BIOPHYSICAL ASSESSMENT (VERTEBRATE FAUNA & FLORA): MEOB BAY TOURISM DEVELOPMENT PROJECT – UPDATED 2022 [EIA]

SPECIALIST CONTRIBUTION:

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1 Introduction

The objective of the Meob Bay Tourism Development Project (NAMAB (Pty) Ltd) is to establish a low impact lodge and camping facilities approximately 190km south of Walvis Bay in the general Meob Bay area.

Environment and Wildlife Consulting, Namibia has been appointed by Knight Piésold (Pty) Ltd to undertake a baseline ecological assessment of the vertebrae fauna and flora (i.e. literature review and rapid site assessment) known and expected to occur in the proposed development site south of Meob Bay. Very little work has been conducted on the vertebrate fauna and flora from the Meob-Conception Bay areas with limited documented information (Walmsley n.d.).

A desktop study (i.e. literature review) was conducted between 13 and 14 June 2019 on the vertebrate fauna (e.g. reptiles, amphibians, mammals and birds) and flora (trees and shrubs >1m in height) expected to occur in the general Meob Bay area. This was followed by a rapid site assessment conducted between 18 and 21 June 2019 at the proposed development areas. This report was updated during August 2022.

The literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general area commonly referred to as the Southern Namib or Southern Desert (Giess 1971, Mendelsohn *et al.* 2022, van der Merwe 1983). This area is bordered inland by the Semi-desert and Savanna Transition Zone or Desert – Dwarf Shrub Transition (Giess 1971, Mendelsohn *et al.* 2022). Climatically the coastal area is referred to as Cool Desert with a high occurrence of fog (van der Merwe 1983). The Namib Desert Biome makes up a large proportion (32%) of the land area of Namibia with parks in this biome making up 69% of the protected area network or 29.7% of the biome (Barnard 1998). Four of 14 desert vegetation types are adequately protected with up to 94% representation in the protected area network in Namibia (Barnard 1998). The proposed development site falls within the Namib-Naukluft Park (49,768km²) which extends from the Kuiseb River southwards to the Tsau//Khaeb National Park (Sperrgebied) in the general Lüderitz area.

The Namib-Naukluft Park is classified as a UNESCO world heritage site since 2013 – Namib Sand Sea – one of only two such sites in Namibia. The criterions for heritage site which are met by Namib Sand Sea include: Criteria vii (The property is the world's only coastal desert that includes extensive dune fields influenced by fog); Criteria viii (The property represents an exceptional example of ongoing geological processes involving the formation of the world's only extensive dune system in a coastal fog desert through transport of material over thousands of kilometres by river, ocean current and wind); Criteria ix (The property is an exceptional example of ongoing ecological process in a coastal fog desert where plant and animal communities are continuously adapting to life in a hyper arid environment) and Criteria x (The property is of outstanding importance for the in-situ conservation of an unusual and exceptional array of endemic species uniquely adapted to life in a hyper-arid desert environment in which fog serves as the primary source of water) (See: www.whc.unesco.org).

SAIEA (2010) classifies the Sandwich Harbour (203km²) and Kuiseb Delta (344km^2) areas as high biodiversity red flag areas due to being internationally recognised as a Ramsar wetland (Kuiseb Delta) and important bird area (Sandwich Harbour) and the very high density of !nara (*Acanthosicyos horridus*) plants and its importance for the Topnaar livelihood (Kuiseb Delta) albeit far to the north of the Meob Bay area. No communal and freehold conservancies are located in the general area with the closest communal conservancy being the ≠Gaingu Conservancy in the Spitzkoppe area approximately 300km to the northeast and the closest freehold conservancy being the Tiras Mountain Conservancy approximately 250km to the southeast (Mendelsohn *et al.* 2022, MEFT/NACSO 2021). Furthermore, the offshore area is classified as Marine Protected Area and Fish Sanctuary (Swart *et al.* 2012).

Two important coastal wetlands – i.e. Walvis Bay Wetlands and Sandwich Harbour – both Ramsar sites, occur to the north of the Meob Bay area. According to Curtis and Barnard (1998) the entire coast and the Walvis Bay lagoon as a coastal wetland, are viewed as sites with special ecological importance in Namibia. The known distinctive values along the coastline are its biotic richness (arachnids, birds and lichens) with the Walvis Bay lagoon's importance being its biotic richness and migrant shorebirds as well as being the most important Ramsar site in Namibia. The Ramsar site covers 12,600ha with regular counts of birds varying between 37,000 and well over 100,000 individuals, albeit mainly migratory species (Kolberg n.d.). The Walvis Bay wetland is considered the most important coastal wetland in southern Africa and one of the top 3 in Africa (Shaw *et al.* 2004). The Sandwich Harbour Ramsar site covers 16,500ha and falls within the Namib-Naukluft Park and enjoys full protection (Kolberg n.d.). This area is a centre of concentration of migratory shorebirds, waders and flamingos regularly supporting over 142,000 and 50,000 birds during summer and winter, respectively (Kolberg n.d.).

The main drainage line in the general area, albeit to the north of the general Meob Bay area, is the Kuiseb River with a catchment area of 15,500km² with common riparian species including Ana tree, Tamarix, Camelthorn, Salvadora, Fig, Euclea, !Nara and Mesquite.Other ephemeral drainage lines to the east of the general Meob Bay area include the Tsondab and Tsauchab, although neither reach the coast but end as pans inland – e.g. Tsondabvlei and Sossusvlei (Jacobson *et al.* 1995).

The central coastal region and the general Meob Bay area in particular, is regarded as "relatively low" in overall (all terrestrial species) diversity (Mendelsohn *et al.* 2022). Overall terrestrial endemism in the area on the other hand is "moderate to high" (Mendelsohn *et al.* 2022).The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "low to medium" with 1-2 species while overall diversity of large carnivorous mammals (large predators) is determined at 4 species with brown hyena being the most important with "medium" densities expected in the area (Mendelsohn *et al.* 2022).

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (*Asteraceae*) (385), legumes (*Fabacea*e) (377) and fygies (*Mesembryanthemaceae*) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species – approximately 687 species in total – are mainly associated with the Kaokoveld (northwestern) and the succulent Karoo (southwestern) Namibia. The major threats to the floral diversity in Namibia are:
1) Conversion of the land to agriculture (with associated problems) and,
2) Poorly considered development (Maggs 1998, Mendelsohn *et al.* 2022).

The vegetation in the Desert Biome is characterised by a dominance of therophytes which persist in the form of seeds during unfavourable conditions (Lovegrove 1999). According to Mendelsohn *et al.* (2022) the dominant vegetation structure in the Southern Desert is grassland and dwarf shrubland. These Namib grasslands – mainly annual species – are very sparse, but nevertheless still dominate the little vegetation that grows there. The average plant production is extremely low with 0-5% variation in green vegetation biomass (Mendelsohn *et al.* 2022). The overall plant diversity (all species) in the general Meob Bay area is estimated as <50 species (Mendelsohn *et al.* 2022). These estimates are limited to "higher" plants as information regarding "lower" plants is sparse. Burke (2003a) estimates that over 400 species – 10% of the flora of Namibia – occur in the central Namib and although it has not been identified as a centre of endemism, it is dominated by endemics such as *Arthraerua leubnitziae*. The greatest variables affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas.

Pockets of high diversity are found throughout Namibia in “unique” habitat – often transition zones – e.g. mountains, inselbergs, etc. Plant endemism is viewed as “low” – with between 2-5 endemics expected from the general area (Mendelsohn *et al.* 2022). Furthermore, Mendelsohn *et al.* (2002) views the grazing and browse as virtually nonexistent in the general area. The tourism potential of this area is viewed as moderate (Mendelsohn *et al.* 2022, van der Merwe 1983).

It is estimated that at least 26 reptile, 3 amphibian, 35 mammal, 51 bird species (breeding residents), up to 14 species of larger trees and shrubs and up to 29 grasses are known to or expected to occur in the general/immediate Meob Bay area of which a high proportion are endemics (e.g. 46.2% of reptiles).

2 Background

2.1 Project Description

The objective of the Meob Bay Tourism Development Project (NAMAB (Pty) Ltd) is to establish a low impact lodge and camping facilities approximately 190km south of Walvis Bay in the general Meob Bay area (Figure 1).

The project comprises of the construction of:

- Lodge development = 10 x stand alone units, central communal area and staff accommodation (located approximately 600m east of the proposed lodge); and
- Tented camp = 20 x tented chalets and kitchen area.

The existing Fishersbrun airfield will be used to fly guests to/from the lodge and all vehicle movement would be limited to existing tracks only. Access to the tented camps would be either via Walvis Bay (combination of coastal and dune routes) or Farm Kanaan (dune route) in the Betta area.

The purpose of this study is to determine the effect that the proposed above mentioned developments in the general area south of Meob Bay may have on the bio-physical environment (vertebrate fauna and flora) in the affected area and immediate surroundings as gathered from a comprehensive biophysical study (literature review) and rapid site assessment to confirm species and issues *in situ*.

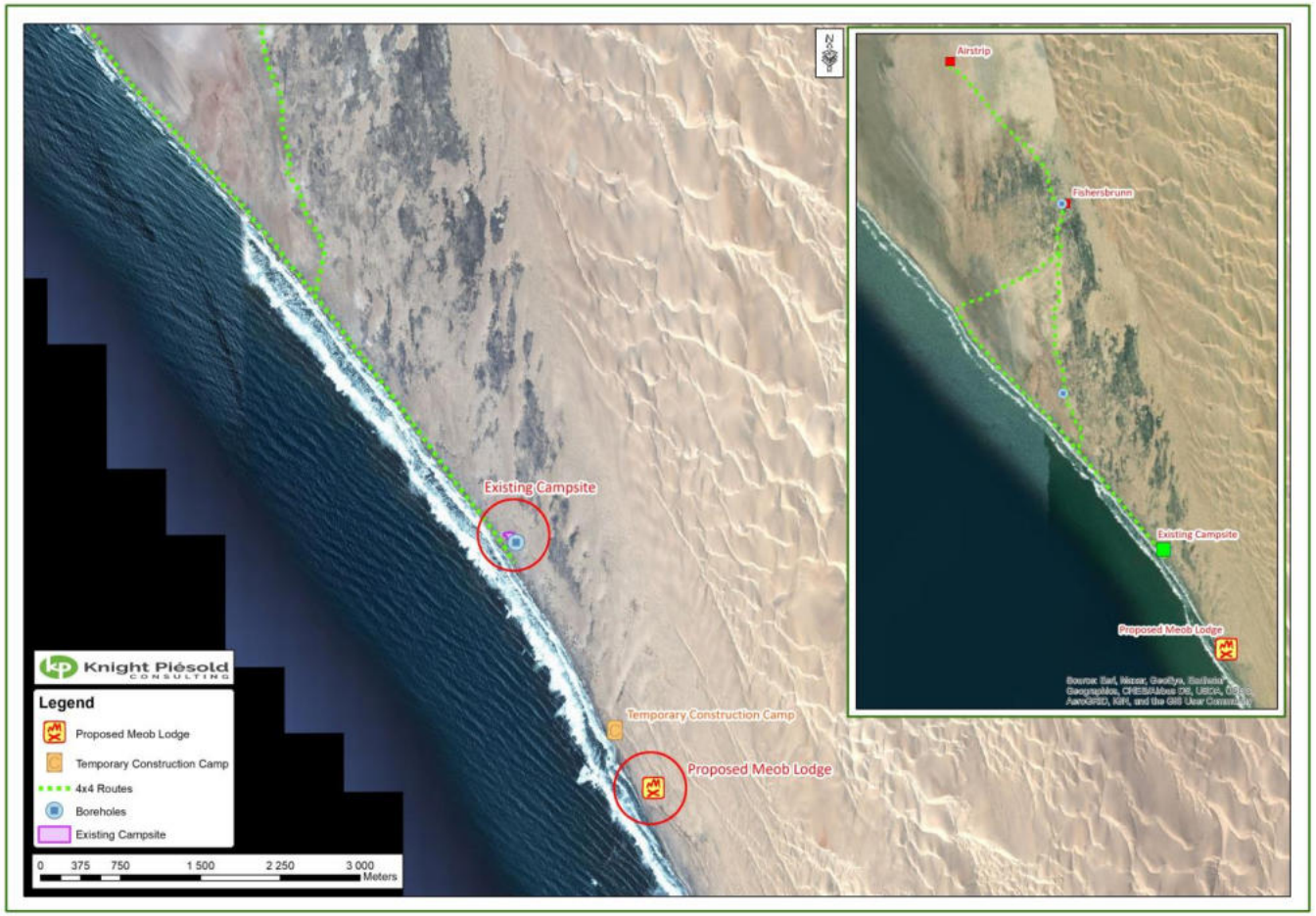

Figure 1. Proposed lodge development layout south of Meob Bay and existing campsite (©Knight Piésold Consulting).

2.2 Terms of Reference (ToR)

According to the ToR the following was expected:

1. Assess the bio-physical (vertebrate fauna and flora) issues relevant to the above mentioned area.
2. Assess the significance of development and environmental impact that such development(s) may have on the vertebrate fauna and flora at the proposed development site(s) including general comments.

3 Approach to Study

3.1 Literature Review

A comprehensive literature review on the existing as well as "recent" relevant publications pertinent to the topic was conducted prior to the site visit. This review included vertebrate fauna (amphibians, mammals, reptiles and birds) and flora (larger trees/shrubs and grasses) known or expected to occur in the general/immediate Meob BayTourism Development area. The focus was on unique species – i.e. rare, threatened and endangered (RT and E), protected, endemic, etc. species as determined by the International and Namibian legal status for such species. This report was undated during August 2022. A list of the references consulted can be viewed in the Reference section (Page 46).

3.2 Fieldwork

- Small mammal trapping was conducted by active trapping using collapsible Sherman traps. Small mammals caught were identified *in situ*, photographed, measured (when applicable to facilitate identification) and released unharmed at the site of capture. Twenty traps were set along 2 tap lines at 2 sites over 2 nights – i.e. 40 traps with a maximum capture rate of 40 rodents.

- Larger mammal presence was determined by direct observations including other signs – e.g. tracks, scats, carcasses, burrows, scrapes, etc. Camera traps (x 2) were set to capture images of larger mammals in the area.

- Reptile and amphibian presence was determined by actively traversing the area on foot during the day and night (using a gas lantern) to determine the diurnal and nocturnal reptile diversity. Reptiles and amphibians were caught using active capture technique ('reptile noosing') and identified *in situ*, photographed, measured (when applicable to facilitate identification) and released unharmed at the site of capture.

- All birds observed in the area were identified using binoculars to ID and confirm species.

- All flora observed in the area were identified.

4 Baseline Description

4.1 Reptile Diversity

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continent's species diversity (Griffin 1998a). At least 22% or 55 species of Namibian lizards are classified as endemic. The occurrence of reptiles

of “conservation concern” includes about 67% of Namibian reptiles (Griffin 1998a). Emergency grazing and large-scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998a).

The overall reptile diversity and endemism in the general Meob Bay Tourism Development area is estimated at between 16-20 species and 5-8 species, respectively (Mendelsohn *et al.* 2022). Griffin (1998a) presents figures of between 1-10 and 1-2 for endemic lizards and snakes, respectively, from the general area. The Namib-Naukluft Park has an estimated 100 species of reptiles, although the majority of these reptiles are found further inland and not associated with the coastal areas (Griffin 1998a). Walmsley (n.d.) indicates that the vertebrate fauna in the Meob-Conception Bay areas are expected to be dominated by snakes, lizards and skinks (although this study does not indicate species).

At least 26 species of reptiles are expected to occur in the general Meob Bay Tourism Development area with 12 species being endemic – i.e. 46.2% endemic. One species known/expected to occur in the area (*Meroles micropholidotus*) is classified as “rare” and “insufficiently known” and 1 species as “peripheral” (*Dermochelys coriacea*) under Namibian legislation (Table 1). The IUCN (2022) classifies 1 species as “vulnerable” (*Dermochelys coriacea*) and 24 species as “least concern” although many reptiles have not yet been assessed by the IUCN Red List. The SARDB classifies 1 species as “vulnerable” and 2 species as “peripheral” while 2 species are classified by CITES as either Appendix I or Appendix II (1 species each). The leatherback turtle (*Dermochelys coriacea*) is known to occur offshore and although it is not classified under the Nature Conservation Ordinance No 4 of 1975 it is protected under the Sea Fisheries Regulations of 2001 (Griffin 2003).

The 26 species known/expected to occur in the general area consist of at least 1 turtle; 1 blind snake; 7 typical snakes; 6 skinks; 4 old world lizards; 1 chameleon and 6 geckos.

Gecko’s (6 species with 4 species being endemic [66.7%]), old world lizards (4 species with 2species being endemic and 1 species classified as “rare” [50%]) and skinks (6 species with 3 species being endemic [50%]) are the most important groups of reptiles expected to occur in the general area. Griffin (1998a) confirms the importance of the gecko fauna in Namibia while Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a).

From a conservation point of view, the endemic *Bitis peringueyi* is viewed as the most important snake occurring in the area although it occurs between the Kunene River and Lüderitz with 90% of the taxon’s range within Namibia. Similarly, the most important lizard is viewed as the small-scaled desert lizard (*Meroles micropholidotus*) which occurs in widely isolated populations dependent on vegetation and is classified as endemic, “insufficiently known” and “rare” and occurs between Walvis Bay and Lüderitz (i.e. 100% of the taxon’s range within Namibia). Most other reptile species are found further inland or are found more widespread throughout the general area and not limited to the immediate coastal areas.

During the fieldwork 9 reptile species were confirmed to occur in the general area although 1 species – leatherback turtle – is a marine species with occasional sightings of dead individuals along the shore only (Jaques Delport pers. com.) while 2 species were viewed further inland in the more stable dune areas (*Psammophis leightoni namibensis* and *Meroles anchietae*) and not at the proposed coastal development sites (Figure 2; Table 1). The most conservational important species confirmed in/around the proposed development sites would be the endemic and range restricted small-scaled desert lizard (*Meroles micropholidotus*) as well as the other endemics, especially Péringuey’s adder (*Bitis peringueyi*) (Figure 3) and web-footed gecko (*Pachydactylus rangei*) (Figure 4). Examples of other species encountered are presented in Figures 5-7.

Table 1. Reptile diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status		
				SARDB	IUCN	CITES
TURTLES AND TERRAPINS						
Dermochelys coriacea	Leatherback Turtle	√#	Peripheral	V	V	C1
SNAKES						
Blind Snakes						
Rhinotyphlops schinzi	Schinz's Beaked Blind Snake		Secure; Endemic	P	LC	
Typical Snakes						
Boaedon (Lamprophis) fuliginosus	Brown House Snake		Secure		LC	
Dipsina multimaculata	Dwarf Beaked Snake		Secure; Endemic		LC	
Psammophis notostictus	Karoo Sand Snake		Secure		LC	
Psammophis leightoni namibensis	Namib Sand Snake	√*	Secure		LC	
Bitis caudalis	Horned Adder	√	Secure		LC	
Bitis cornuta	Many Horned Adder		Secure		LC	
Bitis peringueyi	Péringuey's Adder	√	Secure; Endemic		LC	
LIZARDS						
Skinks						
Acontias lineatus lineatus	Striped Legless Skink		Secure		LC	
Typhlosaurus braini	Brain's Blind Legless Skink		Secure; Endemic		LC	
Typhlosaurus meyeri	Meyer's Blind Legless Skink		Secure; Endemic		LC	
Typhlacontias brevipes	FitzSimons' Burrowing Skink		Secure; Endemic		LC	
Trachylepis occidentalis	Western Three-striped Skink		Secure		LC	
Trachylepis variegata variegata	Variegated Skink		Secure		LC	
Old World Lizards						
Meroles anchietae	Shovel-snouted Lizard	√*	Secure		LC	
Meroles cuneirostris	Wedge-snouted Desert Lizard	√	Secure; Endemic		LC	
Meroles micropholidotus	Small-scaled Desert Lizard	√	Endemic; Insufficiently known;Rare?		LC	
Meroles suborbitalis	Spotted Desert Lizard		Secure		LC	
Chameleons						
Chamaeleo namaquensis	Namaqua Chameleon		Secure		LC	C2
Geckos						
Chondrodactylus angulifer namibensis	Giant Ground Gecko		Secure; Endemic		LC	

Chondrodactylus (Pachydactylus) turneri	Turner's Thick-toed Gecko		Secure		LC
Pachydactylus rugosus rugosus	Rough Thick-toed Gecko		Secure; Endemic		LC
Pachydactylus rangei	Web-footed Gecko	√	Secure; Endemic	P	LC
Ptenopus garrulous maculatus	Common Barking Gecko	√	Secure		
Ptenopus kochi	Koch's Barking Gecko		Secure; Endemic		LC

Namibian conservation and legal status according to the Nature Conservation Ordinance No 4 of 1975 (Griffin 2003)
Endemic – includes Southern African Status (Branch 1998)
South African Red Data Book (SARDB) (2004): V – Vulnerable; P – Peripheral
International Union for the Conservation of Nature and Natural Resources (IUCN) (2022): V – Vulnerable; LC – Least Concern
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Appendix 1 or 2 species
√# = Personal communication with Jaques Delport
√* = Observed further inland – i.e. stable sand dunes

Source for literature review: Alexander and Marais (2007), Branch (1998), Branch (2008), Bonin *et al.* (2006), Boycott and Bourquin 2000, Broadley (1983), Buys and Buys (1983), Cunningham (2006), Griffin (1998a), Griffin (2003), Hebbard (n.d.), IUCN (2022), Marais (1992), SARDB (2004), Schleicher (2020), Tolley and Burger (2007)

Figure 2. Namib sand snake (*Psammophis leightoni namibensis*) remains found to the east of the development area in the dune area.

Figure 3. The endemic and nocturnal Péringuey's adder (*Bitis peringueyi*) were located in coastal dune hummock areas.

Figure 4. The endemic and nocturnal web-footed gecko (*Pachydactylus rangei*) located on sandy substrate in the coastal dune hummock areas.

Figure 5. The endemic and diurnal wedge-snouted desert lizard (*Meroles cuneirostris*) was the most commonly encountered species in the area.

Figure 6. Common barking gecko (*Ptenopus garrulous maculates*) were located in sandy areas with sparse vegetation.

Figure 7. Typical horned adder (*Bitis caudalis*) tracks were observed in well vegetated dune hummock areas.

However, none of the important reptile species are exclusively associated with the proposed development areas while the proposed low impact developments are not expected to detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

Lodge impact

The impact during construction of lodge infrastructures is expected to be detrimental to reptiles associated with the affected area/habitat. This would affect a relatively small area (~2ha) over a short/limited period of time.

The impact of lodge infrastructures is not expected to be detrimental to reptiles – i.e. would not impede their movement, etc.

Pipeline impact
The impact during excavation of a trench to bury the proposed HDPE (50mm) water pipeline is expected to be detrimental to reptiles associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

However, an open trench could act as a pitfall trap and should not be left open overnight and/or have regular exists along its route, especially at the two ends of the trench.

The impact of below ground pipeline infrastructure is not expected to be detrimental to reptiles – i.e. would not impede their movement, etc.

Wind turbine impact
The impact during construction of wind turbine infrastructures is expected to be detrimental to reptiles associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

The impact of wind turbine infrastructures is not expected to be detrimental to reptiles – i.e. would not impede their movement, etc.

4.2 Amphibian Diversity

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

The dry sandy coastal desert (Namib) and saline coastal areas are poor habitat for amphibians (Cunningham and Jankowitz 2010). Although the ephemeral Kuiseb River occasionally reaches the sea in the Walvis Bay area, it seldom flows with temporary freshwater pools being rare close to the coast. The ephemeral Tsondab and Tsauchab Rivers, located towards the east of the general Meob Bay area, do not reach the coast and end as pans inland although fresh water does percolate through the sand dune barrier with seeps located along the coast or as shallow water bodies just beneath the soil behind the coastal dune hummocks (Jacobson *et al.* 1995). Other water bodies in the area (e.g. extensive coastal pan system between Meob and Conception Bay) are generally saline of nature and not suitable habitat for amphibians. Overall, the saline coastal habitats are marginal for amphibians.

According to Mendelsohn *et al.* (2002), the overall frog diversity in the general area is estimated at 0 species. Griffin (1998b) puts the species richness in the general area between 0-1species.

According to the literature review, up to 3 species of amphibians can occur in suitable habitat in the general area. The area is under-represented, with 1 species each for rubber, sand frog and platanna known and/or expected (i.e. potentially could be found in the area) to occur in the area.

One species (33%) – *Phrynomantis annectens*– is classified as endemic to Namibia (Griffin 1998b) while all 3 species are classified as "least concern" by the IUCN (2022) (Table 2).

Table 2. Amphibian diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International Status: IUCN
Rubber Frog				
Phrynomantis annectens	Marbled Rubber Frog		Endemic	LC
Bull and Sand Frog				
Tomopterna tandyi	Tandy's Sand Frog			LC
Platannas				
Xenopus laevis	Common Platanna			LC

IUCN (2022): LC – Least Concern

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

The area is extremely marginal with very little rainfall (<50mm annual average) generally occurring in the area and being highly variable (>100% coefficient of variation) and sporadic of nature (Mendelsohn *et al.* 2022). The lack of open surface water; no inland connectivity of drainage lines and saline coastal conditions, result in a lack of suitable amphibian habitat in the general area and make the area marginal for amphibians. Even artificial water points at Fishersbrunn and isolated wells are deemed marginal habitat (Figures 8 and 9).
The endemic species expected to occur throughout the general area and viewed as the most important is *Phrynomantis annectens* (marbled rubber frog), although probably does not occur in the area. The desert rain frog (*Breviceps macrops*) classified as "near threatened" by the IUCN (2022) and known to occur in the Lüderitz area and southwards into South Africa, is a species that potentially could survive in the general Meob Bay area although have not yet been located here and probably blocked from the area by the sand sea reaching the coast at places such as Langer Wand between Meob Bay and Lüderitz. Walmsley (n.d.) indicates that *B. macrops* may occur in the Meob-Conception Bay area although not yet confirmed.

However, none of the important amphibian species, including *B. macrops* (should it occur in the area), are exclusively associated with the proposed development areas while the proposed low impact developments are not expected to detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

Figure 8. Open surface water, albeit excavated by humans in the Fishersbrunn area, are utilised by a variety of bird and mammal species.

Figure 9. Well in the Meob Bay Tourism Development area (See arrow).

Lodge impact

The impact during construction of lodge infrastructures is expected to be detrimental to amphibians associated with the affected area/habitat. This would affect a relatively small area (~2ha) over a short/limited period of time.

The impact of lodge infrastructures is not expected to be detrimental to amphibians – i.e. would not impede their movement, etc.

Pipeline impact

The impact during excavation of a trench to bury the proposed HDPE (50mm) water pipeline is expected to be detrimental to reptiles associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

The impact of below ground pipeline infrastructure is not expected to be detrimental to amphibians – i.e. would not impede their movement, etc.

Wind turbine impact
The impact during construction of wind turbine infrastructures is expected to be detrimental to amphibians associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

The impact of wind turbine infrastructures is not expected to be detrimental to amphibians – i.e. would not impede their movement, etc.

4.3 Mammal Diversity

Namibia is well endowed with mammal diversity with at least 250 species occurring in the country. These include the well known big and hairy as well as a legion of smaller and lesser-known species. Currently 14 mammal species are considered endemic to Namibia of which 11 species are rodents and small carnivores of which very little is known. Most endemic mammals are associated with the Namib and escarpment with 60% of these rock-dwelling (Griffin 1998c). According to Griffin (1998c) the endemic mammal fauna is best characterized by the endemic rodent family *Petromuridae* (Dassie rat) and the rodent genera *Gerbillurus* and *Petromyscus*. Mammals are generally not well represented in the saline pan areas found along the Namibian coast (Cunningham and Jankowitz 2010).

The overall mammal diversity in the general area is estimated at between 9-15 species with 1-2 species being endemic to the area (Mendelsohn *et al.* 2022). Griffin (1998c) puts the species richness distribution of endemics also between 1-2 species in the general area while the Namib-Naukluft Park, of which the coastal area forms part of, is expected to have up to 80 species of mammals. Walmsley (n.d.) indicates that gemsbok, brown hyena, black-backed jackal, golden mole, gerbils and mice (not identified to species level) occur in the Meob-Conception Bay area.

According to the literature at least 35 species of mammals are known and/or expected to occur in the general area of which 2 species – sub Antarctic fur seal and elephant seal – are rare vagrants to the area. Five species (14.3%) are classified as endemic; 1 rare; 3 vulnerable; 3 protected game; 4 insufficiently known; 3 peripherals; 1 problem animal; 2 huntable game and 2 species not listed. The majority of mammalian species expected to occur in the general area are bats and rats/mice – 12 and 8 species each (i.e. 34.3% and 22.9% each) of which 1 bat – *Cistugo seabrai* (8%) – is viewed as endemic and "rare" and 4 rats/mice are classified as endemic (50%), respectively. *Eremitalpa granti*, *Macroscelides proboscideus flavicaudalis*, *Cistugo seabrai, Gerbillurus paeba infernus*, *Gerbillurus tytonis* and *Petromyscus collinus* are classified as endemic species.

Twelve species (34.3%) have some form of international conservation status of which 1 species – brown hyena – is classified as "near threatened" by the IUCN (2022); 9 species are listed by the SARDB (6 near threatened, 1 endangered and 2 vulnerable) and another 4 species listed as CITES Appendix II species [some species have more than one listing].

The most important species from the general area are probably all those classified as endemic, "rare" (Namibian wing-gland bat – 2 other rare species are marine mammals), and "vulnerable" (i.e. brown hyena, African wild cat and Cape fox) by Namibian legislation. Other important species are those classified internationally by the IUCN (2022) and SARDB (2004) as "near threatened" (i.e. brown hyena – IUCN; Cape horseshoe bat, Darling's horseshoe bat, Natal long-fingered bat, Littledale's whistling rat, brown hyena, spotted hyena) (See Table 3).The carnivores *Hyaena brunnea* (brown hyena) and *Felis silvestris* (African wild cat) are shy and elusive species and tend to avoid disturbed areas. *H. brunnea* are nowhere common throughout their range while *F. silvestris* furthermore faces genetic pollution issues with feral cats close to human settlements.

Table 3. Mammal diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International Status		
				SARDB	IUCN	CITES
Moles						
Eremitalpa granti	Grant's Golden Mole	√	Endemic; Secure	V	LC	
Elephant Shrews						
Macroscelides proboscideus	Round-eared Elephant-shrew		Endemic; Secure		LC	
Bats						
Lissonycteris angolensis	*Angolan Soft-furred Fruit Bat		Not listed		LC	
Tadarida aegyptiaca	Egyptian Free-tailed Bat		Secure		LC	
Cistugo seabrae	Namibian Wing-gland Bat		Endemic; Rare	V	LC	
Nycteris thebaica	Common Slit-faced Bat		Secure		LC	
Rhinilophus darlingi	Darling's Horseshoe Bat		Secure	NT		
Rhinolophus capensis	*Cape Horseshoe Bat		Secure	NT	LC	
Taphozous mauritianus	*Mauritanian Tomb Bat		Secure		LC	
Chaerephon ansorgei	*Ansorge's Free-tailed Bat		Not listed		LC	
Miniopterus natalensis	Natal Long-fingered Bat		Secure	NT	LC	
Eptesicus hottentotus	Long-tailed Serotine		Secure		LC	
Neoromicia zuluensis	*Zulu Serotine		Secure		LC	
Pipistrellus rueppellii	*Rüppell's Pipistrelle		Insufficiently known; Peripheral		LC	
Hares and Rabbits						
Lepus capensis	Cape Hare	√	Secure			
Rodents					LC	
Rats and Mice						
Parotomys littledalei namibensis	Littledale's Whistling Rat		Endemic; Secure	NT	LC	
Rhabdomys pumilio	Striped Mouse	√	Secure		LC	
Aethomys chrysophilus	Red Veld Rat		Secure		LC	
Micaelamys (Aethomys) namaquensis	Namaqua Rock Mouse		Secure		LC	
Desmodillus auricularis	Short-tailed Gerbil		Secure		LC	
Gerbillurus paeba	Hairy-footed Gerbil		Endemic; Insufficiently known		LC	
Gerbillurus tytonis	Dune Hairy-footed Gerbil	√	Endemic; Secure		LC	
Petromyscus collinus	Pygmy Rock Mouse		Endemic; Secure		LC	
Carnivores						

Parahyaena (Hyaena) brunnea	Brown Hyena	√#	Insufficiently known; Vulnerable?; Peripheral	NT	NT	
Crocuta crocuta	Spotted Hyena		Secure?; Peripheral	NT	LC	
Felis silvestris	African Wild Cat	√#	Vulnerable		LC	C2
Vulpes chama	Cape Fox	√Δ	Vulnerable?		LC	
Canis mesomelas	Black-backed Jackal	√	Secure;Problem animal		LC	
Ictonyx striatus	Striped Polecat		Secure		LC	
Antelopes						
Sylvicapra grimmia	Common Duiker		Secure		LC	
Antidorcas marsupialis	Springbok		Secure; Huntable game		LC	
Oryx gazella	Gemsbok	√	Secure; Huntable game		LC	
Seals						
Arctocephalus pusillus	South African Fur Seal	√*	Secure		LC	C2
Arctocephalus tropicalis	Subantarctic Fur Seal		Rare	E	LC	C2
Mirounga leonina	Southern Elephant Seal		Rare		LC	C2

SARDB (2004): E – Endangered; V – Vulnerable; NT – Near Threatened
IUCN (2022): NT – Near Threatened; LC – Least Concern
CITES: Appendix 2 species
* Unconfirmed bat species although potentially could occur in area according to habitat modelling (Monadjem*et al.* 2010)
√# = Personal communication with Jaques Delport
√Δ = Personal communication with Piet van Wyk
√* = Observed further north – i.e. between Meob and Conception Bay

Source for literature review: De Graaff (1981), Estes (1995), Frost (2014), Griffin and Coetzee (2005), IUCN (2022), Joubert and Mostert (1975), Monadjem *et al.* (2010), Picker and Griffiths (2011), Skinner and Smithers (1990), Skinner and Chimimba (2005), Stander and Hanssen (2003) and Taylor (2000)

Habitat alteration and overutilization are the two primary processes threatening most mammals (Griffin 1998c) with species probably underrepresented in the above-mentioned Table 3 for the general area being the bats and rodents, as these groups have not been well documented from the arid coastal western part of Namibia. However, bats are not sedentary with the overall available coastal desert habitat not viewed as a preferred habitat in the area although places such as Sandwich Harbour area could be an important feeding ground not yet confirmed.

During the fieldwork 10 species were confirmed to occur in the general area although 1 species – South African fur seal – is a marine species observed between Meob and Conception Bay; 2 species – brown hyena and African wild cat – confirmed by Jaques Delport (pers. com.) and 1 species – Cape fox – confirmed by Piet van Wyk (pers. com.) albeit from the general area and not at the proposed coastal development sites (Table 3). The most important species confirmed in/around the proposed development sites would be the brown hyena, African wild cat and Cape fox. Examples of species encountered are presented in Figures 10-12.

Figure 10. Black-backed jackal (*Canis mesomelas*) is ubiquitous throughout the area.

Figure 11. Gemsbok (*Oryx gazella*) typically forage on tough halophytic (salt-loving) grasses such as *Cladoraphis cyperoides* and *Odyssea paucinervis*.

Figure 12. Cape hare (*Lepus capensis*) faeces (above) and tracks confirm their presence in the area.

Small mammal trapping resulted in a success rate of 40% (16/40 traps) over 2 nights at 2 sites – proposed lodge area (4/20 traps) and current tented camp site (12/20 traps). Only 1 species – dune hairy-footed gerbil (*Gerbillurus tytonis*) – was captured (Figures 13 and 14).

Figure 13. Sherman small mammal trap baited with peanut butter and oats used to trap rodents in the area.

Figure 14. A high density – 40% trap success – of dune hairy-footed gerbil (*Gerbillurus tytonis*) was confirmed from the area.

However, none of the important mammal species are exclusively associated with the proposed development areas while the proposed low impact developments are not expected to detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

Lodge impact
The impact during construction of lodge infrastructures is expected to be detrimental to mammals associated with the affected area/habitat. This would affect a relatively small area (~2ha) over a short/limited period of time.

The impact of lodge infrastructures is not expected to be detrimental to mammals – i.e. would not impede their movement, etc.

Pipeline impact
The impact during excavation of a trench to bury the proposed HDPE (50mm) water pipeline is expected to be detrimental to mammals associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

However, an open trench could act as a pitfall trap and should not be left open overnight and/or have regular exists along its route, especially at the two ends of the trench.

The impact of below ground pipeline infrastructure is not expected to be detrimental to mammals – i.e. would not impede their movement, etc. (See Cunningham et al. 2015 for impacts on mammals of aboveground pipeline infrastructures).

Wind turbine impact
The impact during construction of wind turbine infrastructures is expected to be detrimental to mammals associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

Bats suffer major mortalities at wind farms in the United States and Canada with recent research indicating that tree dwelling species and species migrating long distances are mostly affected. Bat mortalities fall into two general categories – i.e. proximate (collision with rotating blades and barotrauma) and ultimate (random collisions, coincidental collisions and attraction to turbines). Attraction to turbines suggests that bats may visit turbines out of

curiosity, misperception, potential feeding, roosting, flocking or mating opportunities (Cryan 2008, Cryan 2011, Cryan and Barclay 2009, Cryan et al. 2012).

As this technology is new to Namibia, long term monitoring and formal studies once the wind turbine is in place, are imperative to determine which species would be affected most and how species would be affected. However, as this is an individual small turbine (and not a wind farm development with numerous large turbines, etc.) to support a generator system, it is not expected to affect bats in the way the typical wind farms do.

The impact of wind turbine infrastructures is not expected to be detrimental to mammals – i.e. would not impede their movement, etc.

4.4 Avian Diversity

Although Namibia's avifauna is comparatively sparse compared to the high rainfall equatorial areas elsewhere in Africa, approximately 658 species have already been recorded with a diverse and unique group of arid endemics (Maclean 1985). Fourteen species of birds are endemic or near endemic to Namibia with the majority of Namibian endemics occurring in the savannas (30%) of which ten species occur in a north-south belt of dry savannah in central Namibia (Brown *et al.* 1998). The combination of nutrient rich ocean waters, tidal shoreline and coastal wetlands along the Namibian coast provides a habitat and feeding ground for many species of seabird's and waders that congregate in very large numbers at certain times of the year (Lowery 2001). Bird diversity is viewed as low in the general area with between 1-50 species (this would include migrant species) and at least 1-3 endemic species expected (Mendelsohn *et al.* 2022). Walmsley (n.d.) indicates that the bird diversity is relatively low due to the aridity and low biomass production in the Meob-Conception Bay area although the salt flats attract large flocks of sea birds and waders during the summer months.

According to the literature review, at least 51 species of terrestrial ["breeding residents"] birds occur and/or could occur in the general area at any time (Hockey *et al.* 2006, Maclean 1985, Tarboton 2001). Although many of the species mentioned in Table 4 do not occur permanently in the general area, environmental conditions such as "berg winds" ("East weather" – local vernacular) often brings unexpected avian guests to the coastal areas although these are not resident all year (e.g. Lüdwig's bustard, lappet-faced vulture, etc. – Pers obs). All the migrant species (the Namibian coastal areas are world renowned for its Palaearctic migrants) have been excluded here, although the various bays along the coast (e.g. Meob, Conception, Sandwich, etc.) serve as important feeding grounds for a variety of mainly aquatic species.

Four of the 14 Namibian endemics (Rűppell's korhaan, Damara tern, dune lark and Gray's lark) are expected to occur in the general area (28.6% of all Namibian endemic species or 7.8% of all the species expected to occur in the area) (Hockey *et al.* 2006). However, Simmons *et al.* (2015) indicate that only 3 endemics – Rűppels korhaan, dune and gray's larks – are expected to occur in the general area while Damara tern is viewed as a near endemic species. Furthermore, 1 species are classified as "critically endangered" (Cape gannet), 4 species as "endangered" Lüdwig's bustard, bank cormorant, Cape cormorant, African penguin), 6 species as "vulnerable" (Hartlaub's gull, Caspian tern, lappet-faced vulture, greater flamingo, lesser flamingo's, great white pelican), 4 species is also classified as "near threatened" (African black oystercatcher, Damara tern, black-necked grebe, crowned cormorant) (Simmons *et al.* 2015) while no species are viewed as potentially "invasive alien" species (Picker and Griffiths 2011). The IUCN (2022) classifies 6 species as "endangered" (Lüdwig's bustard, lappet-faced vulture, Cape gannet, bank cormorant, Cape cormorant, African penguin) and 1 species as "near threatened" (lesser flamingo).

Other conservation important birds not included in Table 4 as they are not expected to be permanently associated with the area although potentially may pass through the general area are:

- Moccoa duck (NT);
- Eurasian curlew (NT);
- Chestnut-banded plover (NT);
- African marsh-harrier (E); and
- Black harrier (E).

The Namibian coastal wetlands are very important with Walvis Bay viewed as the most important coastal wetland in southern Africa attracting between 80,000 (winter) and 250,000 (summer) individual birds of 40-50 species in some places (Shaw *et al.* 2004). This wetland is considered the most important coastal wetland in southern Africa and one of the top 3 in Africa (Bethune *et al.* 2007) and supports mainly Palaearctic migrants, often comprising up to 88% of the birds – e.g. up to 1% of the global chestnut-banded plover (approximately 2,000 individuals) are expected to occur in the Walvis Bay area (Whitelaw *et al.* 1978). Between 70,000 and 100,000 birds in winter and up to 250,000 in spring are supported by the wetland (Bethune *et al.* 2007). The Namib coast is especially important for 8 species and in terms of global populations it supports >90% of the world's chestnut-banded plovers (*Charadrius pallidus*); 31% of Cape teals (*Anas capensis*); and 26% of African black oystercatchers (*Haematopus moquini*). In terms of African endemic races it supports: >90% of theblack-necked grebe (*Podiceps nigricollis gurneyi*); and 33% of the white-fronted plover (*Charadrius m*. *marginatus*); and in terms of southern African sub-continental population's it supports 31% of pied avocets (*Recurvirosta avocetta*), 13.7% of greater flamingos (*Phoenicopterus roseus*) and 10.3% of lesser flamingos (*Phoenicopterus minor*) (Williams and Simmons 2008a). Furthermore, up to 200,000 Holarctic shorebirds are supported seasonally along the Namibian coast belonging largely to 12 annually occurring species, of which 5 species occur in numbers that form a significant proportion of the southern African flyway populations – e.g. curlew sandpiper (*Calidris ferruginea* 35%); sanderling (*C*. *alba* 32%); ruddy turnstone (*Arenaria interpres* 17.5%); grey plover (*Pluvialis squatarola*7.8%) and red knot (*Calidris canutus* 1.6%) (Williams and Simmons 2008b). According to Simmons *et al.* (2015) 28 wetland bird species are of special concern in Namibia.

The Walvis Bay and Sandwich Harbour wetlands are also classified as Ramsar sites (i.e. Namibia is signatory to the Ramsar Convention protecting important wetland sites) as well as globally Important Birding Area (IBA's) (Simmons 1998a). The Namib-Naukluft Park is also viewed as an IBA of global status (Simmons 1998a). Coastal areas and wetlands are immensely important as 8 and 34 bird species are classified as Critically Endangered (CE), Endangered (E) or Vulnerable (V) in each of the biomes (i.e. Coastal areas and Wetlands), respectively (Simmons 1998a).

Table 4. Bird diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area. This table excludes migratory birds (e.g. petrel, albatross, skua, etc.) and species breeding extralimital (e.g. stints, sandpipers, etc.) and rather focuses on birds that are breeding residents or can be found in the area during any time of the year. This would imply that many more birds (e.g. Palaearctic migrants) could occur in the area depending on "favourable" environmental conditions.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International Status	
				Southern Africa	IUCN
Struthio camelus	Common Ostrich				
Streptopelia senegalensis	Laughing Dove				
Streptopelia capicola	CapeTurtle Dove	√			
Oena capensis	Namaqua Dove				
Neotis ludwigii	Ludwig's Bustard		E	N-end	E
Eupodotis rueppellii	Rűppells Korhaan		End	N-end	
Pterocles namaqua	Namaqua Sandgrouse				
Haematopus moquini	African Black Oystercatcher		NT	End	
Charadrius pecuarius	Kittlitz's Plover				
Charadrius marginatus	White-fronted Plover	√			
Larus dominicanus	Kelp Gull	√			
Larus cirrocephalus	Grey-headed Gull				
Larus hartlaubii	Hartlaub's Gull		V	End	
Sterna caspia	Caspian Tern		V		
Thalasseus (Sterna) bergii	Swift Tern				
Sternula (Sterna) balaenarum	Damara Tern		NT; End	End	
Aegypius tracheliotos	Lappet-faced Vulture		V		E
Circaetus pectoralis	Black-chested Snake-Eagle				
Melierax canorus	Southern Pale Chanting Goshawk			N-end	
Falco rupicolus	Rock Kestrel	√			
Falco rupicoloides	Greater Kestrel	√			
Podiceps nigricollis	Black-necked Grebe		NT		
Morus capensis	Cape Gannet		CE	End	E
Phalacrocorax coronatus	Crowned Cormorant		NT	End	
Phalacrocorax lucidus	White-breasted Cormorant				
Phalacrocorax neglectus	Bank Cormorant		E	End	E
Phalacrocorax capensis	Cape Cormorant	√	E	End	E
Ardea cinerea	Grey Heron				

Ardea melanocephala	Black-headed Heron				
Phoenicopterus ruber	Greater Flamingo	√	V		
Phoenicopterus minor	Lesser Flamingo		V		NT
Pelecanus onocrotalus	Great White Pelican		V		
Spheniscus demersus	African Penguin		E	End	E
Dicrurus adsimilis	Fork-tailed Drongo	√			
Corvus capensis	Cape Crow	√			
Corvus albus	Pied Crow	√			
Lanius collaris	Common Fiscal	√			
Pycnonotus nigricans	African Red-eyed Bulbul	√		N-end	
Parisoma subcaeruleum	Chestnut-vented Tit-Babbler				
Calendulauda erythrochlamys	Dune Lark	√	End	End	
Ammomanopsis grayi	Gray's Lark		End	N-end	
Certhilauda subcoronata	Karoo Long-billed Lark	√			
Eremopterix verticalis	Grey-backed Sparrowlark			N-end	
Calandrella cinerea	Red-capped Lark	√			
Cercomela schlegelii	Karoo Chat			N-end	
Cercomela tractrac	Tractrac Chat	√		N-end	
Cercomela familiaris	Familiar Chat				
Nectarinia fusca	Dusky Sunbird	√		N-end	
Passer melanurus	Cape Sparrow			N-end	
Motacilla capensis	Cape Wagtail	√			
Emberizaim petuani	Lark-like Bunting			N-end	

Namibian (Simmons *et al.* 2015): CE – Critically Endangered; E – Endangered; V – Vulnerable NT – Near Threatened
Southern African (Hockey *et al.* 2006): E – Endemic; N-end – Near Endemic
IUCN (2022): E – Endangered; NT – Near Threatened. All other species are classified as "least concern" and/or have not yet been assessed by the IUCN Red List.

Source for literature review: Brown *et al.* (1998), Hockey *et al.* (2006), IUCN (2022), Komen (n.d.), Little and Crowe (2011), Maclean (1985), Peacock (2015), Peacock (2016), Picker and Griffiths (2011), Simmons *et al.* (2015) and Tarboton (2001).

The latest winter (August 2018) bird counts at the Walvis Bay lagoon and Sandwich Harbour resulted in 80,729 (38 species) and 51,109 (31 species), respectively (Kolberg 2019). Winter counts typically result in fewer birds as this excludes most Palaearctic migrant species.

According to Swart *et al.* (2012), the extensive salt pans in the Meob-Conception Bay area provide a valuable stopover for migrating birds with bird counts in the Conception Bay area typically recording about 17,000 birds (25 species) and often include large numbers of terns (e.g. 13,000 common terns recorded in one July count).Other species recorded in significant numbers include Sandwich tern, Cape cormorant, kelp gull and greater flamingo while Damara terns breed in the salt flats. The importance of the salt flats for Palaearctic birds in the general Meob-Conception Bay area is confirmed by Walmsley (n.d.).

During the fieldwork 18 species were confirmed to occur in the general area with Cape turtle dove, Karoo long-billed lark and dusky sunbird not previously been recorded from the area. The most important species confirmed from the area was Cape cormorant ("endangered") and greater flamingo ("vulnerable") although these marine species were typically observed flying offshore and/or along the coast or basking with kelp gull on the sandy beaches (Figure 15).

A bird count conducted along a 9km stretch of coastline between the tented camp site and the Fishersbrunn turnoff from a vehicle travelling at a speed of 20km/h between 14h00 and 14h30, to indicate species typically observed in the area, resulted in the following:

- Cape cormorant = 3
- Cape crow = 2
- Cape wagtail = 10
- Kelp gull = 183
- Pied crow = 7
- White-fronted plover = 6

The low number of bird species observed throughout the proposed development area is probably due to the marginal nature of the entire area with a limited range of habitats; little surface water as well as a sandy beach along the coast. A greater variety of marine bird species were observed in the Meob and Conception Bay area's, towards the north of the proposed development area, indicating the importance of rocky coastal areas and the protected bays along the Namibian coast.

However, none of the important bird species are exclusively associated with the proposed development areas while the proposed low impact developments are not expected to detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

Figure 15. Kelp gull (adults and sub-adults) and Cape cormorants observed basking along the beach in the area.

Lodge impact
The impact during construction of lodge infrastructures is expected to be detrimental to birds associated with the affected area/habitat. This would affect a relatively small area (~2ha) over a short/limited period of time.

The impact of lodge infrastructures is not expected to be detrimental to birds – i.e. would not impede their movement, etc.

Pipeline impact
The impact during excavation of a trench to bury the proposed HDPE (50mm) water pipeline is expected to be detrimental to birds associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

The impact of below ground pipeline infrastructure is not expected to be detrimental to birds – i.e. would not impede their movement, etc.

Wind turbine impact
The impact during construction of wind turbine infrastructures is expected to be detrimental to birds associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

Birds, especially migratory aquatic species, are expected to be affected most by the proposed wind turbine. According to the RSPB (Royal Society for the Protection of Birds) wind farms can harm birds in three possible ways – disturbance, habitat loss or damage (both direct and indirect), and collision and if located away from major migration routes and important feeding, breeding and roosting areas of those bird species known or suspected to be at risk, there is a strong possibility that they will have minimal impact on wildlife (See: www.rspb.org.uk/ourwork/policy/windfarms). Placement of wind farms should avoid breeding grounds of especially vulnerable species (Pearce-Higgins et al. 2009, See: www.birdwatch.co.uk).

A number of scientific studies published in peer reviewed journals have been conducted on the effects wind farms have on birds with birds generally expected to be sensitive to wind farms, although effects vary between sites and species (e.g. Pearce-Higgens et al. 2009). The same authors furthermore indicate that the wind turbines are avoided more strongly than

the transmission lines related to these turbines, but conclude that wind farms should be avoided in areas with high densities of potentially vulnerable species. Species differ greatly in their sensitivity to wind turbines as found off the coast in the North Sea (Garthe and Hüppop 2004) and thus long-term monitoring of such a facility would be necessary locally to eventually determine which species are more prone to wind turbine collisions.

Bird abundance and mortality (mainly raptors) due to collision with wind turbines are not closely related – i.e. mortality is not highest in season with highest bird abundances (De Lukas et al. 2008). The authors concluded that vultures (Griffin) seemed to be greatest affected by the wind turbines and wind farms should avoid typical vulture habitat and that other than for species, turbine height and elevation above sea level result in more raptor mortalities. However, raptors are not common in the Meob Bay area and not expected to be affected.

Birds use vision to avoid wind turbines which may result in loss of habitat – i.e. some birds avoid wind farms and should these be located in favourable habitat it would consequently result in a loss of such habitat (Larson and Guillemette 2007).

Placement (i.e. away from bird breeding/roosting/foraging sites) and visibility of turbines – diurnal and nocturnal – is thus imperative to minimise bird collisions. As this technology is new to Namibia, long term monitoring and formal studies once the wind turbine is in place, are imperative to determine which species would be affected most and how species would be affected. However, as this is an individual small turbine (and not a wind farm development with numerous large turbines, etc.) to support a generator system, it is not expected to affect birds in the way the typical wind farms do.

The impact of wind turbine infrastructures is expected to be detrimental to birds – i.e. would impede their movement, etc.

4.5 Flora

4.5.1 Tree and Shrub Diversity

It is estimated that at least 14species of larger trees and shrubs (>1m) occur in the general area (Mannheimer and Curtis 2018) (Table 5).

Southern Namib
According to Giess (1971) the Southern Namib stretches from the Swakop River southwards until Lüderitz. *Stipagrostis sabulicola* (tough dune grass) occurs with *Trianthema hereroeensis* on the dunes while the inter-dune flats (streets) are covered with *Stipagrostis gonatostachys* after rains. The eastern inland sections – pro-Namib – are dominated by *Stipagrostis obtusa* and *S. ciliata* after rains while the plains closer towards the coast are dominated by *Mesembryanthemum cryptanthum* (Giess 1971). A common plant in the area is *Triathema hereroensis* which is known to be able to absorb fog-water through its leaves (Seely 2010). According to Walmsley (n.d.) there is very little vegetation in the Meob-Conception Bay area with some hummock vegetation associated with the shallow groundwater table in the Fishersbrunn and Reutersbrunn areas and consists of *Salsola nollothensis*, *Brownanthus namibensis*, *Amphibolia rupis-arcutae* and *Orthonna furcata*.

An interesting feature of the coastal areas is the extensive formation of gypsum crusts in the soil as a result of sulphur releases during upwelling events in the ocean in the past. These substrates support the most diverse lichen fields in the world (Burke 2003). Namibia has some of the rarest and most interesting species of lichens in the world although many have still not been officially described (Craven and Marais 1986).

Table 5 indicates the tree and shrub diversity known and/or expected to occur in the general area and are derived from Mannheimer and Curtis (2018). Species are known from the quarter-degree square distribution principle used and don't necessarily occur throughout the area.

Table 5. Tree and shrub diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area.

Species: Scientific name	Species confirmed	Namibian conservation and legal status	International status: IUCN
Vachellia (Acacia) erioloba		Protected (F)	LC
Acanthosicyos horridus		Protected (F); N-end	
Adenolobus pechuelii			LC
Capparis hereroensis	√	End	
Faidherbia albida		Protected (F)	LC
Gossypium anomalum			NT
Lycium cinereum			
Lycium hirsutum			
Lycium tetrandrum	√		
Pechuel-Loeschea leubnitziae			
Salsola nollothensis	√		
Salvadora persica			LC
Tamarix usneoides		Protected (F)	
Zygophyllum stapffii		End	

Endemic (Craven 1999)
F – Forest Act No. 12 of 2001
End; N-end – Endemic and Near-endemic (Mannheimer and Curtis 2018)
IUCN (2022): NT – Near Threatened; LC – Least Concern

Source for literature review: IUCN (2022), Mannheimer and Curtis (2018)

At least 14 species of trees/shrubs are expected to occur in the general area. Two species of trees and shrubs (14.3%) expected to occur in the area are classified as endemics, 1 species as near endemic (7.1%) and4 species (28.6%) are protected under the Forest Act No. 12 of 2001.

The most important species expected to occur in the area are *Acanthosicyos horridus* (Protected F; N-end) which could be considered one of Namibia's most characteristic plants (Seely 2010) and remains an important commodity to the local Topnaar people (Burke 2003) and *Capparis hereroensis* (End).

Loots (2005) lists at least 3 species of conservation concern – i.e. Red Data species – from the general Meob Bay area (although further south) of which 3 species are endemic and viewed as least concern (Table 6).

Table 6. Important species – i.e. Red Data spp. – known to occur in the general Meob Bay (inland) area according to Loots (2005).

Species: Scientific name	Conservation status
Brownanthus namibensis	End, LC
Eremothamnus marlothianus	End, LC
Pteronia spinulosa	End, LC

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

During the fieldwork only 3 species were confirmed to occur in the general area with the endemic *Capparis hereroensis* viewed as the most important species (Figure 16). The *Salsola nollothensis* coastal dune hummocks serve as an important habitat to a variety of vertebrate (and invertebrates); food for grazers (e.g. gemsbok) as well as stabilise dunes (Figure 17). The Namib coastal areas are not suitable habitat to larger tree/shrub species, especially those which cannot tolerate saline conditions, and which require much underground water and/or rainfall to survive.

Figure 16. Stands of the endemic *Capparis hereroensis* (See arrows) located in a saline depression in the general area.

Figure 17. *Salsola nollothensis* hummocks frequented by gemsbok (See tracks) throughout the area.

However, none of the important larger tree and shrub species is exclusively associated with the proposed development areas while the proposed low impact developments are not expected to detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

4.5.2 Grass Diversity

It is estimated that up to 29 grasses (4 to 23 species) – (Burke 2003a [5 spp.], Burke 2003b [6 spp.], Mannheimer *et al.* 2008 [5 spp.], Müller 2007 [4 spp.], Van Oudshoorn 2012 [23 spp.]) – potentially occur in the general area (Table 7).

Table 7. Grass diversity known and/or expected and confirmed during a rapid site assessment (√) from the general Meob BayTourism Development area. This is derived from [1]Müller (2007), [2]Van Oudtshoorn (2012), [3]Burke (2003a), [4]Burke (2003b), [5]Mannheimer *et al.* (2008).

Species: Scientific name	Species confirmed	Status	Ecological Status	Grazing Value
[2]*Anthephora pubescens*			Decreaser	High
[2]*Aristida congesta*			Increaser 2	Low
[2]*Brachiaria deflexa*			Increaser 2	Average
[2,4]*Cenchrus ciliaris*			Decreaser	High
[2,4,5]*Centropodia glauca*			Decreaser	High
[3,5]*Cladoraphis cyperoides*	√			
[2,3,5]*Cladoraphis spinosa*	√#		Increaser 1	Low
[1,2]*Cynodon dactylon*			Increaser 2	High
[2,4]*Enneapogon desvauxii*			Intermediate	Average
[2]*Enneapogon scaber*			?	Low
[2]*Enneapogon scoparius*			Increaser 3	Low
[1]*Eragrostis annnulata*			Increaser 2	Low
[2]*Eragrostis cilianensis*			Increaser 2	Low
[2,4]*Eragrostis nindensis*			Increaser 2	Average
[2]*Eragrostis rotifer*			?	Average
[2]*Fingerhuthia africana*			Decreaser	Average
[1]*Odyssea paucinervis*	√		?	Low
[2]*Phragmites australis*	√		Decreaser	Low
[2]*Polypogon monspeliensis*		Alien		
[2]*Schmidtia kalahariensis*			Increaser 2	Low
[2]*Setaria verticillata*			Increaser 2	Average
[2]*Sporobolus festivus*			Increaser 2	Low
[2,3,4]*Stipagrostis ciliata*			Decreaser	High
[3,5]*Stipagrostis geminifolia*		[5]N-end	?	High
[3,4,5]*Stipagrostis sabulicola*	√#	[4,5]End	?	Low
[2]*Stipagrostis namaquensis*			Decreaser	High
[2]*Stipagrostis obtusa*			Increaser 2	Low
[1]*Tragus berteronianus*			Increaser 2	Low
[2]*Tricholaena monachne*			Increaser 2	Average

End– Endemic (Burke 2003a, Mannheimer *et al.* 2008)
N-end – Near endemic (Mannheimer *et al.* 2008)
? – Not classified in literature, but often similar to other species within the genus
√#– Observed towards the east on dunes and inter-dune flats on route between Farm Kanaan and the coastal area.

Source for literature review: Burke (2003a), Burke (2003b), Mannheimer *et al.* (2008), Müller (2007), Van Oudtshoorn (2012)

Up to 29 grasses are expected in the general area. Of these, 1 species is alien, 1 species endemic (*Stipagrostis sabulicola*) and 1 species near endemic (*Stipagrostis geminifolia*). Burke (2003) describes *Stipagrostis sabulicolia* as a "true Namib endemic" which only occurs in the dune fields of the Namib Desert and although viewed as the most important species in the general area, it occurs widespread in the dune areas. None of the grasses mentioned in

Table 6 are exclusively associated with the general area and generally not viewed as very important.

During the fieldwork only 3 species were confirmed to occur in the general area while 2 more species were observed further east behind the true mobile coastal dune belt (Table 6). Extensive patches of the salt-loving *Odyssea paucinervis* occurs in saline depressions east of the proposed lodge development area, together with the reed *Phragmites australis*, all heavily utilised by gemsbok and Cape hare. Extensive patches of the sedge-like *Cladoraphis cyperoides* occurs around Fishersbrunn and the tented campsites (Figures 18-20).

The Namib coastal areas are not suitable habitat to grass species, especially those which cannot tolerate saline conditions, and which require much underground water and/or rainfall to survive. However, although grasses are typically not viewed as an important component of the vegetation along saline coastal areas, its soil stabilisation effect; habitat to a variety of vertebrates (and invertebrates); overall lack of vegetation including fact that the vegetation is extensively utilised by gemsbok and Cape hare makes it important.

Figure 18. Lawns of the salt-loving *Odyssea paucinervis*, found in saline depressions throughout the area, are well utilised by grazers – e.g. gemsbok.

Figure 19. The reed *Phragmites australis* found together with *Odyssea paucinervis* in the general area. In most cases *P. australis* has been grazed down to a well manicured lawn by gemsbok.

Figure 20. The sedge-like *Cladoraphis cyperoides* is associated with shallow underground water as in the Fishersbrunn area where it dominates the terrain.

All the vegetation confirmed at the proposed development areas is indicated in Table 8. The vegetation towards the east of the mobile dune belt– i.e. along access route from Farm Kanaan – and north towards Walvis Bay, is also included. However, the focus was on the proposed development areas with more species known/expected to be associated with the access routes.

Table 8. Vegetation confirmed at each proposed development site in the general Meob Bay Tourism Development area.

Species: Scientific name	Camp Site 1	Camp Site 2	Lodge area	Staff accommodation	Fishersbrunn area	Access route: East	Access route: North
Acacia erioloba						√	
Acanthosicyos horridus							√
Cladoraphis cyperoides	√	√	√	√	√	√	√
Cladoraphis spinosa						√	
Capparis hereroensis			√		√		√
Lycium tetrandrum			√	√	√	√	√
Odyssea paucinervis			√	√			√
Phragmites australis			√	√			√
Salsola nollothensis	√	√	√	√	√		√
Stipagrostis sabulicola						√	√
Triathema hereroensis						√	√
Tamarix usneoides							√

Camp Site 1 – Kommetjie camp site (southern site); Camp Site 2 – Main camp site; Lodge area – Proposed lodge area; Staff accommodation – located approximately 600m east of lodge area; Access route: East – Eastern access route from Farm Kanaan; Access route: North – Northern access route from Walvis Bay

However, none of the important grass species are exclusively associated with the proposed development areas while the proposed low impact developments are not expected to

detrimentally affect these species significantly, especially if the proposed mitigations are incorporated and adhered to.

Lodge impact
The impact during construction, are not expected to be detrimental to larger trees/shrubs and grasses associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

Pipeline impact
The impact during excavation of a trench to bury the proposed HDPE (50mm) water pipeline are not expected to be detrimental to larger trees/shrubs and grasses associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

Wind turbine impact
The impact during construction of wind turbine infrastructures are not expected to be detrimental to larger trees/shrubs and grasses associated with the affected area/habitat. This would affect a relatively small area over a short/limited period of time.

4.5.3 Other species

Aloes
Aloes are protected throughout Namibia (See Nature Conservation Ordinance No. 4 of 1975) and although the coastal western areas are not favourable habitat for most aloes,1 species – *Aloe namibensis* – occurs in the general area although most often associated with rocky terrain further inland (Rothmann 2004). No Aloe species were observed during the fieldwork and none expected to occur in the proposed development areas.

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

Ferns
At least 64 species of ferns, of which 13 species are endemic, occur throughout Namibia. Ferns in the general area include at least 3 indigenous species (*Cheilanthes inaequalis*, *C. dinteri* and *Ophioglossum polyphyllum*) (Crouch *et al.* 2011) although probably found further inland associated with rocky terrain. Although the proposed development areas are marginal habitat for ferns, the general area is undercollected with more species probably occurring than presented above. No fern species were observed during the fieldwork and none expected to occur in the proposed development areas.

Hoodia
Ten species of *Hoodia* occur in Namibia and although none are threatened with extinction, overharvesting of some species is a concern (Anon n.d.). No *Hoodia* species were observed during the fieldwork and none expected to occur in the proposed development areas.

Lichens
The overall diversity of lichens is poorly known from Namibia, especially the coastal areas and statistics on endemicity is even sparser (Craven 1998). To indicate how poorly known lichens are from Namibia, the recent publication by Schultz *et al.* (2009) indicating that 37 of the 39 lichen species collected during BIOTO surveys in the early/mid 2000's were new to science (i.e. new species), is a case in point. More than 120 species are expected to occur in the Namib Desert with the majority being uniquely related to the coastal fog belt (Wirth 2010). Lichen diversity is related to air humidity and generally decreases inland form the

Namibian coast (Schultz and Rambold 2007). Many lichens look similar are highly variable in appearance and notoriously difficult to identify unless with the use of a microscope (e.g. crustose lichens) or certain chemical tests.

Off road driving is the biggest threat to these lichens which are often rare and unique to Namibia. Lichens are important as the endemic Damara tern often uses these fields as a breeding ground (Craven and Marais 1986) and may even reveal life-saving antibiotics in future (Seely 2010).

Lichen diversity and abundance decreases from the sandy/gravel plains just south of the Swakop River to the sandy/gypsum plains north of the Kuiseb River east of the dune belt. The closest lichen hotspots includes a Crustose lichen zone east of the dune belt area while extensive patches of fruticose and foliose lichens occur in the Mile 8 and Wlotzkasbaken areas between Swakopmund and Henties Bay – i.e. far to the north and east of the proposed development areas.

Lichens are important pioneer plants that colonise bare desert habitats; slow growing; depend on moisture from coastal fog; prevent wind and water erosion by stabilising the soil; provide ecological niches for other flora and fauna; are an important food source for beetles and a range of larger animals from gerbils to springbok and are highly vulnerable to the impacts of off-road driving and mining (Swart *et al.* 2012).

At least 6 species of lichen were observed during the fieldwork in the general area and although difficult to confirm (See above) resemble the following species:

- *Teloschistes capensis*
- *Xanthodactylon flammeum*
- *Xanthodactylon turbinatum*
- *Xanthodactylon walteri*
- *Ramalina canariensis*
- *Ramalina fimbriata*

Figure 21. Most lichens observed were fruticose and attached to vegetation, often dead tufts of *Cladoraphis spinosa* or branches of *Lycium tetrandrum* – e.g. *Teloschistes capensis* (left) and *Xanthodactylon flammeum* (right).

However, identifying all the different species would require expert input and not part of the study. The importance of lichens should be recognised and areas (i.e. lichen fields) of high density and diversity avoided.

Lithops
All lithops species are protected (See Nature Conservation Ordinance No. 4 of 1975) and are known to occur in the general area and are often difficult to observe, especially during the dry season when their aboveground structures wither. Although the coastal areas are not viewed as suitable habitat for most Lithop species the following 2 species are known/expected to occur in the general Walvis Bay area (albeit further to the east behind the dune belt) – *Lithops gracilidelineata* subsp. *gracilidelineata* var. *gracilidelineata* and *L. g.* subsp. *gracilidelineata* var. *waldroniae*– and *L. optica* is known/expected from the Lüderitz area (Cole and Cole 2005, Earle and Round n.d.). No lithop species were observed during the fieldwork and none expected to occur in the proposed development areas.

!nara
The endemic and protected *Acanthosicyos horridus* (!nara) is an important commodity for the Topnaars living along the Kuiseb River. *A. horridus* occur towards the north in the Sandwich Harbour area – i.e. along the access route towards Walvis Bay – but not observed during the fieldwork in the proposed development areas.

5 Important Areas

Gravel & Gypsum plains
Gravel and gypsum plains, such as those between Conception Bay and Meob Bay, are fragile habitats that are easily damaged by vehicle tracks and other disturbances (Swart *et al.* 2012, Walmsley n.d.) (Figure 22).

Avoid off road driving on gravel and gypsum plains.

Salt pans
According to Swart *et al.* (2012) and Walmsley (n.d.), the extensive salt pans in the Meob-Conception Bay area provide a valuable summer stopover for migrating Palaearctic birds (Figure 22).

Avoid off road driving on salt pans.

Damara tern breeding sites
Gravel, and gypsum plains and salt pans are favoured breeding sites for Damara terns along the Namibian coast. These pan areas around Meob Bay are known breeding sites for a bird which could be viewed as a coastal Namibian flagship species with nests of between 1-18 (18-100 pairs), 14 (14-50 pairs) and 6-18 (0-10 pairs) confirmed from the Meob Bay, Conception Bay and Sandwich Harbour areas, respectively (Braby 2011). Furthermore, Damara terns prefer undisturbed areas as breeding sites (Braby *et al.* 2009) with off road driving viewed as one of the main causes of disturbance affecting their successful breeding throughout its range (Braby *et al.* 2009, Braby 2011) (Figure 22).

Avoid off road driving on gravel and gypsum plains and salt pans which could potentially be used by Damara terns for breeding.

Figure 22. Gravel/gypsum/salt pans which could serve as potential Damara tern breeding sites are indicated by the blue dotted line. The approximate location of Fishersbrunn (black star), proposed lodge (red star) and camp sites 1 and 2 (white and yellow stars) are also indicated.

Bird flyways

Although very little is known regarding bird flight paths in Namibia, especially species moving/migrating at night, most birds seem to follow the shortest routes between selected habitats – e.g. dams, estuaries, bays, etc. However, unpredictable rainfall events may lure species into areas not normally frequented – e.g. kori and Ludwig's bustards into the coastal areas – and storms (e.g. berg winds) may also force birds into areas not regularly visited. Planning for all eventualities is therefore not always possible. Walmsley (n.d.) indicates that the salt flats in the Meob-Conception Bay area are used as stopover by Palaearctic migrant birds.

Avifauna is expected to be potentially affected by the proposed new wind turbine to complement the provision of power at the proposed lodge area although this would depend on the design, location, size and height of the turbine blades. Although, none of the unique/important bird species are exclusively associated with the proposed development area, the effect of wind turbine infrastructure is expected to be detrimental to certain birds – e.g. "turbine sensitive species".

Birds expected to be negatively affected by wind turbine developments include:

- Birds flying at turbine height – e.g. bustards, swifts, sandgrouse, ravens, raptors and aquatic and marine species.
- Birds with nocturnal transients – e.g. Palaearctic migrants and wetland birds (i.e. coastal area).
- Birds following certain geological and/or landscape features (e.g. shoreline; rivers; mountain ranges, etc.) whilst foraging and/or migrating – e.g. aquatic/marine species and raptors.

- Birds attracted to the area during rainfall events – e.g. bustards – and temporary water sources in ephemeral rivers/drainage lines – e.g. aquatic/marine species.

Although little is known regarding turbine sensitive bird species it is expected to be similar to birds affected by pylons/transmission lines elsewhere. Scott and Scott (n.d.) indicate a list of "pylon sensitive bird species" from Namibia.

Pylon sensitive bird species (See Scott and Scott n.d.) known/expected to occur in the general area include:

- Caspian tern;
- Chestnut-banded plover;
- Great crested grebe;
- Great white pelican;
- Greater flamingo;
- Lesser flamingo;
- Ludwig's bustard; and
- Maccoa duck.

The factors influencing collision risk for birds with wind turbines is expected to be similar to birds affected by pylons/transmission lines elsewhere as published by van Rooyen (2003).

Factors influencing collision risk

The following factors influence the collision risk for birds (See: van Rooyen 2003):

- Body size and flight behaviour – i.e. birds with a heavy body size and small wing surface are more prone to collisions;
- Flight height and habitat use – i.e. short distance, low altitude, frequency of overhead structures;
- Age (i.e. young birds more prone to collisions);
- Resident versus migratory birds (i.e. movement into unfamiliar terrain increases collisions);
- Weather (i.e. inclement weather increases collisions);
- Time of day (i.e. nocturnal movement increases collisions);
- Land use (i.e. cultivated areas attract birds); and
- Topography (i.e. mountains/rivers/shorelines act as corridors).

Species potentially affected by the proposed overhead wind turbine once operational and at greatest risk would be those larger species flying at turbine height (e.g. greater and lesser flamingos and great white pelican); nocturnal travellers (e.g. flamingos and Palaearctic species) and species potentially visiting the area for roosting/foraging, etc. (e.g. bustards). Although very little is known regarding the actual flight paths used by the birds frequenting the general area, Figures 23-24 indicate potential flight paths and Figure 25 indicate documented bird mortalities caused by transmission lines throughout Namibia. Bird mortalities caused by transmission lines are presented here to indicate that above ground infrastructures such as transmission lines (and probably wind turbines) are "hotspot" sites along coastal areas.

Reconsider wind turbine technology and/or ensure that the technology to be used would not affect birds negatively as this may contribute to bird mortalities in an otherwise pristine area.

Figure 23. Expected bird flight paths between Walvis Bay-Sandwich Harbour-Conception Bay-Meob Bay-St, Francis Bay-Lüderitz Bay (blackdashed arrows). The approximate location of the Meob bay Tourism Development Project is indicated by red star.

Figure 24. Greater flamingo observed following the coast, albeit offshore, from south to north in the proposed development area.

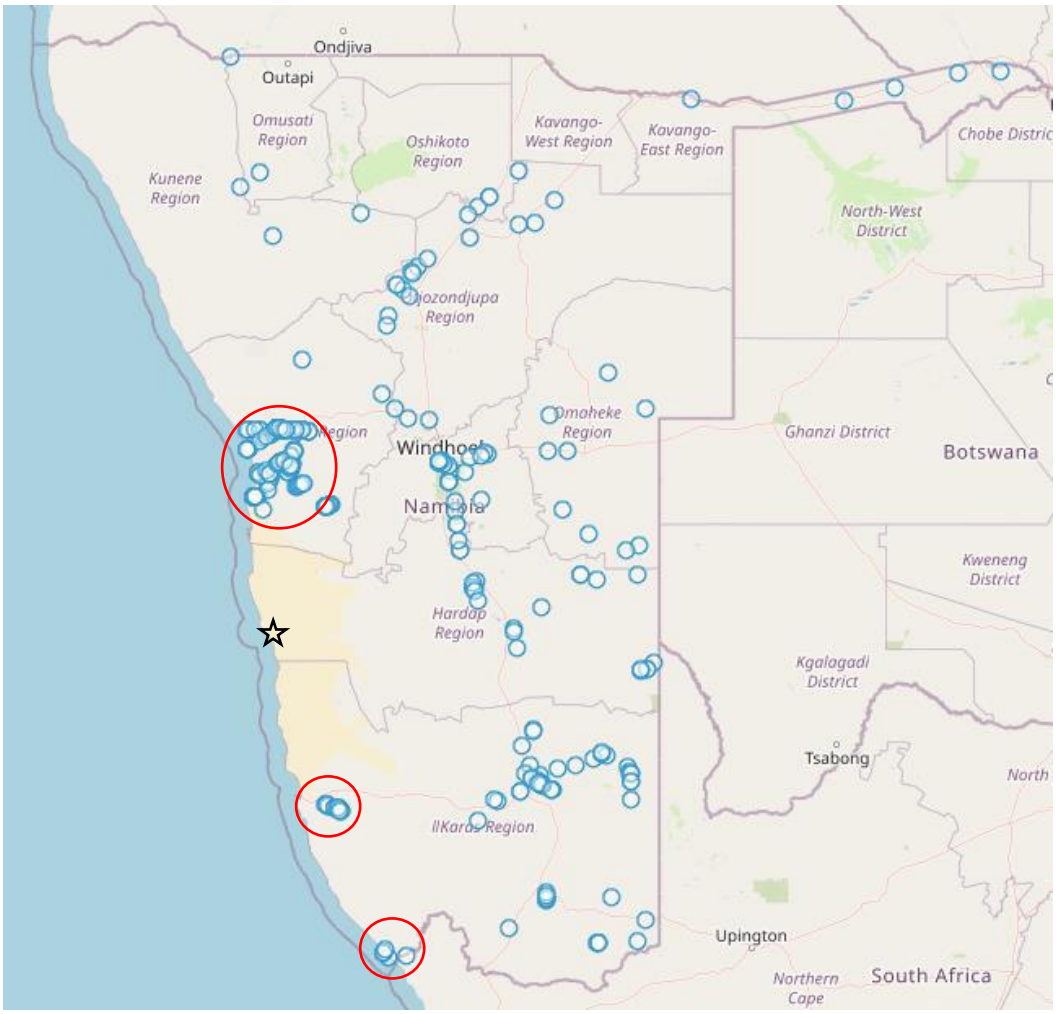

Figure 25. Known bird mortalities caused by transmission lines throughout Namibia (March 2021) are indicated by blue circles. The coastal general Walvis Bay, Lüderitz and Oranjemund areas – indicated by a red circles – are "hotspot" BIRD collision risk areas (Source: www.the-eis.com). The black star indicates the approximate position of the Meob Bay Lodge Development area.

Water sources

As water is extremely sparse along the coastal Namib Desert, all such areas are viewed as extremely important. Known water sources in the general area include Fishersbrunn and artificial wells at the various camp sites.

Avoid overexploiting and/or contaminating all water sources throughout the area as this will ultimately affect on the vegetation, especially the extensive stands of *Cladoraphis cyperoides* and *Odyssea paucinervis* which in turn provide habitat and serve as a source of food for a variety of vertebrates.

Vegetated dune hummocks

The dune hummocks, dominated by *Cladoraphis cyperoides* and *Salsola nollothensis*, are important as they stabilise the soil and serve as a source of food and habitat for a variety of vertebrate (and invertebrate) species. Another important plant with similar functions is the endemic and protected *Acanthosicyos horridus* (!nara) as it is important as a commodity for the Topnaars (living along the Kuiseb River) and serves as refuge and a source of food for various desert dwelling fauna.

Although there are no !Nara in the proposed development area, the northern access route from Walvis Bay passes patches of these plants in the Sandwich Harbour area and these should be avoided.

6 Impact Assessment

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

6.1 Faunal loss/disturbance

Habitat loss associated with various developments would be localised and dependant on the activities – i.e. some activities may have more impact than others. The following table summarises the potential/envisaged impacts expected to occur (faunal loss/disturbance is closely linked to habitat loss):

Table 9. Faunal loss expected to occur with the proposed Meob Bay Tourism Development activities.

Description	Faunal loss/disturbance will vary depending on the scale/intensity of the development operation and associated and inevitable infrastructure. The impacts would be contained and/or limited depending on the various proposed developments envisaged. Each development would have to be assessed individually to ascertain the scale of impact.
Extent	Localised disruption/destruction of the habitat and thus consequently flora associated directly with this habitat and the actual development sites. This however, would be limited to the development area with localised implications. Further developments – e.g. more lodges; tented camps; tracks/roads, etc. – throughout the area would however increase the extent of impact.
Duration	The duration of the impact is expected to be permanent over most of the proposed development sites once established. Most fauna species (especially species associated with the well vegetated dune hummocks – e.g. various reptiles and small mammals) are expected to re-colonise the areas not actually changed after completion of the development(s). Duration viewed as short-medium term. Disturbances to larger mammals (e.g. oryx, brown hyena, etc.), not viewed as sedentary and/or permanently associated with the area, would not be affected as severely as these species are not permanently associated with the area – i.e. duration viewed as short to medium term. This however, would be limited to the development area(s) with localised implications.

Intensity	The actual development site would be permanently altered with the intensity of faunal loss/disturbance depending on the species involved – e.g. slow moving and sedentary species will succumb to development while the more mobile species are expected to vacate the area. Implications are expected to be localised, depending on the scale of developments. The areas adjacent the development site should not be significantly affected. This, however, would depend on the proposed development, but should be limited to localised implications. Areas not directly affected by the development, although within the immediate vicinity, would be affected minimally. This would include increased vehicle movement, light, noise and other associated disturbances mainly associated with the construction and operational phase(s). The effect that aircraft may have on the fauna is difficult to determine beforehand although increased disturbance associated with increased activities are expected. As the Fishersbrunn runway is an existing runway with infrequent use, the impact is viewed as minimal as larger species would be accustomed to the disturbance. This would however be limited to the actual areas affected.
Mitigation	**Lodge area:** The envisaged development site is a sparsely vegetated dune area and with careful selection, design and placement of the chalets, the impact on the vertebrate fauna is expected to be minimal. **1.** Construct the chalets between the *Salsola nollothensis* and *Cladoraphis cyperoides* hummocks for least impact on vertebrate species favouring these areas (e.g. reptiles and small mammals) – i.e. do not destroy this habitat. Incorporating these hummocks into the lodge layout would furthermore contribute to the overall desert ambiance of the facility. **2.** Prevent and discourage indiscriminate killing of perceived dangerous species (e.g. snakes, etc.) as this would diminish and negatively affect the local fauna. No form of poaching, illegal collecting of veld foods (e.g. bird eggs, etc.), etc. should be tolerated, especially during the construction phase. **3.** Remove and relocate perceived dangerous species (e.g. snakes) to similar undisturbed habitats in the general area. **4.** Make use of existing tracks/roads as much as possible throughout the area. **5.** Implement and maintain track discipline limited to pre-determined tracks with maximum speed limits (e.g. 30km/h) as this would result in fewer faunal road mortalities and overall destruction of vegetated areas which serve as habitat to a variety of fauna. **6.** Avoid off road driving in areas prone to scarring (e.g. gravel/gypsum/salt plains/flats/pans). Nocturnal driving should also be avoided as this result in the destruction of slow-moving fauna – e.g. various reptiles and other nocturnal species. **7.** Rehabilitate all new tracks, construction site(s), temporary accommodation site(s), etc. **8.** Avoid and/or limit the use of lights during nocturnal activities as this influence and/or affects various nocturnal species – e.g. especially migrating

	Palaearctic birds, bats, owls, etc. and contribute to "light pollution". Use focused lighting for least effect. **9.** Use portable toilets to avoid faecal pollution during the construction phase(s). **10.** Invest is a suitable contained sewage system for the least impact on the environment and ensure that a risk strategy is in place to contain potential operational problems. **11.** Initiate a suitable and appropriate refuse removal policy as littering could result in certain animals becoming accustomed to humans and associated activity and result in typical problem animal scenarios – e.g. crows, black-backed jackal, brown hyena, various gulls, etc. **12.** Prevent using driftwood and other firewood sourced throughout the area, but rather source firewood from outside the Park, especially invasive alien species such as *Prosopis* spp. as this would show true local commitment to the environment. **13.** Prevent (do not allow) domestic pets – e.g. cats and dogs – accompanying, workers/staff/tourists as they cause considerable damage to the local fauna. Cats also interbreed and transmit diseases to the indigenous African wildcat found in the area while dogs could transmit canine diseases to brown hyena. The indiscriminate and wanton killing of the local fauna by such pets should be avoided at all cost. **14.** Reconsider a wind turbine for electricity generation as this may result in mortalities of birds, especially Palaearctic migratory species, and some bat species. This however would depend on the type of turbine; height; location, etc. Should this technology be required then long-term monitoring of bird (and bat) collision is imperative. **15.** Water abstraction would have to be conservative so as not to impact negatively on the groundwater recharge and consequently the associated vegetation which would affect vertebrate species dependent thereon. Monitoring of water levels and potential impacts on vegetation should be mandatory. **16.** Educate/inform contractors and staff on dangerous (e.g. snakes) and protected species (e.g. brown hyena) to avoid and the consequences of killing and/or illegal collection of such species. Liaise with MET to provide this service as the area is within the Namib-Naukluft Park and UNESCO World Heritage Site. **Camp sites:** **17.** As above. **Staff accommodation:** **18.** As above. **Fishersbrunn runway:** This is an existing runway situated towards the north of Fishersbrunn and no new infrastructure developments are envisaged. **19.** Although an existing runway, it is situated on gravel/gypsum plains which potentially could be used by Damara terns as a breeding site. As these terns are migratory and breed between September-March, a survey of the area should be conducted to determine if the area is utilised for breeding or not. This period would also be the high-risk period for the birds should they utilise

	the general area. **20.** Aviation fuel storage facilities (should this be necessary) should be contained and ensure that a risk strategy is in place to contain potential operational problems. **21.** All other aviation regulations (e.g. flight height, etc.) conducted over National Parks, etc. should be adhered to.
Frequency of occurrence	Expected to be "once off" and only affecting the selected site(s).
Probability	Definite (100%) negative impact on fauna – especially slow moving and/or sedentary species (e.g. reptiles) – is expected in the development areas. Highly Probable (75%) negative impact on fauna is expected in the general areas as a result of noise, increased activities, etc. Probable (50%) negative impact on fauna is expected from the infrastructure (roads/tracks). Precautionary principle (e.g. avoid important habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. vegetated dune hummock areas; gravel/gypsum plains, etc.) with associated fauna would bear the brunt of this proposed development but be limited in extent and only permanent at the actual development sites and access routes.
Legal requirements	Fauna related: Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN and SARDB Habitat – Flora related: Forest Act No.12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES
Degree of confidence in predictions	As an ecologist I am sure of the above-mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local fauna in the area.

6.2 Floral loss/disturbance

Habitat loss associated with various developments would be localised and dependant on the activities – i.e. some activities may have more impact than others. The following table summarises the potential/envisaged impacts expected to occur (floral loss/disturbance is closely linked to habitat loss):

Table 10. Floral loss expected to occur with the proposed Meob Bay Tourism Development activities.

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

	The impacts would be contained and/or limited depending on the various proposed developments envisaged. Each development would have to be assessed individually to ascertain the scale of impact.
Extent	Localised disruption/destruction of the habitat and thus consequently flora associated directly with this habitat and the actual development sites. This however, would be limited to the development area with localised implications. Further developments – e.g. more lodges; tented camps; tracks/roads, etc. – throughout the area would however increase the extent of impact.
Duration	The duration of the impact is expected to be permanent over most of the proposed development sites once established. Most flora species are expected to re-colonise the areas permanently altered after completion of the development(s). Duration viewed as short-medium term. This, however, would be limited to the development area(s) with localised implications.
Intensity	The actual development sites would be permanently altered with the intensity of floral loss depending on the species involved – e.g. slow growing species will be affected most. Implications are expected to be localised, depending on the scale of developments. The areas adjacent the development sites should not be significantly affected. This, however, would depend on the proposed development, but should be limited to localised implications. Areas not directly affected by the development, although within the immediate vicinity, would be affected minimally. The effect that a variety of developments may have on the flora is difficult to determine beforehand as this is dependent on the type of developments. This would however be limited to the actual areas affected.
Mitigation	**Lodge area:** The envisaged development site is a sparsely vegetated dune area and with careful selection, design and placement of the chalets, the impact on the flora is expected to be minimal. **1.** Construct the chalets between the *Salsola nollothensis* and *Cladoraphis cyperoides* hummocks for least impact on flora – i.e. do not destroy this habitat. Incorporating these hummocks into the lodge layout would furthermore contribute to the overall desert ambiance of the facility. **2.** Prevent and discourage illegal collection of flora (e.g. unique bulbs potentially occur in the area and only visible of periodic rain showers) as this would diminish and negatively affect the local flora. **3.** Make use of existing tracks/roads as much as possible throughout the area. **4.** Implement and maintain track discipline limited to pre-determined tracks with maximum speed limits (e.g. 30km/h) as this would result in less dust pollution and overall destruction of vegetated areas which serve as habitat to a variety of fauna.

	5. Avoid off road driving in areas prone to scarring (e.g. gravel/gypsum/salt plains/flats/pans) or dominated by lichens. **6.** Prevent the planting of potentially alien invasive plant species (e.g. *Tecoma stans*, *Pennisetum setaceum*, etc.) for ornamental purposes as part of the landscaping (e.g. around lodge, staff accommodation, etc.) should this be thought necessary. Alien species often "escape" and become invasive causing further ecological damage. **7.** Implement a policy of "no tolerance" towards any invasive alien plant species encountered in future in the area. This should include the removal and destruction of these species throughout the proposed development areas. Such activity would be beneficial to the overall ecology of the areas. **8.** Incorporate indigenous vegetation into the overall landscaping of the area (e.g. around lodge, staff accommodation, etc.). This would create a natural ambiance while indigenous species require less water and overall maintenance. **9.** Rehabilitation of the disturbed areas – i.e. initial development access route "scars" and associated tracks and other infrastructure developments. Such rehabilitation would not only confirm the company's environmental integrity, but also show true local commitment to the environment. **10.** Water abstraction would have to be conservative so as not to impact negatively on the groundwater recharge and consequently the associated vegetation which would affect vertebrate species dependent thereon. Monitoring of water levels and potential impacts on vegetation should be mandatory. **11.** Educate/inform contractors and staff on protected species to avoid and the consequences of illegal collection of such species. Liaise with MET to provide this service as the area is within the Namib-Naukluft Park and UNESCO World Heritage Site. **Camp sites:** **12.** As above. **Staff accommodation:** **13.** As above. **Fishersbrunn runway:** This is an existing runway situated towards the north of Fishersbrunn and no new infrastructure developments are envisaged. **14.** Although an existing runway, it is situated on gravel/gypsum plains which potentially could support lichens. These areas should then be avoided. **15.** Aviation fuel storage facilities (should this be necessary) should be contained and ensure that a risk strategy is in place to contain potential operational problems.
Frequency of occurrence	Expected to be a "once off" issue affecting the selected site(s).
Probability	Definite (100%) negative impact on flora is expected in the development areas as well as the access route construction sites. This however, would be much localised and cover limited areas. Highly Probable (75%) negative impact on flora is expected from the

	infrastructure (roads/tracks). Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. vegetated dune hummock areas, lichen fields, etc.) with associated flora would bear the brunt of this proposed development, but be limited in extent and only permanent at the actual development sites and access routes.
Legal requirements	Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES
Degree of confidence in predictions	As an ecologist I am sure of the above-mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local flora in the area.

6.3 Assessing Significance

Table 11 summarises the assessment of significance of potential/envisaged impacts expected to occur (i.e. loss/disturbance of vertebrate fauna; avifauna – wind turbine; flora) during the construction, operation and decommissioning phases of the proposed Meob Bay Tourism Development project.

Depending on the design, size, location, etc. the installing of a wind turbine to supplement electricity generation is the only activity that potentially could affect negatively on the environment – i.e. avifauna (especially Palaearctic migrant species).

The other proposed tourism development activities are viewed as medium/low impact (prior to mitigations being implemented), when using existing infrastructure (e.g. tracks/roads, campsite(s), etc.) and adhering to the mitigation measures.

Table 11. Significance table: construction, operation and decommissioning phases of the proposed Meob Bay Tourism Development project.

Project activity or issue	Potential impact	Nature of impact		Significance before mitigation							Significance after mitigation as per EMP						
		+ / -	D/I/C	M	R	D	S	P	TOTAL	SP	M	R	D	S	P	TOTAL	SP
Vertebrate Fauna																	
Construction	Loss/disturbance of vertebrate fauna	-	D	2	1	1	2	5	30	M	1	1	1	2	5	25	L
Operation	Loss/disturbance of vertebrate fauna	-	D	2	3	2	2	5	45	M	1	1	1	2	5	25	L
Decommissioning	Loss/disturbance of vertebrate fauna	-	D	1	1	1	1	5	20	L	1	1	1	1	1	5	L
Avifauna																	
Construction	Loss/disturbance of avifauna - wind turbine	-	D	2	1	1	2	5	30	M	1	1	1	1	5	20	L
Operation	Loss/disturbance of avifauna - wind turbine	-	D	2	3	4	5	5	70	H	1	1	1	1	5	20	L
Decommissioning	Loss/disturbance of avifauna - wind turbine	-	D	1	1	1	1	5	20	L	1	1	1	1	5	20	L
Flora																	
Construction	Loss/disturbance of flora	-	D	2	1	3	2	5	40	M	1	1	1	2	5	25	L
Operation	Loss/disturbance of flora	-	D	2	3	1	2	5	40	M	1	1	1	2	5	25	L
Decommissioning	Loss/disturbance of flora	-	D	1	1	1	1	5	20	L	1	1	1	1	5	20	L

7 Conclusion

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

Vertebrate fauna species most likely to be adversely affected by the proposed Meob Bay tourism developments – i.e. lodge, camp site(s), staff accommodation, pipeline, wind turbine, etc. – would be the unique species of reptiles (i.e. *Bitis peringueyi* and *Meroles* spp.) potentially occurring in the area, as reptiles are sedentary, slow moving and less mobile than mammals and birds. However, none are exclusively associated with the proposed development sites. Amphibians are not expected to be adversely affected by these developments due to the overall lack of suitable habitat throughout the general area. Mammals are more mobile and although important species are known to occur and/or pass through the area (see elsewhere in this report) none are expected to be specifically associated and/or expected to be negatively affected by the developments. Bird species, especially wind turbine sensitive species, are at greatest risk should a wind turbine be essential for electricity generation. Species at risk would be larger species flying at turbine height (e.g. greater and lesser flamingos and great white pelican); nocturnal travellers (e.g. flamingos and Palaearctic species) and species potentially visiting the area for roosting/foraging (e.g. bustards). Although very little is known regarding the actual flight paths used by the birds frequenting the general area, Figures 23 and 25 indicate potential flight paths and known collision risk sites. However, this would be dependent on the design, size, location, etc. of the wind turbine.

There are various anthropomorphic activities throughout the general area (e.g. historic mining infrastructure, existing tracks, etc.) and the proposed tourism development would have a small footprint and are not expected to affect any unique flora species negatively.

Important areas in the general vicinity are viewed as the gravel/gypsum/salt pans; Damara tern breeding sites/habitat; vegetated dune hummocks; water sources and bird flyways.

Swart *et al.* (2012) succinctly points out the following: “Any new developments in this sensitive area must be tightly monitored and controlled so as to minimise environmental impacts, and to ensure that the developments generate real value for the Hardap region in a sustainable way”.

It is not expected that the proposed Meob Bay Tourism Development Project would adversely affect any unique vertebrate fauna and flora, especially if the proposed recommendations (mitigation measures) are incorporated and adhered to.

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