Conclusion

As all development have potential negative environmental consequences, identifying the most important faunal species including high risk habitats beforehand, coupled with environmentally acceptable mitigating factors, lessens the overall impact of such development.

Vertebrate fauna species most likely to be adversely affected by the proposed ML197 Project development would be sedentary species (i.e., species with limited mobility) such as unique reptiles (i.e. tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. natalensis*; *Varanus albigularis*; some of the endemic and little known gecko species – e.g. *Pachydactylus* species and species viewed as “rare” – i.e. *Rhinotyphlops lalandei* – although very little is known about this species). *Pyxicephalus adspersus*, associated with the

ephemeral pans in the area, would be affected by habitat destruction while mammals are more mobile and although important species are known to occur and/or pass through the area (see elsewhere in this report) none are expected to be specifically associated and/or expected to be negatively affected by the developments. Although general disturbances could affect bird species of concern – i.e., species classified as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard) by the IUCN (2022) as well as those classified by Simmons *et al.* (2015) from Namibia as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard) – birds are also mobile and not limited to the area.

Flora species most likely to be adversely affected by mining developments would be the various protected species – See Tables 6 and 9; Section 3.9 – although these species are not specifically associated with the development sites.

Important areas in the general vicinity are viewed as the Black Nossob River and ephemeral pans – See Section 3.9 and Figure 36.

It is not expected that mining developments will adversely affect any unique vertebrate fauna and flora in the ML197 Project areas, especially if the proposed recommendations (mitigation measures) are incorporated – See Sections 3.8, 3.9, 4 and 5.

7 References

Barnard, P. 1998. Underprotected habitats. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Bester, B. 1996. Bush encroachment – A thorny problem. *Namibia Environment* 1: 175-177.

Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. Struik Publishers, Cape Town, RSA.

Branch, B. 2008. Tortoises, terrapins and turtles of Africa. Struik Publishers, Cape Town, RSA.

Bonin, F., Devaux, B. and Dupré, A. 2006. Turtles of the world. John Hopkins University Press, Baltimore, USA.

Boycott, R. C. and Bourquin, O. 2000. The Southern African Tortoise Book. O Bourquin, Hilton, RSA.

Broadley, D.G. 1983. Fitzsimons' Snakes of southern Africa. Jonathan Ball and AD. Donker Publishers, Parklands, RSA.

Brown, C.J., Jarvis, A., Robertson, T. and Simmons, R. 1998. Bird diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Buys, P.J. and Buys, P.J.C. 1983. Snakes of Namibia. Gamsberg Macmillan Publishers, Windhoek.

Carruthers, V.C. 2001. Frogs and frogging in southern Africa. Struik Publishers, Cape Town, RSA.

Channing, A. 2001. Amphibians of Central and Southern Africa. Protea Bookhouse, Pretoria, RSA.

Channing, A. and Griffin, M. 1993. An annotated checklist of the frogs of Namibia. *Madoqua* 18(2): 101-116.

Coats Palgrave, K. 1983. Trees of Southern Africa. Struik Publishers, Cape Town, RSA.

Cole, D.T. and Cole, N.A. 2005. Lithops Flowering Stones. Cactus and Co. Libri.

Craven, P. 1998. Lichen diversity in Namibia. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Craven, P. (ed.). 1999. A checklist of Namibian plant species. Southern African Botanical Diversity Network Report No. 7, SABONET, Windhoek.

Craven, P. and Marais, C. 1989. Waterberg Flora. Gamsberg, Windhoek.

Crouch, N.R., Klopper, R.R., Burrows, J.E. and Burrows, S.M. 2011. Ferns of southern Africa – a comprehensive guide. Struik Nature, Cape Town, RSA.

Cunningham, P.L. 1998. Potential Wood Biomass Suitable for Charcoal Production in Namibia. *Agri-Info* 4(5): 4-8.

Cunningham, P.L. 2006. A Guide to the Tortoises of Namibia. Polytechnic of Namibia, Windhoek, 19pp.

Cunningham, P.L. 2013. Vegetation and habitat assessment, EPL4704, Otjozondu/Hochveld area. Unpublished report, LM Consulting, Windhoek.

Curtis, B. and Barnard, P. 1998. Sites and species of ecological, economic or archaeological importance. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Curtis, B. and Mannheimer, C. 2005. Tree Atlas of Namibia. National Botanical Research Institute, Windhoek, Namibia.

De Graaff, G. 1981. The rodents of southern Africa. Buterworths, RSA.

Duncan, G., Jeppe, B. and Voigt, L. 2020. Field guide to the Amaryllis Family of Southern Africa and surrounding territories. Gally Press, Mpumalanga, RSA.

Earle, R. and Round, J. n.d. Lithops of Namibia. www.lithopsfoundation.com

Estes, R.D. 1995. The behaviour guide to African mammals. Russel Friedman Books, Halfway House, RSA.

Frost, W. 2014. The antelope of Africa. Jacana Media (Pty) Ltd, Aucland Park, RSA.

Giess, W. 1971. A preliminary vegetation map of South West Africa. *Dinteria* 4: 1 – 114.

Griffin, M. 1998a. Reptile diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Griffin, M. 1998b. Amphibian diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Griffin, M. 1998c. Mammal diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Griffin, M. 2003. Annotated checklist and provisional national conservation status of Namibian reptiles. Ministry of Environment and Tourism, Windhoek.

Griffin, M. and Coetzee, C.G. 2005. Annotated checklist and provisional national conservation status of Namibian mammals. Ministry of Environment and Tourism, Windhoek.

Hebbard, S. n.d. A close-up view of the Namib and some of its fascinating reptiles. ST Promotions, Swakopmund, Namibia.

Hockey, P.A.R, Dean, W.R.J. and Ryan, P.G. (eds). 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trusrees of the John Voelker Bird Book Fund, Cape Town.

IUCN 2022. IUCN Red List of Threatened Species. <www.iucnredlist.org>.

Jarvis, A., Mendelsohn, J., Mendelsohn, M. and Robertson, T. 2022. Atlas of Namibia: its land, water and life. Namibia Nature Foundation, Windhoek.

Joubert, E. and Mostert, P.M.K. 1975. Distribution patterns and status of some mammals in South West Africa. *Madoqua* 9(1): 5-44.

Komen, L. n.d. The Owls of Namibia – Identification and General Information. NARREC, Windhoek.

Little, R., and Crowe, T. 2011. Gamebirds of southern Africa. Struik, Cape Town, RSA.

Loots, S. 2005. Red data book of Namibian plants. Southern African Botanical Diversity Network Report No. 38. SABONET, Pretoria and Windhoek.

Maclean, G.L. 1985. Robert's birds of southern Africa. John Voelcker Bird Book Fund.

Marais, J. 1992. A complete guide to the snakes of southern Africa. Southern Book Publishers, Witwatersrand University Press, Johannesburg, RSA.

Mannheimer, C. and Curtis, B. (eds) 2009. Le Roux and Müller's field guide to the trees and shrubs of Namibia. 1st edition, Namibia Publishing House, Windhoek.

Mannheimer, C. and Curtis, B. (eds) 2018. Le Roux and Müller's field guide to the trees and shrubs of Namibia. 2nd edition, Namibia Publishing House, Windhoek.

MEFT/NACSO 2021. The state of community conservation in Namibia (Annual Report 2019). MEFT/NACSO, Windhoek.

Mendelsohn, J., Jarvis, A., Roberts, C. and Robertson, T. 2004. Atlas of Namibia – a portrait of the land and its people. David Philip Publishers, Cape Town.

Möller, A. and Becker, R. 2019. Field guide to the succulent Euphorbias of southern Africa. Briza Publications, Pretoria, RSA.

Müller, M.A.N. 2007. Grasses of Namibia. John Meinert Publishers (Pty) Ltd, Windhoek.

NCE, LCMAN, MEFT (eds) 2022. Conservation status and red list of the terrestrial carnivores of Namibia. MEFT, LCMAN, NCE, Windhoek.

Nott, K. and Curtis, B. 2006. Aromatic resins from *Commiphora* trees. *Roan News Special Anniversary Edition* 2006: 22-24.

Passmore, N.I. and Carruthers, V.C. 1995. South African Frogs - A complete guide. Southern Book Publishers, Witwatersrand University Press, Johannesburg, RSA.

Peacock, F. 2015. The definitive guide to southern Africa's little brown jobs. CTP Book Printers, Cape Town, South Africa.

Rothmann, S. 2004. Aloes, aristocrats of Namibian flora. ST Promotions, Swakopmund, Namibia.

SARDB, 2004. CBSG Southern Africa. In: Griffin, M. 2005. Annotated checklist and provisional national conservation status of Namibian mammals. Ministry of Environment and Tourism, Windhoek.

Schultz, M. and Rambold, G. 2007. Diversity shifts and ecology of soil lichens in central Namibia. Talk, Ecological Society of Germany, Austria and Switzerland (GfÖ), 37th Annual Meeting, Marburg: 12/9/2007 to 15/9/2007.

Schultz, M., Zedda, L. and Rambold, G. 2009. New records of lichen taxa from Namibia and South Africa. *Bibliotheca Lichenologica* 99: 315-354.

Simmons, R.E. 1998a. Important Bird Areas (IBA's) in Namibia. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Simmons, R.E. 1998b. Areas of high species endemism. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Simmons, R.E., Brown, C.J. and Kemper, J. 2015. Birds to watch in Namibia: red, rare and endemic species. Ministry of Environment and Tourism and Namibia Nature Foundation, Windhoek.

Skinner, J.D. and Smithers, R.H.N. 1990. The mammals of the southern African subregion. University of Pretoria, RSA.

Skinner, J.D. and Chimimba, C.T. 2005. The mammals of the southern African subregion. Cambridge University Press, Cape Town, RSA.

Steyn, M. 2003. Southern Africa Commiphora. Polokwane, RSA.

Tarboton, W. 2001. A guide to the nests and eggs of southern African birds. Struik Publishers, Cape Town, RSA.

Taylor, P.J. 2000. Bats of southern Africa. University of Natal Press, RSA.

Van Oudtshoorn, F. 2012. Guide to grasses of southern Africa. Briza Publications, Pretoria, South Africa.

Van Wyk, B. and Van Wyk, P. 1997. Field guide to trees of Southern Africa. Cape Town: Struik Publisher.

Wirth, V. 2010. Lichens of the Namib Desert. Klaus Hess Verlag, Windhoek/ Göttingen.