RVM 1 HYDROELECTRIC POWER (PTY) LTD

RIEMVASMAAK HYDROPOWER PROJECT, ORANGE RIVER, NORTHERN CAPE PROVINCE, SOUTH AFRICA

FAUNAL IMPACT ASSESSMENT

Prepared by:	Prepared for:
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Cover images (WR Branch)
Top - Site of proposed weir on Orange River

Bottom:	Left	Cape Ground Squirrel	(*Xerus inauris*)
	Middle	Augrabies Thick-toed Gecko	(*Pachydactylus atorquatus*)
	Right	Marbled Rubber Frog	(*Phrynomantis annectans*)

Author

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Bill Branch obtained B.Sc. and Ph.D. degrees at Southampton University, UK. He was employed for 31 years as the herpetologist at the Port Elizabeth Museum, and now retired holds the honorary post of Curator Emeritus. He has published over 260 scientific articles, as well as numerous popular articles and books. The latter include the Red Data Book for endangered South African reptiles and amphibians (1988), and co-editing its most recent upgrade – the *Atlas and Red Data Book of the Reptiles of South Africa, Lesotho and Swaziland* (2014). He has also published guides to the reptiles of both Southern and Eastern Africa. He has chaired the IUCN SSC African Reptile Group. He has served as an Honorary Research Professor at the University of Witwatersrand (Johannesburg), and has recently been appointed as a Research Associate at the Nelson Mandela Metropolitan University, Port Elizabeth. His research concentrates on the taxonomy, biogeography and conservation of African reptiles, and he has described over 30 new species. He has extensive field work experience, having worked in over 16 African countries, including Gabon, Ivory Coast, DRC, Zambia, Mozambique, Malawi, Madagascar, Namibia, Angola and Tanzania. His African bird list exceeds 1200 species.

EXECUTIVE SUMMARY

INTRODUCTION

Project

RVM 1 Hydro Electric Power (Pty) Ltd (hereinafter referred to as RVM1) wishes to construct a 40 Megawatt (MW) hydroelectric -power station on the Orange River, on the farms Riemvasmaak, and waterval, north of the Augrabies Falls in the Northern Cape Province of South Africa.

The proposed hydropower project utilizes a natural hydrological feature in the vicinity of the Augrabies Falls. This is a 'palaeochannel' that represents an old drainage line of the Orange River and forms the topographical component of the project.

The proposed hydropower project consists of the following components:

- a weir across the Orange River (not greater than 5 m measured from the river bed to the spill crest);
- an off-take structure;
- buried water conveyance infrastructure (comprising twin culverts);
- a head pond;
- two buried steel (or other suitable pipe material) penstocks;
- an underground power chamber to house the turbines and generation equipment;
- an underground tailrace from the power chamber to the palaeochannel;
- a switch room and transformer yard; and
- access roads.

Energy generated by the proposed hydropower station would be evacuated from the site via a proposed 33 kV underground transmission line across Riemvasmaak (RVM) land (referred to as Portion 481/1) and State owned land (Portion 497/0). The transmission line will then surface outside of RVM where it will connect to the project substation. A 132 kV overhead line will then cross the Orange River and connect to either an existing 132KV Eskom power line between Renosterkop and Blouputs or directly at the Renosterkop substation.

Objectives

The following objectives have been defined for the faunal diversity and faunal impact assessment:

- To provide a general description of the terrestrial vertebrate fauna of the project and adjacent areas;
- To review the fauna identified in the project area for the presence of Species of Conservation Concern (SCC);
- Assess the habitat associations of the faunal components, and;
- Provide an impact assessment of the project actions, during the construction, operational and decommissioning phases, on the resident fauna and their associated habitats.

Assumptions and Limitations

Study specific assumptions and limitations include:

- Due to seasonal constraints only a single faunal survey was undertaken.
- Many faunal groups are often difficult to find and may also be difficult to identify unless collected for detailed analysis. Thus species collected during faunal surveys do not usually comprise an exhaustive list of the true faunal diversity in the region.
- Although knowledge of faunal diversity in South Africa continues to improve, for certain groups (particularly reptiles and bats), new species are regularly discovered. It is possible that these and additional SCC will be found subsequent to the production of this report.

METHODOLOGY

Only a single faunal survey was undertaken relatively late in the wet season (9-13 February 2015).

Faunal Diversity

The known diversity of the terrestrial vertebrate fauna in the project area was determined by a literature review. Species known from the region, or from adjacent regions whose preferred habitat(s) were known to occur within the study area, were also included. Checklists for terrestrial vertebrate fauna at Augrabies Falls National Park (AFNP) were updated and adjusted where necessary.

Field methods for compiling the species lists for all vertebrate groups mainly involved visual encounter surveys at day and night, and were supplemented with observations on scats, tracks, regurgitated pellets, nests, feathers, bird calls along paths, at water points, and when walking through the site.

Species of Conservation Concern (SCC)

These comprise:

- Threatened species listed as threatened in the revised South African Red Data Books and/or included in other international lists (e.g., 2014 IUCN Red List of Threatened Animals).
- Sensitive species: Species not falling in the categories above but listed in Appendix 1 or 2 of the Convention of International Trade in Endangered Species (CITES).
- Species endemic to the Northern Cape and/or South Africa.

Vegetation and Habitat mapping

Existing vegetation maps for the area include those created by SANBI (Mucina & Rutherford, 2006), as well as in the AFNP Management Plan (2013-2023) and the Botanical Assessment for the Riemvasmaak Hydro-Power project (McDonald, 2015).

Impact Assessment Methodology

The CES impact rating methodology was used.

Physical Description of Area

The study area falls within the Nama Karoo Biome, Bushmanland and West Griqualand Bioregion, one of South Africa's most arid regions. Rainfall is greatest between February and April with a distinct peak in March. The mean annual rainfall is 251 mm, mean summer daytime temperature (October to March) of 35°C, and mean winter night temperature (April to September) of 5°C.

The geology consists mainly of granite-gneiss of the Kakamas Terrane of the Namaqua-Natal Province, with small outcrops of ultrametamorphic rocks in places. The landscape is complex, with three main land types recognised.

1. A riparian zone comprised of alluvial sediments (Tertiary to Recent) over intrusive rock (mainly granite) of the Namaqualand Metamorphic Complex. This occurs along the existing and previous river channels and is covered in a localized vegetation type (Lower Gariep Alluvial Vegetation).
2. Broken, deeply incised terrain consisting of igneous granitic-amphobilitic rocks of the Toeslaan Formation (Korannaland Sequence) occur in the "canyon zone" below Augrabies Falls.
3. The southern and northern sides of the Orange River comprise migmatite, gneiss and granite with the land surface dissected by sub-dentritic drainage channels.

Vegetation and Habitats

Three vegetation types are found, namely Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. Neither Lower Gariep Broken Veld nor Bushmanland Arid

Grassland are listed in the National List of Threatened Ecosystems, but Lower Gariep Alluvial Vegetation is listed as Endangered A1.

Lower Gariep Alluvial Vegetation
This is found on the recently deposited alluvial sediments along the Orange River. The reason for the loss of this vegetation is the intense irrigated agriculture on the alluvial soils from Groblershoop as far west as Augrabies. In the study area it was encountered at the proposed weir site and lining the river banks of the Orange River and its side-channels above the Augrabies Falls, and along the palaeochannels north of the falls.

Lower Gariep Broken Veld
This is found on the rugged koppies and inselbergs (the Hardeveld) interspersed with low plains, east along the Orange River from Onseepkans as far as Prieska. It includes a large area of Riemvasmaak. At Augrabies it is found along the gorge below the falls where the soils are skeletal and form shallow soil over rock. The vegetation is sparse, dominated by shrubs and dwarf shrubs with perennial grasses and annual species in spring.

Bushmanland Arid Grassland
This is much more widespread than either of the other vegetation types which occur in the study area. It occurs over a wide expanse in the Northern Cape Province from the Bushmanland Basin in the south to the vicinity of the Orange River in the north, and from Prieska to Aggeneys. It differs from Lower Gariep Broken Veld in the relatively greater abundance of 'white grasses' (*Aristida* and *Stipagrostis* species). In the Riemvasmaak area it predominates in the north where it is dissected by sandy seasonal 'washes' or streams.

Two main abiotic habitats exist on the study area. In these, faunal requirements are met by, for example, rock structures or the presence of water, and not by the composition of the vegetation.

Rocky and mountainous areas
Most of the project area is composed of red biotite granite gneiss. Different weathering patterns create hollows in the rock, exfoliation domes, and thin slabs of rock that detach from the rock surface. The numerous rock cracks and fissures form refugia for numerous small mammals (elephant shrews and bats), nesting sites for Alpine Swift, Lanner and Peregrine Falcon and Rock Kestrel, as well as roosts for many other birds. The conspicuous Augrabies Flat Lizard frequents the exposed bedrock and cliff walls at the falls and form a popular tourist attraction in the summer months.

Wetlands
The project site falls in a summer rainfall area, the shallow sandy soils drain quickly and standing water is seasonal, scarce and often short-lived. Important temporary water sources occur in small side channels within the braid section of the Orange River above the falls; and as increasing isolated pools within the lower palaeochannel. These pools are usually surrounded by wetland vegetation such as sedges (*Cyperus* spp.) and reeds (*Phragmites australis*) and form important habitat for certain birds, and essential breeding sites for semi- to fully aquatic frogs. The insect fauna associated with, and breeding in, these wetlands form an essential food resource for many birds, and particularly the Augrabies Flat Lizard. These predators play an important role in controlling known insect pests in the region, e.g. black fly.

Faunal Surveys

The Northern Cape Province has a relatively low faunal diversity, particularly for aquatic species and large mammal herbivores. However, many desert-adapted reptiles and birds are endemic or near-endemic to the region. Amphibians are the least specious group of terrestrial vertebrates in the project area. Reptile diversity in and around the study area is high, with over 50 species known or likely to occur. The Nama Karoo supports a particularly high diversity of bird species endemic to southern Africa, and characteristically comprises species of open habitats, particularly larks. Much of the historical large mammal fauna in the region has been greatly reduced or even eradicated.

Some have subsequently been re-introduced into AFNP, and the re-introduction of others is planned.

Amphibians
Amphibians are important components of wetland systems, particularly ephemeral systems from which fish are either excluded or are of minor importance. In these habitats, they are dominant predators of invertebrates. Southern Africa has rich amphibian diversities, comprising 160 species. However, the arid western region of the Northern Cape Province holds the lowest amphibian diversity (25 species) in the subcontinent, and only 12 species may occur in the Augrabies-Kakamas area.

Only three of these 12 species were recorded in the project area during the survey visit; the Guttural Toad, Marbled Rubber Frog, and tadpoles of Poynton's River Frog. The Guttural Toad has an extensive range in the savannahs of southern and eastern Africa, and is tolerant of human development. It has expanded its range, in association with irrigated agriculture, along the Lower Orange River.

No threatened amphibian species or SCC occurs in the project area. The Marbled Rubber Frog is listed as 'endemic' for AFNP, but although nationally restricted to rocky habitats along the Lower Orange River, it extends through western Namibia to southern Angola, and globally and nationally is of Least Concern.

Reptiles
South Africa has one of the highest reptile diversities in the world, and the highest in Africa, with the highest diversity and endemicity occurring in the more arid parts of the country. Of the 435 reptile species recorded from South Africa, at least one third (139 species) occur in the Northern Cape. Reptile diversity in the study region is high, with 56 species known or likely to occur (3 chelonians, 35 lizards, and 18 snakes).

Sixteen reptile species were recorded during the survey, with a further three species collected earlier at Farm Dabaras. Thirty seven other species have been recorded from the general region. Two geckos, previously unrecorded in the AFNP reptile checklist, were shown to be present during the faunal survey. The Augrabies Thick-toed Gecko (*Pachydactylus atorquatus*) was only recently described from specimens collected in the AFNP. It was recorded in the Riemvasmaak area, only the second record of the species north of the Orange River. Haacke's Thick-toed Gecko occurs mainly in southern Namibia with small populations are known from the Lower Orange River, particularly in the Richtersveld and Augrabies region. It was common on the rock faces of the AFNP 'Canyon Zone', on both sides of the river.

There are no threatened reptile species recorded from the project area or immediate adjacent areas. Two monitor lizards and two chelonians are listed on CITES Appendix II, but all are common throughout much of the region and are well protected in existing conserved areas.

Birds
The Nama-Karoo supports a particularly high diversity of bird species endemic to southern Africa, particularly ground-dwelling species of open habitats. Many endemic and near-endemic larks have ranges centred in the Karoo region. The 'linear oasis' of the Lower Orange River supports a greater diversity than more easterly regions of the river valley and the surrounding Nama Karoo. The project area, which is managed by the AFNP, falls within an Important Bird Area (IBA), considered important in the conservation of threatened and near-threatened birds, as well as protecting endemic, near-endemic and range-limited species.

Of the possible 431 bird species which occur in the Northern Cape province of South Africa, 247 species may occur in or near the project area. Of these 246 species, 111 were observed during the survey. Some are non-breeding Palaearctic migrants, whilst others are breeding IntraAfrican migrants or species that show seasonal movements within the subcontinent and adjacent Africa. A significant number (13) are Range or Biome restricted, or Near Endemic species.

The project area may host 33 species of conservation concern, 14 of which were recorded on site. Twenty one (21) of these SCC are globally threatened (5 Endangered species, 7 Vulnerable species, 9 Near Threatened). Twenty-eight of these also occur in SA Red Data Book – Birds (1 Endangered, 9 Vulnerable and 18 Near Threatened).

Three bird species (Southern Black Korhaan, Cape Long-billed Lark and Cape Bulbul) are endemic South African species, all of which were recorded during the site visit.

The most significant avian SCC that have previously been recorded in the region include the Globally Threatened White-backed Vulture (EN), Ludwig's Bustard (EN), Secretary Bird (VU) and Black Harrier (VU), as well as the National Threatened Martial Eagle (VU) and Kori Bustard (VU). These are all wide-ranging species whose population declines result from numerous and wide-spread anthropogenic threats. The presence of 10 nationally Near Threatened birds and no less than 14 Near Endemic or Range or Biome Restricted species has increased the significance of the site for the conservation of birds.

Mammals

Large mammals are not generally a feature in the Nama Karoo, with the majority of mammals present being small to medium-sized. The long history of persecution and hunting have also reduced large mammal numbers and diversity in the region.

A total of 50 mammal species are listed in the AFNP mammal checklist, but this omits additional bats (five species recorded in the AFNP, a further four recorded in close proximity) and rodents seven species recorded in the AFNP checklist, and a further nine recorded within close proximity). There are also a number of corrections, resulting from new taxonomic insight. An updated checklist for the mammals, large and small, of the AFNP is given.

Only 17 terrestrial mammal species were observed during the survey, whilst a further four were identified by scats, etc. Due to time constraints no micro-mammal trapping was undertaken, and this component of the project area faunal diversity remains poorly known.

Only one globally threatened mammal, Hartmann's Mountain Zebra (VU) currently occurs in the AFNP. Another, the Hook-lipped Rhinoceros (globally and regionally CR), was previously introduced into the AFNP in the Riemvasmaak region, but has since been re-located. Among the expanded micro-mammal checklist none are globally or nationally threatened, although Shortridge's Thallomys is poorly-known (Data Deficient) and the Dassie Rat and Honey Badger are regionally Near Threatened.

Conservation areas

Augrabies Falls National Park (AFNP)

The AFNP was proclaimed in August 1966 and is situated along the southern edge of the Kalahari Desert and the eastern border of Namibia. It covers 52 898 ha, with most (38 888 ha) lying south of the Orange River, with a smaller portion (14 010 ha) to the north of the falls. The northern section of the AFNP, on Portions 498/1 and 497/0 are managed by SANParks in accordance with the AFNP Management Plan[1]. Portion 498/1 includes land referred to as Riemvasmaak, upon which the proposed project it to be sited. Riemvasmaak (previously called Melkbosrand) was deproclaimed in 2004 and returned to the Riemvasmaak Community, but part of it continues to be managed by AFNP.

To maintain viable biodiversity and ecosystem functioning, AFNP management plan to both expand the footprint of the AFNP, as well as generate a border of meaningful buffer zones where land use is directed towards the same conservation goals. The AFNP Management Plan for 2013-

[1] South African national parks (2012) Augrabies Falls National Park Management Plan for the period 2013-2013.

2023 identifies various sections of the AFNP, as well as areas that fall within the Park's buffer zone such as the Riemvasmaak (Melkbosrant) section, as zoned for Primitive-Remote usage, which is an "area retaining an intrinsically wild appearance and character".

Important Bird Areas
The function of the Important Bird Area (IBA) programme is to identify and protect a network of sites critical for the long-term viability of naturally occurring bird populations. A total of 121 IBAs occur in South Africa, with 11 in the Northern Cape. Many are situated in the Orange River drainage, with the AFNP (IBA ZA022) forming the nearest IBA to the project area.

Sensitive areas
The AFNP Management Plan (2013-2023) Sensitivity Map (Fig 7.1), which covers land on which the proposed development will be located, includes areas requiring both conservation and visual protection. It notes, on page 14,that areas with extremely high sensitivity to visual impacts need to be carefully managed to minimise or eliminate any aesthetic or visual intrusion of development and tourism activities. These areas were concentrated along the gorge and falls, as well as highly visible mountainous areas both north and south of the Orange River. It includes not only the existing Orange River course, but also the upper 'palaeochannel' that includes much of the lower pipeline option route, as well as the outlet for the proposed hydro-electric tunnel.

The most sensitive habitats in the project area are discussed below.

Wetlands and Riverine Habitats
Wetlands and riverine habitats constitute features of conservation concern as they are ecological process areas. They are essential for ecosystem functioning and for maintaining ecological processes and provide niche habitats for a variety of plants and animals. These areas have very high sensitivity. The AFNP Management Plan has prioritized protection of the Lower Gariep Alluvial Vegetation as a 'Special conservation area'. It has become increasingly rare in the region due to habitat loss for agricultural use. In the project area it forms part of the riverine habitats along the Orange River in the vicinity of the proposed weir. It also forms part of the northern drainage line of Riemvasmaak, particularly where it connects to the existing Orange River, and therefore forms sensitive bird habitat essential to the functioning of the AFNP IBA.

Steep Slopes and Rocky Areas
Steep slopes and rocky areas in the AFNP Sensitivity Map are protected for their intrinsic visual beauty. However, these areas are also important features of conservation concern. They are difficult to rehabilitate and are easily affected by changes in land use, with erosion being an important impact factor. In addition these areas support unique assemblages of dwarf succulents and bulbs, and are important reptile habitats, especially for near-endemic rupicolous species (e.g. Augrabies Flat Lizard and Augrabies Thick-toed Gecko). These areas exist throughout the project area, but are particularly significant in the 'Canyon Zones' and project actions in these areas should be minimized. This is particularly important during the construction phase, where the dangers of erosion and impaired visual impact may become significant after construction of all access roads, but particularly the tail race tunnel haul road, and in the selection of construction material, e.g. borrow pits.

Faunal Impacts

Existing Land Use
Impacts have been assessed separately for both the existing land use, and for the different phases of the proposed project. Although the project area is currently managed by SANParks, the existing land use was based on that of surrounding agricultural developments which have caused a HIGH negative impact in the long-term.

Existing Land Use Impacts					
Impact 1: Existing land use impacts on fauna					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**
Impact 2: Habitat Loss					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**

Construction Phase
Impacts during the construction phase will generally range from LOW to MODERATE. Most of the latter, with the exception of Noise Pollution, can be mitigated to LOW impact.

The impact on fauna of habitat fragmentation and habitat loss will, however, with be VERY HIGH due to short-term impacts associated with the construction of the weir and pipeline, but particularly the haul road into the lower 'palaeochannel' for excavation of the tail race tunnel. This impact can only be mitigated to MODERATE for the weir and pipeline developments, but will probably remain HIGH for the tail race haul road.

Construction Phase Impacts					
Issue 1: Loss of Biodiversity					
Impact 1: Loss of Amphibian Diversity					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**
Impact 2: Loss of Reptile Diversity					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
Impact 3: Loss of Bird Diversity					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study area	Moderate	Probable	**MOD**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**
Impact 4: Loss of Mammal Diversity					
Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
Impact 5: Loss of Species of Conservation Concern					

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderate	Probable	MOD
With Mitigation	Medium term	Study area	Slight	Probable	LOW
Issue 2: Loss of Habitat loss and fragmentation					
Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised	Very severe	Definite	VERY HIGH
With Mitigation	Medium term	Localised	Moderate	Probable	MOD
Issue 3: Additional Construction Impacts on Fauna					
Impact 1: Ecological impacts from dust					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Slight	Definite	LOW
With Mitigation	Short term	Localised	Slight	Probable	LOW
Impact 2: Disruption to fauna from increased noise levels					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Severe	Definite	MOD
With Mitigation	Short term	Study area	Moderate	Definite	MOD
Impact 3: Chemical Pollution					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	MOD
With Mitigation	Medium term	Localised	Slight	Probable	LOW

Operation Phase

As the project is semi-automated, impacts during the Operational phase will be mainly LOW. The greatest impact will result from the overhead transmission line, particularly where it transverses the Orange River. It may result in a HIGH impact on a bird migration route, causing increased mortality to Bird SCC. This impact can be only partially mitigated to MODERATE. Impacts during the Operational phase, however, will be off-set by probable beneficial impacts resulting from increased water flow into the lower 'palaeochannel', with the resultant increase in riverine habitat benefiting various faunal groups.

Operation Phase Impacts					
Issue 1: Loss of Biodiversity					
Impact 1: Loss of Biodiversity					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Probable	LOW
With Mitigation	Medium term	Localised	Moderate	Probable	LOW
Impact 2: Loss of Species of Conservation Concern					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	HIGH
With Mitigation	Medium term	Study area	Moderate	Probable	MOD
Impact 3: Introduction of Alien fauna					

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	LOW
With Mitigation	Medium term	Localised	Slight	Unlikely	LOW
Impact 4: Threats to Animal Movements					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	HIGH
With Mitigation	Medium term	Study area	Moderate	Probable	MOD
Issue 2: Habitat Impacts					
Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	LOW
With Mitigation	Medium term	Localised	Moderate	Unlikely	LOW
Impact 2: Impacts due to changes in hydrology					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Positive	Definite	BENEFICIAL
With Mitigation	NA	NA	NA	NA	NA
Issue 3: Additional Operational Impacts on Fauna					
Impact 1: Increased Dust Levels					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Slight	Definite	LOW
With Mitigation	Medium term	Localised	Slight	Probable	LOW
Impact 2: Noise Pollution					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	LOW
With Mitigation	Medium term	Localised	Moderate	Unlikely	LOW

Decommission Phase

Impacts associated with this phase are LOW to MODERATE and of short-term.

Decommissioning Phase Impacts					
Issue 1: General Decommissioning Impacts on Fauna					
Impact 1: Increased Dust Levels					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study Area	Slight	Definite	LOW
With Mitigation	Short term	Localised	Slight	Probable	LOW
Impact 2: Noise Pollution					
Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study Area	Moderate	Definite	MOD
With Mitigation	Short term	Localised	Moderate	Definite	LOW

Conclusions

Faunal environment

The project area remains relatively natural due to its recent history of management by the AFNP. The riparian vegetation is also largely intact, unlike that in upstream regions where it has largely been replaced by irrigated cultivation.

The project area is contiguous with, and currently managed by the adjacent AFNP, which is also one of the 122 Important Bird Areas in South Africa. It retains significant components of Nama Karoo biodiversity, and due to its proximity to the AFNP forms an important component of protection of this biome.

Few amphibians occur in the Lower Orange River area, with a maximum of 12 species likely to occur in the project area. No amphibians are endemic to the region and no amphibians of conservation concern occur. The most sensitive habitats for amphibians are perennial pools of water in the Orange River palaeochannels.

Reptile diversity in the region is much greater, with 57 species known in the region. Two lizards are Near Endemic to the region, but no reptiles of conservation concern are present. The most sensitive habitats for reptiles are expansive rocky areas, particularly in the 'Canyon Zone'.

Although 247 bird species have been recorded for AFNP and surrounds, many of these are of seasonal, irregular or vagrant occurrence. Only 111 species were recorded during the brief survey. Fourteen (14) birds of conservation concern are recorded in the region, whilst 15 species are near endemic or are range or biome-restricted species. The most significant avian SCC recorded in the region are Kori Bustard (VU), Black Stork (NT), Openbill Stork (NT), Lanner Falcon (NT), Rosy-faced Lovebird (NE), Karoo Lark (NE), Karoo Long-billed lark (NE), Black-eared Sparrowlark (NE) and Namaqua Warbler (NE). The most sensitive habitat for birds is the riparian vegetation along the Orange River and its palaeochannels.

Large mammals are no longer a feature of Northern Cape landscapes, except in protected areas. In 2012 150 head of game (mainly Springbok, Gemsbok and Eland) occurred in the Riemvasmaak region. The majority of mammals present are small to medium-sized, and the micro-mammal component in the region is much greater than indicated on the AFNP mammal checklist. Mammals use all habitats in the region, and the rock fissures and cracks of the Canyon region form roosts for large numbers of bats which play an important role in the control of insect pests over the irrigated agricultural lands, as well as control black fly pests that have a significant economic impact in the region.

There are few SCC for all faunal groups in the region, and most are well protected in the AFNP. The use of the Riemvasmaak as a Hook-lipped rhino refuge is no longer viable for security issues, but the area presents suitable habitat for this species.

Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog.

The riverine habitats at the weir site, and in the palaeochannels of the Orange River form sensitive wetland habitats, and important habitats for amphibians and birds, and drinking points for large mammals.

The upper 'palaeochannel' forms a significant ecological corridor of high sensitivity. The route of the proposed pipeline runs in very close proximity to the right edge of this drainage line.

Faunal impacts

Impacts were grouped into large themes (Issues) and considered for Existing Land Use and during the different phases of the development, i.e. Design and pre-construction, Construction, Operational and Decommissioning.

Existing Land Use: The Riemvasmaak property has been actively managed for conservation by the AFNP, with a policy for the zone on very limited human contact. Existing environmental impacts are therefore minimal (LOW). However, faunal impacts for adjacent irrigated areas of the Orange River are HIGH due mainly to extensive habitat loss and fragmentation.

Construction Phase: Numerous impacts will occur during the construction phase. Most impacts were of MODERATE significance (6), with others LOW (2) or VERY HIGH (1). Only three remained MODERATE if mitigation measures were implemented. The highest impact will result from habitat fragmentation, particularly from the proposed haul road into the lower 'palaeochannel' for construction of the tail race tunnel.

Operational Phase: Following planned rehabilitation and the implementation of mitigation, few impacts will attend the operational phase. Most (5) will be of LOW significance. Two impacts will be of HIGH significance, and can be only partially moderated. They both result from the overhead transmission line, particularly the section where it crosses the Orange River to connect to the existing transmission network. Bird collisions with this structure, particularly SCC such as storks, raptors and bustards, can be expected. Mitigation in the design structure is essential, but will only partially mitigate the impact.

There will substantial changes in local hydrology resulting from the construction of the Head Pond and the release of substantial amounts of water from the tail race into the lower palaeochannel. This channel will change from a very seasonal system into a perennial system. This will generate additional wetland and riparian habitat, both of which are sensitive habitats and important for supporting faunal diversity in the region. This will probably result in a POSITIVE impact, which will, to some extent and due to the creation of an additional habitat, mitigate the HIGH impacts associated with the route of transmission line.

Decommissioning Phase: Most impacts associated with the decommissioning phase will be temporary and result from the removal of infrastructure and rehabilitation. This will lead to LOW to MODERATE impacts from noise and dust pollution. These result from heavy and continuous vehicle movements and plant machinery use, and are unlikely to be mitigated and therefore remain Moderate.

Access roads, particularly the construction of the route down the steep slopes of the Canyon zone necessary for the construction of the tail race, will be difficult to rehabilitate and can be effectively considered permanent.

Recommendations

1. The Riemvasmaak Community (Melkbosrandsamewerkingskomitee) remain in discussion with the AFNP with respect to the unresolved future land use of the Riemvasmaak property. From a faunal perspective, it has formed an important component of the wilderness area of the buffer area adjacent to the AFNP for nearly 60 years, and is considered by SANPArks as an important component in meeting the park's conservation objectives, if even as part of a planned Buffer Zone. The region is planned for Primitive-Remote use categories involving minimal human use. This may conflict with a desire by the Riemvasmaak community for the region to serve as an economic driver of community upliftment.

2. There is little doubt that the region forms an important and integral part of the maintenance of faunal diversity . All efforts should therefore be made to ensure this continued function. In discussion with the Riemvasmaak Community it should be emphasized that recent research has shown that in Costa Rica rural communities on land neighbouring conservation areas had lower rates of poverty relative to other areas. However, if the region is to retain its high conservation value as well as the need for the community to derive economic benefit from their land, then it will require a compromise, allowing greater utilization from that envisaged in the AFNP Management Plan. The Riemvasmaak 'Canyon Zone' has outstanding visual impact and

developments in the region remain out of view of the AFNP main visitor area on the south bank of the falls. Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog.

3. The riverine habitats at the weir site, and in the palaeochannels of the Orange River form sensitive wetland habitats, and important habitats for amphibians and birds, and drinking points for mammals. These are of high biological value and should be avoided. The proposed construction of a haul road into the lower 'palaeochannel' for excavation of the tail race tunnel has the potential to cause significant impact on sensitive habitats, on the visual beauty of the area, and thus on potential future economic benefits from tourism. However, it needs to be recognized that there has been little impact from tourism historically. In this context, the economic benefits of the proposed project far out strip the envisaged potential benefits from tourism, particularly considering that the road will very rarely be used during operations.

4. The upper 'palaeochannel' running from the weir region to the 'palaeo Falls' and then into the lower 'palaeochannel' forms a significant ecological corridor of High sensitivity. The proposed pipeline runs in very close proximity to the right edge of this drainage line. Excavation of a 10m trench to accommodate the pipeline may therefore cause disruption to the normal hydrology of this drainage line and should therefore be avoided. It is recommended that all construction associated with the pipeline, particularly the temporary storage of excavated material, should avoid the route of the upper 'palaeochannel', with an exclusion zone (preferably 50m) between the northern edge of the palaeochannel and the pipeline trench.

5. Certain aspects of the Hydro Power Infrastructure, particularly power to the site and transport links may also serve other land use options. The planning of the Hydro Power project should be integrated with future land use of the Riemvasmaak area to minimize the duplication of environmental impacts.

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1. INTRODUCTION

RVM 1 Hydro Electric Power (Pty) Ltd (hereinafter referred to as RVM1) wishes to construct a 40 Megawatt (MW) hydropower station on the Orange River, on the farm Riemvasmaak (Remainder of Farm no. 497 and Portion 1 of Farm no. 498) (hereinafter referred to as Riemvasmaak), north of the Augrabies Falls, approximately 40 km north west of Kakamas in the Northern Cape Province of South Africa.

Riemvasmaak, owned by the Riemvasmaak Community Trust, was located within the borders of the Augrabies Falls National Park (AFNP). The farm was however excluded from AFNP in terms of Section 2(3) of the National Parks Act of 1976 (refer to Annexure D for a copy of the deproclamation) following the first successful land restitution in South Africa after the 1994 elections. The land was returned to the Riemvasmaak community following their forced removal in 1973/74 during Apartheid. Portions of the proposed project (e.g. the power house and tailrace) would be located on Riemvasmaak, however other portions (e.g. a weir and canal) would be located on land owned by the South African Government. The AFNP Management Plan (2013-2023) refers to Riemvasmaak as the Melkbosrant region.

1.1. Proposed Project

The proposed Hydro Power project utilizes a natural hydrological feature in the vicinity of the Augrabies Falls. This is a 'palaeochannel' that represents an old ('palaeo') drainage line of the Orange River and forms the topographical component of the Hydro Power project. This drainage line still serves as a 'side channel' of the Orange River at times of high floods. It also flows following sufficient local rain forming the natural course of water flowing from the sub-dendritic drainage lines in the northeast section of Riemvasmaak.

It may be divided into an upper 'palaeochannel' draining for 4-5km from the region of the weir site to near the Power House site. The lower pipeline option follows in part this natural drainage line of the 'palaeochannel'. Just south of the Power House site the upper 'palaeochannel' enters the 'Canyon Zone' of the Riemvasmaak area, where it flows over a 'palaeo' falls (Fig. 1.1). A deep pool, probably filled with water in most years, occurs at the base of the 'palaeo falls'. It forms the most scenic spot in the Riemvasmaak area. From this pool the lower 'palaeochannel' runs through a deep gorge with scattered riverine vegetation and rocky pools before re-joining the Orange River (Fig. 4.5).

The proposed hydropower station would consist of the following components:

- a weir across the Orange River (not greater than5 m high, measured from the river base to the spill crest);
- an off-take structure;
- buried water conveyance infrastructure (pipeline);
- a head pond;
- two buried steel (or other suitable pipe material) penstocks;
- an underground power chamber to house the turbines and generation equipment;
- a switch room and transformer yard; and
- access roads.

Energy generated by the proposed hydropower station would be evacuated from the site via a proposed 33 kV underground transmission line across Riemvasmaak (RVM) land (referred to as Portion 481/1) and State owned land (Portion 497/0). An overhead line will then cross the Orange River and connect to either an existing Eskom 132 kV line between Renosterkop and Blouputs or directly or directly at the Renosterkop substation (Fig 1.2). Fuller documentation of the proposed activity, with specific reference to the construction, operation and decommissioning of the proposed hydropower station are discussed in terms of location, activity, site layout and technology in the Environmental Impact Assessment Report.

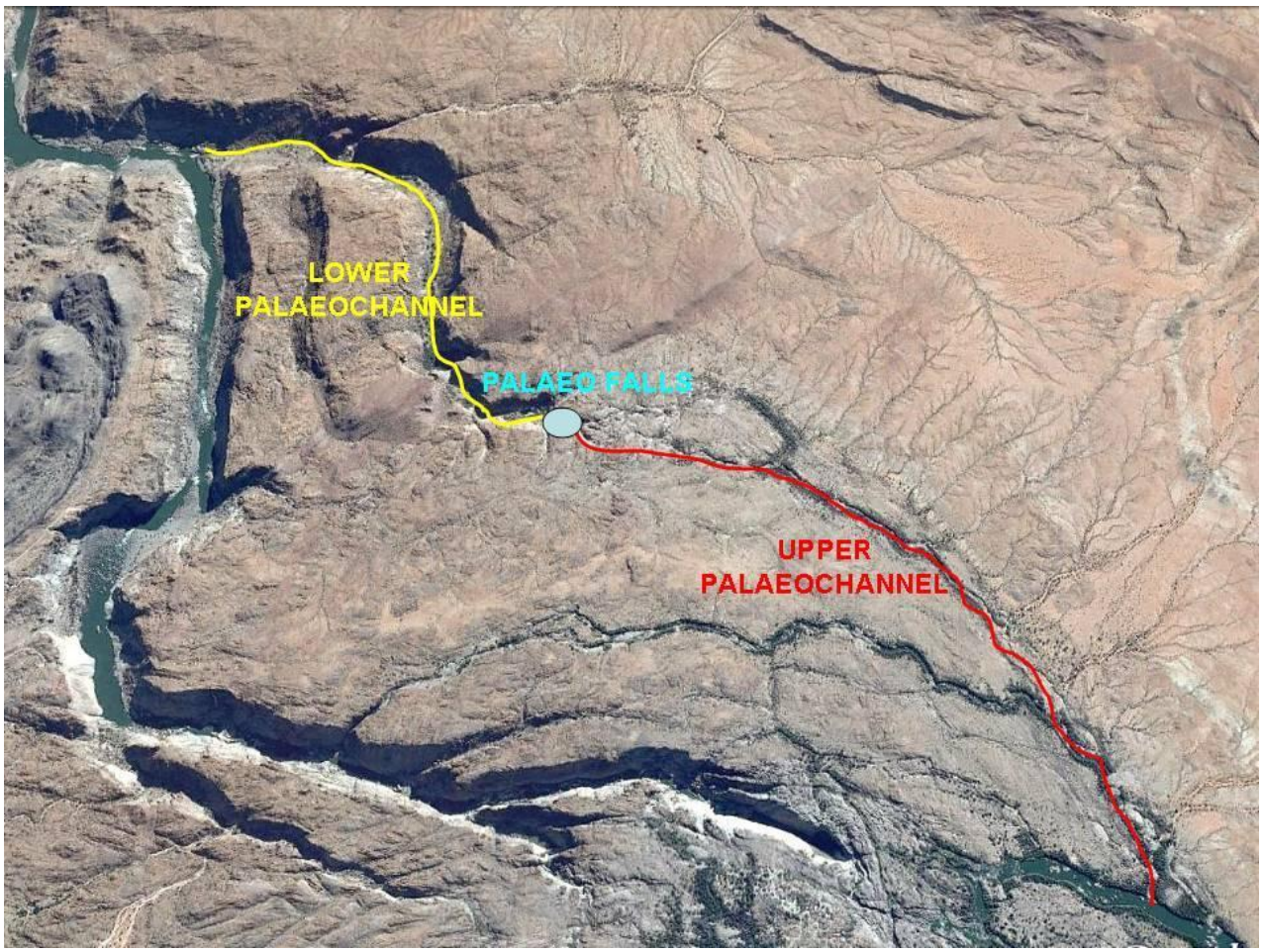

Figure 1.1: 'Palaeochannel' and 'palaeo falls' referred to in the text.

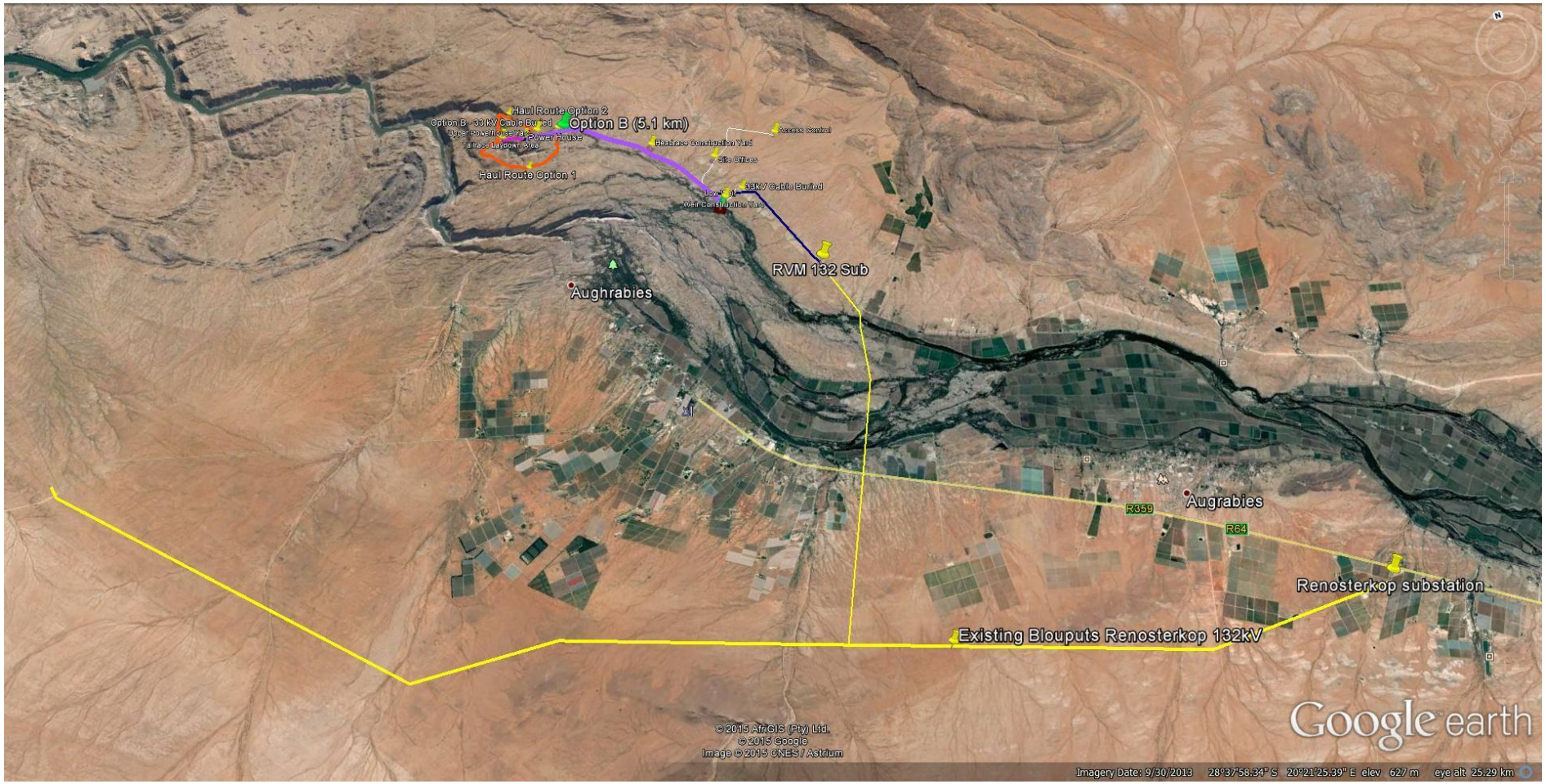

Figure 1.2. Locality and components of the Proposed RVM Hydropower Project

Note the position of the weir (top centre), the proposed pipeline route (purple), and connection to existing transmission network (yellow). Land types noted in Section 3.3: The 'Upland' Zone (large area top right and much smaller area bottom left) appears orange with prominent subdendritic drainage lines. The 'Canyon Zone' is the deeply incised central region, including the existing Orange River and a number of 'palaeochannels' of previous river courses (some of which may still flow at times of high water). The Riparian zone is small and restricted to the braided channel of the existing Orange River above the falls and, in smaller part, in the lower 'palaeochannel'.

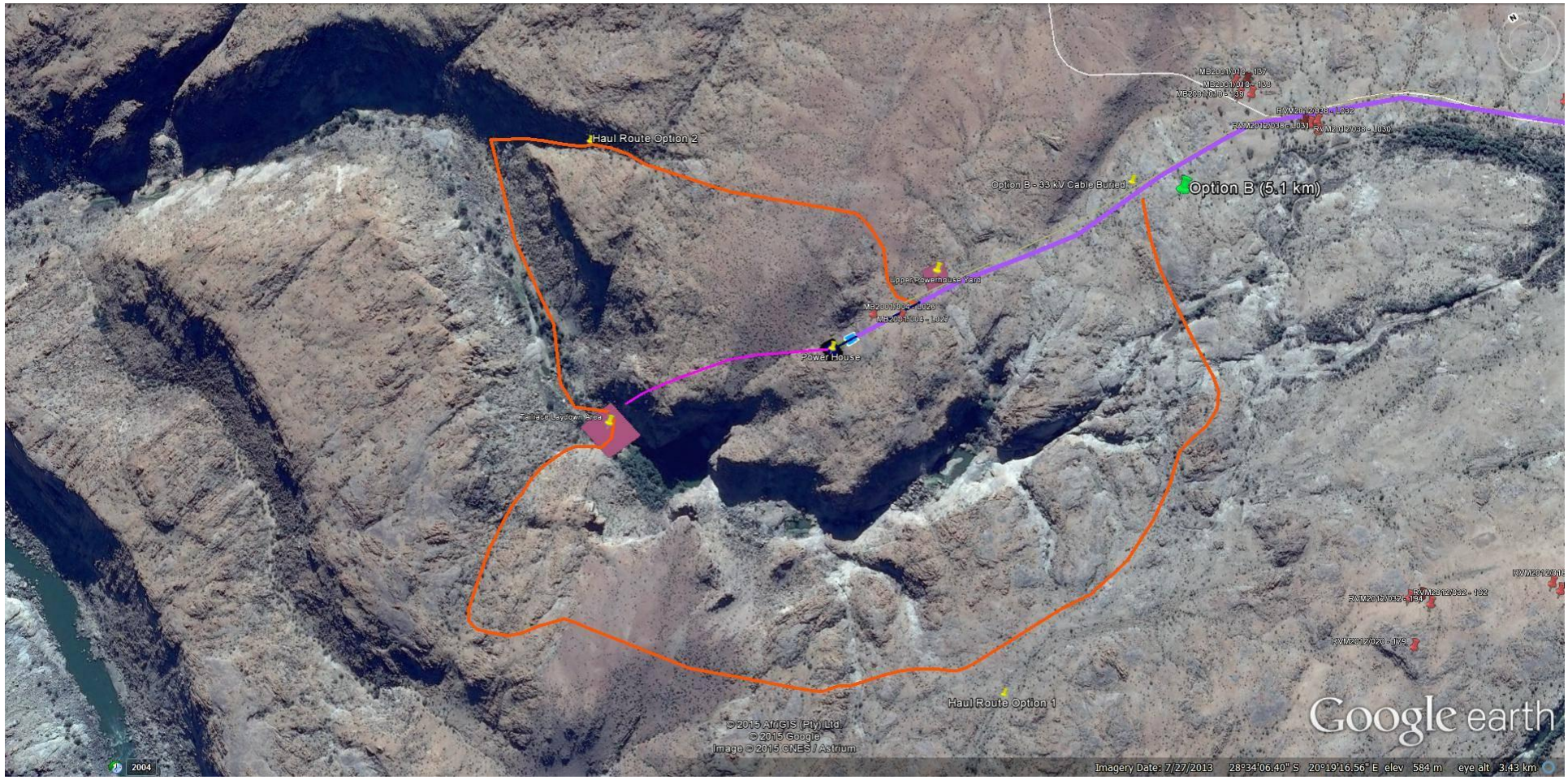

Figure 1.3. Locality and components of the Infrastructure at the Power House site.

Note the position of the power house and Head Pond (blue) (centre), pipeline connection from weir (purple), and the proposed haul road routes (2) into the lower 'palaeochannel' for construction of the tail race tunnel (orange).

1.2. Objectives

The following objectives have been defined for the faunal diversity and faunal impact assessment:

- To provide a general description of the terrestrial vertebrate fauna of the project area and adjacent areas;
- To review the fauna identified in the project area for the presence of Species of Conservation Concern (SC);
- Assess the habitat associations of the faunal components, and;
- Provide an impact assessment of the project actions, during the construction, operational and decommissioning phases, on the resident fauna and their associated habitats.

1.3. Assumptions and Limitations

Study specific assumptions and limitations include:

1. Due to seasonal constraints only a single faunal survey was undertaken.
2. Many faunal groups are often difficult to find and may also be difficult to identify unless collected for detailed analysis. Thus species collected during the faunal survey did not usually comprise an exhaustive list of the true faunal diversity in the region.
3. Although knowledge of faunal diversity in South Africa continues to improve, for certain groups (particularly reptiles and bats), new species are regularly discovered. It is possible that these and additional SCC will be found subsequent to the production of this report.

2. METHODOLOGY

Only a single faunal survey was undertaken relatively late in the wet season (9-13 February 2015).

2.1. Faunal Diversity

The known diversity of the terrestrial vertebrate fauna in the project area was determined by a literature review. Species known from the region, or from adjacent regions whose preferred habitat(s) were known to occur within the study area, were also included. Literature sources included:

- Amphibians – Channing (2001), Du Preez & Carruthers (2009), Frost (2014).
- Reptiles – Branch (1998, 2008), Bauer & Branch (2001), Bauer et al. (2006a,b).
- Birds – Hockey *et al.* (2005), Cohen *et al.* (2006), Sinclair *et al.* (2011), IUCN (2014).
- Mammals – Stuart & Stuart (2001), Kingdon (1997), IUCN (2014), Avery & Avery (2011).

Checklists for terrestrial vertebrate fauna at Augrabies Falls National Park (AFNP) were available on the website http://www.parksandreserves.co.za/downloads.php. These have, where necessary, been updated and adjusted where necessary. The official AFNP mammal checklist overlooks earlier records of small mammals, particularly shrew and bats, that have been recorded from the park or from its close proximity. These have been noted in the review of Northern Cape micromammals (Avery & Avery, 2011) and the checklist updated accordingly.

Over and above the literature review, the field methods for compiling the species lists involved the following:

Amphibians and reptiles: Visual Encounter Survey method was used for amphibians and reptiles. Visual Encounter Surveys included active searching at day and night. In addition, an experienced herpetologist identified suitable habitats and searched for certain herpetofauna associated with those habitats (e.g. rupicolous geckos).

Avifauna: The Visual Encounter Survey strategy was utilised for compiling the avifauna species list. Visual Encounter Surveys include the observations of scat, regurgitated pellets, nests, feathers, bird calls and birds in flight.

Medium to large sized mammals: “Scats, tracks and traces” for terrestrial mammals were observed along paths, at water points, and when walking through the site. The recording of opportunistic sightings was also utilised. In addition, local knowledge of the presence or absence of mammals in the project area was also solicited.

2.2. Species of Conservation Concern

Species of Conservation Concern (SCC) in terms of the project area are defined as:

- **Threatened species**:
  - species listed as threatened in the revised South African Red Data Books (amphibians - du Preez and Carruthers, 2009, Minter *et al*., 2004, Measey, 2011; reptiles - Bates *et al.,* 2014, Branch, 2014; birds – Barnes, 2000; mammals – Friedman & Daly, 2004); and/or
  - species included in other international lists (e.g., 2014 IUCN Red List of Threatened Animals). Definitions include:
    - *Critically Endangered* (CR) - A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
    - *Endangered* (EN) - A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
    - *Vulnerable* (VU) - A taxon is Vulnerable when the best available evidence indicates

that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
    - *Near Threatened* (NT) - A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
- **Sensitive species**: Species not falling in the categories above but listed in:
  Appendix 1 or 2 of the Convention of International Trade in Endangered Species (CITES).

- **Endemic species**: Species endemic to the Northern Cape and/or South Africa (amphibians, du Preez & Carruthers, 2009; reptiles, Bates et al, 2014; birds Barnes, 2000).

2.3. Vegetation and Habitat mapping

No vegetation or habitat mapping was performed as detailed maps for the area are present in the national vegetation map created by SANBI (Mucina & Rutherford, 2006), as well as in the AFNP Management Plan (2013-2023) and the Botanical Assessment for the Riemvasmaak Hydro-power project (McDonald, 2015).

2.4. Impact Assessment Methodology

The CES impact rating methodology was used (see Appendix F in the EIAR).

3. PHYSICAL DESCRIPTION OF THE AREA

This chapter describes the physical setting of the project area, and does not comment on the fauna or flora, which is described in detail in the ensuing chapters.

3.1. Location of the site

The proposed site is situated in the Kai !Garib Local Municipality in the Northern Cape. The town of Kakamas is located approximately 31 km south-east of the proposed site. The nearest town to the proposed site is Augrabies, located approximately 11 km south east of the site. The proposed site itself is located adjacent to the borders of the AFNP on land owned by the Riemvasmaak Community Trust (Portion 498/1) as well as State owned land (Portion 497/0).

3.2. Climate

The study area falls within the Nama Karoo Biome which is one of the most arid regions in South Africa. According to long term records, rainfall is greatest between February and April with a distinct peak in March (autumn) (McDonald, 2015). As mentioned previously Augrabies is the closest town to the proposed development. According to McDonald (2012) Augrabies has a mean annual rainfall of 251 mm, mean summer daytime temperature (October to March) of 35°C and mean winter night temperature (April to September) of 5°C.

3.3. Geology and soils

The geology of the site is complex consisting of a main rock type known as granite-gneiss of the Kakamas Terrane of the Namaqua-Natal Province, with small outcrops of ultrametamorphic rocks in places. The landscape is complex, with three main landtypes recognised.

The first comprises a riparian zone along the existing and previous (palaeo) river channels, which comprises alluvial sediments (Tertiary to Recent) over intrusive rock (mainly granite) of the Namaqualand Metamorphic Complex (Werger & Coetzee 1977). This is covered in a localized vegetation type (Lower Gariep Alluvial Vegetation, see below).

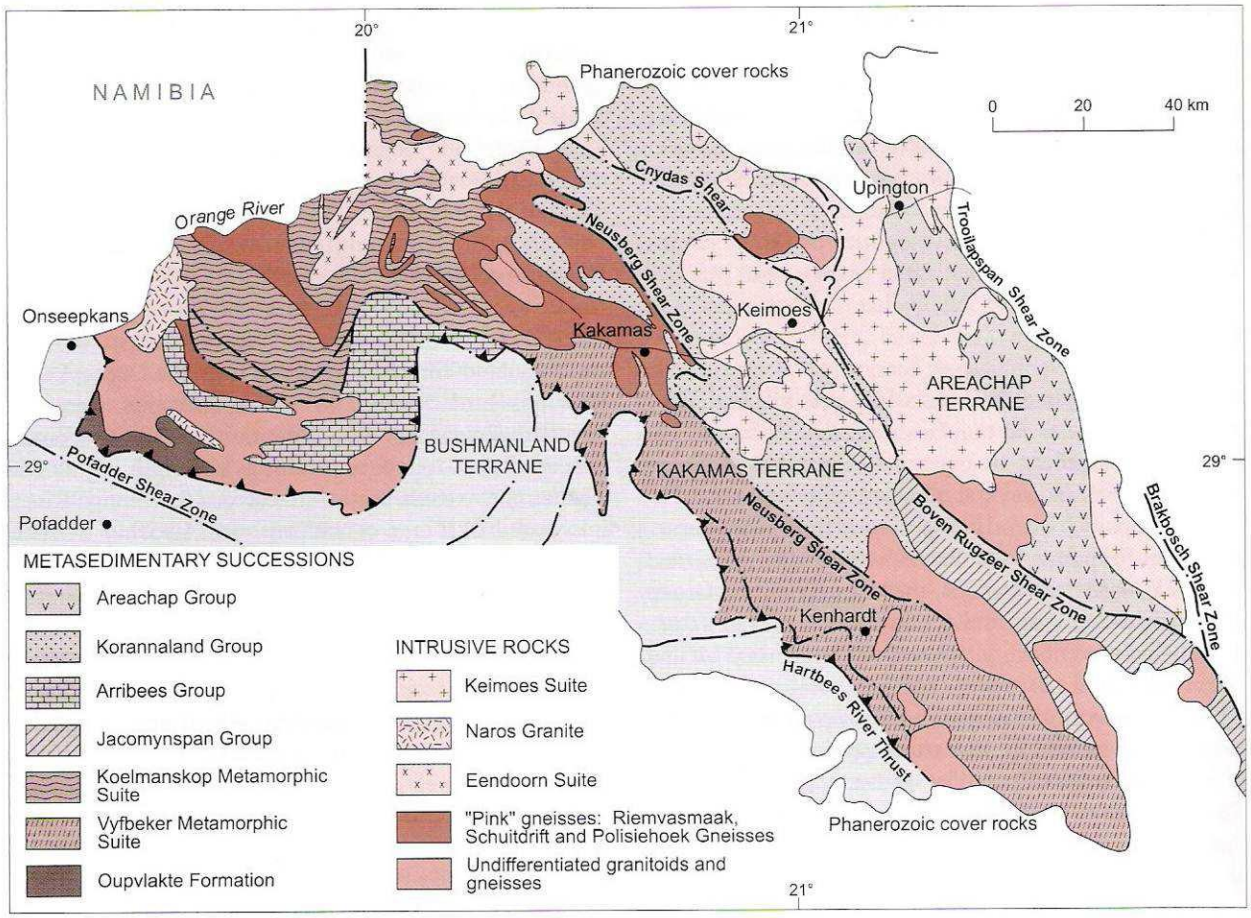

Figure 3.1 Generalised geological map of part of the Northern Cape Province.
(*The study area lies northwest of Kakamas (from McDonald, 2015*))

The second land-type consists of broken, deeply incised terrain consisting of igneous granitic-amphobilitic rocks of the Toeslaan Formation (Korannaland Sequence, and is found in the “canyon zone” below the Augrabies Falls.

The third land-type (“upland zone”) characterises the southern and northern sides of the Orange River. The underlying geology of this land-type consists of migmatite, gneiss and granite with the land surface dissected by sub-dentritic drainage channels (Werger & Coetzee 1977).

4. VEGETATION AND HABITATS OF THE STUDY AREA

The Botanical Assessment of the site (McDonald ,2012) noted that the study area is located within the Nama Karoo Biome, Bushmanland and West Griqualand Bioregion (Rutherford & Westfall, 1994; Mucina et al., 2006). Three vegetation types are found (see Fig. 4.1), namely Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. Neither Lower Gariep Broken Veld nor Bushmanland Arid Grassland are listed in the National List of Threatened Ecosystems, but Lower Gariep Alluvial Vegetation is listed as Endangered A1 (the A1 criterion means there is irretrievable loss of natural habitat with the remaining natural habitat of this type ≤ biodiversity target +15%).

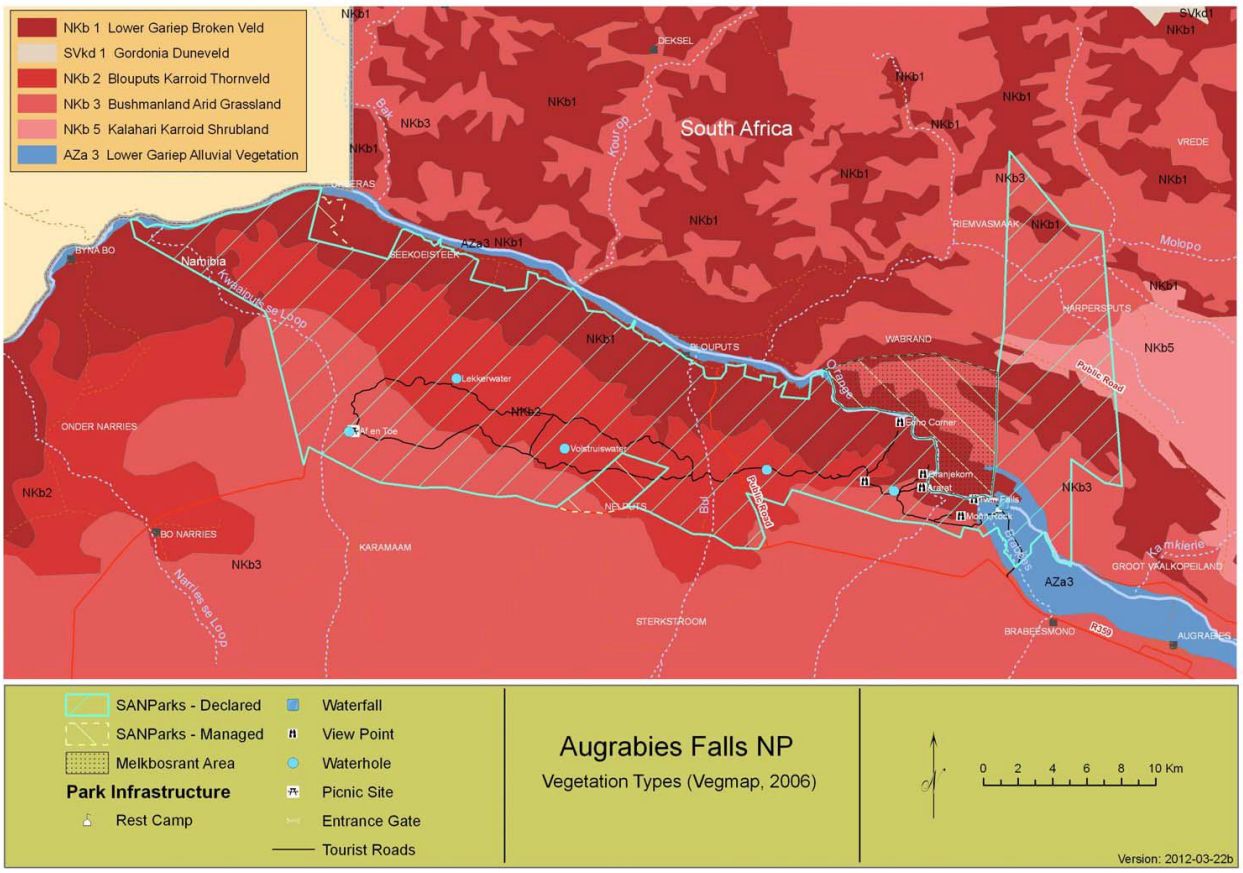

Figure 4.1: Vegetation types of Augrabies region (from AFNP Management Plan, 2013)

4.1. Lower Gariep Alluvial Vegetation

The Lower Gariep Alluvial Vegetation is found on the recently deposited alluvial sediments along the Orange River. On the upper banks it forms dense thickets of thorn trees (*Vachellia karroo* and to a lesser extent *Vachellia erioloba*) with other species such as *Searsia pendulina, Ziziphus mucronata, Maerua gilgii* and *Lycium bosciifolium*. Other prominent trees are *Euclea pseudebenus* and *Tamarix usneoides*. The riverine thickets are often invaded by exotic mesquite (*Prosopis glandulosa* var. *glandulosa*) which forms dense, impenetrable, thorny masses in the riparian vegetation. In the main river channels and occasionally where water persists in the mainly dry side channels the dominant species is *Phragmites australis* which forms extensive reed-beds.

The reason for the loss of Lower Gariep Alluvial Vegetation is the intense agriculture (mainly table grapes and citrus) on the alluvial soils in the Groblershoop area and mainly west of Upington as far as Augrabies, but also further west along the Orange River where it forms the boundary with Namibia. In the study area Lower Gariep Alluvial Vegetation was encountered at the proposed weir site, and lining the river banks along the Orange River and its side-channels above the Augrabies Falls, as wells as along the palaeochannels north of the falls (Figure 4.2).

Figure 4.2: Lower Gariep Alluvial Vegetation
(*along banks of Orange River at the proposed weir site*)

4.2. Lower Gariep Broken Veld

Lower Gariep Broken Veld is found on the rugged ultrametamorphic koppies and inselbergs (the Hardeveld) interspersed with low plains, along the Orange River from Onseepkans, including a large area of Riemvasmaak, in the west to as far as Prieska in the east and from Karos in the north to Marydale in the south. At Augrabies it is found along the gorge below the falls (Mucina *et al*., 2006, in Mucina & Rutherford, 2006). The soils are skeletal and typically Mispah and Glenrosa forms where shallow soil is found over rock.

The vegetation of the Lower Gariep Broken Veld is sparse, dominated by shrubs and dwarf shrubs with perennial grasses. Annual species are more prominent in spring. Tall *Aloe dichotoma* var*. dichotoma* is found as scattered isolated individuals or groups and the ubiquitous black-thorn (*Vachellia* mellifera subsp. detinens). A list of important plant taxa is provided by Mucina *et al.* (2006).

Figure 4.3: Lower Gariep Broken Veld
(*with large expanses of exposed bedrock crystalline gneiss and granulite*)

4.3. Bushmanland Arid Grassland

Bushmanland Arid Grassland is much more widespread than either of the other vegetation types which occur in the study area. It occurs over a wide expanse in the Northern Cape Province from the Bushmanland Basin in the south to the vicinity of the Orange River in the north and from Prieska in the east to Aggeneys in the west (Mucina *et al.,* 2006). At Augrabies it mixes with Lower Gariep Broken Veld and has numerous plant species in common with the latter type.

One of the striking differences between the Lower Gariep Broken Veld and Bushmanland Arid Grassland is the relatively greater abundance of 'white grasses' (*Aristida* and *Stipagrostis* species) in the latter. In the Riemvasmaak it predominates in the north where it is dissected by sandy seasonal 'washes' or streams.

Figure 4.4: Bushmanland Arid Grassland
- *near the disused bush-camp (left) and on the eastern pipeline option, just south of the powerhouse site (right)*

4.4. Abiotic Habitats

Two main abiotic habitats exist in which the faunal requirements are met by, for example, rock structures or the presence of water, and not by the composition of the vegetation. These habitats include:

4.4.1. Rocky and mountainous areas

Most of the project area is composed of red biotite granite gneiss, which is one of the three types of granite gneiss called pink gneiss. It typically has a brown colour on weathered surfaces. The pink gneiss resembles granite mineralogically and in chemical composition. Different weathering patterns can be seen in the park, such as hollows in the rock, exfoliation domes, and 'pop ups', which appear when thin slabs of rock detach from the rock surface due to extreme changes in the rock, pop up, and lean against another thin slab, forming an 'A-tent' shape. Hollows occur when decomposing feldspar causes hard granite to become crumbly, and wind and rainwater wear away parts of the rock. Exfoliating domes are created by chemical weathering stress along sub horizontal joints, which causes thin slabs of rock to detach from the rock surface (Werger & Coetzee 1977). The numerous rock cracks and fissures form refugia for numerous small mammals (elephant shrews and bats), nesting sites for Alpine Swift, Lanner and Peregrine Falcon and Rock Kestrel, as well as roosts for many other birds. The conspicuous Augrabies Flat Lizard (*Platysaurus broadleyi*) frequents the exposed bedrock and cliff walls at the falls and form a popular tourist attraction in the summer months.

Figure 4.5: Rocky cliffs and outcrops at the 'palaeo' Falls below the Power House site.

4.4.2. Wetlands

The Augrabies area falls in a summer rainfall area, and when rain falls the Orange River and its associated drainage lines, including the palaeochannels may temporarily flow with run-off water. However, the shallow sand soils drain quickly and standing water is seasonal, scarce and often short-lived. Important temporary water sources occur in small side channels within the braid section of the Orange River above the falls; and as increasing isolated pools within the lower palaeochannel (see Fig. 4.5 for the largest pool at the base of the 'palaeo falls' which is 700 m from the underground power house, and likely to be marginally affected during construction). These pools are usually surrounded by wetland vegetation such as sedges (*Cyperus* spp.) and reeds (*Phragmites australis*) and form important habitat for certain birds, e.g. *Acrocephalus*

Warblers, and essential breeding sites for semi- to fully aquatic frog species (e.g. Poynton's River Frog and Common Platanna).

The braided channel of the Orange River above the falls, with its associated Lower Gariep Alluvial Vegetation (see Fig. 4.2) forms drinking access for large mammals (e.g. Kudu and Eland), feeding habitat for aquatic mammals (Cape Clawless Otter and Water Mongoose) and piscivorous birds such as Reed and White-fronted cormorant, African Darter, various heron, and at least three species of kingfisher. The insect fauna associated with and breeding in these wetlands form important food resources for insectivores, including three species of Bee-eater. Simulid flies hatching in the falls are an essential food resource for the high densities of Broadley's Flat Lizard, and in turn these lizards play an important role in controlling these known insect pests (Myburgh & Nevill, 2003). There are few natural fountains on Riemvasmaak, with the one (Fig 4.6) situated in the northwest of the project area, and falling out of the area directly impacted by the proposed project.

Figure 4.6: Natural fountain (spring) in the Riemvasmaak (28º31'06.4"S, 20º15'50.3"E).

5. FAUNAL SURVEYS

5.1. Introduction

Due to its high aridity, the Northern Cape Province has a relatively low faunal diversity, particularly for aquatic species and large mammal herbivores. However, many desert-adapted reptiles and birds are endemic or near-endemic to the region. The AFNP Management Plan (2013) notes that the park contains 49 mammal species (50 are listed on the on-line mammal checklist), 186 bird species, 41 reptile species, six amphibian species. However, there are no published reports of detailed faunal surveys in the AFNP for amphibians, reptiles, birds or small mammals (including bats) since the 1970s, soon after the formation of the AFNP. Many of these are now out of date.

Amphibians are the least specious group of terrestrial vertebrates in the project area. South Africa has one of the highest reptile diversities in the world, with the highest endemicity occurring in the more arid parts of the country (Branch, 1998). Reptile diversity in and around the study area is high, with over 50 species known or likely to occur (Branch, 1998). The Nama Karoo supports a particularly high diversity of bird species endemic to southern Africa, although both diversity and endemicity decrease in the northwest as aridity increases. The avifauna characteristically comprises ground-dwelling species of open habitats, particularly in the lark family, Alaudidae (Barnes & Anderson, 1998). Much of the historical large mammal fauna in the region was greatly reduced or even eliminated during the 19th-20th century, although some have subsequently been re-introduced into AFNP, and the re-introduction of others are planned.

5.2. Amphibians

5.2.1. Regional Overview of Amphibians

Amphibians are an important and often neglected component of terrestrial vertebrate faunas. They are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded (Frost, 2014). Currently amphibians are of increasing scientific concern as global reports of declining amphibian populations continue to appear (Phillips, 1994; Blaustein & Wake, 1990). Although there is no consensus on a single cause for this phenomenon, there is general agreement that the declines in many areas, even in pristine protected parks, are significant and do not represent simple cyclic events. Frogs have been aptly called bio-indicator species, whose abundance and diversity is a poignant reflection of the general health and well-being of aquatic ecosystems. They are important components of wetland systems, particularly ephemeral systems from which fish are either excluded or are of minor importance. In these habitats, they are dominant predators of invertebrates.

Southern Africa has a rich amphibian diversities, comprising 160 species (Du Preez & Carruthers, 2009 and updates). However, the arid western region of the Northern Cape Province holds the lowest amphibian diversity (25 species) in the subcontinent. Only eight species have been recorded from the Richtersveld NP (Bauer & Branch 2001), and 12 species (Appendix 1) may occur in the Augrabies-Kakamas area (Du Preez & Carruthers, 2009 and updates).

5.2.2. Recorded Amphibians

Only three of the 12 amphibian species recorded in the area were observed during the survey visit, namely the Guttural Toad (*Amietophrynus gutturalis*), Marbled Rubber Frog (*Phrynomantis annectans*), and tadpoles of Poynton's River Frog (*Amietia poyntoni*). The first two are illustrated in Fig 5.1 and both species were breeding during the survey period.

The presence of the Marbled Rubber Frog (*Phrynomanris annectans*) in South Africa was first signalled only in 1977 (Pienaar, 1977) when specimens were collected in AFNP. Although the AFNP Management Plan (2013) notes "The Marbled rubber frog, *Phrynomantis annectens* is endemic to the park", this is incorrect as it has also been collected in the Richtersveld NP (Bauer & Branch, 2001), and has a large range that extends from the Northern Cape through Namibia to southern Angola.

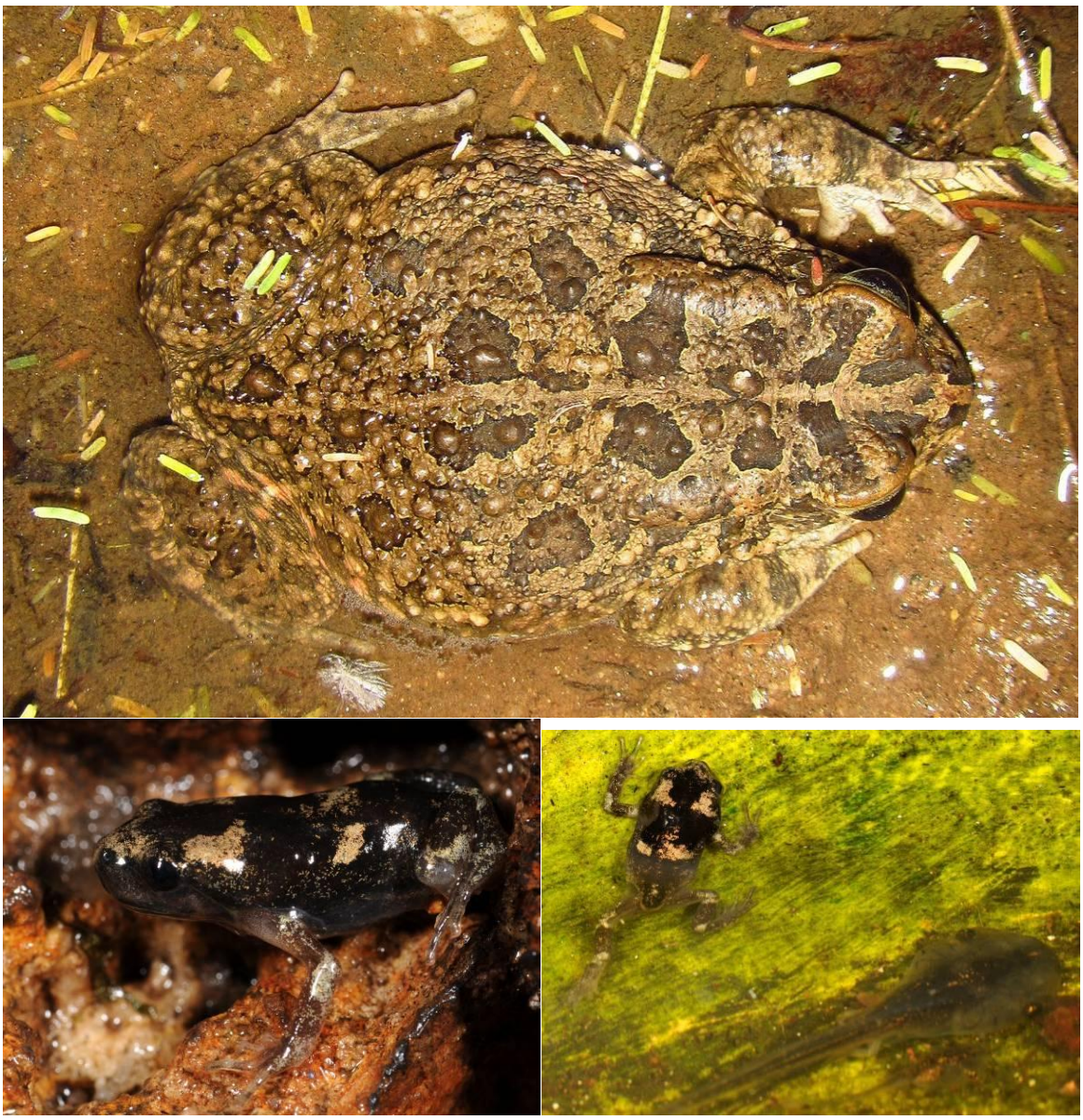

Figure 5.1: Two amphibian species encountered during the site visit.
Above – Guttural Toad (Ameitophrynus gutturalis), below – Marbled Rubber Frog (Phrynomantis annectans)

Amphibians differ in their water requirements for breeding. Some species, e.g. rain frogs (*Breviceps* sp.) have direct development, without a free-swimming tadpole stage. The Marbled Rubber frog has a nectonic tadpole stage that feeds in midwater on plankton and algae. Due to this unique feeding behaviour the frog only breeds in small, isolated, temporary water bodies that are free from fish and other aquatic predators. The Marbled Rubber Frog was collected at two sites (Fig. 5.2) in the Project area. The first comprised small rock pools in granite bedrock at the point where the seasonally dry drainage line (upper 'palaeochannel') empties into the 'palaeo Falls' in close proximity to the Power House site (28º34'13.0"S, 20º29'35.2"E). Such rock pools are a favoured habitat for the species. The other site comprised a series of small pools beneath large boulders in a dry channel draining next to the fountain at the extreme northwest of the project site (28º31'06.4"S, 20º15'50.3"E, Fig. 5.2).

Figure 5.2: Breeding sites for the Marbled Rubber Frog
Left - A small pool in granite bedrock in the upper 'palaeochannel' of the Orange River Right – a drying pool of water beneath a boulder in a drainage line. Both contained tadpoles and metamorphs of the Marbled Rubber Frog.

The Guttural Toad has an extensive range in the savannahs of southern and eastern Africa, and is tolerant of human development. This adaptability has led to invasive translocations to the south-western Cape (Measey & Davis, 2011), and also a natural expansion in its range, in association with irrigated agriculture, along the Lower Orange River (Fig. 5.3).

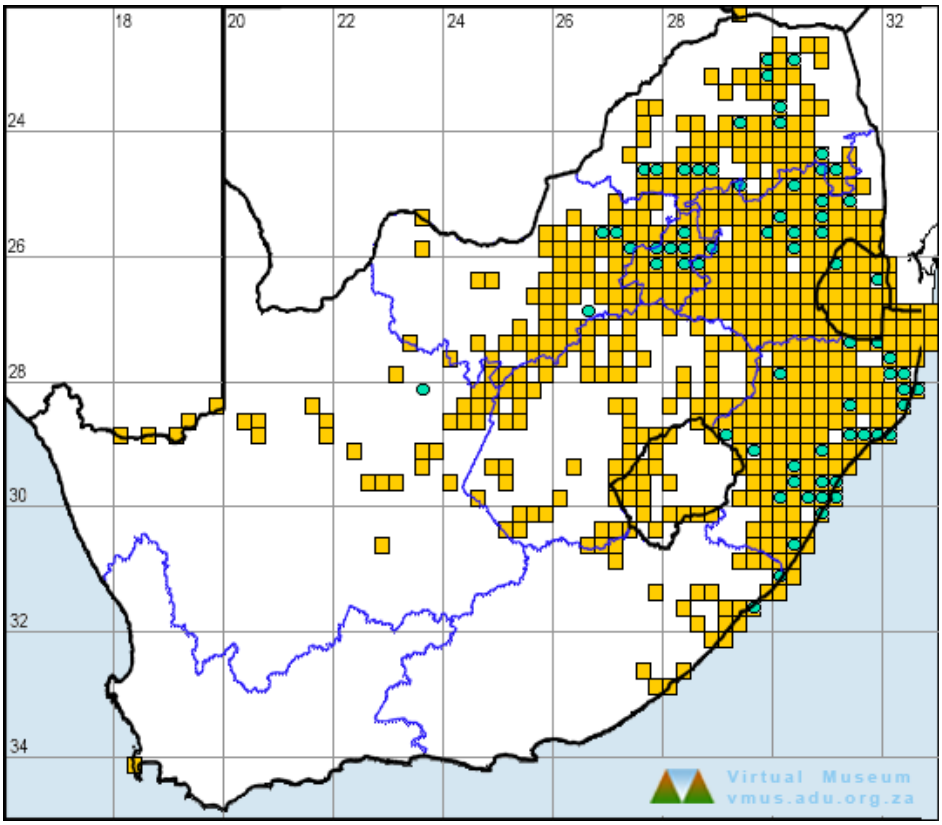

Figure 5.3: Map of the South African distribution of the Guttural Toad (*Amietophrynus gutturalis*)
(http://vmus.adu.org.za/vm_sp_summary.php). *Note the recent range extensions into the south-western Cape and along the irrigated areas of the Lower Orange River*.

5.2.3. Amphibian SCC

No threatened amphibian species or SCC occurs in the project area. The Marbled Rubber Frog was listed as 'Peripheral' in the South African Red Data Book – Reptiles and Amphibians (Branch ed. 1988), but later amended to Least Concern in the 2004 revision (Minter *et al.*, 2004). It remains known from few (<10) quarter-degree squares in South Africa, mainly in the Augrabies and Richtersveld regions. Nationally it has a restricted range in South Africa where it occurs in rocky habitats along the Lower Orange River (Fig 5.4). However, it extends through western Namibia to southern Angola, and globally and nationally is of Least Concern.

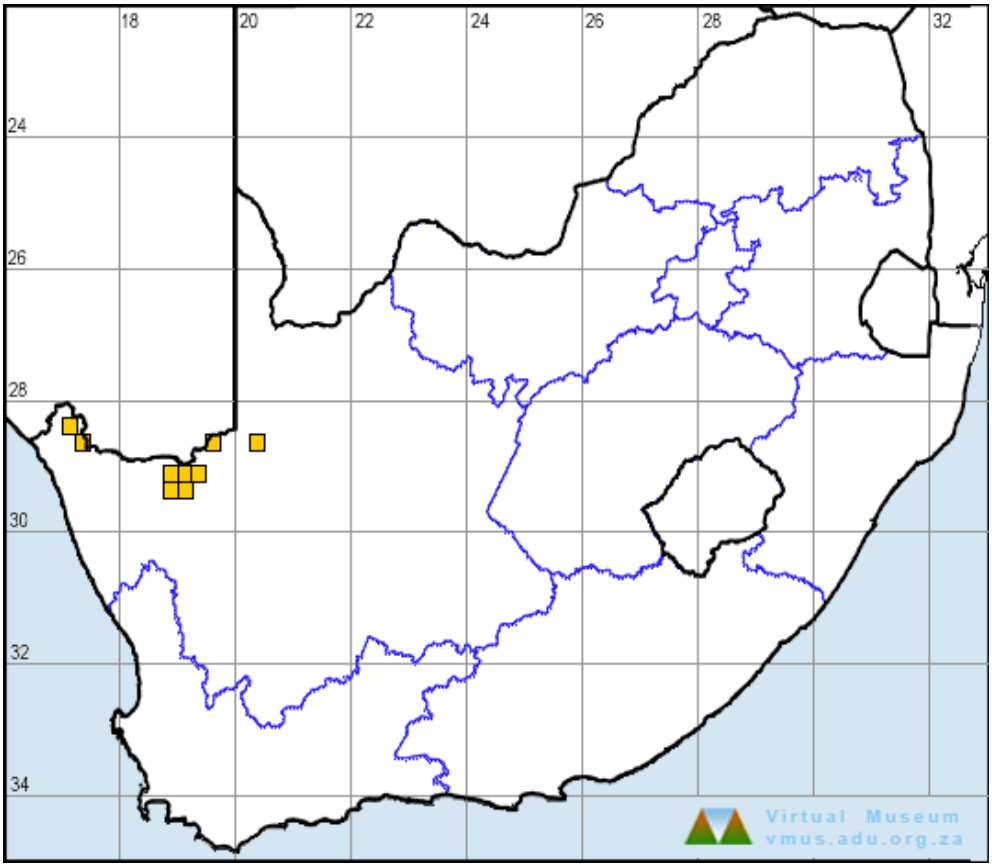

Figure 5.4: South African distribution of Marbled Rubber Frog (*Phrynomantis annectans*)
(http://vmus.adu.org.za/vm_sp_summary.php)

5.3. Reptiles

5.3.1. Regional Overview of Reptiles

Reptiles are one of the most diverse and adaptive terrestrial vertebrate groups in the world. However, nineteen percent of all reptile species are currently threatened with extinction (Böhm *et al.*, 2013), with the main threats being habitat destruction, invasive alien species and illegal pet trade. The same trends exist for South African reptiles, with 22% threatened (Branch, 2014).

South Africa has one of the highest reptile diversities in the world, and the highest in Africa, with the highest diversity occurring in the more arid parts of the country (Branch, 1998). Of the 435 reptile species recorded from South Africa (Bates *et al.*, 2014), at least one third (139 species) occur in the Northern Cape (Branch, 1998, plus subsequent studies). Reptile diversity in the study region is high, with 56 species known or likely to occur (including 3 chelonians, 35 lizards, and 18 snakes), and one other lizard possibly occurring in the region (Appendix 2).

5.3.2. Recorded Reptiles

Of the possible 56 reptile species likely to occur in the project area, 16 were recorded during the present survey (see Appendix 2), whilst a further three species (*Pachydactylus montanus, P. purcellii* and *P. latirostris* were collected in September 2006 during herpetological fieldwork at Farm Dabaras as the western end of AFNP (Branch, unpub. obs.). Additional, easily recognized species, e.g. the Puffadder (*Bitis arietans*), Cape Cobra (*Naja nivea*) and Black Spitting Cobra (*Naja nigricincta woodi*) were also known to rangers (pers. comm., Nardus du Plessis, AFNP). Thirty seven other species have been recorded from the general region (SARCA maps; Bates, *et al.*, 2014).

Two geckos, previously unrecorded in the AFNP reptile checklist, were shown to be present during the faunal survey. The Augrabies Thick-toed Gecko (*Pachydactylus atorquatus*) was only recently described from specimens collected in the AFNP (Bauer, *et al.,* 2006b). It was recorded in the Riemvasmaak area (28º34'25.7"S, 20º22'31.1"E, 664m), and this is only the second record of the species north of the Orange River (Bauer, *et al*., 2006b). Apart from one other record in southern Namibia, the species is endemic to the AFNP.

Haacke's Thick-toed Gecko is found mainly in southern Namibia with small populations known from the Lower Orange River, particularly in the Richtersveld (Bauer & Branch, 2001) and Augrabies region (Farm Dabaras, Branch unpub. obs.; Bauer *et al.*, 2006b). It is common on the rock faces of the AFNP 'Canyon Zone', on both sides of the river.

5.3.3. Reptile SCC

There are no threatened reptile species recorded from the project area or immediate adjacent areas. Two monitor lizards and two chelonians are listed on CITES Appendix II, but all are common throughout much of the region, and/or further afield, and all are well protected in existing conserved areas with no evidence of illegal or unsustainable exploitation in the region. Their inclusion on CITES Appendix II is a precautionary measure covering all members of groups that are regularly involved in the international skin (monitor lizards) or pet trade (tortoises).

Figure 5.5: New Gecko records for the AFNP
Top - the near-endemic Augrabies Thick-toed gecko (Pachydactylus atorquatus), and bottom Haacke's Thick-toed gecko (Pachydactylus haackei).

5.4. Birds

5.4.1. Regional Overview of birds

The Nama-Karoo supports a particularly high diversity of bird species endemic to southern Africa. Its avifauna characteristically comprises ground-dwelling species of open habitats. Rainfall in the Nama-Karoo falls mainly during the austral summer, whilst the adjacent Succulent Karoo lies within the winter-rainfall region. This provides opportunities for birds to migrate between the two biomes to exploit the enhanced productivity associated with rainfall. A high frequency of endemics and near-endemics with their ranges centred in the Karoo are in the lark family (Alaudidae), including Barlow's Lark (*Certhilauda barlowi*), Karoo Lark (*C. albescens*), Karoo Long-billed Lark (*C. subcoronata*), Cape Long-billed Lark (*C. curvirostris*), Red Lark (*C. burra*), Sclater's Lark (*Spizocorys sclateri*) and Large-billed Lark (*Galerida magnirostris*), as well as Black-eared Sparrowlark (*Eremopterix australis*) (Barnes & Anderson, 1998).

Simmons & Allan, (2002) surveyed the Lower Orange River avifauna around Noordoewer. They found, perhaps surprisingly, that the arid habitats of the Lower Orange River support greater diversity than more easterly regions, when all current surveys of richness and abundance for sites along the river from Lesotho to the mouth were combined. The river valley forms a 'linear oasis', and species richness was higher in riverine habitat (71 species) than in the surrounding Nama Karoo (46 species). Overall species richness amounted to 103 birds with a density of riparian birds of 31–34 birds/10 km.

Many typical karroid species are nomads, able to use resources that are patchy in time and space (Barnes & Anderson, 1998). Although a few birds are commensal, rapidly and successfully adapting to modified environments, the majority of birds are sensitive to disturbance and either migrate away from, or suffer greater mortality within degraded habitats. However, because of their high mobility, birds are capable of rapidly re-colonising rehabilitated habitats.

As the project area is managed by and contiguous with the AFNP it therefore falls within an Important Bird Area (IBA - Birdlife International, 2013), which are considered important areas in the conservation of a range of threatened and near-threatened bird species, as well as centres of endemic, near-endemic or range limited species.

5.4.2. Recorded Birds

Of the possible 431 bird species which occur in the Northern Cape province of South Africa, 247 species may occur in or near the project area. Of these 246 species, 111 were observed during the survey. Some of the species in the project area, e.g. Barn Swallow, Common House Martin, European Bee-eater, Willow Warbler, and many waders, are non-breeding Palaearctic migrants, others (White-throated Swallow, Greater Striped Swallow, African Reed Warbler, African Hoopoe) are breeding Intra-African migrants or species that show seasonal movements within the subcontinent and adjacent Africa. A significant number of species e.g. Jackal Buzzard, Black Harrier, Karoo Lark, Grey Tit, Karoo Thrush, Karoo Prinia, Namaqua Warbler, Fiscal Flycatcher, Layard's Tit-Babbler, Pied Starling, Southern Double-collared Sunbird, Black-headed Canary, Cape Weaver, etc) are Range or Biome restricted, or Near Endemic species (see Appendix 3).

5.4.3. Birds SCC

Out of the possible 246 bird species which may occur in the project area, 33 may be considered species of conservation concern (SCC) (Table 5.1); 14 of which were recorded on site. Twenty one (21) of these SCC are globally threatened according to IUCN: five Endangered species; seven Vulnerable species; and nine Near Threatened species (Table 5.1).

At a finer scale, the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland identify 28 threatened species made up of one Endangered species; nine Vulnerable species; and 18 Near Threatened species (Table 5.1).

Three bird species (Southern Black Korhaan, Cape Long-billed Lark and Cape Bulbul) are endemic South African species, all of which were recorded during the site visit (Table 5.1).

The most significant avian SCC recorded in the region included the Globally Threatened White-backed Vulture (EN), Ludwig's Bustard (EN), Secretary Bird (VU) and Black Harrier (VU), as well as the National Threatened Martial Eagle (VU) and Kori Bustard (VU). These are all wide-ranging species whose population declines result from numerous and wide-spread anthropogenic threats. The presence of ten additional nationally Near Threatened birds also increase the conservation significance of the project area avifauna. Finally, no less than 14 of the bird species are Near Endemic to South Africa, or are Range or Biome Restricted species (Table 5.1). The White-backed Night Heron (*Gorsachius leuconotus*, VU), although recorded elsewhere in the Lower Orange (Simmons & Allen, 2002), has not been recorded in the AFNP or during this survey.

Table 5.1: Bird SCC likely to be encountered in the greater project area

Full Name	*Scientific Name*	IUCN	RD	NE
Ludwig's Bustard	*Neotis ludwigii*	EN	VU	
White-backed Vulture	*Gyps africanus*	EN	VU	
Secretarybird	*Sagittarius serpentarius*	VU	NT	
Black Harrier	*Circus maurus*	VU	NT	(*)
Greater Flamingo	*Phoenicopterus rubber*		NT	
Lesser Flamingo	*Phoeniconaias minor*	NT	NT	
Verreaux's Eagle (Black Eagle)	*Aquila verreauxii*	NT	VU	
Martial Eagle	*Polemaetus bellicosus*	NT	VU	
Black Stork	*Ciconia nigra*		NT	
Marabou Stork	*Leptoptilos crumeniferus*		NT	
Greater Flamingo	*Phoenicopterus roseus*		NT	
Peregrine Falcon	*Falco peregrinus*		NT	
Lanner Falcon	*Falco biarmicus*		NT	
Kori Bustard	*Ardeotis kori*	NT	VU	
Chestnut-banded Plover	*Charadrius pallidus*		NT	
Rosy-faced Lovebird	*Agapornis roseicollis*			*
Karoo Lark	*Calendulauda albescens*			*
Karoo Long-billed Lark	*Certhilauda subcoronata*			*
Black-eared Sparrow-lark	*Eremopterix australis*			*
Sclater's Lark	*Spizocorys sclateri*		NT	*
Grey Tit	*Parus afer*			*
Layard's Tit Babbler	*Parisoma layardi*			*
Karoo Thrush	*Turdus smithi*			*
Fiscal Flycatcher	*Sigelus silens*			*
Namaqua Warbler	*Phragmacia substriata*			*
Pied Starling	*Spreo bicolour*			*
Southern Double-collared Sunbird	*Cinnyris chalybeus*			*
Cape Weaver	*Ploceus capensis*			*
Black-headed Canary	*Serinus alario*			*
Totals	**29**	**8**	**16**	**15**

NE = Near Endemic to South Africa; EN = Endangered; VU = Vulnerable; NT = Near Threatened.

5.5. Mammals

5.5.1. Regional Overview of Mammals

Large game makes up less than 15% of the mammal species in South Africa and a much smaller percentage in numbers and biomass. In the Nama Karoo, large mammals are not generally a feature with the majority of mammals present being small to medium-sized. Large to medium-sized mammal species that have adapted to these harsh conditions include some of South Africa's most familiar and widespread species, including Klipspringer, Aardvark, Baboon, Steenbok, Duiker, Cape Porcupine, Black-backed Jackal and Leopard.

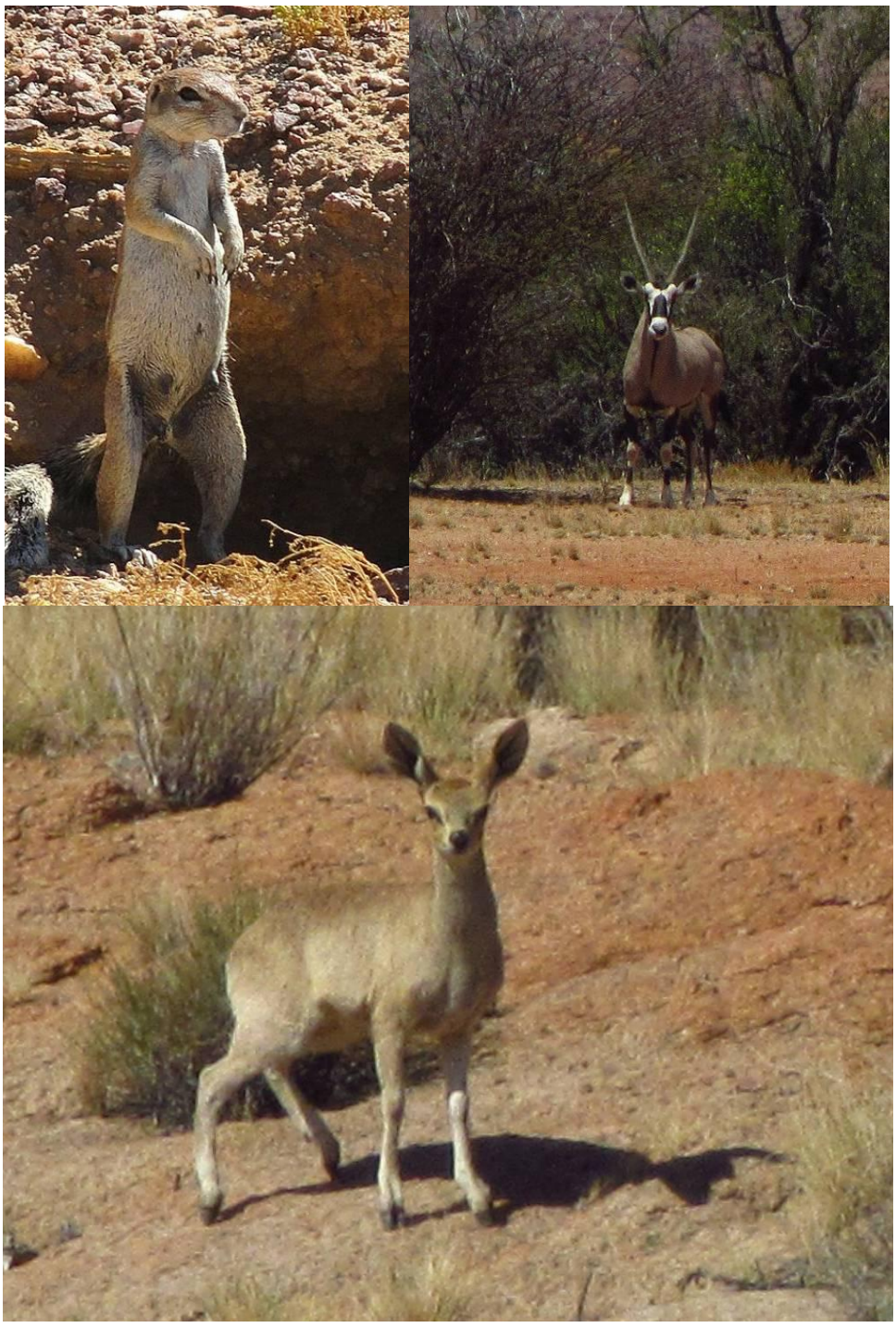

Figure 5.6 Mammals recorded during the Faunal Survey
Cape Ground Squirrel (Xerus inauris), Gemsbok (Oryx gazelle) and Klipspringer (Oreotragus oreotragus)

A total of 50 mammal species are listed on the publically available 2012 mammal checklist for AFNP (http://www.sanparks.org/assets/docs/parks_augrabies/conservation/mammal_list.pdf). The list includes only two bat species and 16 rodents. Surprisingly it lists no species of true shrew (Sorcidae) and only a single elephant shrew. However, Avery & Avery (2011) have reviewed micromammal records for the Northern Cape and document numerous overlooked historical records for the Augrabies region, including an additional elephant shrew (Western Rock Elephant Shrew) and adding three true shrews (Reddish-grey Musk Shrew, Bicolored Musk Shrew and Lesser Red Musk Shrew) to the AFNP mammal checklist. Five additional bat species (Rock-loving Flat-headed Bat, Egyptian Free-tailed Bat, Darling's Horseshoe Bat, Cape Horseshoe Bat and Rüppell's Pipistrelle) have been recorded in the AFNP, with a further four species having been recorded in close proximity (Long-tailed House Bat, Egyptian Slit-faced Bat, Cape Serotine Bat and Natal Long-fingered Bat). For rodents, the same authors (Avery & Avery, 2011) note that the Spectacled Dormouse (*Graphiurus ocularis*), which is listed on the AFNP mammal checklist does not occur in the region. It may have been mistaken for the Large Savannah African Dormouse (*Graphiurus microtis*), which is known from the region from Holocene deposits, but is otherwise undocumented for the AFNP. They also add an additional seven species to the small mammals to the AFNP checklist, and note a further nine that have been recorded within close proximity. There are also a number of corrections, resulting from new taxonomic insight. The Acacia Rat (*Thallomys paedulcus*) no longer occurs in AFNP, whilst both Shortridge's Thallomys (*Thallomys shortridgei*) and the Black-tailed Thallomys (*Thallomys nigricauda*) have been recorded in close proximity to AFNP and either (or both) may therefore occur within the park. An updated checklist for the mammals, large and small, of the AFNP is given in Appendix 4.

5.5.2. Mammals recorded during survey

Of the terrestrial mammal species which may occur in the project area, 17 were observed during the survey and a further four (Cape Clawless Otter, Water Mongoose, Aardvark and Cape Porcupine) were identified by scats, tracks, etc. The larger ruminants, e.g. Springbok, Gemsbok, and Eland, were all very cautious and did not allow close approach, indicating they are un-acclimated to human activity in the region. Due to time constraints no micro-mammal trapping was undertaken, and this component of the project area faunal diversity remains poorly known.

5.5.3. Mammal SCC

Only one globally threatened mammal, Hartmann's Mountain Zebra (VU) currently occurs in the AFNP, with the population in 2012 comprising 75 animals, most in the Western section of the park, and only 5 in the Riemvasmaak region. Another threatened large mammal, the Hook-lipped Rhinoceros (globally and regionally CR) had previously been introduced into the AFNP in the Riemvasmaak region, but in the current climate of heavy rhino poaching the small population was re-located for security reasons. The AFNP Management Plan (2013-2023) notes that re-introduction of the species forms part of future planning, but this must await a drastic decline in southern Africa in the current national levels of rhino poaching and they are unlikely to be placed on land not owned or fully managed by SANParks.

Although the Small Spotted Cat (also referred to as the Black-footed Cat) is globally Vulnerable, it is not listed in the AFNP checklist. It is rare compared to the other small cats of southern Africa (Sliwa, 2008) and therefore may have been overlooked. It is endemic to the subcontinent, and is a specialist of open, short grass areas with an abundance of small rodents and ground-roosting birds. It inhabits dry, open savanna, grasslands and Karoo semi-desert with sparse shrub and tree cover and a mean annual rainfall of between 100 and 500 mm. This habitat type is rare in the predominantly rocky Riemvasmaak region.

Among the expanded micro-mammal checklist none are globally or nationally threatened, although Shortridge's Thallomys (*Thallomys shortridgei*) is poorly-known (Data Deficient), and the Dassie Rat (*Petromus typicus*) and Honey Badger (*Mellivora capensis*) are regionally Near Threatened.

Mammal SCC for the Project area are summarized in Table 5.2.

Table 5.2: Mammals SCC which are known or possibly occur within the project area.

English Name	Scientific Name	IUCN	SA RB	Possible	Present
Small Spotted Cat	*Felis nigripes*	VU		1	
Hartmann's Mountain Zebra	*Equus zebra hartmannae*	VU			1
Hook-lipped Rhinoceros	*Diceros bicornis bicornis*	CR	CR		1
Brown Hyaena	*Hyaena brunnea*	NT	NT		1
Leopard	*Panthera pardus*	NT			1
Dassie Rat	*Petromus typicus*		NT		1
Honey Badger	*Mellivora capensis*		NT		1
Total	**7**	**5**	**4**	**1**	**6**

6. CONSERVED AREAS

All proposed projects should take cognisance of their relationship to the existing and proposed network of conserved areas within the region. The following section looks at the existing conserved network.

6.1. Protected Areas

The Augrabies Falls National Park (AFNP) was proclaimed in August 1966 and is located in the Northern Cape, approximately 120 km west of Upington and 40 km west of Kakamas. The park is situated along the southern edge of the Kalahari Desert and the eastern border of Namibia (Fig. 6.1). It was initially proclaimed in order to conserve a small area of geological interest around the Augrabies Falls, which is the largest waterfall on the Orange River. It currently covers 52 898 ha, with most (38 888 ha) lying south of the Orange River, with a smaller portion (14 010 ha) to the north of the falls. Part of this northern section (Portion 1 of the farm Riemvasmaak 498) was deproclaimed in 2004. Portion 0 (Remainder) of farm Waterval 497 is owned by the State. Riemvasmaak 498 (previously called Melkbosrand, and named as such on AFNP maps and in their reports) was a section of the old AFNP that was deproclaimed and returned to the Riemvasmaak Community. The AFNP Management Plan (2013-2023) includes both these portions in its coverage, and notes that:

> "*The draft agreement recognises the Riemvasmaak Community as the owners of the land, and agrees that the land will only be used in ways that are compatible with nature conservation. The community has access to graves and other sites of historical value. A committee, the Melkbosrandsamewerkingskomitee (MSK) has been established to achieve consensus on the management of the area north of the Orange River*."

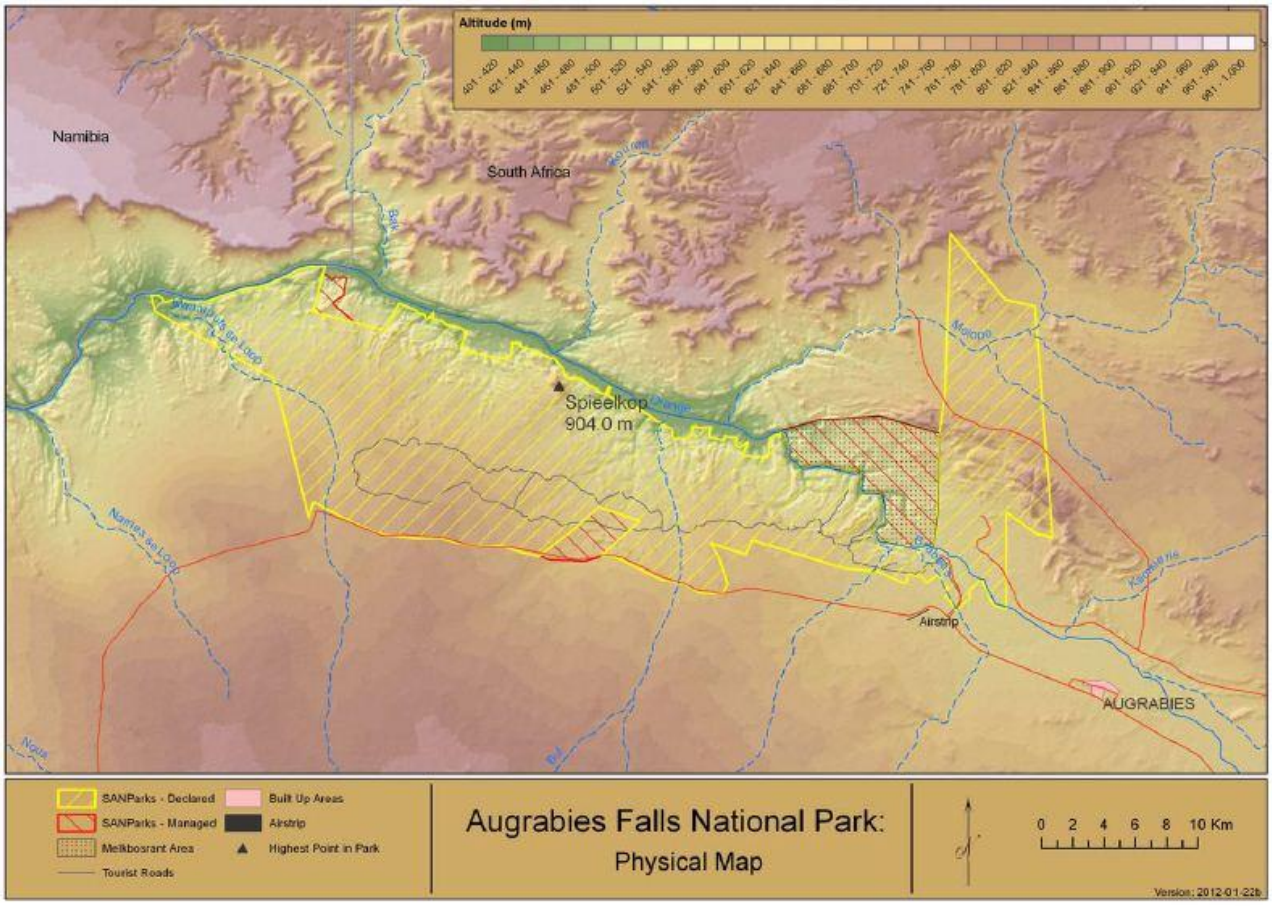

Figure 6.1 Augrabies Falls National Park
(*from AFNP Management Plan (2013-2023) Map 2*)

The current Management Plan for the AFNP (AFNP Management Plan (2013-2023) directs and enables its stated 'Mission':

> *"Augrabies Falls National Park will manage and conserve the biodiversity, geology and cultural heritage as part of the functional and sustainable patchwork of different land uses within the Benede-Oranje region, through collaboration and education, to promote better livelihoods, as well as benefits and enjoyment for all."*

The AFNP Management Plan (2013-2023) further notes that "Over the next 20 years it is predicted that the relative biodiversity value of AFNP will be stable, and biodiversity risks are low compared to other parks. The components that are currently strong, *namely the high scenic value of the park* and its potential to generate income, will be maintained and strengthened." (author's highlight)

To maintain viable biodiversity and ecosystem functioning, AFNP management plan to both expand the footprint of the AFNP, as well as generate a border of meaningful buffer zones where land use is directed towards the same conservation goals. Use zones have also been identified for various sections of the AFNP, with the Riemvasmaak (Melkbosrant) section zoned for Primitive-Remote usage. A Remote zone is an "area retaining an intrinsically wild appearance and character, or capable of being restored to such and which is undeveloped and roadless (although limited unimproved management tracks are allowed). There are no permanent improvements or any form of human habitation. It provides outstanding opportunities for solitude, with awe inspiring natural characteristics with sight and sound of human habitation and activities barely discernable and at far distance. The conservation objective is to maintain the zone in a natural state with no impact on biodiversity pattern or processes. Existing impacts on biodiversity either from historical usage or originating from outside the zone should be minimised. The aesthetic / recreational objectives for the zone specify that activities which impact on the intrinsically wild appearance and character of the area, or which impact on the wilderness characteristics of the area (solitude, remoteness, wildness, serenity, peace etc) will not be tolerated." (AFNP Management Plan (2013-2023, p13)

The prime characteristic of a Primitive zone "is the experience of wilderness qualities with access controlled in terms of numbers, frequency and size of groups. The zone has wilderness qualities, but with limited access roads (mostly 4x4) and the potential for basic small-scale self-catering accommodation facilities or small concession lodges (which would generally have more sophisticated facilities). Views of human activities and development outside of the park may be visible from this zone. The conservation objective is to maintain the zone in an almost completely natural state with little or no impact on biodiversity processes, and very limited and site specific impacts on biodiversity pattern. Existing impacts on biodiversity either from historical usage or originating from outside the zone should be minimised. The aesthetic / recreational objectives for the zone specify that activities which impact on the intrinsically wild appearance and character of the area, or which impact on the wilderness characteristics of the area (solitude, remoteness, wildness, serenity, peace etc) should be restricted and impacts limited to the site of the facility. Ideally visitors should only be aware of the facility or infrastructure that they are using, and this infrastructure / facility should be designed to fit in with the environment within which it is located in order to avoid aesthetic impacts." (AFNP Management Plan (2013-2023, p13-14)). Maps from the AFNP Management Plan (2013-2023) detailing these proposed expansions, buffer and use zones are included below (Figs 6.2 to 6.4).

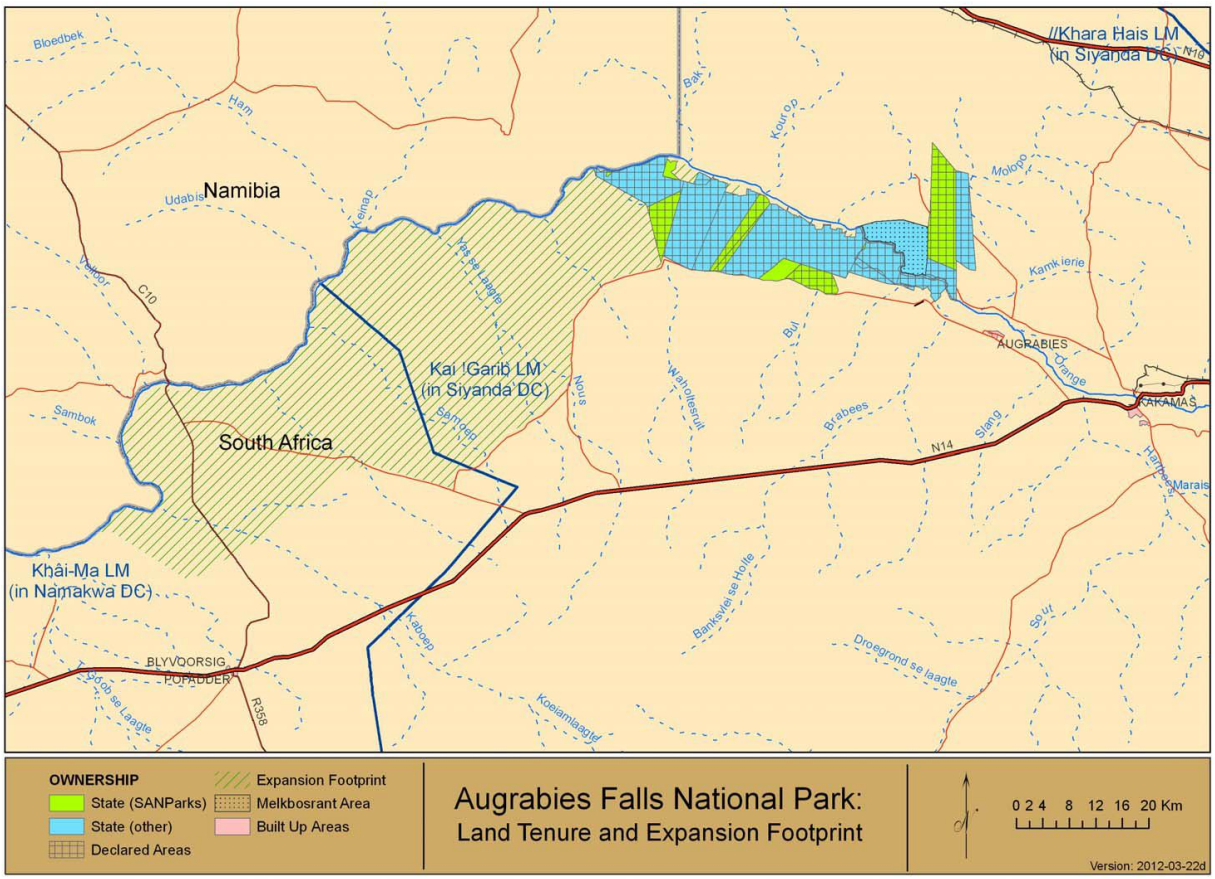

Figure 6.2: Augrabies Falls National Park – Land Tenure and Expansion Footprint
(from AFNP Management Plan (2013-2023) Map 3)

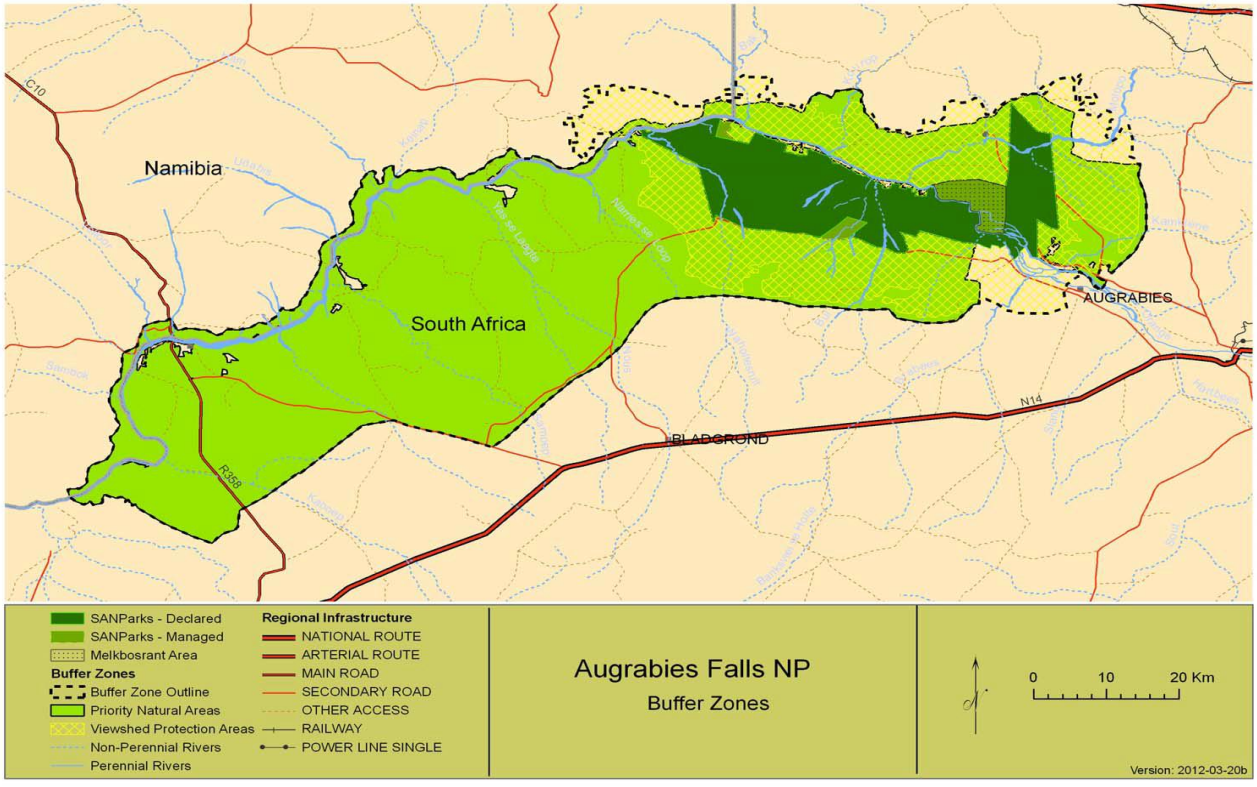

Figure 6.3: Augrabies Falls National Park – Buffer Zones
(from AFNP Management Plan (2013-2023) Map 6)

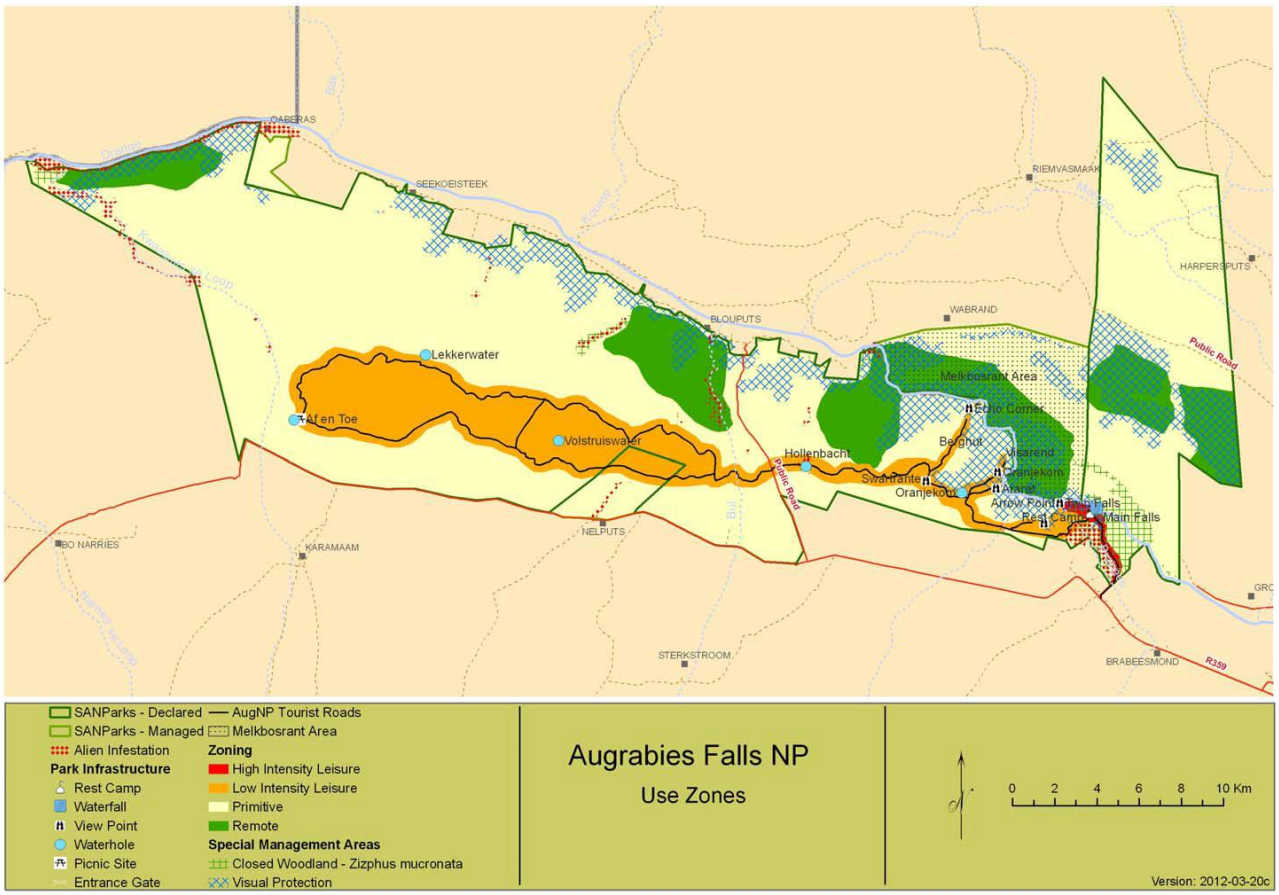

Figure 6.4: Augrabies Falls National Park – User Zones
(from AFNP Management Plan (2013-2023) Map 4)

6.2. Important Bird Areas

The function of the Important Bird Area (IBA) programme is to identify and protect a network of sites, at a biogeographic scale, critical for the long-term viability of naturally occurring bird populations, across the range of those bird species for which the site-based approach is appropriate. A total of 121 IBAs occur in South Africa (Barnes, 1998), with 11 in the northern Cape. Many are situated in the Orange River drainage, with the only IBA occurring within 100km of the proposed site being the AFNP.

Augrabies Falls National Park (IBA ZA022)
Barnes (1998) notes that a total of 195 species have been recorded in the park (this has since been increased). Despite the relatively low avian diversity, the park is an IBA as it supports many Nama Karoo biome-restricted assemblage birds, as well as a host of other arid-zone species. The lowland plains are particularly important for large wide-ranging species such as Martial Eagle (*Polemaetus bellicosus*), Kori Bustard (*Ardeotis kori*), Ludwig's Bustard (*Neotis ludwigii*) and Karoo Bustard (*Eupodotis vigorsii)*. The plains also support Karoo lark (*Certhilauda albescens*), Karoo Chat (*Cercomela schlegelii*), Tractrac Chat (*C. tractrac*), Sickle-winged Chat (*C. sinuate*) and Rufous-eared Weaver (*Malcorus pectoralis*). The Black-headed Canary (*Serinus alario*) occurs wherever there is seeding grass and water. The belts of riverine Acacia woodland hold Karoo Scrub Robin (*Cercotrichas coryphaeus*), Kalahari Scrub Robin (*C. paean*), Namaqua Warbler (*Phragmacia substriata*), Layard's Tit Babbler (*Sylvia layardi*), Marico Flycatcher (*Bradornis mariquensis*), Scaley-feathered Finch (*Sporopipes squamifrons*) and Rosy-faced Lovebird (*Agapornis roseicollis*). Pale-winged Starling (*Onychognathus nabouroup*), Bradfield's Swift (*Apus bradfieldi*) and the secretive and localized Cinnamon-breasted Warbler (*Euryptila subcinnamomea*) occur in the river's steep gorges and associated rocky kloofs.

7. SENSITIVITY

The most sensitive habitats in the project area are discussed below.

7.1. Wetlands and Riverine habitats

Wetlands and riverine habitats constitute features of conservation concern as they are ecological process areas. They are essential for ecosystem functioning and process and provide niche habitats for a variety of plants and animals. These areas have VERY HIGH sensitivity.

The AFNP Management Plan (2013-2023) has prioritized for protection as a 'Special conservation area' the Closed woodland of Buffalo Thorn (*Zizyphus mucronata*) that forms a vulnerable vegetation subtype of Lower Gariep Alluvial Vegetation. It has become increasingly rare in the region due to habitat loss for agricultural use and is needs protection to minimise the risk of continued loss of habitat, as well as to prioritise rehabilitation work. In the project area it forms part of the riverine habitats along the Orange River in the vicinity of the proposed weir. It also forms part of the northern drainage line of Riemvasmaak, particularly where it connects to the existing Orange River. Simmon & Allen (2002) note that riverine habitat shelters the greatest bird diversity within the Orange River avifauna, and it therefore forms sensitive bird habitat essential to the functioning of the AFNP IBA.

7.2. Steep Slopes and Rocky Areas

Steep slopes, rocky areas in the AFNP Sensitivity Map are protected for their intrinsic visual beauty. However, these areas with shallow soils and large expanses of fissured rock also constitute important features of conservation concern. They are difficult to rehabilitate and are easily affected by changes in land use, with erosion being an important impact factor. In addition these areas support unique assemblages of dwarf succulents and bulbs, and are important reptile habitats, especially for near-endemic rupicolous species (e.g. Augrabies Flat Lizard and Augrabies Thick-toed Gecko). These areas exist throughout the project area, but are particularly significant in the 'Canyon Zones' and project actions in these areas should be minimized. This is particularly important during the construction phase, where the dangers of erosion and impaired visual impact may become significant after construction of all access roads, but particularly the tail race tunnel haul road, and in the selection of construction material, e.g. borrow pits.

8. ASSESSMENT OF FAUNAL IMPACTS

8.1. Introduction

This chapter details the faunal impacts identified by the specialist consultants during the specialist studies phase. For each issue identified, details are provided, followed by the mitigation measures required to minimise the negative impacts associated with the issue. The impact rating methodology used to determine the impacts below is presented in Appendix F of the Environmental Impact Assessment Report.

8.2. Existing Land Use

The Riemvasmaak area is currently managed as a part of the AFNP (the Melkbosrant region) in which the region falls into Primitive and Remote Use zones. These are the highest protected area, where human access and impact is either fully curtailed or rigorously controlled.

Should the *Melkbosrandsamewerkingskomitee* agree to maintain existing management as outlined in the AFNP Management Plan (2013-2023), there would be no increase in negative environmental impacts.

8.3. Land Use changes to that of surrounding irrigated agriculture

With the current lack of resolution of the fate of Riemvasmaak, the following discussion of possible Land Use notes the impact of the existing irrigated agriculture that surround the Riemvasmaak and contiguous AFNP.

8.3.1. Issue 1: Loss of faunal biodiversity

Historically, the Nama Karoo supported a large diversity of animals as noted by early travellers and as recorded in present day place names (Skead, 1980). A long list of small (e.g. steenbok, duiker) and large ungulates (e.g. gemsbok, eland) as well as mega-herbivores (such as elephant, black rhinoceros and hippopotamus) and their associated predators (e.g. lion, cheetah hyena) were recorded in the region and reflect this diversity (Skead, 1980). However, the density of animals, as well as the extent of population fluctuations that would have occurred in the Nama Karoo prior to colonial settlement at the Cape, is harder to determine (Hoffman & Rhode, 2006).

It appears that wildlife was only seasonally abundant in the region prior to colonialism, and although the 'linear oasis' of the Orange River would have supplied water for many species it would not have supported large herds of grazing ungulates. Encroaching farmers would have regarded wildlife as both food and vermin that competed with their livestock for food, space and water (Lovegrove, 1993). Along with habitat loss to fenced livestock farms and a rinderpest outbreak at the end of the 19th Century, game numbers were dramatically reduced. Fence lines also restrict seasonal game movements, restricting their migration to resources. Fortunately, fences do not limit birds or reptiles. Many granivorous birds migrate hundreds of kilometres to find food in the region after good rainfall events stimulate plant growth (Dean and Milton, 1999).

Existing land use is primarily focused on agriculture, with livestock grazing restricted to regions out of the Orange irrigation zone. Irrigation-dependent cultivation, of grapes and citrus primarily, is now widespread along the Lower Orange, particularly in the zone from Keimos to Augrabies (Fig 8.1).

Figure 8.1: Irrigated agriculture along the Lower Orange River from Kakamas to Augrabies

Impact 1: Existing land use impacts on fauna

Cause and comment

While many of the larger mammals were eliminated in historical times, present day impacts on fauna come in numerous forms. Predatory animals such as black-backed jackal (*Canis mesomelas*), caracal (*Felis caracal*) and leopard (*Panthera pardus*) have been known to effect stock numbers, thus impacting upon local livelihoods in the region. However, the hunting and trapping of predators can often lead to an increase in predator numbers because of the elimination of alpha males that restrict access of other predators within their territory (NDBSP, 2008). Thus, common methods of predator control can have the opposite effect to that which is intended.

Fence lines along roads and between farm paddocks may restrict the movement of non-volant (walking) large animals across the landscape. The faunal impact depends on the size and structure of these linear barriers. Low electric fences, designed to restrict the moment of small predators, e.g. jackal, are particularly lethal to other wildlife, e.g. larger tortoises (Burger & Branch, 1994). The use of poisoned carcasses by livestock farmers to kill "problem" animals such as black-backed jackal and hyena often results in poisoning of non-target raptors and other scavenging species (Lloyd, 1999, Anderson, 2000). Some species, like the Martial Eagle (*Polemaetus bellicosus*) and Black Eagle (*Aquila verreauxii*), perceived to prey on domestic livestock and poultry, may be deliberately targeted (Anderson, 2000). Practices such as the use of gin traps are also problematic for local biodiversity, as it is an indiscriminate method that usually serves to eradicate more non-target animals, such as tortoises, aardvarks, etc, than it does the predator in question.

Drownings in farm reservoirs are also accountable for a significant number of raptor mortalities in the Karoo (Anderson, 2000), whilst pesticides used to control brown locust (*Locustana pardalina*) outbreaks also impact wildlife severely, with high concentrations being found at the top of the food chain, particularly lizards (Alexander *et al*., 2002) and raptors (Lovegrove, 1993).

One of the most important faunal impacts results from competing requirements for water use in the region. Heath & Brown (2007) note that the construction of dams for electric power generation has resulted in the loss of species diversity which may be regionally severe, and the river immediately below Vanderkloof Dam has been described as an ecological desert. They summarize the environmental issues associated with the Orange River are “directly related to the anthropogenic use of the water. The major impact is due to the altered flows of the Orange River due to man

reallocating this water for uses outside the catchment, for hydro-power, agricultural and mining use. As a result the river's ecological integrity has been classified as Category C by the aquatic specialist. This means it is moderately modified as a result of a loss and change to natural habitat and biota, but the basic ecosystem functions are still predominantly unchanged (see Aquatic Specialist Report for more detail) .

In a related consequence, Myburgh & Nevill (2003) noted that in 1996 blackflies (particularly *Simulium chutteri*) caused R88 million damages per annum in the middle and Lower Orange River. They state that "invertebrates in the Lower Orange River are largely modified due to the overwhelming and persistent abundance of filter-feeders, in particular the pest proportion numbers of the blackfly, *Simulium chutteri*. The large-scale programme to control this pest, using aerial applications of insecticides, highlights the extent of the problem (Palmer, 1993). The outbreaks are attributed to stable flow conditions, in particular high winter flows, deterioration in water quality and encroachment of in-stream vegetation."

Existing land use impacts on fauna in the project area results in a definite severe negative impact in the long-term in the region. The environmental significance of this impact is HIGH.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**

8.3.2. Issue 2: Habitat impacts

The Lower Orange River is now extensively utilised for irrigated cultivation (Fig. 8.1). This has resulted in the removal of natural vegetation for cultivation, particularly Lower Gariep Alluvial Vegetation. Simmon & Allen (2002) note that riverine habitats shelter the greatest bird diversity within the Orange River avifauna.

Impact 1: Habitat Loss

Cause and comment

Large sections of the Lower Orange River above the Augrabies Falls are now heavily degraded by conversion to irrigated cultivation. This impact is continuing, with irrigated cultivation occurring further away from the river (see Fig. 8.1 for recent developments of additional irrigated lands) Existing and potential land-use practices that currently, and may further threaten the region's biodiversity include:

- The increase of communally-owned land, if accompanied by increasing small scale livestock use, may lead via overgrazing to desertification.
- Increasing irrigated agriculture, especially citrus suitable for soils outside the flood plain of the Orange River, will result in further habitat alteration and loss.
- The increasing fertilizer and insecticide run-off from irrigated lands may secondarily affect riverine vegetation, resulting in further habitat loss, downstream from the agricultural areas.

Existing habitat loss on the fauna has resulted in the project area has resulted in a definite severe negative impact in the long-term in the Region. The environmental significance of this impact is HIGH.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**

8.4. Design and Pre-construction Phase

Activities associated with the design and pre-construction phase will not have significant impacts on the biophysical environment. The phase consists of planning and design around the proposed development, and is done mainly at a desktop level. Field studies, including site visits, and in this case specialist studies need to take place but the impact of these visits is negligible, if any, e.g. photographs, GPS point's etc. The exception are any geotechnical investigations, the impacts of which will be assessed in the Environmental Impact Assessment Report and the EMP.

8.5. Construction Phase

This section presents the issues that may impact terrestrial faunal systems arising from the construction of the hydropower project, including its associated infrastructure such as lay down areas,, batching plants etc. (which are absent during the operational phase), the access roads (particularly those associated with construction of the outflow tunnel within the lower 'palaeochannel', the excavation of the pipeline route), the construction of the weir, head pond and power house, and the development of transmission line connections to the existing Eskom network near Augrabies.

8.5.1. Issue 1: Loss of Biodiversity

All faunal groups will suffer a general loss of biodiversity due to varied impacts, particularly due to increased mortality and migration away from the project area. This will result from various project actions, including collision with vehicles, loss and fragmentation of suitable habitat due to the footprint of project structures, and various forms of pollution associated with traffic and development. This will be greatest for small, slow-moving species, e.g. amphibians, tortoises and snakes, and terrestrial species will suffer higher mortalities than arboreal or burrowing species. Volant species (birds and bats) will suffer less mortality, except where important breeding or roosting sites are lost or migration routes disrupted.

Impact 1: Loss of Amphibian Diversity

Cause and Comment

Amphibians are the least specious group of terrestrial vertebrates in the concession area. However, frogs, along with bats and lizards are important predators of insect pests. Myburgh & Nevill (2003) noted that in 1996 blackflies (particularly *Simulium chutteri*) caused R88 million damages per annum in the middle and Lower Orange River. Due to habitat loss and mortalities directly associated with specific project actions, a loss of amphibian diversity will probably occur. Amphibian mortalities will occur during all phases (construction and operational) but will be most significant in association with habitat loss, particularly of wetlands. The most widespread and common species in the region are associated with the existing Orange River course, and will therefore be most impacted during the construction of the weir. The Marbled Rubber Frog (*Phrynomantis annectans*) requires temporary water bodies for tadpole development, and breeding sites in the Power House region (see section 5.2.2) should avoided.

All amphibians recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, should avoid these areas with a buffer distance of at least 50 m.
- Wetlands must be protected and/or rehabilitated if damaged.
- Water quality and flow dynamics should be maintained.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**

Impact 2: Loss of Reptile Diversity

Cause and Comment

The Project Area probably contains a greater diversity of reptiles than discovered during the survey. Reptile populations, particularly snakes, are difficult to study. Increased human numbers associated with the development of the project will lead to increased mortality of reptiles, particularly tortoises and snakes, directly from road mortalities and human attitudes, as well as the losses from habitat loss and fragmentation.

All reptiles recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging pristine habitats, particularly in the riverine zone.
- Protect abiotic habitats, such as rock outcrops, which shelter many reptile species.
- Curtail unnecessary project-related night driving on roads during construction. However, night driving will have to take place, such as during the pouring of concrete, which needs to be done in the cooler early mornings.
- Prohibit exploitation of sensitive reptiles, e.g. tortoises and chameleons.
- Educate construction staff about the necessity of protecting snakes.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**

Impact 3: Loss of Bird Diversity

Cause and Comment

Birds are by far the most speciose vertebrate component in the region. Birds play important and diverse roles in ecosystem functioning (e.g. seed dispersal and trophic transfer) and maintenance of bird diversity is important to maintain viable habitats. Although a few birds are commensal, and can rapidly and successfully adapt to disturbed environments, the majority of birds are sensitive to disturbance and either migrate away from, or suffer greater mortality within, degraded habitats. However, because of their high mobility, birds are capable of rapidly re-colonising rehabilitated habitats, provided suitable microhabitats are available.

All birds recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging pristine habitats, particularly the riverine zone which shelters the highest avian diversity.
- Maintain habitat connectivity, particularly to protected areas, via habitat corridors.
- Undertake habitat clearance during winter when birds are not breeding.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderate	Probable	**MOD**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**

Impact 4: Loss of Mammal Diversity

Cause and Comment

The long history of human settlement, associated with subsistence and later commercial farming, has greatly reduced the presence of large mammals in the region. A number of large ruminants previously extirpated in the region have been re-introduced, whilst several large predators (e.g. leopard and brown hyena) have probably increased in number during the period of management of the Riemvasmaak property by the AFNP. The maintenance of these, as well as that of the small mammal diversity, depends on the continued conservation management and the maintenance of habitat corridors and habitat diversity.

All mammals recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging pristine habitats.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small mammals, including bats.
- Maintain protection of the existing mammal fauna from human impact, particularly persecution and illegal hunting.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**

Impact 5: Loss of Species of Conservation Concern

Cause and comment

Numerous birds, reptiles and mammal species are either endemic to the region or are of conservation concern. Two characteristic reptiles, the Augrabies Flat Lizard and Augrabies Thick-toed Gecko, and charismatic Near Endemics, whilst the Marbled Rubber Frog is a habitat specialist

with only a marginal presence in South Africa.

Fourteen of the possible 247 bird species in the region are threatened or near threatened globally or regionally. The most significant avian SCC recorded on site, either during the faunal survey or elsewhere, include Ludwig's Bustard (EN), Secreatry Bird (VU) and Black Harrier (VU). Fifteen bird species are regional or biome endemics.

Of the 72 terrestrial mammal species which may occur on site, only one is threatened (Hartmann's Mountain Zebra, VU), whilst another was reintroduced but has been relocated (Hook-lipped Rhinoceros, CR), and another may be present (Small Spotted Cat, VU). A number of other mammals are Near Threatened (Dassie Rat, Honey Badger and Brown Hyena), but no species are Endemic or Near Endemic to the region.

All SCCs recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation and management

- Avoid clearing or damaging pristine habitats.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species, including reptiles and bats.
- The design of project structures and transport linkages should avoid where possible sensitive habitat corridors, e.g. drainage lines and wetlands.
- Road designs should incorporate underpasses and culverts that allow the movement of animals.
- Where possible the project-related road traffic should be limited to essential journeys after dark, as much of the surviving fauna is nocturnal, e.g. bats, most snakes, small rodents, amphibians, etc.
- Vehicle speed should be limited to the lowest possible, and should not exceed 50km/h.
- Drivers should be educated regarding their role in impacting on animals and the need to minimize collisions with animals at all times.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderate	Probable	**MOD**
With Mitigation	Medium term	Study area	Slight	Probable	**LOW**

8.5.2. Issue 2: Habitat loss and fragmentation

Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss

Cause and comment

Various components of the development will cause biodiversity loss directly or indirectly through fragmentation of viable habitats for the various faunal groups. This is usually a loss of vegetation (plant communities) that supply food or shelter, but may include abiotic features such as the loss of temporary wetlands, caves or rock outcrop.

Impacts to sensitive habitats are highly probable and will be local and negative in nature, and occur over the long-term. The significance of these impacts may vary from low to high depending upon the local importance of the habitat and the particular fauna that it harbours.

The proposed transport linkages and associated infrastructure will all cause additional habitat loss and fragmentation, over and above the project footprint. The greatest impact on habitat loss and

fragmentation will be associated with the haul roads, and less so with the proposed pipelines from the weir to the Power House. The location of the proposed weir lies in a region of riverine habitat and Lower Gariep Alluvial vegetation, and access and construction of the weir should avoid where possible all riverine vegetation.

The most sensitive region will probably be the construction and rehabilitation of a haul road down the steep sides of the 'Canyon Zone' into the lower 'palaeochannel' in order to allow drilling of the horizontal outlet tunnel. As the descent into the lower 'palaeochannel' is very steep it may not be possible to fully rehabilitate this track, particularly as it may be required for access to the tunnel entrance during the operational phase. Two routes have been proposed (see Fig. 1.3), both traversing the walls of the Canyon zone below the 'palaeo Falls'. Option 2 is shorter and does not cross the 'upper palaeochannel' above the 'palaeo Falls' and is thus the preferred option. However, the design and construction of these haul road options have not been detailed, and either option is likely to result in a permanent impact (in terms of the project life) that cannot be mitigated in a region highlighted as Sensitive in the AFNL Management Plan 2013-203.

Mitigation and management

The negative impact of habitat loss associated with the development of the Hydro Power project cannot be fully mitigated. But the following can assist in reducing the severity of the impact:

- All specific project actions associated with construction, access roads, borrow pits and cut-and-fill construction must avoid sensitive habitats as far as is practicable.
- Natural drainage should be maintained and the silt loads into rivers, streams and wetlands must stay within normal limits.
- Avoid clearing or damaging pristine habitats.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors. The excavation of the pipeline route will form a linear impact, and this should be undertaken in sections. This will allow faunal migration (e.g. for water access) across rehabilitated sections before construction begins on adjacent sections.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species, including reptiles and bats.
- The design of project structures and transport linkages should avoid where possible sensitive habitat corridors, e.g. drainage lines and wetlands.
- Mitigation of the impact entails protection and where necessary, rehabilitation of adjacent habitats as an environmental offset particularly wetland and riparian habitats.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised	Very severe	Definite	**VERY HIGH**
With Mitigation	Medium term	Localised	Moderate	Probable	**MOD**

8.5.3. Issue 3: Additional Construction Impacts on Fauna

A variety of impacts are likely to result from the construction of the various components of the project, both during the construction and operational phases.

However, a significant and widespread impact results from increased transport in the region. Roads are known to alter physical characteristics of the environment and through these impacts roads affect ecosystems, biological communities and species in numerous and different ways.

Impact 1: Ecological impacts from dust

Cause and comment

Increased dust levels are common during construction especially from habitat clearance and

increased vehicular traffic. Short-term increased dust levels will accompany all land preparation associated with construction of project-related infrastructure.

Mitigation and management

- As most access roads will be rehabilitated after the construction phase, the impact cannot be mitigated by hard paving. It is suggested that the area is watered down during high wind conditions.
- Road speeds in sensitive regions e.g. near wetlands, across drainage lines, and during extreme dry climatic conditions, should be limited to curtail dust production.
- Vehicle speed should be limited to the lowest possible, and should not exceed 50km/h off main and provincial roads.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Slight	Definite	**LOW**
With Mitigation	Short term	Localised	Slight	Probable	**LOW**

Impact 2: Disruption to fauna from increased noise levels

Cause and comment

Construction and associated vehicle traffic will create noise pollution that can depress local populations of sensitive faunal groups. Animals differ in the degree to which they tolerate such disturbance, and can be expected to have potentially negative and positive impacts on various faunal groups. Large breeding birds do not usually tolerate continuous disturbance. Increased noise and motor vibrations in wetlands may also impact amphibian breeding choruses, but these impacts will be localised and many amphibian species are surprisingly tolerant of vehicle noise. Noise pollution will occur during all phases (construction, operational, and de-commissioning /closure). Little mitigation is possible.

Mitigation and management

- Mitigation of this impact is difficult, but noise reduction measures should be implemented in all sensitive areas (such as adjacent to wetlands) at sensitive times (especially at night).
- Construction activities after dark should be undertaken only when essential.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Severe	Definite	**MOD**
With Mitigation	Short term	Study area	Moderate	Definite	**MOD**

Impact 3: Chemical Pollution

Cause and comment

Many faunal groups are sensitive to pollutants. Lead concentrations are higher in small terrestrial mammals collected alongside roads than in bats caught in the same areas. Frog diversity in ponds affected by pollution from road run-off is depressed and the accumulation of herbicides and their residues in adjacent wetlands can lead to developmental abnormalities in tadpoles and metamorphosing froglets and also masculinization of female frogs.

Pollution may result from periodic accidents, or from a slow, on-going contamination. During the construction phase heavy mechanical equipment and vehicles will be present. The use of inflammable liquids such as diesel will probably result in periodic accidents. Heavy vehicle traffic is also associated with increased local pollution resulting from exhaust fumes, oil spillage and accumulation of rubber compounds from tyre wear. These pollutants can cause localised impacts.

Mitigation and management

- Storage facilities for chemicals, particularly diesel, should not be situated in regions subject to flooding.
- Such stores should be bunded so that in the event of spillage their contents run immediately into large catchments for decontamination.
- The application of herbicides or insecticides to control plant growth or insect pests should be prohibited.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

8.6. Operational Phase

This section presents the issues that may impact terrestrial faunal systems arising from the operation of the Hydro Power Project. Following construction the plant will be automatically operated off-site.

It is assumed that all mitigatory measures proposed are implemented and that full rehabilitation of the main areas affected by construction is undertaken, particularly:

- that associated with the weir construction,
- the excavation of the pipeline route,
- the Head Pond,
- and the transmission lines.

However, access roads will need to be maintained for maintenance and repair to the various components, particularly the weir, transmission lines and outlet tunnel.

8.6.1. Issue 1: Loss of Biodiversity

Impact 1: Loss of faunal biodiversity

Cause and comment

Impacts during the operational of the proposed developments will vary for the different groups. Amphibian diversity may be impacted by possible small scale, localized changes in water flow dynamics in the region of the pipeline. For some species, however, this will probably be offset by increased breeding habitat associated with the existence of the head pond and also increased water flow via the discharge tunnel into the lower ‘palaeochannel’. Similarly, increased bird numbers and diversity can be expected in the more vegetated riverine habitats in the lower ‘palaeochannel’. Both groups may be positively impacted during this phase. Mammals such as Cape Clawless Otter and Water Mongoose may increase in number in the lower ‘palaeochannel’ due to an increase in fish numbers and other small vertebrates that form their diet. Due to an increase in well-vegetated riverine habitats along the lower ‘palaeochannel’ changes negative impacts on faunal diversity in the region can be expected to be self-mitigated.

Mitigation and Management

- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, should avoid these areas. Including a buffer distance of 30 m.
- Maintenance of water quality and flow dynamics.
- Prohibit night driving on access roads during maintenance visits to the site.
- Eradicate or control alien plant encroachment, particularly aquatic aliens (e.g. *Phragmites* reeds) in the Head Pond and lower 'palaeochannel'.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**

Impact 2: Loss of Species of Conservation Concern

Cause and comment

The primary impact on SCC will be mainly related to the section of above-ground power transmission, particularly the crossing of the Orange River to connect to the existing Eskom transmission network near Augrabies. Overhead Transmission lines form a well-documented threat to a number of threatened bird species. This results from two main impacts; electrocution from contact with live elements when birds nest or roost on the supporting pylons; and collisions with overhead power lines when in flight (Anderson, 2002; Jenkins and Smallie, 2009; Jenkins et al. 2010; Jenkins *et al.,* 2011, 2013). The latter is particularly important for storks and bustards, which have limited frontal vision and so may not see power lines, even if they are marked (Martin and Shaw, 2010). Collision rates on high voltage transmission lines in the De Aar area of the Karoo may exceed one Ludwig's Bustard per kilometre per year (Anderson, 2002; Jenkins *et al*., 2011), and there is preliminary evidence for this level of mortality on transmission lines across the Karoo, indicating that the problem is widespread (Jenkins et al. 2011). It is estimated that such collisions alone are already enough to cause a rapid decline in the Ludwig's Bustard population and may increase in the future (Jenkins *et al*., 2011). Electrocutions on support pylons have been greatly reduced with new pylon designs. In fact, due to their use as roosting and nesting structures, well-designed pylons may even have a beneficial impact in arid regions by supplying roosting and nesting sites in areas where these are of limiting availability.

Some mammals and ground-nesting birds are known to avoid habitats up to several kilometers from high-voltage power lines. Tyler et al. (2014) propose that ultraviolet discharges on power lines ('standing corona' along cables and irregular 'corona flashes' from insulators) are a possible cause of this avoidance.

Mitigation and Management

- Numerous pylon designs and transmission cable attachments are available to reduce bird collisions and electrocutions (for an international review see APLIC 2012; and Jenkins et al. 2013). Suitable design and warning attachments (bird flappers) should be incorporated into the design of the above ground transmission network.
- Regular monitoring for bird mortalities along the transmission line should be included as part of the EMPr.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	**HIGH**
With Mitigation	Medium term	Study area	Moderate	Probable	**MOD**

Impact 3: Introduction of Alien fauna

Cause and comment

The threat presented by alien invasive fauna is limited. Developments such as Hydro Power project offer corridors for the introduction of alien species via roads associated with their construction and operation. Introduced urban rodent pests such as the house mouse (*Mus musculus*), house rat (*Rattus rattus*) and the Norwegian rat (*Rattus norvegicus*) are not recorded in the AFNP, but are likely to occur in adjacent populated areas. These species generally tend to survive alongside human habitation, and don't spread in natural areas.

The most widespread and common alien bird is the House Sparrow (*Passer domesticus*) which is now distributed almost worldwide. In addition, the European Starling (*Sturnus vulgaris*) is also an abundant introduced resident avian species. Neither were recorded on site. The most recent and active bird invasive in the Nama Karoo region is the Pied Crow (*Corvus splendens*), which is actively expanding its range in association with the greater availability from human structures of nesting sites in semi-arid regions. Increased food resources, via mortalities and prey visibility, are also afforded by roads.

As the operational phase of the project requires little road access and no on-site habitation the risk of alien fauna introduction is slight.

Mitigation and management

- The deliberate introduction of alien species should be prohibited, unless a full environmental assessment is undertaken and control methods for escapees detailed.
- Eradication programs of problem animals should be undertaken if needed and in consultation with conservation authorities.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**

Impact 4: Threats to Animal Movements

Cause and comment

Linear developments, such as roads and transmission lines, disrupt the movement of species within their normal home ranges or the seasonal movements of migratory species. Habitat fragmentation may require species to make long movements between patches of suitable habitat in search of mates, breeding sites or food. At such times they may suffer increased mortality, either directly by road vehicles, or from their natural predators due to increased exposure.

Reptiles and amphibians do not undertake long distance migrations, but both groups may undertake short seasonal movements. Many snakes undertake movements between winter

hibernation sites and their summer foraging areas. Amphibians are known to experience the highest levels of mortalities associated with the presence of roads among vertebrates. This is mainly attributed to en masse seasonal migrations to and from their breeding sites. However, both toad species in the region, e.g. Guttural Toad and Raucous Toad, are not explosive breeders and mass migrations are not expected. Impacts on animal movements will be significant for all faunal groups. For amphibians this impact will be greatest where the road runs adjacent to wetlands suitable for breeding. It is an impact of high probability that will be negative due to increased mortality. It will be localised and occur over the long-term.

The Riemvasmaak Hydro Power project forms part of the expanding power generation capacity of southern Africa. The project's power connection will be underground in the section from the power house to the weir region. This is beneficial as some large mammals and ground-nesting birds are known to avoid habitats up to several kilometers from high-voltage power lines. Tyler *et al*. (2014) propose that ultraviolet discharges on power lines ('standing corona' along cables and irregular 'corona flashes' from insulators) are the main cause of this avoidance. However, the rest of the line runs above ground and crosses the Orange River to connect to the existing Eskom transmission network near Augrabies. The Orange River forms an important flight path for many birds, particularly water birds moving along the Orange River (e.g. Black Stork, NT), or for birds migrating between important IBAs such as the Orange River Mouth Wetlands (IBA ZA030), the AFNP (IBA ZA022) and inland seasonal wetlands, e.g. Kamfers Dam, Kimberley (IBA ZA032), e.g. Greater and Lesser flamingo (NT).

As noted earlier overhead power lines form a well-documented threat to birds, particularly large threatened species such as raptors, storks and bustards. The nature of these threats and mitigatory measures are discussed under Impact 2 - Loss of Species of Conservation Concern, above.

Mitigation and management

- Numerous pylon designs and transmission cable attachments (bird flappers) are available to reduce bird collisions and electrocutions (for an international review see APLIC, 2012; and Jenkins *et al*., 2013). Suitable design and warning attachments should be incorporated into the design of the above ground transmission network.
- Regular monitoring for bird mortalities along the transmission line, and for road mortalities within the Riemvasmaak region should be included as part of the EMP

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	**HIGH**
With Mitigation	Medium term	Study area	Moderate	Probable	**MOD**

8.6.2. Issue 2: Habitat impacts

Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss

No additional habitat loss or fragmentation will occur during the operational phase.

Cause and comment

The maintenance of some access roads to the power house and into the lower 'palaeochannel' will maintain habitat fragmentation generated during the construction phase.

Mitigation and management

Access routes for maintenance and repair should be the minimum required for intermittent access. Material required for road maintenance should be sourced from existing borrow pits, ideally

situated outside the Riemvasmaak area, or from the spoil site, should the community operate the spoil site commercially for the sale of material.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Moderate	Unlikely	**LOW**

Impact 2: Impacts due to changes in hydrology

The project will result in the diversion of up to a maximum of 38 m^3/sec of water after the Environmental Flow Reserve has been met and when sufficient river flow is available. The diverted water will be conveyed in a pair of buried rectangular culverts piped approximately 4.6km, and then empty into a head pond retained by a low levee (max. height 3m). The head pond will be approximately 90m wide and 130m long, up to 3m deep, and have a surface area of about 8100m^2. After power generation in the Power House, the tailrace tunnel will travel 675m through the rock and exit into the lower 'palaeochannel' approximately 200m below the 'palaeo falls', before then flowing back into the Orange River (see Fig. 4.5)

Cause and comment

These changes will generate changes in the distribution and availability of water for the fauna in the project area.

- At low water levels the weir will retain water in a greater area of the upstream braided channels. In general this will be a positive or insignificant impact.
- The southern part of the route of the proposed pipeline runs in, or in very close proximity to the right edge of the upper 'palaeochannel', which forms a significant ecological corridor of High Sensitivity. Intrusion into this area should be avoided.
- The head pond will form a substantial new water body that would provide increased access to water for large mammals, birds and amphibians. This will have a generally positive impact on the fauna, although increased mortality from animals passing into the power tunnel can also be expected and should be mitigated.
- The discharge of up to 38 m^3/sec of water into the lower palaeochannel from the tailrace for about 8-9 months of the year will result in a substantial increase of water into the seasonally dry drainage line. This will generate increased vegetation growth resulting in increased riparian habitat for all vertebrate groups. The numbers of fish migrating up from the Orange River at the point below the falls where this channel enters the main river will also increase and form increased food for piscivores, including various birds (fish eagle, cormorants, kingfishers, etc), otters, water monitors, etc. This change in hydrology will also have a generally positive impact on the fauna.
- Deaths and breeding disruptions may occur with the sudden outflow of water into the lower 'palaeochannel' when power generation is initiated at the start of seasonal power generation. This should be avoided by having a staged start up protocol.

Mitigation and management

The changes in hydrology will be generally positive, although increased mortality will occur from animals (frogs and fish) getting sucked into the power house, and then from the sudden inflow of water into the lower 'palaeochannel'.

- Excavation of a 10m trench for the headrace and the buried pipeline in close proximity to the upper 'palaeochannel' may cause disruption to the normal hydrology (surface and groundwater) of the drainage line and the upper palaeochannel should therefore be avoided.

- During construction of the pipeline route all excavated material must be stored temporarily before backfill away from the palaeochannel.
- An effective barrier – a trash rack - must be erected at the entrance of water into the penstock from the head Pond to prevent large mammals or reptiles (monitors and large tortoises) from being sucked in.
- The release of water into the lower 'palaechannel' after power generation should occur in stages before full discharge to allow wildlife to vacate the area. However, the channel width is much greater than the volume of water and animals should have sufficient time to move away.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Beneficial	Definite	**MODERATE (+VE)**
With Mitigation	NA	NA	NA	NA	**NA**

8.6.3. Issue 3: Additional Operational Impacts on Fauna

Few impacts are likely to result in the operational phase of the Hydro Power project. Operation of power generation is automated and controlled off-site. The design of the weir means that at low water levels water flow to the Hydro Power option ceases. Many operational impacts result from increased transport in the region. However, low levels of access are required for maintenance and repair of the Hydro Power facility. Roads are known to alter physical characteristics of the environment, namely: soil density, temperature, soil water content, light penetration, dust production, surface water flow, run-off pattern and sedimentation. Via their impacts on these parameters roads affect ecosystems, biological communities and species in numerous and different ways. The significance of these effects is determined largely by the location, density, and distribution of roads across the landscape. Generally roads have negative effects on the biotic integrity in both terrestrial and aquatic ecosystems and these effects can be classified under various categories: increased mortality from road construction and vehicle collisions; modification of animal behaviour, particularly movement patterns; alteration of the physical environment; and chemical environment; spread of exotic species; and increased alteration and use of habitats by humans.

Impact 1: Increased Dust Levels

Cause and comment

Increased dust levels are common after veld clearance activities, and from vehicular traffic, even on paved surfaces. Dust settling on adjacent vegetation can block plant photosynthesis, respiration and transpiration, in addition to causing physical injuries of plants. Its presence may also make plants unpalatable, thus acting as a possible deterrent to grazing. Dust from road surfaces can also transport chemical pollutants to adjacent regions, thus affecting riparian ecosystems via impacts on water quality.

Mitigation and management

- After the construction phase, roads within the area should be returned to small tracks.
- Road speed throughout the region should be limited to 50km per hour to curtail dust generation.
- Road use during and immediately after heavy rain should be prohibited to avoid damage to the surface.
- All vehicular traffic should be restricted to existing tracks, and no off-road vehicle activity should be permitted.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Slight	Definite	**LOW**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

Impact 2: Noise Pollution

Cause and comment

Operational activity will be restricted to inspection and maintenance with limited vehicle traffic. This will have an intermittent impact that may reduce the abundance of sensitive birds and large mammals.

Mitigation and management

- Mitigation of this impact basically unnecessary, but should involve a restriction of all but essential project-related journeys at night.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Slight	Definite	**LOW**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

8.7. Decommissioning Phase

8.7.1. Issue 1: General Decommissioning Impacts on Fauna

A variety of impacts are likely to result from the decommissioning of the various components of the Hydro Power Project. General decommissioning operations (e.g. transport, fuel dumps, etc) may cause chemical pollution, raise dust levels, increase noise and light levels and lead to changes in water hydrodynamics and fire regimes. The extent of these impacts results, in part from what future land use options are envisaged after the termination of the project. Returning the site to a pristine state will require the removal of the weir, head pond, power house and generating equipment, and is not practical. Removal the hydro tunnel and pipeline are likely to generate more environmental impacts than simply covering their appearance. Access roads used in construction and access during the operational phase will be difficult to remove, particularly the access route down the steep canyon walls of the lower 'palaeochannel'.

Impact 1: Increased Dust Levels

Cause and comment

Increased dust levels are common during decommissioning, especially in association with destruction of infrastructure and the removal from site of artefacts (equipment, machinery and construction materials such as metal and concrete. Dust from rubble and road traffic can be expected.

Mitigation and management

- Road speeds throughout the site, especially during very dry and windy weather, should be limited to curtail dust generation.
- Speed limits on unpaved roads should be reduced, and in areas of high dust production road surfaces should be dampened.
- Any chemicals that need to be transported should be done in closed trucks or containers to

avoid contamination to the surrounding area.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study Area	Slight	Definite	**LOW**
With Mitigation	Short term	Localised	Slight	Probable	**LOW**

Impact 2: Noise Pollution

Cause and comment

Decommissioning activities, especially increased road traffic and the operation of heavy machinery will generate increased noise levels in the project area. This will reduce the abundance of sensitive birds and large mammals.

Mitigation and management

- Mitigation of this impact is difficult and unlikely to be effective but could involve prohibition of activities before 06h00 and after 18h00.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study Area	Moderate	Definite	**MOD**
With Mitigation	Short term	Localised	Moderate	Definite	**LOW**

9. CONCLUSIONS AND RECOMMENDATIONS

9.1. Conclusions

9.1.1. Faunal environment

The project area remains relatively natural due to its recent history of management by the AFNP. In part, the intact vegetation cover is due to the re-introduction of large mammals, now locally exinct in the region, and the establishment of natural grazing patterns. The riparian vegetation is also largely intact, unlike that in upstream regions where it has largely been replaced by irrigated cultivation.

The project area is contiguous with, and currently managed by, the adjacent AFNP, which is also one of the 122 Important Bird Areas in South Africa.

The project area retains significant components of Nama Karoo biodiversity, and due to its proximity to the AFNP forms an important component of protection of this biome.

Few amphibians occur in the Lower Orange River area, with a maximum of 12 species likely to occur in the project area. Only three were recorded during the Riemvasmaak survey, but others are likely to be present in both the project and surrounding area. No amphibians are endemic to the region, despite the claim in the AFNP Management Plan that the Marbled Rubber Frog is endemic to the region; it has only a peripheral occurrence in South Africa in the Augrabies and Richtersveld, but is widespread throughout Namibia, reaching southern Angola. No amphibians of conservation concern occur in the region. The most sensitive habitats for amphibians are perennial pools of water in the Orange River palaeochannels.

Reptile diversity in the region is much greater, with 19 of the 57 species known in the region recorded during the survey. Two lizards are Near Endemic to the region, no reptiles of conservation concern are present, and commercial trade in only 5 species is subject to CITES Appendix 2 regulation, although there is no commercial exploitation of all of these species in South Africa. The most sensitive habitats for reptiles are expansive rocky areas, particularly in the 'Canyon Zone'.

The Nama Karoo supports a particularly high diversity of bird species endemic to southern Africa. Its avifauna characteristically comprises ground-dwelling species of open habitats. Although 247 bird species have been recorded for AFNP, many of these are of seasonal, irregular or vagrant occurrence, and only 111 species were recorded during the brief survey. Fourteen (14) bird of conservation concern are recorded in the region, whilst 15 species are near endemic or range or biome-restricted species. The most significant avian SCC recorded on site included Kori Bustard (VU), Black Stork (NT), Openbill Stork (NT), Lanner Falcon (NT), Rosy-faced Lovebird (NE), Karoo Lark (NE), Karoo Long-billed lark (NE), Black-eared Sparrowlark (NE) and Namaqua Warbler (NE). The most sensitive habitat for birds is the riparian vegetation along the Orange River and its palaeochannels.

Large mammals are not generally a feature of Northern Cape landscapes, except in protected areas. In 2012 150 head of game (mainly Springbok, Gemsbok and Eland) occurred in the Riemvasmaak region. The majority of mammals present are small to medium-sized, and the micromammal component in the region is much greater than indicated on the AFNP mammal checklist. Mammals use all habitats in the region, and the rock fissures and cracks of the Canyon region form roosts for large numbers of bats that play an important role in the control of insect pests over the irrigated agricultural lands, as well as control black fly pests that have a significant economic impact in the region.

9.1.2. Sensitive areas

There are few SCC for all faunal groups in the region, and most are well protected in the AFNP. The use of the Riemvasmaak as a Hook-lipped rhino refuge is no longer viable for security issues, but the region presents suitable habitat for this species.

Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog.

The Riverine habitats at the weir site, and in the palaeochannels of the Orange River form sensitive wetland habitats, and important habitats for amphibians and birds, and drinking points for large mammals.

The upper 'palaeochannel' running from the weir region to the 'palaeo Falls' and then into the lower 'palaeochannel' forms a significant ecological corridor of High sensitivity.

9.1.3. Faunal impacts

Impacts were grouped into large themes (Issues) and considered for Existing Land Use and during the different phases of the development, i.e. Design and pre-construction, Construction, Operational and Decommissioning.

Existing Land Use
The Riemvasmaak property has been actively managed for conservation by the AFNP, with a policy for the zone on very limited human contact. Existing environmental impacts are therefore minimal (LOW). However, faunal impacts for adjacent irrigated areas of the Orange River are HIGH due mainly to extensive habitat loss and fragmentation.

Construction Phase
Numerous impacts will occur during the construction phase. Most impacts were of MODERATE significance (6), with others LOW (2) or VERY HIGH (1). Only three remained MODERATE if mitigation measures were implemented. The highest impact was considered to result from Habitat fragmentation, particularly from the proposed haul road into the lower palaeochannel for construction of the tail race tunnel.

Operational Phase
Following planned rehabilitation and the implementation of mitigation, few impacts will attend the operational phase. Most (5) will be of LOW significance. Two impacts will be of HIGH significance, and can be only partially moderated. They both result from the overhead transmission line, particularly the section where it crosses the Orange River to connect to the existing transmission network. Bird collisions with this structure, particularly SCC such as storks, raptors and bustards, can be expected. Mitigation in the design structure is essential, but will only partially mitigate the impact.

There will substantial changes in local hydrology resulting from the construction of the Head Pond and the release of substantial amounts of water from the tail race into the lower palaeochannel. This channel will change from a very seasonal system into a perennial system. This will generate additional wetland and riparian habitat, both of which are sensitive habitats and important for supporting faunal diversity in the region. This will probably result in a POSITIVE impact, which will mitigate the HIGH impacts associated with the route of transmission line.

Decommissioning Phase
Most impacts associated with the decommissioning phase will be temporary and result from the removal of infrastructure and rehabilitation. This will lead to LOW to MODERATE impacts from noise and dust pollution. These result from heavy and continuous vehicle movements and plant machinery use, and are unlikely to be mitigated and therefore remain Moderate.

Access roads, particularly the construction of the route down the steep slopes of the Canyon zone necessary for the construction of the tail race, will be difficult to rehabilitate and can be effectively considered permanent.

9.2. Recommendations

1. The Riemvasmaak Community (*Melkbosrandsamewerkingskomitee*) remain in discussion with the AFNP with respect to the unresolved future land use of the Riemvasmaak property. It has formed an important component of the wilderness area of the buffer area adjacent to the AFNP for nearly 60 years, and is considered by SANParks as an important component in meeting the Park's conservation objectives, if even as part of a planned Buffer Zone (see. Fig. 6.3). The region is planned for Primitive-Remote use, categories involving minimal human use. This may conflict with a desire by the Riemvasmaak community for the region to serve as an economic driver of community upliftment.

2. There is little doubt that the region forms an important and integral part of the maintenance of faunal diversity. All efforts should therefore be made to ensure this continued function. In discussion with the Riemvasmaak Community it should be emphasized that recent research (Ferraro & Hanauer, 2015) has shown that in Costa Rica rural communities on land neighboring conservation areas had lower rates of poverty relative to other areas. However, if the region is to retain its high conservation value as well as the need for the community to derive economic benefit from their land, then it will require a compromise, allowing greater utilization from that envisaged in the AFNP Management Plan. The Riemvasmaak 'Canyon Zone' has outstanding visual impact and developments in the region remain out of view of the AFNP main visitor area on the south bank of the Falls. Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog. The proposed construction of a haul road into the lower 'palaeochannel' for excavation of the tail race tunnel has the potential to cause significant impact on sensitive habitats, on the visual beauty of the area, and thus on potential future economic benefits from tourism.

3. The Riverine habitats at the weir site, and in the palaeochannels of the Orange River form sensitive wetland habitats, and important habitats for amphibians and birds, and drinking points for large mammals. These are of high biological value and should be avoided in all project actions and phases.

4. The upper 'palaeochannel' running from the weir region to the 'palaeo Falls' and then into the lower 'palaeochannel' forms a significant ecological corridor of High sensitivity. The proposed pipeline runs in very close proximity to the right edge of this drainage line. Excavation of a 10m trench to contain the pipeline may therefore cause disruption to the normal hydrology of this drainage line and should therefore be avoided. It is recommended that all construction associated with the pipeline, particularly the temporary storage of excavated material, should avoid the route of the upper 'palaeochannel', with a 50m exclusion zone between the northern edge of the palaeochannel and the pipeline trench.

5. Certain aspects of the Hydro Power Infrastructure, particularly power to the site and transport links may also serve other land use options. The planning of the Hydro Power project should be integrated with future land use of the Riemvasmaak to minimize the duplication of environmental impacts.

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APPENDIX 1: LIST OF AMPHIBIAN SPECIES

Full Name	*Scientific Name*	IUCN / CITES	Endemic (95%)	Previously Recorded*	Recorded During Site Visit
Karoo Toad	*Vandijkophrynus gariepensis*			Y	
Western Olive Toad	*Amietophrynus poweri*			Y	
Guttural Toad	*Amietophrynus gutturalis*			Y	Y
Raucous Toad	*Amietophrynus rangeri*			Y	
Bushveld Rain Frog	*Breviceps adspersus*			Y	
Marbled Rubber Frog	*Phrynomantis annectens*			Y	Y
Common Platanna (African Clawed Frog)	*Xenopus laevis*			Y	Y
Poynton's River Frog	*Amietia poyntoni*			Y	Y
Boettger's Caco	*Cacosternum boettgeri*			Y	
Giant Bullfrog	*Pyxicephalus adspersus*			Y	
Tremolo Sand Frog	*Tomopterna cryptotis*			Y	
Tandy's Sand Frog	*Tomopterna tandyi*			Y	
Total	**12**	**0**	**0**	**12**	**4**

* Recorded in the ongoing Frog Atlas Project from Augrabies-Kakamas region

APPENDIX 2: LIST OF REPTILE SPECIES

Full Name	*Scientific Name*	IUCN/ CITES	Endemic (95%)	Previously Recorded* (P =possible)	Recorded During Site Visit
Tortoises & Turtles					
Karoo Tent Tortoise	*Psammobates t. tentorius*	II		1	
Leopard Tortoise	*Stigmochelys pardalis*	II		1	
Marsh Terrapin	*Pelomedusa subrufa*	II		1	
Lizards					
Striped Legless Skink	*Acontias lineatus*			1	
Cape Skink	*Trachylepis capensis*				Y
Western Three-striped Skink	*Trachylepis occidentalis*			1	
Western Rock Skink	*Trachylepis sulcata*				Y
Variegated Skink	*Trachylepis variegate*				Y
Kalahari Tree Skink	*Trachylepis spilogaster*				Y
Karasburg Tree Skink	*Trachylepis sparsa*			1	
Spotted Desert Lizard	*Meroles suborbitalis*			1	
Western Sandveld Lizard	*Nucras tessellata*			1	
Spotted Sand Lizard	*Pedioplanis lineoocellata*			1	
Namaqua Sand Lizard	*Pedioplanis namaquensis*			1	
Plain Sand Lizard	*Pedioplanis inornata*				Y
Dwarf Plated Lizard	*Cordylosaurus subtessellatus*			P	
Karoo Girdled Lizard	*Karusasaurus polyzonus*			1	
Broadley's Flat Lizard	*Platysaurus broadleyi*				Y
Water Monitor	*Varanus niloticus*	II			Y
Eock Monitor	*Varanus albigularis*	II		1	
Ground Agama	*Agama aculeate*				Y
Anchieta's Agama	*Agama anchieta*			1	
Southern Rock Agama	*Agama atra*				Y
Giant Ground Gecko	*Chondrodactylus angulifer*				Y
Striped Ground Gecko	*Colopus wahlbergii furcifer*			1	
Bradfield's Dwarf Gecko	*Lygodactylus bradfieldi*				Y
Bibron's Gecko	*Chondrodactylus bibronii*				Y
Tubercled Gecko	*Chondrodactylus laevigatus*			1	
Cape Thick-toed Gecko	*Pachydactylus capensis*			1	
Quatz Thick-toed Gecko	*Pachydactylus latirostris*				E**
Rough Thick-toed Gecko	*Pachydactylus rugosus*			1	
Namaqua Mountain Gecko	*Pachydactylus montanus*				E

Full Name	*Scientific Name*	IUCN/ CITES	Endemic (95%)	Previously Recorded* (P =possible)	Recorded During Site Visit
Augrabies Thick-toed Gecko	*Pachydactylus atorquatus*		Y		Y
Purcell's Gecko	*Pachydactylus purcelli*				E
Haacke's Thick-toed Gecko	*Pachydactylus haackei*				Y
Common Barking Gecko	*Ptenopus garrulous*			1	
Kalahari Round-headed Worm Lizard	*Zygaspis quadrifrons*			1	
Dusky Spade-snouted Worm Lizard	*Monopeltis infuscate*			1	
SNAKES					
Schinz's Beaked Blind Snake	*Rhinotyphlops schinzi*			1	
Namaqua Worm Snake	*Namibiana occidentalis*			1	
Common Egg Eater	*Dasypeltis scabra*			1	
Coral Snake	*Aspidelaps lubricus*			1	
Black-necked Spitting Cobra	*Naja nigricincta woodi*			1	
Cape Cobra	*Naja nivea*			1	
Brown House Snake	*Boaedon capensis*				Y
Dwarf Beaked Snake	*Dipsina multimaculata*			1	
Cape Wolf Snake	*Lycophidion capense*			1	
SW Shovel-snout Snake	*Prosymna frontalis*			1	
Damara Tiger Snake	*Telescopus s. polystictus*			1	
Beetz's Tiger Snake	*Telescopus beetzi*			1	
Kalahari Sand Snake	*Psammophis trinasalis*			1	
Karoo Sand Snake	*Psammophis notostictus*			1	
Mole Snake	*Pseudaspis cana*			1	
Puff Adder	*Bitis arietans*			1	
Desert Mountain Adder	*Bitis xeropaga*			1	
Horned Adder	*Bitis caudalis*				Y
Subtotals	**3 Chelonians 35 Lizards 18 Snakes**				
TOTAL	**57**	**0**	**1**	**56 (P = 1)**	**19**

* Recorded during SA Reptile Atlas (Bates *et al*. 2014) from Augrabies-Kakamas region

E** collected at Dabaras 9-10 September 2006

APPENDIX 3: LIST OF BIRD SPECIES

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
Common Ostrich	*Struthio camelus*				
Little Grebe (Dabchick)	*Tachybaptus ruficollis*				Y
Black-necked Grebe	*Podiceps nigricollis*			SM	
Reed Cormorant	*Phalacrocorax africanus*				Y
White-breasted Cormorant	*Phalacrocorax lucidus*				Y
African Darter	*Anhinga rufa*				Y
Little Egret	*Egretta garzetta*				Y
Yellow-billed Egret	*Egretta intermedia*				
Grey Heron	*Ardea cinerea*				Y
Black-headed Heron	*Ardea melanocephala*				Y
Goliath Heron	*Ardea goliath*				
Purple Heron	*Ardea purpurea*				Y
Western Cattle Egret	*Bubulcus ibis*				Y
Squacco Heron	*Ardeola ralloides*				
Black-crowned Night Heron	*Nycticorax nycticorax*				Y
White-backed Night Heron +	*Gorsachius leuconotus*		VU		
Little Bittern	*Ixobrychus minutus*				
Hamerkop	*Scopus umbretta*				Y
Black Stork	*Ciconia nigra*				Y
Abdim's Stork	*Ciconia abdimii*			SM	
White Stork	*Ciconia ciconia*			PAM	
Marabou Stork	*Leptoptilos crumeniferus*		NT	SM	
Openbill Stork	*Anastomus lamelligerus*		NT	SM	Y
Hadeda Ibis	*Bostrychia hagedash*				Y
African Sacred Ibis	*Threskiornis aethiopicus*				Y
African Spoonbill	*Platalea alba*				
Greater Flamingo	*Phoenicopterus rubber*		NT	SM	
Lesser Flamingo	*Phoenicopterus minor*	NT	NT	SM	
Maccoa Duck	*Oxyura maccoa*			SM	
Egyptian Goose	*Alopochen aegyptiaca*				Y
South African Shelduck	*Tadorna cana*				Y
Spur-winged Goose	*Plectropterus gambensis*				
Cape Teal	*Anas capensis*				
African Black Duck	*Anas sparsa*				Y
Yellow-billed Duck	*Anas undulata*				Y
Cape Shoveler	*Anas smithii*				
Red-billed Teal	*Anas erythrorhyncha*				Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
Southern Pochard	*Netta erythrophthalma*				
Secretarybird	*Sagittarius serpentarius*	VU	NT		
Black-shouldered Kite	*Elanus caeruleus*				Y
Black Kite	*Milvus migrans*			IAM	
Yellow-billed Kite	*Milvus aegyptius*			IAM	Y
African Fish Eagle	*Haliaeetus vocifer*				Y
White-backed Vulture	*Gyps africanus*	EN	VU		
Black-chested Snake Eagle	*Circaetus pectoralis*				
Black Harrier	*Circus maurus*	VU	NT	NE	
African Harrier-hawk (Gymnogene)	*Polyboroides typus*				
Southern Pale Chanting Goshawk	*Melierax canorus*				Y
Gabar Goshawk	*Melierax gabar*				
Steppe Buzzard	*Buteo vulpinus*			PAM	
Jackal Buzzard	*Buteo rufofuscus*			NE	Y
Steppe Eagle	*Aquila nipalensis*			PAM	
Verreaux's Eagle (Black Eagle)	*Aquila verreauxii*				Y
Booted Eagle	*Aquila pennatus*			IAM	
Martial Eagle	*Polemaetus bellicosus*				
Pygmy Falcon	*Polihierax semitorquatus*				Y
Lesser Kestrel	*Falco naumanni*			PAM	
Rock Kestrel	*Falco rupicolus*				Y
Greater Kestrel	*Falco rupicoloides*				Y
Red-necked Falcon	*Falco chicquera*				
Lanner Falcon	*Falco biarmicus*		NT		Y
Peregrine Falcon	*Falco peregrinus*		NT		
Cape Spurfowl	*Pternistis capensis*				Y
Swainson's Spurfowl	*Pternistis swainsonii*				
Common Quail	*Coturnix coturnix*			IAM	
Helmeted Guineafowl	*Numida meleagris*				Y
African Rail	*Rallus caerulescens*				
Black Crake	*Amaurornis flavirostris*				
African Swamphen	*Porphyrio madagascariensis*				
Common Moorhen	*Gallinula chloropus*				Y
Red-knobbed Coot	*Fulica cristatus*				Y
Ludwig's Bustard	*Neotis ludwigii*	EN	VU	BR	
Kori Bustard	*Ardeotis kori*	NT	VU		Y
Red-crested Korhaan	*Lophotis ruficrista*				
Northern Black Korhaan	*Afrotis afraoides*				Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
Karoo Korhaan	*Eupodotis vigorsii*			BR	
Kittlitz's Plover	*Charadrius pecuarius*				
Three-banded Plover	*Charadrius tricollaris*				Y
Chestnut-banded Plover	*Charadrius pallidus*		NT	SM	
Blacksmith Lapwing	*Vanellus armatus*				Y
Crowned Lapwing	*Vanellus coronatus*				
Little Stint	*Calidris minuta*			PAM	Y
Curlew Sandpiper	*Calidris ferruginea*			PAM	
Ruff	*Philomachus pugnax*			PAM	
Common Sandpiper	*Actitis hypoleucos*			PAM	
Marsh Sandpiper	*Tringa stagnatilis*			PAM	
Common Greenshank	*Tringa nebularia*			PAM	
Green Sandpiper	*Tringa ochropus*			PAM	
Wood Sandpiper	*Tringa glareola*			PAM	Y
Black-winged Stilt	*Himantopus himantopus*				Y
Pied Avocet	*Recurvirostra avosetta*			SM	
Water Thick-knee	*Burhinus vermiculatus*				
Spotted Thick-knee	*Burhinus capensis*				Y
Double-banded Courser	*Rhinoptilus africanus*			SM	
Burchell's Courser	*Cursorius rufus*			SM	
Whiskered Tern	*Chlidonias hybrida*			SM	
Namaqua Sandgrouse	*Pterocles namaqua*				Y
Double-banded Sandgrouse	*Pterocles bicinctus*				
Rock Dove	*Columba livia*				Y
Speckled Pigeon (Rock Pigeon)	*Columba guinea*				Y
Laughing Dove	*Streptopelia senegalensis*				Y
Cape Turtle Dove	*Streptopelia capicola*				Y
Red-eyed Dove	*Streptopelia semitorquata*				Y
Namaqua Dove	*Oena capensis*				Y
Rosy-faced Lovebird	*Agapornis roseicollis*			NE	
Jacobin Cuckoo	*Clamator jacobinus*			IAM	
Dideric Cuckoo	*Chrysococcyx caprius*			IAM	
Western Barn Owl	*Tyto alba*				
Southern White-faced Owl	*Ptilopsis granti*				
Spotted Eagle Owl	*Bubo africanus*				Y
Verreaux's Eagle Owl (Giant Eagle Owl)	*Bubo lacteus*				
Freckled Nightjar	*Caprimulgus tristigma*				
Rufous-cheeked Nightjar	*Caprimulgus rufigena*				Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
African Palm Swift	*Cypsiurus parvus*			SM	
Alpine Swift	*Tachymarptis melba*			SM	Y
Common Swift	*Apus apus*			PAM	
African Black Swift	*Apus barbatus*			SM	Y
Bradfield's Swift	*Apus bradfieldi*				
Little Swift	*Apus affinis*				Y
White-rumped Swift	*Apus caffer*				Y
White-backed Mousebird	*Colius colius*				Y
Speckled Mousebird	*Colius striatus*				
Red-faced Mousebird	*Urocolius indicus*				Y
Malachite Kingfisher	*Alcedo cristata*				Y
Giant Kingfisher	*Megaceryle maximus*				
Pied Kingfisher	*Ceryle rudis*				Y
White-fronted Bee-eater	*Merops bullockoides*				Y
Little Bee-eater	*Merops pusillus*				
Swallow-tailed Bee-eater	*Merops hirundineus*				Y
European Bee-eater	*Merops apiaster*			PAM	Y
European Roller	*Coracias garrulus*			PAM	
Purple Roller	*Coracias naevius*			SM	
African Hoopoe	*Upupa africana*			SM	Y
Common Scimitarbill	*Rhinopomastus cyanomelas*				Y
Southern Yellow-billed Hornbill	*Tockus leucomelas*				
Acacia Pied Barbet	*Tricholaema leucomelas*				
Greater Honeyguide	*Indicator indicator*				
Lesser Honeyguide	*Indicator minor*				Y
Golden-tailed Woodpecker	*Campethera abingoni*				
Cardinal Woodpecker	*Dendropicos fuscescens*				Y
Eastern Clapper Lark	*Mirafra fasciolata*				
Sabota Lark	*Calendulauda sabota*				Y
Fawn-coloured Lark	*Calendulauda africanoides*				
Karoo Lark	*Calendulauda albescens*			NE, BR	Y
Spike-heeled Lark	*Chersomanes albofasciata*				
Karoo Long-billed Lark	*Certhilauda subcoronata*			NE	Y
Black-eared Sparrow-lark	*Eremopterix australis*			NE, SM, RR	Y
Grey-backed Sparrow-lark	*Eremopterix verticalis*			SM	
Red-capped Lark	*Calandrella cinerea*				Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
Stark's Lark	*Spizocorys starki*			SM, BR	
Pink-billed Lark	*Spizocorys conirostris*			SM	
Sclater's Lark	*Spizocorys sclateri*		NT	NE	
Sand Martin	*Riparia riparia*			PAM	
Brown-throated Martin	*Riparia paludicola*				Y
Banded Martin	*Riparia cincta*				
Barn Swallow	*Hirundo rustica*			PAM	Y
White-throated Swallow	*Hirundo albigularis*			IAM	Y
Pearl-breasted Swallow	*Hirundo dimidiata*			SM	
Greater Striped Swallow	*Hirundo cucullata*			SM	Y
South African Cliff Swallow	*Hirundo spilodera*			IAM	
Rock Martin	*Hirundo fuligula*				Y
Common House Martin	*Delichon urbicum*			PAM	Y
Fork-tailed Drongo	*Dicrurus adsimilis*				Y
Cape Crow	*Corvus capensis*				
Pied Crow	*Corvus albus*				
Cape Penduline Tit	*Anthoscopus minutus*				
Ashy Tit	*Parus cinerascens*				
Grey Tit	*Parus afer*			NE	
Long-billed Crombec	*Sylvietta rufescens*				
Yellow-bellied Eremomela	*Eremomela icteropygialis*				Y
Sedge Warbler	*Acrocephalus schoenobaenus*			PAM	
African Reed Warbler	*Acrocephalus baeticatus*			IAM	Y
Lesser Swamp Warbler	*Acrocephalus gracilirostris*				
Willow Warbler	*Phylloscopus trochilus*			PAM	Y
Layard's Tit Babbler	*Parisoma layardi*			NE, RR	
Chestnut-vented Tit Babbler	*Parisoma subcaeruleum*				Y
Garden Warbler	*Sylvia borin*			PAM	
African Red-eyed Bulbul	*Pycnonotus nigricans*				Y
Short-toed Rock Thrush	*Monticola brevipes*				
Groundscraper Thrush	*Psophocichla litsitsirupa*				
Karoo Thrush	*Turdus smithi*			NE	Y
Chat Flycatcher	*Bradornis infuscatus*				
Marico Flycatcher	*Bradornis mariquensis*				Y
Fiscal Flycatcher	*Sigelus silens*			NE	Y
Spotted Flycatcher	*Muscicapa striata*			PAM	Y
Cape Robin Chat	*Cossypha caffra*				
Kalahari Scrub Robin	*Cercotrichas paena*			RR	Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
Karoo Scrub Robin	*Cercotrichas coryphoeus*				
African Stonechat	*Saxicola torquatus*				
Mountain Wheatear (Mountain Chat)	*Oenanthe monticola*				
Capped Wheatear	*Oenanthe pileata*				
Sickle-winged Chat	*Cercomela sinuata*			BR	Y
Karoo Chat	*Cercomela schlegelii*			BR	
Tractrac Chat	*Cercomela tractrac*			RR	
Familiar Chat	*Cercomela familiaris*				Y
Ant-eating Chat	*Myrmecocichla formicivora*				Y
Grey-backed Cisticola	*Cisticola subruficapilla*				
Levaillant's Cisticola	*Cisticola tinniens*				
Zitting Cisticola	*Cisticola juncidis*				Y
Desert Cisticola	*Cisticola aridulus*				
Black-chested Prinia	*Prinia flavicans*				
Namaqua Warbler	*Phragmacia substriata*			NE, RR	Y
Rufous-eared Warbler	*Malcorus pectoralis*				
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*			NE, BR	
Pririt Batis	*Batis pririt*				Y
African Pied Wagtail	*Motacilla aguimp*				Y
Cape Wagtail	*Motacilla capensis*				Y
African Pipit (Grassveld Pipit)	*Anthus cinnamomeus*				Y
Long-billed Pipit	*Anthus similis*				
Red-backed Shrike	*Lanius collurio*			PAM	
Lesser Grey Shrike	*Lanius minor*			PAM	
Common Fiscal	*Lanius collaris*				Y
Brubru	*Nilaus afer*				
Crimson-breasted Shrike	*Laniarius atrococcineus*				
Bokmakierie	*Telophorus zeylonus*				
Pale-winged Starling	*Onychognathus nabouroup*				Y
Cape Glossy Starling	*Lamprotornis nitens*				
Pied Starling	*Spreo bicolor*			NE	
Wattled Starling	*Creatophora cinerea*			SM	
Southern Double-collared Sunbird	*Cinnyris chalybeus*			NE	
Dusky Sunbird	*Cinnyris fuscus*				Y
Orange River White-eye	*Zosterops pallidus*				Y
White-browed Sparrow-weaver	*Plocepasser mahali*				Y
Social Weaver	*Philetairus socius*				Y

Full Name	*Scientific Name*	IUCN	SA RD	Near Endemic , Restricted, & Migrant **	Recorded During Survey
(Sociable Weaver)					
House Sparrow	*Passer domesticus*				
Great Sparrow	*Passer motitensis*				
Cape Sparrow	*Passer melanurus*				Y
Southern Grey-headed Sparrow	*Passer diffusus*				Y
Yellow-throated Petronia (Yellow-throated Sparrow)	*Petronia superciliaris*				
Scaly-feathered Finch	*Sporopipes squamifrons*				Y
Cape Weaver	*Ploceus capensis*			NE	
Southern Masked Weaver	*Ploceus velatus*				Y
Red-billed Quelea	*Quelea quelea*			SM	
Southern Red Bishop	*Euplectes orix*				Y
Red-headed Finch	*Amadina erythrocephala*			SM	
Common Waxbill	*Estrilda astrild*				Y
Green-winged Pytilia	*Pytilia melba*				
Red-billed Firefinch	*Lagonosticta senegala*				
Pin-tailed Whydah	*Vidua macroura*				
Dusky Indigobird (Black Widowfinch)	*Vidua funerea*				
Black-headed Canary	*Serinus alario*			NE	
Black-throated Canary	*Crithagra atrogularis*				
Yellow Canary	*Crithagra flaviventris*				
White-throated Canary	*Crithagra albogularis*				
Lark-like Bunting	*Emberiza impetuani*			SM	Y
Cinnamon-breasted Bunting (Rock Bunting)	*Emberiza tahapisi*				
Cape Bunting	*Emberiza capensis*				Y
Total	**247**	**6**	**14**	**NE = 15**	**111**

IUCN = International Union for Conservation of Nature (red list); SA RD = SA Red Data Book Birds; NE = Near Endemic (South Africa);
RR = Range Restricted; BR = Biome (Nama-Karoo) Restricted; IAM = Intra-African Migrant; PAM = PalaeoArctic Migrant;
SM = Seasonal Migrant
+ Not recorded from AFNP but known from Lower Orange River

APPENDIX 4: LIST OF MAMMAL SPECIES *

English Name	Scientific Name	IUCN	SA RDB	Possible	Recorded S = survey P = before
Western Rock Elephant Shrew	*Elephantulus rupestric*				P
Short-eared Elephant-shrew	*Macroscelides proboscideus*			1	
Reddish-grey Musk Shrew	*Crocidura cyanea*				P
Bicolored Musk Shrew	*Crocidura fuscomurina*			1	
Lesser Red Musk Shrew	*Crocidura hirta*			1	
Rock-loving Flat-headed Bat	*Sauromys petrophilus*				P
Egyptian Slit-faced Bat	*Nycteris thebaica*			1	
Darling's Horseshoe Bat	*Rhinolophus darlingi*				P
Cape Horseshoe Bat	*Rhinolophus capensis*				P
Cape Serotine Bat	*Neoromicia capensis*			1	
Rüppell's Pipistrelle	*Pipistrellus ruepellii*				P
Long-tailed House Bat	*Eptesicus hottentotus*			1	
Egyptian Free-tailed Bat	*Tadarida aegyptiaca*				P
Natal Long-fingered Bat	*Miniopterus natalensis*			1	
Vervet Monkey	*Cercopithecus pygerythrus*				S
Chacma Baboon	*Papio ursinus*				S
Smith's Red Rock Rabbit	*Pronolagus rupestris*				S
Cape Hare	*Lepus capensis*				S
Scrub Hare	*Lepus saxatilis*				P
Cape Ground Squirrel	*Xerus inauris*				S
Cape Short-tailed Gerbil	*Desmodillus auricularis*				P
Hairy-footed Gerbil	*Gerbillurus paeba*				P
Highveld Gerbil	*Gerbilliscus brantsii*			1	
Bushveld Gerbil	*Gerbilliscus leucogaster*				P
Brush-tailed Hairy-footed Gerbil	*Gerbilliscus vallinus*				P
Veld Aethomys	*Aethomys ineptus*			1	
Southern African Mastomys	*Mastomys coucha*				P
Southern African Pouched mouse	*Saccostomus campestris*				P
Namaqua Rock Rat	*Micaelamys namaquensis*				P
Pygmy Mouse	*Mus indutus/minutoides*			1	
Four-striped Grass Mouse	*Rhabdomys pumilio*				S
Brants's Whistling Rat	*Parotomys brantsii*				P
Littledale's Whistling Rat	*Parotomys littledalei*			1	
Black-tailed tree Rat	*Thallomys nigricauda*			1	
Shortridge's Thallomys	*Thallomys shortridgei*	DD		1	

English Name	Scientific Name	IUCN	SA RDB	Possible	Recorded S = survey P = before
Pygmy Rock Mouse	*Petromyscus collinus*				P
Large-eared African Desert Mouse	*Malacothrix typical*			1	
Great African Climbing Mouse	*Dendromus melanotis*				P
Southern African Mole Rat	*Cryptomys hottentotus*			1	
Large Savannah Dormouse	*Graphiurus microtis*			1	
Cape Porcupine	*Hystrix africaeaustralis*				S
Dassie Rat	*Petromus typicus*		NT		S
Springhare	*Pedetes capensis*				S
Bat-eared Fox	*Otocyon megalotis*				P
Black-backed Jackal	*Canis mesomelas*				S
African Clawless Otter	*Aunyx capensis*				S
Honey Badger	*Mellivora capensis*		NT		P
Striped Polecat	*Ictonyx striatus*				P
Yellow Mongoose	*Cynictis penicillata*				S
Small Grey Mongoose	*Galerella pulverulenta*				P
Slender Mongoose	*Galerella sanguinea*				P
Small-spotted Genet	*Genetta genetta*				P
Water Mongoose	*Atilax paludinosus*				S
Brown Hyaena	*Hyaena brunnea*	NT	NT		S
Aardwolf	*Proteles cristatus*				P
Caracal	*Felis caracal*				P
African Wild Cat	*Felis silvestris*				P
Small spotted Cat	*Felis nigripes*	VU		1	
Leopard	*Panthera pardus*	NT			P
Aardvark	*Orycteropus afer*				S
Rock Dassie	*Procavia capensis*				S
Hook-lipped Rhinoceros	*Diceros bicornis bicornis*	CR	CR		
Giraffe	*Giraffa camelopardalis*				P
Hartmann's Mountain Zebra	*Equus zebra hartmannae*	VU			P
Common Eland	*Tragelaphus oryx*				S
Greater Kudu	*Tragelaphus strepsiceros*				P
Gemsbok	*Oryx gazelle*				S
Red Hartebeest	*Alcelaphus buselaphus*				P
Springbok	*Antidorcas marsupialis*				S
Klipspringer	*Oreotragus oreotragus*				S
Steenbuck	*Raphicerus campestris*				S
Common (Grey) Duiker	*Sylvicapra grimmia*				P
Total	**72 (53)**	**6**	**4**	**19**	**S = 21, P = 32**

* Based on Augrabies Falls National Park checklist with micromammal updates from Avery & Avery (2011)
IUCN = International Union for Conservation of Nature (red list); RDB = SA Red Data Book