

ECOLOGICAL FAUNA AND FLORA HABITAT SURVEY

**Proposed De Heus development, Middelburg, Eastern  
Cape Province, South Africa**



View of part of the site. Succulent in the picture is the alien invasive *Cyllindropuntia imbricata*.  
Photo: R.F. Terblanche.

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**COMPILED BY:**

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(M.Sc : Ecology, *Cum Laude*; Pr.Sci.Nat, Reg. No. 400244/05)

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## I) SPECIALIST EXPERTISE

### SYNOPTIC CV: REINIER. F. TERBLANCHE

Reinier is an ecologist and in particular a habitat specialist with an exceptional combination of botanical and zoological expertise which he keeps fostering, updating and improving. He is busy with a PhD for which he registered at the Department of Conservation Ecology at the University of Stellenbosch in July 2013. The PhD research focuses on the landscape ecology of selected terrestrial and wetland butterflies in South Africa. Reinier's experience includes being a lecturer in ecology and zoology at the North West University, Potchefstroom Campus (1998-2008). Reinier collaborates with a number of institutes, organizations and universities on animal, plant and habitat research.

Qualifications:

Qualification	Main subject matter	University
<b>M.Sc Cum Laude, 1998:</b> Botany: Ecology	Quantitative study of invertebrate assemblages and plant assemblages of rangelands in grasslands.	North-West University, Potchefstroom
<b>B.Sc Honns Cum Laude, 1992</b> Botany: Taxonomy	Distinctions in all subjects: Plant Anatomy, Taxonomy, Modern Systematics, System Modelling, Plant Ecology, Taxonomy Project. Also included: Statistics Attendance Course.	North-West University, Potchefstroom
<b>B.Sc</b> Botany, Zoology	Main subjects: Botany, Zoology.	North-West University, Potchefstroom
<b>Higher Education Diploma, 1990</b>	Numerous subjects aimed at holistic training of teachers.	North-West University, Potchefstroom

In research Reinier specializes in conservation biology, threatened butterfly species, vegetation dynamics and ant assemblages at terrestrial and wetland butterfly habitats as well as enhancing quantitative studies on butterflies of Africa. He has published extensively in the fields of taxonomy, biogeography and ecology in popular journals, peer-reviewed scientific journals and as co-author and co-editor of books (see 10 examples beneath).

Reinier practices as an ecological consultant and has been registered as a Professional Natural Scientist by SACNASP since 2005: Reg. No. 400244/05. His experience in consultation includes: Flora and fauna habitat surveys, Threatened species assessments, Riparian vegetation index surveys, Compilation of Ecological Management Plans, Biodiversity Action Plans and Status quo of biodiversity for Environmental Management Frameworks, Wetland Assessments, Management of Rare Wetland Species.

*Recent activities/ awards:* Best Poster Award at Oppenheimer De Beers Group Research Conference 2015, Johannesburg. One of the co-authors of Guidelines for Standardised Global Butterfly Monitoring, 2015, Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany (UNEP-WCMC), GEO BON Technical Series 1. Awarded the prestigious Torben Larsen Memorial Tankard in October 2017; one is awarded annually to the person responsible for the most outstanding written account on Afrotropical Lepidoptera. Lectured as Conservationist-in-Residence in the Wildlife Conservation Programme of the African Leadership University, Kigali, Rwanda, 9-23 February 2019. Reinier won a photographic competition which resulted his photograph of the Critically Endangered *Erikssonia edgei* (Waterberg Copper) being on the front cover of the Synthesis Report of the National Biodiversity Assessment (2018) prepared by SANBI. Reinier is a Research Fellow at the University of South Africa (Unisa) from 1 January 2020.

## EXPERIENCE

Lecturer: Zoology 1998-2008	Main subject matter and level	Organization
Lectured subjects	- <u>3<sup>rd</sup> year level</u> Ecology, Plantparasitology - <u>2<sup>nd</sup> year level</u> Ethology - <u>Master's degree</u> Evolutionary Ethology, Systematics in Practice, Morphology and Taxonomy of Insect Pests, Wetlands.	North-West University, Potchefstroom and University of South Africa
Co-promoter	PhD: Edge, D.A. 2005. Ecological factors that influence the survival of the Brenton Blue butterfly	North-West University, Potchefstroom
Study leader/ assistant study leader	Six MSc students, One BSc Honn student: Various quantitative biodiversity studies (terrestrial and aquatic).	North-West University, Potchefstroom
Teacher 1994-1998	Biology and Science, Secondary School	Afrikaans Hoër Seunskool, Pretoria
Owned Anthene Ecological CC 2008 – present	- Flora and Fauna habitat surveys - Highly specialized ecological surveys - Riparian vegetation index surveys - Ecological Management Plans - Biodiversity Action Plans - Biodiversity section of Environmental Management Frameworks - Wetland assessments	Private Closed Corporation that has been subcontracted by many companies
Herbarium assistant 1988-1991	- Part-time assistant at the A.P. Goossens herbarium, Botany Department, North-West University, 1988, 1989, 1990 and 1991 (as a student).	North-West University, Potchefstroom

## 10 EXAMPLES OF PUBLICATIONS OF WHICH R.F. TERBLANCHE IS AUTHOR/ CO-AUTHOR

(Three books, two chapters in books and five articles are listed here as examples)

- HENNING, G.A., TERBLANCHE, R.F. & BALL, J.B. (eds) 2009. *South African Red Data Book: butterflies*. SANBI Biodiversity Series 13. South African National Biodiversity Institute, Pretoria. 158p. ISBN 978-1-919976-51-8
- MECENERO, S., BALL, J.B., EDGE, D.A., HAMER, M.L., HENNING, G.A., KRÜGER, M., PRINGLE, E.L., TERBLANCHE, R.F. & WILLIAMS, M.C. (eds). 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and atlas*. Safronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- VAN SWAAY, C., REGAN, E., LING, M., BOZHINOVSKA, E., FERNANDEZ, M., MARINI-FILHO, O.J., HUERTAS, B., PHON, C.-K., KŐRÖSI, A., MEERMAN, J., PE'ER, G., UEHARA-PRADO, M., SÁFIÁN, S., SAM, L., SHUEY, J., TARON, D., TERBLANCHE, R.F. & UNDERHILL, L. 2015. Guidelines for Standardised Global Butterfly Monitoring. Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany. GEO BON Technical Series 1.
- TERBLANCHE, R.F. & HENNING, G.A. 2009. *A framework for conservation management of South African butterflies in practice*. In: Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds). *South African Red Data Book: Butterflies*. SANBI Biodiversity Series 13. South African National Biodiversity Institute, Pretoria. p. 68 – 71.
- EDGE, D.A., TERBLANCHE, R.F., HENNING, G.A., MECENERO, S. & NAVARRO, R.A. 2013. Butterfly conservation in southern Africa: Analysis of the Red List and threats. In: Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. (eds). *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. pp. 13-33. Safronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- TERBLANCHE, R.F., SMITH, G.F. & THEUNISSEN, J.D. 1993. Did Scott typify names in *Haworthia* (Asphodelaceae: Aloioideae)? *Taxon* 42(1): 91–95. (International Journal of Plant Taxonomy).
- TERBLANCHE, R.F., MORGENTHAL, T.L. & CILLIERS, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.
- EDGE, D.A., CILLIERS, S.S. & TERBLANCHE, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.
- GARDINER, A.J. & TERBLANCHE, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae) *African Entomology* 18(1): 171-191.
- TERBLANCHE, R.F. 2016. *Acraea trimeni* Aurivillius, [1899], *Acraea stenobea* Wallengren, 1860 and *Acraea neobule* Doubleday, [1847] on host-plant *Adenia repanda* (Burch.) Engl. at Tswalu Kalahari Reserve, South Africa. *Metamorphosis* 27: 92-102.

\* A detailed CV with more complete publication list is available.

## II) SPECIALIST DECLARATION

I, Reinier F. Terblanche, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Name of Specialist: Reinier F. Terblanche



Signature of the specialist

Date: 24 June 2021

# 1 INTRODUCTION

An ecological habitat survey was required for proposed De Heus developments approximately 4 km southeast of the centre of Middelburg, Eastern Cape Province, South Africa (elsewhere referred to as the site). The survey mainly focused on the possibility that Threatened flora and fauna known to occur in Eastern Cape Province are likely to occur at the site or not. Species which are not threatened but of conservation concern, for example near threatened, data deficient or declining species also received attention in the survey.

## 1.1 OBJECTIVES OF THE HABITAT STUDY

The objectives of the habitat study are to provide:

- A detailed fauna and flora habitat survey;
- A detailed habitat survey of possible threatened or localised plant species, vertebrates and invertebrates;
- Recording of possible host plants of fauna such as butterflies.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species;
- Literature investigation of possible species that may occur on site;
- Identification of potential ecological impacts on fauna and flora that could occur as a result of the development; and
- Make recommendations to reduce or minimise impacts, should the development be approved.

## 1.2 SCOPE OF STUDY

- A survey consisting of visits to investigate key elements of habitats on the site, relevant to the conservation of fauna and flora.
- Recording of any sightings and/or evidence of existing fauna and flora.
- The selective and careful collecting of voucher specimens of invertebrates where deemed necessary.
- An evaluation of the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Literature investigation of possible species that might occur on site.
- Integration of the literature investigation and field observations to identify potential ecological impacts that could occur as a result of the development.
- Integration of literature investigation and field observations to make recommendations to reduce or minimise impacts, should the development be approved.

## 2 STUDY AREA

The study area is approximately 4 km southeast of the centre of Middelburg, Eastern Cape Province, South Africa (elsewhere referred to as the site). Site is part of the Nama-Karoo Biome which is represented by the Eastern Upper Karoo vegetation type (Mucina & Rutherford 2006).

To serve as local context for the landscape and vegetation at the site an outline of the Eastern Upper Karoo (NKu 4) from Mucina and Rutherford (2006) follows.

### **NKu 4 Eastern Upper Karoo**

**Distribution:** Eastern Upper Karoo is present in parts of the Northern Cape Province, Eastern Cape Province and Western Cape Province. Eastern Upper Karoo is located between the towns of Carnarvon and Loxton in the west, De Aar, Petrusville and Venterstad in the north, Burgersdorp, Hofmeyr and Cradock in the east and the Great Escarpment and the Sneeuberge-Coetzeesberge mountain chain in the south. Altitude varies mostly between 1000 – 1700 m (Mucina & Rutherford, 2006).

**Vegetation and landscape features:** Flats and gently sloping plains (interspersed with hills and rocky areas of Upper Karoo Hardeveld in the west, Besemkaree Koppies Shrubland in the northeast and Tarkastad Montane Shrubland in the southeast), dominated by dwarf microphyllus shrubs, with “white” grasses of the genera *Aristida* and *Eragrostis* (these become prominent especially in the early autumn months after good summer rains). The grass cover increases along a gradient from southwest to northeast (Mucina & Rutherford, 2006).

**Geology and soils:** Mudstones and sandstones of the Beaufort Group (including both Adelaide and Tarkastad Subgroups) supporting duplex soils with prisma-cutanic and/or pedocutanic diagnostic horizons dominant (Da land type) as well as some shallow Glenrosa and Mispah soils (Fb and Fc land types). In places, less prominent Jurassic dolerites (Karoo Dolerite Suite) are also found (Mucina & Rutherford, 2006).

**Climate:** Rainfall takes place mainly in autumn and summer, peaking in March. Mean Annual Precipitation (MAP) ranges from about 180 mm in the west to 430 mm in the east. Incidence of frost is relatively high, but ranging widely from <30 days (in the lower-altitude Cradock area) to >80 days of frost per year (bordering the Upper Karoo Hardeveld on the Compassberg and mountains immediately to the west) (Mucina & Rutherford, 2006).

**Important taxa.** Tall shrubs: *Lycium cinereum*, *Lycium horridum*, *Lycium oxycarpum*. Low shrubs: *Chrysocoma ciliata*, *Eriocephalus ericoides* subsp. *ericoides*, *Eriocephalus spinescens*, *Pentzia globosa*, *Pentzia incana*, *Phymaspermum parvifolium*, *Salsola calluna*, *Aptosimum procumbens*, *Felicia muricata*, *Gnidia polycephala*, *Helichrysum dregeanum*, *Helichrysum lucilioides*, *Limeum aethiopicum*, *Nenax microphylla*, *Osteospermum leptolobum*, *Plinthus karoicus*, *Pteronia glauca*, *Rosenia humilus*, *Selago geniculata*, *Selago saxatilis*. Succulent shrubs: *Euphorbia hypogaea*, *Ruschia intricata*. Herbs: *Indigofera alternans*, *Pelargonium minimum*, *Tribulus terrestris*. Geophytic herbs: *Moraea pallida*, *Moraea polystachya*, *Syringodea bifucata*, *Syringodea concolor*.

Succulent herbs: *Psicaulon coriarium*, *Tridentea jucunda*, *Tridentia virescens*. Graminoids: *Aristida congesta*, *Aristida diffusa*, *Cynodon incompletus*, *Eragrostis bergiana*, *Eragrostis bicolor*, *Eragrostis lehmanniana*, *Eragrostis obtusa*, *Sporobolus fimbriatus*, *Stipagrostis ciliata*, *Tragus koelerioides*, *Aristida adscensionis*, *Chloris virgata*, *Cyperus usitatus*, *Digitaria eriantha*, *Enneapogon desvauxii*, *Enneapogon scoparius*, *Eragrostis curvula*, *Fingerhuthia africana*, *Heterpogon contortus*, *Sporobolus ludwigii*, *Sporobolus tenellus*, *Stipagrostis obtusa*, *Themeda triandra* and *Tragus berteronianus*.

Note: Though some plant species of the above listed vegetation types are present at the site, not necessarily all of the plant species listed above are present at the site.





**Figure 1** Map with indication of the location of the site.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2020).

### **3 METHODS**

A desktop study comprised not only an initial phase, but also it was used throughout the study to accommodate and integrate all the data that become available during the field observations.

Surveys were conducted by R.F. Terblanche on 31 May 2021 and 1 June 2021 to note key elements of habitats on the site, relevant to the conservation of fauna and flora. The main purpose of the site visit was ultimately to serve as a habitat survey that noted the possible presence or not of threatened species and other species of particular conservation concern.

The following sections highlight the materials and methods applicable to different aspects that were observed.

#### **3.1 HABITAT CHARACTERISTICS AND VEGETATION**

The habitat was investigated by noting habitat structure (rockiness, slope, plant structure/ physiognomy) as well as floristic composition. Voucher specimens of plant species were only taken where the taxonomy was in doubt and where the plant specimens were of significant relevance for invertebrate conservation. In this case no plant specimens were needed to be collected as voucher specimens or to be send to a herbarium for identification. A wealth of guides and detailed works of plant identifications, ecology and conservation is fortunately available and very useful. Field guides, biogeographic works, species lists, diagnostic outlines, conservation statuses and detail on specific plant groups were sourced from Court (2010), Germishuizen (2003), Germishuizen, Meyer & Steenkamp (2006), Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), Manning (2003), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008), Pooley (1998), Retief & Herman (1997), Smit (2008), Van Ginkel, Glen, Gordon-Gray, Cilliers, Muasya & Van Deventer (2011), Van Jaarsveld (2006), Van Oudtshoorn (2012), Van Wyk (2000), Van Wyk & Smith (2001), Van Wyk & Smith (2014), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (2013). Lists of species, species names and the conservation status of species were mainly sourced from Raimondo, von Staden, Victor, Helme, Turner, Kamundi & Manyama (2009) and updated versions of red lists and species from the Threatened Species Programme of SANBI and the Red List of South African Plants ([sanbi.org.za](http://sanbi.org.za))

#### **3.2 MAMMALS**

Mammals were noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps

(2000) are consulted. Sites have been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces were recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) were consulted for additional information and for the identification of tracks and signs. Because of the type of threatened mammals that are assessed in the local area such as the blackfooted cat and golden moles or rough-haired golden moles which are not to be trapped in normal way, the poor trapping success with normal traps of species in question such as the White-tailed Mouse as well as the similarity of terrestrial habitats and lack of unique habitats at the sites, trapping was not done since it was not deemed necessary in the case of this study. The focus has been on signs and surveying habitat characteristics to note potential occurrences of mammals of particular conservation concern. Many mammals can be identified from field sightings but, with a few exceptions, bats, rodents and shrews can only be reliably identified in the hand, and then some species needs examination of skulls, or even chromosomes (Apps, 2000).

### **3.3 BIRDS**

Birds were noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer was sure of the identity were also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert (2004), Tarboton & Erasmus (1998) and Chittenden (2007) were consulted. Ringing of birds fell beyond the scope of this survey and was not deemed necessary. Sites have been walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests have additionally been recorded. Habitat characteristics were surveyed to note potential occurrences of birds.

### **3.4 REPTILES**

Reptiles were noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) were followed. The Atlas and Red List of Reptiles of South Africa, Lesotho and South Africa (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014) has been used as the main source to compile the list for assessment. Sites were walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice was not necessary in the case of this study. Habitat characteristics are surveyed to note potential occurrences of reptiles.

### **3.5 AMPHIBIANS**

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

### **3.6 BUTTERFLIES**

Butterflies were noted as sight records or voucher specimens. Voucher specimens are mostly taken of those species of which the taxa warrant collecting due to taxonomic difficulties or in the cases where species can look similar in the veldt. Many butterflies use only one species or a limited number of plant species as host plants for their larvae. Myrmecophilous (ant-loving) butterflies such as the *Aloeides*, *Chrysoritis*, *Erikssonina*, *Lepidochrysops* and *Orachrysops* species (Lepidoptera: Lycaenidae), which live in association with a specific ant species, require a unique ecosystem for their survival (Deutshländer & Bredenkamp, 1999; Terblanche, Morgenthal & Cilliers, 2003; Edge, Cilliers & Terblanche, 2008; Gardiner & Terblanche, 2010). Known food plants of butterflies were therefore also recorded. After the visits to the site and the identification of the butterflies found there, a list was also compiled of butterflies that will most probably be found in the area in all the other seasons because of suitable habitat. The emphasis of this study remains a habitat survey that focuses on the likelihood of occurrence of threatened, near threatened or rare butterfly species.

### **3.7 FRUIT CHAFER BEETLES**

Different habitat types in the areas were explored for any sensitive or special fruit chafer species. Selection of methods to find fruit chafers depends on the different types of habitat present and the species that may be present. Fruit bait traps would probably not be successful for capturing *Ichnestoma* species in a grassland patch (Holm & Marais 1992). Possible chafer beetles of high conservation priority were noted as sight records accompanied by the collecting of voucher specimens with grass nets or containers where deemed necessary.

### **3.8 ROCK SCORPIONS**

Relatively homogenous habitat / vegetation areas were identified and explored to identify any sensitive or special species. Selected stones that were lifted to search for Arachnids were put back very carefully resulting in the least disturbance possible. All the above actions were accompanied by the least disturbance possible.

### **3.9 LIMITATIONS**

For each site visited, it should be emphasized that surveys can by no means result in an exhaustive list of the plants and animals present on the site, because of the time constraint. There are many invertebrate groups with considerable taxonomic and biogeographic impediments which further add to limitations of present surveys. The site survey was conducted during May and June 2021 which is a sub-optimal time of the season to find sensitive plant and animal species of high conservation priority. Substantial rains that fell in the summer season led to easier identification of plant species. The focus of the present survey remains a habitat survey that concentrates on the possibility that species of particular conservation priority occur on the site or not. It is unlikely that any more visits would reveal information that would change the outcome of this assessment both in terms of ecosystems of special conservation concern or suitable habitats of species of particular conservation concern. Visits that were conducted therefore appear to be sufficient to address the objectives of this study.

## 4 RESULTS

### 4.1 HABITAT AND VEGETATION CHARACTERISTICS

**Table 4.1** Outline of main landscape and habitat characteristics of the site.

HABITAT FEATURE	DESCRIPTION
Topography	Site is situated on gentle slopes (flat).
Rockiness	No rocky ridges are present.
Presence of wetlands	Wetlands appear to be absent at the site.
Broad overview of vegetation	<p>Large parts of vegetation at the site have been transformed or modified. Remaining vegetation is mainly karroid with few individual trees. Exotic trees or alien invasive trees occur at the golf course section with its associated infrastructure as well as at some other parts of the site. The alien invasive succulent <i>Cylindropuntia imbricata</i> occurs at some parts of the site.</p> <p>Fairly large covers of the alien invasive herb <i>Atriplex lindleyi</i> are conspicuous at areas where the soil have been exposed in the past. Tall shrubs include the indigenous <i>Lycium cinereum</i>, <i>Lycium horridum</i> and <i>Hertia pallens</i> as well as the exotic <i>Atriplex nummularia</i>. Low shrubs include <i>Salsola tuberculata</i>, <i>Salsola calluna</i>, <i>Eriocephalus ericoides</i> subsp. <i>ericoides</i>, <i>Pentzia incana</i>, <i>Chrysocoma ciliata</i>, <i>Aptosimum spinescens</i>, <i>Aptosimum procumbens</i>, <i>Ruschia intricata</i>, <i>Osteospermum leptolobum</i>, <i>Pteronia glauca</i> and <i>Rosenia humilus</i>. Conspicuous indigenous grass species at the site are <i>Eragrostis lehmanniana</i>, <i>Aristida congesta</i>, <i>Eragrostis obtusa</i>, <i>Tragus berteronianus</i>, <i>Enneapogon desvauxii</i> and <i>Stipagrostis uniplumis</i>. Few indigenous trees are found at the site which include <i>Searsia lancea</i> and <i>Vachellia karroo</i>.</p> <p>Alien invasive tree species at the site include <i>Schinus molle</i>, <i>Eucalyptus camaldulensis</i>, <i>Agave americana</i> and <i>Ligustrum lucidum</i>.</p> <p>Some of the alien invasive weed species at hitherto bare ground or ecologically disturbed areas at the site are <i>Salsola kali</i>, <i>Argemone ochroleuca</i>, <i>Chenopodium album</i>, <i>Alternanthera pungens</i>, <i>Datura ferox</i> and <i>Senecio inaequidens</i>.</p>
Signs of ecological disturbances	A golf course and hitherto scraped or excavated areas are present at the site. The remains of furrows at the site do not appear to function in any significant way at the site anymore. Sheet erosion appears to take place and some of the hitherto scraped or excavated areas. Roads, fences and infrastructure associated with buildings and a golf course are present at the site. Various alien invasive weeds are widespread at the site.
Connectivity	The scope for corridors of particular conservation importance at the site is small.



**Photo 1** View of part of the site. Plains and hills in the distance are beyond the site.  
Photo: R.F. Terblanche.



**Photo 2** Large bare areas are found at the site. Plains and mountains in the distance are outside the site.  
Photo: R.F. Terblanche



**Photo 3** View of part of the site. Plains and hills in the distance are outside the site.  
Photo: R.F. Terblanche.



**Photo 4** View of part of the site. Tall shrubs in the picture are the exotic *Salsola nummularia*.  
Photo: R.F. Terblanche





**Photo 5** Buildings at the site.  
Photo: R.F. Terblanche.



**Photo 6** Buildings and infrastructure and associated garden area with exotic trees at the site.  
Photo: R.F. Terblanche



**Photo 7** Part of the site where a section of a golf course is present. Alien invasive *Eucalyptus* trees are conspicuous at the golf course area.  
Photo: R.F. Terblanche.



**Photo 8** View of part of the site. The succulent shrub in the picture is the alien invasive *Cylindropuntia imbricata*.  
Photo: R.F. Terblanche



**Photo 9** Old furrow at the site.  
Photo: R.F. Terblanche.



**Photo 10** Vegetation and exposed soil adjacent to the old furrow at the site.  
Photo: R.F. Terblanche



**Photo 11** Foliage of the alien invasive tree species *Schinus molle* at the site.  
Photo: R.F. Terblanche.



**Photo 12** The exotic shrub *Salsola nummularia* at the site.  
Photo: R.F. Terblanche



**Photo 13** Alien invasive weed *Atriplex lindleyi* at the site.  
Photo: R.F. Terblanche.



**Photo 14** Foliage and flowers of the indigenous shrub *Lycium cinereum*, at the site.  
Photo: R.F. Terblanche



**Photo 15** The indigenous shrub *Ericephalus ericoides* at the site.  
Photo: R.F. Terblanche.



**Photo 16** The indigenous shrub *Hertia pallens* at the site.  
Photo: R.F. Terblanche

## 4.2 ASSESSMENT OF PLANT SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

### 4.2.1 Plant species of particular conservation concern according to the red list of plants

**Table 4.2** Threatened plant species of the Eastern Cape Province which are listed in the **Critically Endangered** category. The list here follows the Red List of South African plant species (Raimondo *et al.* 2009) as well as its updated versions on websites of the South African National Biodiversity Institute (SANBI). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Aspalathus recurvispina</i>	Critically Endangered	No
<i>Lachenalia convallarioides</i>	Critically Endangered	No

**Table 4.3** Threatened plant species of the Eastern Cape Province which are listed in the **Endangered** category. The list here follows the Red List of South African plant species (Raimondo *et al.* 2009) as well as its updated versions on websites of the South African National Biodiversity Institute (SANBI). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Aloe boweia</i>	Endangered	No
<i>Begonia dregei</i>	Endangered	No
<i>Begonia homonyma</i>	Endangered	No
<i>Euphorbia obesa</i>	Endangered	No

**Table 4.4** Threatened plant species of the Eastern Cape Province which are listed in the **Vulnerable** category. The list here follows the Red List of South African plant species (Raimondo *et al.* 2009) or recent update. No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Cotyledon tomentosa</i>	Vulnerable	No
<i>Crassula obovata</i> var. <i>dregeana</i>	Vulnerable	No
<i>Haworthiopsis attenuata</i>	Vulnerable	No
<i>Impatiens flanaganiae</i>	Vulnerable	No

**Table 4.5 Near Threatened** plant species of the Eastern Cape Province. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

<b>Species</b>	<b>Status:</b> Global status or national status indicated	<b>Resident at the site</b>
<i>Aloe micracantha</i>	Near Threatened	No
<i>Euphorbia meloformis</i>	Near Threatened	No
<i>Haworthiopsis fasciata</i>	Near Threatened	No
<i>Haworthiopsis sordida</i>	Near Threatened	No
<i>Plectranthus ernstii</i>	Near Threatened	No

**Table 4.6** Plant species of the Eastern Cape Province which are not threatened and not near threatened but which are of particular conservation concern and listed in the **Critically Rare** category (Raimondo *et al.* 2009). The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

<b>Species</b>	<b>Conservation status</b>	<b>Resident at the site</b>
<i>Crassula arborescens</i> subsp. <i>undulatifolia</i>	Critically Rare	No

**Table 4.7** Plant species of the Eastern Cape Province which are not threatened and not near threatened but of which are of particular conservation concern and listed in the **Rare** category (Raimondo *et al.* 2009). The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

<b>Species</b>	<b>Status:</b> Global status or national status indicated	<b>Resident at the site</b>
<i>Aloe reynoldsi</i>	Rare	No
<i>Aloe pictifolia</i>	Rare	No
<i>Cotyledon pendens</i>	Rare	No
<i>Crassula sarmentosa</i> var. <i>integrifolia</i>	Rare	No
<i>Tetradenia tuberosa</i>	Rare	No



#### 4.2.2 Plant species of particular conservation concern: Nationally Protected Tree Species

**Table 4.8** Tree species of the Eastern Cape Province which are listed as **Protected Tree Species** under the National Forests Act No. 84 of 1998, Section 15(1) which was published under Section 12(1)d in GN1602 of 23 December 2016. No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

Species	Conservation status	Resident at the site
<i>Boscia albitrunca</i> Shepherd's Tree	Nationally Protected Tree	No
<i>Ocotea bullata</i> Stinkwood	Nationally Protected Tree	No
<i>Pittosporum viridiflorum</i> Cheesewood	Nationally Protected Tree	No
<i>Podocarpus elongatus</i> Breede River Yellowwood)	Nationally Protected Tree	No
<i>Podocarpus latifolius</i> Real Yellowwood	Nationally Protected Tree	No
<i>Sideroxylon inerme</i> White-milkwood	Nationally Protected Tree	No

#### 4.3 ASSESSMENT OF VERTEBRATE SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

##### 4.3.1 Mammals of particular high conservation priority

**Table 4.9** Threatened mammal species of the Eastern Cape Province. Literature sources: Child, Roxburgh, Do Linh San, Raimondo, Davies-Mostert (2018), Friedman & Daly, (2004), Skinner & Chimimba (2005), Wilson & Reeder (2005). With mammal species which normally needs a large range their residential status does not implicate that they are exclusively dependent on the site or use the site as important shelter or for reproduction. No = Not recorded at site/ Unlikely to be resident at the site. Yes: Recorded at the site/ Likely to be resident at the site.

Species	Threatened Status	Site is part of range	Recorded at site during survey	Likely to be found based on habitat assessment
<i>Cercopithecus albogularis</i> Samango Monkey	Vulnerable	No	No	No
<i>Chrysofalax trevelyani</i> Giant Golden Mole	Endangered	No	No	No
<i>Dendrohyrax arboreus</i> Southern Tree Hyrax	Endangered	No	No	No
<i>Felis nigripes</i> Black-footed Cat	Vulnerable	No	No	No

<b><i>Mystromys albicaudatus</i></b> White-tailed mouse	Vulnerable	No	No	No
<b><i>Smutsia temminckii</i></b> Ground Pangolin	Vulnerable	No	No	No

**Table 4.10 Near Threatened** mammal species known to occur in the Eastern Cape Province. Literature sources: Child, Roxburgh, Do Linh San, Raimondo, Davies-Mostert (2018), Skinner & Chimimba (2005). No = Not recorded at site/ unlikely to be resident at the site. Yes: Recorded at the site/ Likely to be resident at the site.

Species	Threatened Status	Site is part of range	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Atelerix frontalis</i></b> Southern African Hedgehog	Near Threatened	Yes	No	No
<b><i>Ceratotherium simum</i></b> Southern White Rhinoceros	Near Threatened	No	No	No
<b><i>Graphiurus ocellaris</i></b> Spectacled Dormouse	Near Threatened	No	No	No

#### 4.3.2 Birds of particular high conservation priority

**Table 4.12 Threatened** bird species of the Eastern Cape Province. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007). No = Not recorded at site/ Unlikely to use site as breeding area or particular habitat on which the species depends. Yes = Recorded at site/ Likely to use site as breeding area or particular habitat on which the species depends.

Species	Common name	Threatened Status	Recorded at site during survey	Likely to use site as breeding area or habitat
<i>Afrotis afra</i>	<b>Southern Black Korhaan</b>	Vulnerable	No	No
<i>Aquila rapax</i>	<b>Tawny Eagle</b>	Endangered	No	No
<i>Aquila verreauxii</i>	<b>Verreaux's Eagle</b>	Vulnerable	No	No
<i>Ardeotis kori</i>	<b>Kori Bustard</b>	Vulnerable	No	No
<i>Balearica regulorum</i>	<b>Grey Crowned Crane</b>	Vulnerable	No	No
<i>Ciconia nigra</i>	<b>Black Stork</b>	Vulnerable	No	No
<i>Circus maurus</i>	<b>Black Harrier</b>	Endangered	No	No
<i>Circus ranivorus</i>	<b>African Marsh Harrier</b>	Endangered	No	No
<i>Eupodotis senegalensis</i>	<b>White-bellied Bustard</b>	Vulnerable	No	No
<i>Falco biarmicus</i>	<b>Lanner Falcon</b>	Vulnerable	No	No

<i>Falco naumanni</i>	<b>Lesser Kestrel</b>	Vulnerable	No	No
<i>Grus carunculata</i>	<b>Wattled Crane</b>	Critically Endangered	No	No
<i>Gypaetus barbatus</i>	<b>Bearded Vulture</b>	Endangered	No	No
<i>Gyps coprotheres</i>	<b>Cape Vulture</b>	Endangered	No	No
<i>Mycteria ibis</i>	<b>Yellow-billed Stork</b>	Endangered	No	No
<i>Neotis ludwigii</i>	<b>Ludwig's Bustard</b>	Endangered	No	No
<i>Neotis denhami</i>	<b>Denham's Bustard</b>	Vulnerable	No	No
<i>Polemaetus bellicosus</i>	<b>Martial Eagle</b>	Endangered	No	No
<i>Sagittarius serpentarius</i>	<b>Secretarybird</b>	Vulnerable	No	No
<i>Turnix hottentottus</i>	<b>Hottentot Buttonquail</b>	Vulnerable	No	No
<i>Tyto capensis</i>	<b>African Grass-Owl</b>	Vulnerable	No	No

\* Though some of the above bird species that roams over large areas may occasionally be found at the site, the site does not appear to be a habitat of particular importance to these birds, and these birds also do not use the site as breeding area.

**Table 4.12 Near Threatened** bird species of the Eastern Cape Province. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007). No = Not recorded at site/ Unlikely to be particularly dependent on the site as breeding area or habitat. Yes = Recorded at site/ Likely to be particularly dependant on the site as breeding area or habitat.

Species	Common name	Threatened Status	Recorded at site during survey	Likely to use site breeding area or habitat
<i>Eupodotis vigorsii</i>	<b>Karoo Korhaan</b>	Near Threatened	No	No
<i>Grus paradisea</i>	<b>Blue Crane</b>	Near Threatened	No	No
<i>Oxyura maccoa</i>	<b>Maccoa Duck</b>	Near Threatened	No	No
<i>Phoenicopterus minor</i>	<b>Lesser Flamingo</b>	Near Threatened	No	No
<i>Phoenicopterus ruber</i>	<b>Greater Flamingo</b>	Near Threatened	No	No

\*\* Though some of the above bird species that roams over large areas may occasionally be found at the site, the site does not appear to be a habitat of particular importance to these birds, and these birds also do not use the site as breeding area.

#### 4.3.3 Reptiles of particular high conservation priority

**Table 4.13** Threatened reptile species of the Eastern Cape Province. Main Source: (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014). No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Threatened Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Acontias poecilus</i></b> Variable Legless Skink	Endangered	No	No	No
<b><i>Bitis albanica</i></b> Albany Adder	Critically Endangered	No	No	No
<b><i>Bradypodon caffer</i></b> Transkei Dwarf Chameleon	Endangered	No	No	No
<b><i>Bradypodon taeniabronchum</i></b> Elandsberg Dwarf Chameleon	Endangered	No	No	No

**Table 4.14** Near Threatened reptile species of the Eastern Cape Province. Main Source: Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers (2014). Though *Homoroselaps dorsalis* has not yet been recorded from the North West Province, its presence in some areas of the Province is anticipated. No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Threatened Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Chamaesaura aenea</i></b> Coppery Grass Lizard	Near Threatened	No	No	No
<b><i>Homopus boulengeri</i></b> Karoo Dwarf Tortoise	Near Threatened	No	No	No
<b><i>Tropidosaura cottrelli</i></b> Cottrell's Mountain Lizard	Near Threatened	No	No	No

#### 4.3.4 Amphibian species of particular high conservation priority

**Table 4.15** Threatened amphibian species in the Eastern Cape Province. Sources: Du Preez & Carruthers (2009), Carruthers & Du Preez (2011). No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Red Listed Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Afrixalus knysnae</i></b> Knysna Leaf-folding Frog	Endangered	No	No	No
<b><i>Anhydrophryne rattrayi</i></b> Hogsback Chirping Frog	Endangered	No	No	No
<b><i>Arhtroleptella subvoce</i></b> Northern Moss Frog	Endangered	No	No	No
<b><i>Vandijkophrynus amatolicus</i></b> Amatola Toad	Critically Endangered	No	No	No

#### 4.4 ASSESSMENT OF INVERTEBRATE SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

##### 4.4.1 Butterflies of particular conservation priority

**Table 4.16 Threatened** butterfly species of the Eastern Cape Province. Sources: Henning, Terblanche & Ball (2009), Mecenero *et al.* (2013). Invertebrates such as threatened butterfly species are often very habitat specific and residential status imply a unique ecosystem that is at stake.

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Aloeides clarki</i> Coega Russet	Endangered	No	Highly unlikely
<i>Aslauga australis</i> Southern Purple	Endangered	No	Highly unlikely
<i>Chrysochrysis lyncurium</i> Tsomo River Opal	Vulnerable	No	Highly unlikely
<i>Chrysochrysis penningtoni</i> Gaika Opal	Vulnerable	No	Highly unlikely
<i>Chrysochrysis thysbe whitei</i> Thysbe Opal	Endangered	No	Highly unlikely
<i>Durbania amakosa albescens</i> Amakosa Rocksitter	Vulnerable	No	Highly unlikely
<i>Lepidochrysis ketsi leucomacula</i> Ketsi Giant Cupid	Endangered	No	Highly unlikely
<i>Lepidochrysis victori</i> Bedford Giant Cupid	Vulnerable	No	Highly unlikely
<i>Metisella syrinx</i> Bamboo Sylph	Vulnerable	No	Highly unlikely

**Table 4.17** Butterfly species of the Eastern Cape Province that are **Near Threatened** (Mecenero *et al.*, 2013). No = Butterfly species is unlikely to be a resident at the study area; Yes = Butterfly species is a resident at the study area.

Species	Red List Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Abantis bicolor</i> Bicoloured Paradise Skipper	Near Threatened	No	Highly unlikely

## **5 DISCUSSION**

### **5.1 HABITAT AND VEGETATION CHARACTERISTICS**

An outline of the habitat and vegetation characteristics is given in Table 4.1.

### **5.2 PLANT SPECIES**

Extinct, threatened, near threatened and other plant species of high conservation priority in Northern Cape Province are listed in Tables 4.2 – 4.7. Protected tree species are listed in Table 4.8. The presence or not of all the species listed in the tables was investigated during the survey. None of the Threatened and Near Threatened plant species are likely to occur on the site. No other plant species of particular conservation concern are likely to occur at the site.

### **5.3 VERTEBRATES**

#### **5.3.1 Mammals**

Table 4.9 and Table 4.10 list the possible presence or absence of threatened mammal species, near threatened mammal species and mammal species of which the status is uncertain, respectively, at the site. Literature sources that were used are Friedman & Daly (2004), Skinner & Chimimba (2005) and Wilson & Reeder (2005). Since the site falls outside reserves, threatened species such as the black rhinoceros (*Diceros bicornis*) and the African wild dog (*Lycaon pictus*) are obviously not present. No smaller mammals of particular high conservation significance are likely to be found on the site as well.

#### **5.3.2 Birds**

Table 4.11 and Table 4.12 list the possible presence or absence of threatened bird species and near threatened bird species at the site. With bird species which often have a large distributional range, their presence does not imply that they are particularly dependent on a site as breeding location. Therefore, the emphasis in the right-hand columns of Table 4.11 and Table 4.12 are on the particular likely dependence or not of bird species on the site. Literature sources that were mainly consulted are Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007). No threat to any threatened bird species or any bird species of particular conservation importance are foreseen.

### **5.3.3 Reptiles**

Table 4.13 and Table 4.14 list the possible presence or absence of threatened and near threatened reptile species on the site. The Atlas and Red List of Reptiles of South Africa, Lesotho and South Africa (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014) has been used as the main source to compile the list for assessment. There appears to be no threat to any reptile species of particular high conservation importance if the site is developed.

### **5.3.4 Amphibians**

Table 4.15 lists frog species that are threatened (vulnerable, endangered or critically endangered) in the Northern Cape according to Minter, Burger, Harrison, Braack, Bishop and Kloepfer (2004) as well as Du Preez & Carruthers (2009). Table 4.21 lists *Pyxicephalus adspersus* (Giant Bullfrog) as near threatened (Minter *et al.*, 2004; Du Preez & Carruthers, 2009). Though currently this species is listed as Least Concern (IUCN) it remains as species which is considered as of special conservation priority. There is no suitable habitat for *Pyxicephalus adspersus* (Giant Bullfrog) at the site. There appears to be no threat to any amphibian species of particular high conservation importance if the site is developed.

## **5.4 INVERTEBRATES**

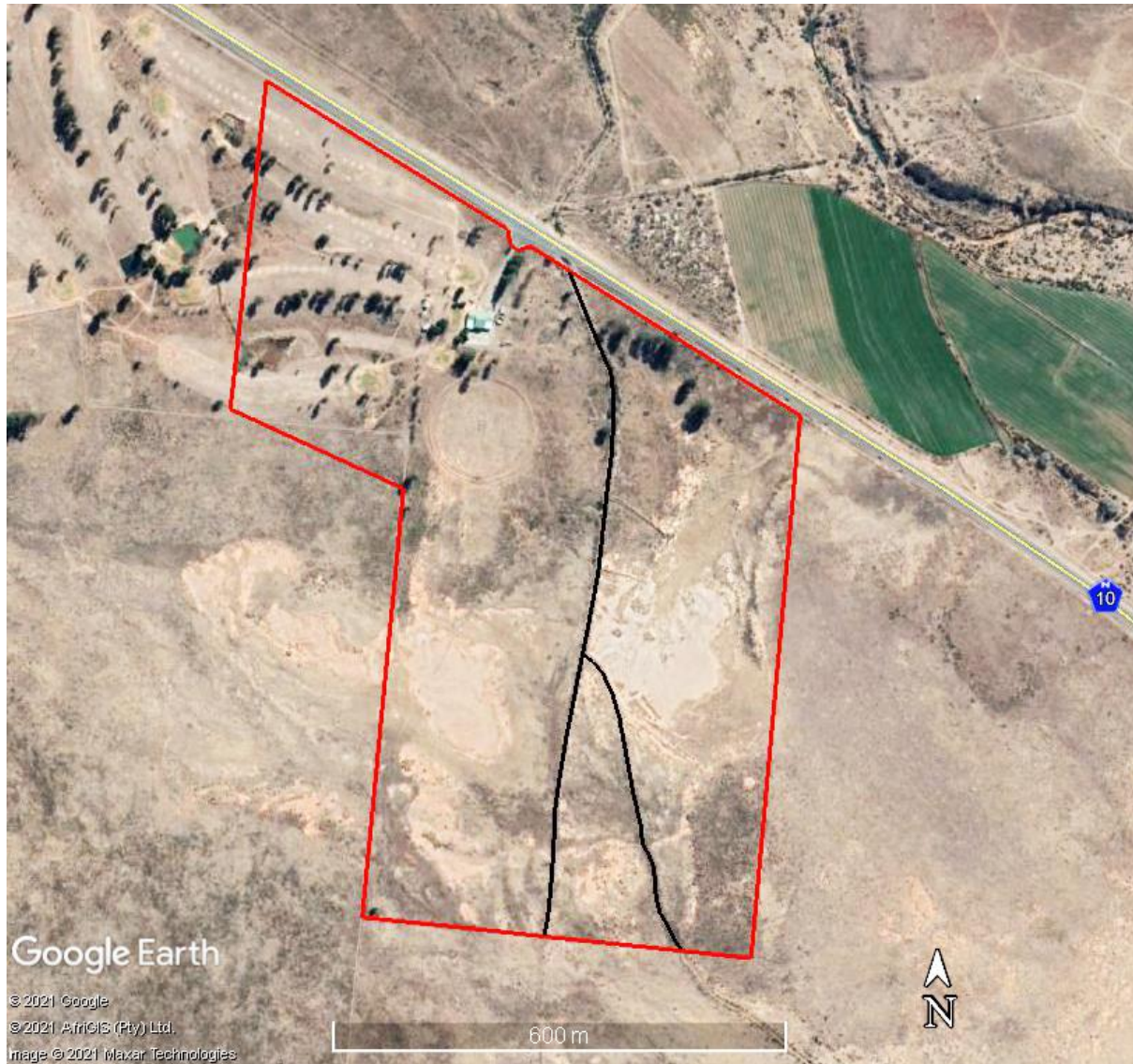
### **5.4.1 Butterflies**

Studies about the vegetation and habitat of threatened butterfly species in South Africa showed that ecosystems with a unique combination of features are selected by these often localised threatened butterfly species (Deuschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008). Threatened butterfly species in South Africa can then be regarded as bio-indicators of rare ecosystems.

Habitat at the site is not suitable for any of the butterfly species of particular conservation concern in the Eastern Cape Province and it is unlikely that any threats to butterfly species of particular conservation concern if the development is approved is unlikely.

## 5.5 Ecological Sensitivity at the site

Old furrows are present at the site (Figure 2). No wetlands or rocky ridges are present at the site. Ecological sensitivity at most of the is currently low with a part being of medium sensitivity (Figure 3).

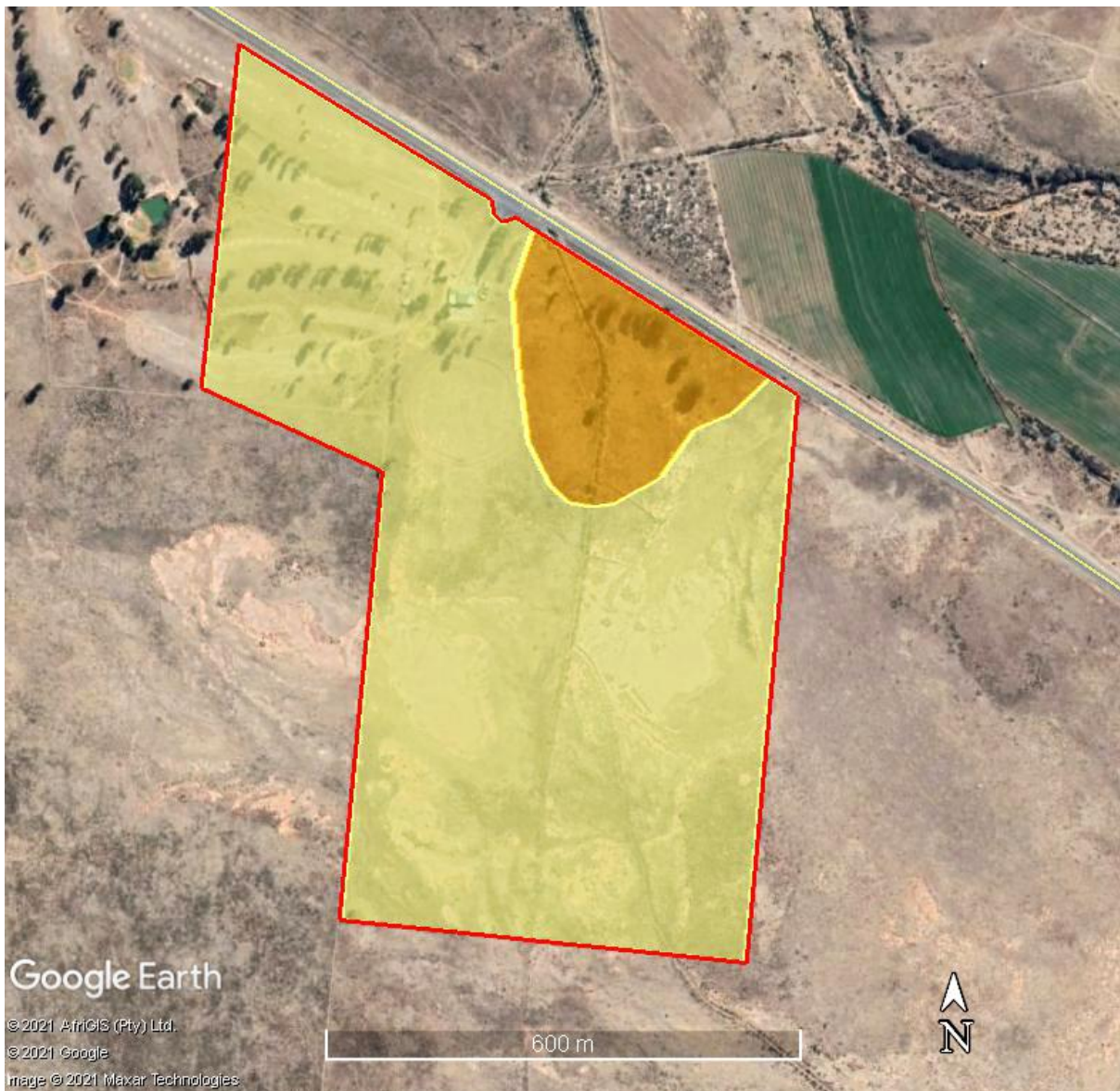


**Figure 2** Indications of old furrows at the site.

- Red outline                      Boundaries of the site
- Black outline                      Indications of old furrows

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 ® instrument. Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2021).





**Figure 3** Indications of ecological sensitivity at the site.

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 20px; height: 2px; background-color: red; margin-right: 5px;"></span> Red outline</li> <li><span style="display: inline-block; width: 20px; height: 2px; background-color: orange; margin-right: 5px;"></span> Orange-brown outline and shading</li> <li><span style="display: inline-block; width: 20px; height: 2px; background-color: yellow; margin-right: 5px;"></span> Light yellow outline and shading</li> </ul> | <ul style="list-style-type: none"> <li>Boundaries of the site</li> <li>Medium Sensitivity</li> <li>Low Sensitivity</li> </ul> |
|--|---|

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 © instrument. Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2021).

## 6 RISKS, IMPACTS AND MITIGATION

### Background:

Habitats of threatened plants are in danger most often due to urban developments such as is the case for the Gauteng Province (Pfab & Victor, 2002). Habitat conservation is the key to the conservation of invertebrates such as threatened butterflies (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008). Furthermore, corridors and linkages may play a significant role in insect conservation (Pryke & Samways, 2003, Samways, 2005).

Urbanisation is a major additional influence on the loss of natural areas (Rutherford & Westfall 1994). In the South Africa the pressure to develop areas are high since its infrastructure allows for improvement of human well-being. Urban nature conservation issues in South Africa are overshadowed by the goal to improve human well-being, which focuses on aspects such as poverty, equity, redistribution of wealth and wealth creation (Cilliers, Müller & Drewes 2004). Nevertheless, the conservation of habitats is the key to invertebrate conservation, especially for those threatened species that are very habitat specific. This is also true for any detailed planning of corridors and buffer zones for invertebrates. Though proper management plans for habitats are not in place, setting aside special ecosystems is in line with the recent Biodiversity Act (2004) of the Republic of South Africa.

Corridors are important to link ecosystems of high conservation priority. Such corridors or linkages are there to improve the chances of survival of otherwise isolated populations (Samways, 2005). How wide should corridors be? The answer to this question depends on the conservation goal and the focal species (Samways, 2005). For an African butterfly assemblage this is about 250m when the corridor is for movement as well as being a habitat source (Pryke and Samways 2003). Hill (1995) found a figure of 200m for dung beetles in tropical Australian forest. In the agricultural context, and at least for some common insects, even small corridors can play a valuable role (Samways, 2005). Much more research remains to be done to find refined answers to the width of grassland corridors in South Africa. The width of corridors will also depend on the type of development, for instance the effects of the shade of multiple story buildings will be quite different from that of small houses.

To summarise: In practice, as far as developments are concerned, the key would be to prioritise and plan according to sensitive species and special ecosystems.

### In the case of this study:

Large parts of vegetation at the site have been transformed or modified. Remaining vegetation is mainly karroid with few individual trees. Exotic trees or alien invasive trees occur at the golf course section with its associated infrastructure as well as at some other parts of the site. The alien invasive succulent *Cylindropuntia imbricata* occurs at some parts of the site.

Fairly large covers of the alien invasive herb *Atriplex lindleyi* are conspicuous at areas where the soil have been exposed in the past. Tall shrubs include the indigenous *Lycium cinereum*, *Lycium horridum* and *Hertia pallens* as well as the exotic *Atriplex nummularia*. Low shrubs include *Salsola tuberculata*, *Salsola calluna*, *Eriocephalus ericoides* subsp. *ericoides*, *Pentzia incana*, *Chrysocoma ciliata*, *Aptosimum spinescens*, *Aptosimum procumbens*, *Ruschia intricata*, *Osteospermum leptolobum*, *Pteronia glauca* and *Rosenia humilis*. Conspicuous indigenous grass species at the site are *Eragrostis lehmanniana*, *Aristida congesta*, *Eragrostis obtusa*, *Tragus berteronianus*, *Enneapogon desvauxii* and *Stipagrostis uniplumis*. Few indigenous trees are found at the site which include *Searsia lancea* and *Vachellia karroo*.

Alien invasive tree species at the site include *Schinus molle*, *Eucalyptus camaldulensis*, *Agave americana* and *Ligustrum lucidum*.

Some of the alien invasive weed species at hitherto bare ground or ecologically disturbed areas at the site are *Salsola kali*, *Argemone ochroleuca*, *Chenopodium album*, *Alternanthera pungens*, *Datura ferox* and *Senecio inaequidens*.

Rocky ridges and wetlands appear to be absent at the site.

No Threatened or Near Threatened plant or animal species appear to be resident at the site. No other plant or animal species of particular conservation concern appear to be present at the site.

The scope for the site to be part of a corridor of particular conservation importance is small.

The following potential risks, impacts and mitigation measures apply to the proposed development:

### **6.1 Identification of potential impacts and risks**

The potential impacts identified are:

#### **Construction Phase**

- Potential impact 1: Loss of habitat owing to the removal of vegetation at the proposed development.
- Potential impact 2: Loss of sensitive species (Threatened, Near-Threatened, Rare, Declining or Protected species) during the construction phase.

- Potential impact 3: Loss of connectivity and conservation corridor networks in the landscape.
- Potential impact 4: Contamination of soil during construction in particular by hydrocarbon spills.
- Potential impact 5: Killing of vertebrate fauna during the construction phase.

### Operational Phase

- Potential impact 6: An increased infestation of exotic or alien invasive plant species owing to disturbance.

## 6.2 Potential impacts and risks during the construction phase

Classes of impacts for this study: Very High, High, Moderate, Low, Very Low

Aspect/Activity	Clearance of vegetation at part of the site for the development
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Clearing of vegetation at the proposed development. This will entail the destruction of habitat of medium/ low ecological sensitivity.
Status	Negative
Mitigation Required	If the development is approved cultivation of indigenous vegetation at the site is imperative.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Moderate
RISK	Following the mitigation measures a moderate risk of impact is expected.

Aspect/Activity	Removal of sensitive species
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Sensitive species: Presence of Threatened or Near Threatened Plants, Mammals, Reptiles, Amphibians and Invertebrates at the site appear to be unlikely. No other plant or animal species of particular conservation concern are anticipated to be resident at the site.
Status	Neutral.
Mitigation Required	No specific mitigation measures for sensitive species apply at the site.
Impact Significance (Pre-Mitigation)	Low
Impact Significance (Post-Mitigation)	Low
RISK	A low risk of threat to any sensitive species at the site is anticipated.

Aspect/Activity	Fragmentation of corridors of particular conservation concern
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Vegetation containing some indigenous vegetation will be destroyed. This vegetation is currently conspicuously transformed or modified or degraded and isolated.
Status	Negative
Mitigation Required	If the development is approved cultivation of indigenous plant species at the site is imperative.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISK	Following mitigation, a low impact risk is expected.

Aspect/Activity	Contamination of soil by leaving rubble/ waste or spilling petroleum fuels or any pollutants on soil which could infiltrate the soil
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Rubble or waste could lead to infiltration of unwanted pollutants into the soil. Spilling of petroleum fuels and unwanted chemicals onto the soils that infiltrate these soils could lead to pollution of soils.
Status	Negative
Mitigation Required	Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction. Measures should be taken to avoid any spills and infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	A low risk is expected following mitigation.

Aspect/Activity	Possible disturbance, trapping, hunting and killing of vertebrates during construction phase
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	During the construction phase animal species could be disturbed, trapped, hunted or killed.
Status	Negative
Mitigation Required	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	Following mitigation a low risk is anticipated.

### 6.3 Potential impacts during the operational phase

Aspect/Activity	An increased infestation of exotic or alien invasive plant species owing to clearance or disturbance where the footprint took place.
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Infestation by alien invasive species could replace indigenous vegetation or potential areas where indigenous vegetation could recover. It is in particular declared alien invasive species such as <i>Prosopis glandulosa</i> (Mesquite) that should not be allowed to establish. Once established combatting these alien invasive plant species may become very expensive in the long term.
Status	Negative
Mitigation Required	Continued monitoring and eradication of alien invasive plant species are imperative. It is in particular declared alien invasive species such as <i>Prosopis glandulosa</i> (Mesquite) that should not be allowed to establish.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	Following mitigation, a low risk is anticipated.

#### 6.4 Risk and impact assessment summary for the construction phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)	
Clearing of vegetation	Habitat loss, loss of indigenous species	Negative	Part of site	Long-Term	Substantial	Very likely	Low	Low	The removal of vegetation takes place at an area of medium/ low ecological sensitivity. If the development is approved, cultivation of indigenous plant species at the site is essential.	Moderate	Moderate	High
Loss of sensitive species	Loss of sensitive species (Note no Threatened species or Near-threatened species)	Neutral	Site	Long-Term	Very low (No species anticipated)	Unlikely	Not applicable	Not applicable	No specific mitigation measures apply to sensitive species at the site.	Moderate	Low	High
Loss of corridors of particular conservation concern	Fragmentation of landscape and loss of connectivity	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	The scope for the degraded and isolated site to be a corridor of particular conservation importance is small. Cultivation of indigenous plant species at the site is essential and will enhance urban conservation corridors.	Moderate	Low	High
Contamination of soil by spilling pollutants on soil which could infiltrate the soil	Soil contamination	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	Rubble and waste removal. Measures that avoid hydrocarbon (petroleum) spills to get into contact with the soil.	Moderate	Low	High

Disturbance or killing of vertebrates	Disturbance or killing of species	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.	Moderate	Low	High
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### 6.5 Risk/ Impact assessment summary for the operational phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)	
Increased infestation of exotic or alien invasive plant species	Loss of habitat quality	Negative	Site	Long-Term	Substantial	Likely	Moderate	Moderate	Monitoring and eradication of alien invasive plant species. Cultivation of indigenous plant species at the site.	Moderate	Low	High

## 6.5 Summary of risks and impacts

Vegetation at the site is transformed/ modified/ disturbed. Rocky ridges and wetland appear to be absent at the site.

No Threatened or Near Threatened plant or animal species appear to be resident at the site. No other plant or animal species of particular conservation concern appear to be present at the site.

The scope for the site to be part of a corridor of particular conservation importance is small.

Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.



## 7 CONCLUSION

- Large parts of vegetation at the site have been transformed or modified. Remaining vegetation is mainly karroid with few individual trees. Exotic trees or alien invasive trees occur at the golf course section with its associated infrastructure as well as at some other parts of the site. The alien invasive succulent *Cylindropuntia imbricata* occurs at some parts of the site.
- Fairly large covers of the alien invasive herb *Atriplex lindleyi* are conspicuous at areas where the soil have been exposed in the past. Tall shrubs include the indigenous *Lycium cinereum*, *Lycium horridum* and *Hertia pallens* as well as the exotic *Atriplex nummularia*. Low shrubs include *Salsola tuberculata*, *Salsola calluna*, *Eriocephalus ericoides* subsp. *ericoides*, *Pentzia incana*, *Chrysocoma ciliata*, *Aptosimum spinescens*, *Aptosimum procumbens*, *Ruschia intricata*, *Osteospermum leptolobum*, *Pteronia glauca* and *Rosenia humilus*. Conspicuous indigenous grass species at the site are *Eragrostis lehmanniana*, *Aristida congesta*, *Eragrostis obtusa*, *Tragus berteronianus*, *Enneapogon desvauxii* and *Stipagrostis uniplumis*. Few indigenous trees are found at the site which include *Searsia lancea* and *Vachellia karroo*.
- Alien invasive tree species at the site include *Schinus molle*, *Eucalyptus camaldulensis*, *Agave americana* and *Ligustrum lucidum*.
- Some of the alien invasive weed species at hirtherto bare ground or ecologically disturbed areas at the site are *Salsola kali*, *Argemone ochroleuca*, *Chenopodium album*, *Alternanthera pungens*, *Datura ferox* and *Senecio inaequidens*.
- Old furrows which do not appear to have a significant function currently are present at the site.
- Large bare areas are present where signs of sheet erosion are visible. Signs of excavations or scraping of extensive areas are noticeable despite a “good rain season”. A number of pioneer and alien plant species that are conspicuous may also be reflection of possible “harsh soil conditions” and/or disturbances of the past.
- Rocky ridges and wetlands appear to be absent at the site.
- Site specific indications of sensitivity from the SANBI EIA Screening Tool for relative plant species theme sensitivity indicates a low sensitivity for the entire site.
- The indications of sensitivity from the SANBI EIA Screening Tool for relative animal species theme sensitivity indicates a very high sensitivity for the entire site. This very high sensitivity indication is owing to the distribution range of the bird species *Neotis ludwigii* (Ludwig’s Bustard). Ludwig’s Bustard is a large bird and a nomad and partial migrant. Though Ludwig’s Bustard roams over large areas and a visit by this large bird to the site cannot be totally excluded, the site does not appear to be a habitat of particular importance to this bird species. The local animal theme sensitivity of the specific site is probably low.

- Indications of sensitivity from the SANBI EIA Screening Tool for relative terrestrial biodiversity indicates a low sensitivity for the entire site.
- A low sensitivity from the SANBI EIA Screening Tool for relative aquatic biodiversity is indicated.
- The findings of the habitat survey at the site also suggest that a low sensitivity for the biodiversity themes at the site is likely.
- No Threatened or Near Threatened plant or animal species appear to be resident at the site. No other plant or animal species of particular conservation concern appear to be present at the site.
- The scope for the site to be part of a corridor of particular conservation importance is small.
- The vegetation type at the site is Eastern Upper Karoo (NKu 4) which is not listed as threatened according to the National List of Threatened Ecosystems (2011).
- Ecological sensitivity at most of the is currently low and at some parts, medium.
- Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.
- Establishment of exotic weeds should be monitored and exotic weeds at the site should be eradicated. A declared invader such as the mesquite tree (*Prosopis* species), should not be planted or allowed to spread from adjacent areas to the proposed footprint.

## 8 REFERENCES

- Alexander, G. & Marais, J. 2007. A guide to the reptiles of Southern Africa. Struik, Cape Town.
- Anderson, M.D. & Anderson, T.A. 2001. Too much, too quickly? Doubts about the sustainability of the camelthorn wood harvest. *African Wildlife* 55(3): 21-23.
- Apps, P. 2012. Smithers' mammals of Southern Africa 4<sup>th</sup> ed: A field guide, revised and updated by Peter Apps. Struik Nature, Cape Town.
- Armstrong, A.J. 1991. On the biology of the marsh owl, and some comparisons with the grass owl. *Honeyguide* 37:148-159.
- Barnes, K.N. ed. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.
- Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria.
- Boon, R. 2010. *Pooley's trees of eastern South Africa: a complete guide 2<sup>nd</sup> ed.* Flora and Fauna Publications Trust, Durban.
- Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. 3<sup>rd</sup> ed. Struik, Cape Town.
- Branch, B. 2008. Tortoises, Terrapins & Turtles of Africa. Struik Nature, Cape Town.
- Branch, W.R. & Patterson, R.W. 1975. Notes on the ecology of the Giant Girdled Lizard, *Cordylus giganteus*. *Journal of Herpetology* 9(4): 364-366.
- Bronner, G. 2011. *Mammals*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 22-35.

- Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications, Pretoria.
- Carruthers, V. & Du Preez, 2011. Frogs and frogging in southern Africa 2<sup>nd</sup> ed. Struik, Cape Town.
- Chittenden, H. 2007. Roberts Bird Guide. John Voelcker Book Fund, Cape Town.
- Cillié, B., Oberprieler, U. & Joubert, C. 2004. Animals of Pilanesberg: an identification guide. Game Parks Publishing, Pretoria.
- Cilliers, S.S., Müller, N. & Drewes, E. 2004. Overview on urban nature conservation: situation in the western-grassland biome of South Africa. *Urban forestry and urban greening* 3: 49-62.
- Coetzee, N. & Monadjem, A. 2008. *Mystromys albicaudatus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <[www.iucnredlist.org](http://www.iucnredlist.org)>.
- Conradie, W., Du Preez, L.H., Smith, K. & Weldon, C. 2006. Field guide to the frogs and toads of the Vredefort Dome World Heritage Site. School of Environmental Sciences and Development, Potchefstroom.
- Court, D. 2010. *Succulent Flora of Southern Africa*. Struik Nature, Cape Town.
- Crouch, N.R., Klopper, R.R., Burrows, J.E. & Burrows, S.M. 2011. Ferns of Southern Africa: a comprehensive guide. Struik Nature, Cape Town.
- Del Hoyo, J., Elliot, J. & Sargatal, J. 1992. Handbook of the birds of the world, Vol. 1. Lynx Editions, Barcelona.
- Deuschländer, M.S. & Bredenkamp, C.J. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis* subsp. *dentatis* (Swierstra) (Lepidoptera: Lycaenidae). *Koedoe* 42(2): 1-12.
- Dippenaar-Schoeman, A.S. 2002. Baboon and trapdoor spiders in southern Africa: an identification manual. Plant Protection Research Institute Handbook No. 13. Agricultural Research Council, Pretoria.
- Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders: an identification manual. Plant Protection Research Institute Handbook No. 9. Agricultural Research Council, Pretoria.

- Drinkwater, T.W., Bate, R. & Du Toit, H.A. 1998. A field guide for identification of maize pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.
- Du Preez, L.H. 1996. Field guide and key to the frogs and toads of the Free State. Department of Zoology and Entomology, University of the Orange Free State, Bloemfontein.
- Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Nature, Cape Town. CD with calls included.
- Edge, D.A., Cilliers, S.S. & Terblanche, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.
- Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. *Annual review of Ecology, Evolution and Systematics*, 34: 487 -515.
- Ferguson-Lees, J. & Christie, D.A. 2001. *Raptors of the world*. Christopher Helm, London.
- Filmer, M.R. 1991. Southern African spiders: an identification guide. Struik, Cape Town.
- Gardiner, A.J. & Terblanche, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae). *African Entomology* 18(1): 171 – 191.
- Germishuizen, G. 2003. Illustrated guide to the wildflowers of northern South Africa. Briza, Pretoria.
- Germishuizen, G., Meyer, N.L. & Steenkamp (eds) 2006. A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- Goldblatt, P. 1986. The Moraeas of Southern Africa. *Annals of Kirstenbosch Botanic Gardens*, Volume 14. National Botanic Gardens, Cape Town.
- Goldblatt, P. & Manning, J. 1998. *Gladiolus* in Southern Africa.

Henderson, L. 2001. *Alien weeds and alien invasive plants: a complete guide to the declared weeds and invaders in South Africa*. Plant Protection Research Institute Handbook No. 12. ARC: Plant Protection Research Institute, Pretoria.

Henderson, L. & Cilliers, C.J. 2002. *Invasive aquatic plants: a guide to the identification of the most important and potentially dangerous invasive aquatic and wetland plants in South Africa*. Plant Protection Research Handbook No. 16. Agricultural Research Council, Pretoria.

Henning, G.A. & Roos, P.S. 2001. Threatened butterflies of South African wetlands. *Metamorphosis* 12(1): 26-33.

Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds) 2009. South African Red Data Book: butterflies. *SANBI Biodiversity Series No 13*. South African National Biodiversity Institute, Pretoria.

Henning, S.F. 1983. Biological groups within the Lycaenidae (Lepidoptera). *Journal of the Entomological Society of Southern Africa* 46(1): 65-85.

Henning, S.F. 1987. Outline of Lepidoptera conservation with special reference to ant associated Lycaenidae. *Proceedings of the first Lepidoptera conservation Symposium, Roodepoort: Lepidopterists' Society of southern Africa*: 5-7.

Henning, S.F. & Henning, G.A. 1989. South African Red Data Book: butterflies. *South African National Scientific Programmes Report No. 158*. CSIR, Pretoria.

Herman, P.P.J. 2002. Revision of the *Tarchonanthus camphoratus* complex (Asteraceae-Tarchonantheae) in southern Africa. *Bothalia* 32,1: 21-28.

Hernandez, R.R., Easter, S.B., Murphy-Mariscal, M.L., Maestre, F.T., Tavassoli, M., Allen, E.B., Barrows, C.W., Belnap, J., Ochoa-Hueso, R., Ravi, S. & Allen, M.F. 2014. Environmental impacts of utility-scale Solar Energy. *Renewable and Sustainable Energy Reviews*, 29: 766-779.

Hill, C.J. 1995. Conservation corridors and rainforest insects. (In Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), *Forests and Insects*. Chapman & Hall, London. p. 381-393.)

Hockey, P. 2011. *Birds*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.

Hockey, P.A.R., Dean, W.J.R. & Ryan, P.G. (eds.). 2005. *Roberts Birds of Southern Africa*. John Voelcker Bird Book Fund, Cape Town.

Holm, E. & Marais, E. 1992. *Fruit chafers of southern Africa*. Ekogilde, Hartebeespoort.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. 2012. *IUCN Red list of Threatened Species*. Version 2012.1)

Jacobsen, W.B.G. 1983. *The ferns and fern allies of Southern Africa*. Butterworths, Durban.

Kemper, N.P. 2001. *RVI: Riparian Vegetation Index, final report*, WRC Report No. 850/3/1. Institute for Water Research, Pretoria.

Kok, J.C. 1998. *Vrystaatse bome, struik en klimplante* Kontak-uitgewers, Pretoria.

Kyalangalilwa, B., Boatwright, J.S., Daru, B.H., Maurin, O. & van der Bank, M. 2013. Phylogenetic position and revised classification of *Acacia* s.l. (Fabaceae: Mimosoideae) in Africa, including new combinations in *Vachellia* and *Senegalia*. *Botanical Journal of the Linnean Society* 172: 500–523.

Larsen, T.B. 1995. *Butterfly biodiversity and conservation in the Afrotropical region*. (In Pullin, A.S. ed. *Ecology and conservation of butterflies*. London: Chapman & Hall. p. 290-303.)

Liebenberg, L. 1990. *A field guide to the animal tracks of Southern Africa*. David Philip Publishers, Cape Town.

Leeming, J. 2003. *Scorpions of southern Africa*. Struik, Cape Town.

Leroy, A. & Leroy, J. 2003. *Spiders of southern Africa*. Struik, Cape Town.

Louw, W.J. 1951. *An ecological account of the vegetation of the Potchefstroom Area*. Botanical Survey of South Africa, Memoir No. 24. Government Printer, Pretoria.

Low, A.B. & Rebelo, A.G. (Eds.) 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Lubke, R.A., Hoare, D., Victor, J. & Ketelaar, R. 2003. The vegetation of the habitat of the Brenton Blue Butterfly, *Orachrysops niobe* (Trimen), in the Western Cape, South Africa. *South African Journal of Science* 99: 201-206.

Manning, J. 2003. *Photographic guide to the wild flowers of South Africa*. Briza, Pretoria.

Manning, J. 2009. *Field guide to the wild flowers of South Africa*. Struik, Cape Town.

McMurtry, D., Grobler, L., Grobler, J. & Burns, S. 2008. *Field guide to the orchids of northern South Africa and Swaziland*. Umdaus Press, Hatfield.

Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. Saftronics, Johannesburg & Animal Demography Unit, Cape Town.

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D. eds. 2004. *Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland*. SI/MAB series 9, Smithsonian Institution, Washington DC.

Mucina, L. & Rutherford, M.C. eds. 2006. *The vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. Pretoria: South African National Biodiversity Institute.

Mucina, L., Rutherford, M.C., and Powrie, L.W. eds. 2005. *Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps*. Pretoria: South African National Biodiversity Institute.

Munguira, M.L. 1995. Conservation of butterfly habitats and diversity in European Mediterranean countries. (*In Pullin, A.S. ed. Ecology and conservation of butterflies*. London: Chapman & Hall. p. 277- 289.)

New, T.R. 1993. ed. *Conservation biology of Lycaenidae (butterflies)*. *Occasional paper of the IUCN Species Survival Commission* No. 8.



- New, T.R. 1995. Butterfly conservation in Australasia – an emerging awareness and an increasing need. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 304 – 315.)
- Oates, M.R. 1995. Butterfly conservation within the management of grassland habitats. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. (p. 98-112.)
- Peacock, F. 2006. Pipits of Southern Africa. Published by the author, Pretoria. [www.pipits.co.za](http://www.pipits.co.za).
- Pfab, M.F. 2002. Priority ranking scheme for Red Data plants in Gauteng, South Africa. *South African Journal of Botany* (68): 299-303.
- Pfab, M.F. & Victor, J.E. 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* (68): 370-375.
- Picker, M. & Griffiths, C. 2011. Alien & Invasive animals: a South African perspective. Struik Nature, Cape Town.
- Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to insects of South Africa. 2<sup>nd</sup> ed. Cape Town: Struik.
- Pooley, E. 1998. A field guide to wild flowers of KwaZulu-Natal and the eastern region. Natal Flora Publications Trust, Durban.
- Pringle, E.L., Henning, G.A. & Ball, J.B. eds. 1994. Pennington's Butterflies of Southern Africa. Struik Winchester, Cape Town.
- Pryke, S.R. & Samways, M.J. 2001. Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* 101: 85-96.
- Pullin, A.S. ed. 1995. Ecology and conservation of butterflies. Chapman & Hall, London.
- Rautenbach, I.L. 1982. The mammals of the Transvaal. Ecoplan monograph 1: 1-211.
- Retief, E. & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characteristics. *Strelitzia* 6. National Botanical Institute, Pretoria.

Rutherford, M.C. & Westfall, R.H. 1994. Biomes of southern Africa: An objective categorisation, 2<sup>nd</sup> ed. Memoirs of the Botanical Survey of South Africa, Vol. 63, pp. 1-94. National Botanical Institute, Pretoria.

Ryan, P. 2001. Practical Birding: A guide to birdwatching in southern Africa. Struik, Cape Town.

Samways, M.J. 2005. Insect diversity conservation. Cambridge University Press, Cambridge.

Saunders, D.A., Hobbs, R.J. & Margules, C.R. 1991. Biological consequences of ecosystem fragmentation: A review. *Conservation Biology* 5(1): 18-32.

Shackleton, R.T., le Maitre, D.C., van Wilgen, B.W. & Richardson, D.M. 2015a. The impact of invasive alien *Prosopis* species (mesquite) on native plants in different environments in South Africa. *South African Journal of Botany*, 97: 25-31.

Shackleton, R.T., le Maitre, D.C. & Richardson, D.M. 2015b. Stakeholder perceptions and practices regarding *Prosopis* (mesquite) invasions and management in South Africa. *Ambio: A Journal of the Human Environment*, 44: 569-581.

Shackleton, R.T., le Maitre, D.C. & Richardson, D.M. 2015c. *Prosopis* invasions in South Africa: Population structures and impacts on native tree population stability. *Journal of Arid Environments*, 114: 70 – 78.

Skelton, P. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik, Cape Town.

Skelton, P. & Weyl, O. 2011. *Fishes*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.

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

Sliwa, A. 2008. *Felis nigripes*. In: IUCN 2012. IUCN Red List of Threatened Species.

Smit, N. 2008. Field guide to the *Acacias* of South Africa. Briza, Pretoria.

- Smithers, R.H.N. 1986. South African Red Data Book: Terrestrial mammals. *South African National Scientific Programmes Report No. 125*. CSIR, Pretoria.
- South Africa. 2004. National Environmental Management: Biodiversity Act No. 10 of 2004. Government Printer, Pretoria.
- Stuart, C. & Stuart, T. 2006. Field guide to the larger mammals of Africa 3<sup>rd</sup> ed. Struik Nature, Cape Town.
- Stuart, C. & Stuart, T. 2013. A field guide to the tracks and signs of Southern, Central and East African wildlife 4<sup>th</sup> ed. Struik Nature, Cape Town.
- Tarboton, W. & Erasmus, R. 1998. Owls and owling in southern Africa. Struik, Cape Town.
- Taylor, J.C., Janse Van Vuuren, M.S. & Pieterse, A.J.H. 2007. The application and testing of diatom-based indices in the Vaal and Wilge Rivers, South Africa. *Water SA* 33(1): 51-59.
- Terblanche, R.F. & Edge, D.A. 2007. The first record of an *Orachrysops* in Gauteng. *Metamorphosis* 18(4): 131-141.
- Terblanche, R.F. 1994. The little hairtail from the Kalahari. *Metamorphosis* 5(4): 173-174.
- Terblanche, R.F., Morgenthal, T.L. & Cilliers, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.
- Terblanche, R.F. & Taylor, J.C. 2000. Notes on the butterflies of Witsand – a unique terrestrial island in the Northern Cape Province, South Africa – with special reference to two RED DATA BOOK butterfly species. *Metamorphosis* 11(3): 122-131.
- Terblanche, R.F. & Van Hamburg, H. 2003. The taxonomy, biogeography and conservation of the myrmecophilous *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 46(2): 65-81.
- Terblanche, R.F. & Van Hamburg, H. 2004. The application of life history information to the conservation management of *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 47(1): 55-65.
- Thomas, C.D. 1995. Ecology and conservation of butterfly metapopulations in the fragmented British landscape. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 46-64.)

Van den Berg, J. & Drinkwater, T.W. 1998. Field guide to identification of sorghum pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

Van Ginkel, C.E., Glen, R.P., Gordon-Gray, K.D., Cilliers, C.J., Muasya, M. & van Deventer, P.P. 2011. Easy identification of some South African Wetland Plants. WRC Report No TT 479/10. Water Research Commission, Gezina.

Van Jaarsveld, E.J. 2006. The Southern African *Plectranthus* and the art of turning shade to glade.

Van Oudtshoorn, F. 2012. Guide to grasses of southern Africa, 3<sup>rd</sup> ed. Briza, Pretoria.

Van Wyk, B. 2000. A photographic guide to wild flowers of South Africa. Struik, Cape Town.

Van Wyk, B. & Malan, S. 1998. Field Guide to the Wild Flowers of the Highveld. Struik, Cape Town.

Van Wyk, A.E. & Smith, G.F. 2001. Regions of floristic endemism in Southern Africa: a review with emphasis on succulents, Umdaus Press, Pretoria.

Van Wyk, B.E. & Smith, G.F. 2014. Guide to the aloes of South Africa. 3<sup>rd</sup> ed. Briza, Pretoria.

Van Wyk, B. & Van Wyk, P. 2013. Field guide to trees of Southern Africa 2<sup>nd</sup> ed. Struik Nature, Cape Town.

Walker, C. 1996. Signs of the Wild. 5<sup>th</sup> ed. Struik, Cape Town.

Warren, M.S. 1995. Managing local microclimates for the high brown fritillary, *Argynnis adipe*. (In Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall.)

Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), Forests and Insects. London: Chapman & Hall. (p. 381-393.)

## ANNEXURE 1: Plants

Plant species marked with an asterisk (\*) are exotic.

Sources: Bromilow (2010); Crouch, Klopper, Court (2010); Duncan (2016); Fish, Mashau, Moeaha & Nembudani (2015); Germishuizen (2003), Goldblatt (1986); Goldblatt & Manning (1998); Johnson & Bytebier (2015); Manning (2007), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008); Smith, Crouch. & Figueiredo (2017); Van Ginkel *et al.* (2011); Van Jaarsveld (2006); Van Oudtshoorn (2012); Van Wyk (2000); Van Wyk & Gericke (2000); Van Wyk & Malan (1998); Van Wyk & Van Wyk (2013); Van Wyk & Smith (2014); Van Wyk, van Oudtshoorn & Gericke (2009)

TAXON	COMMON NAMES	FAMILY
<b>ANGIOSPERMAE: MONOCOTYLEDONS</b>		
<i>Agave americana</i>	Sisal, Century Plant	AGAVACEAE
<i>Aristida adscensionis</i>		POACEAE
<i>Aristida congesta</i>	Tassel Three-awn	POACEAE
<i>Asparagus burchellii</i>	Wild Asparagus	ASPARAGACEAE
<i>Chloris virgata</i>		POACEAE
<i>Cynodon dactylon</i>	Couch Grass	POACEAE
<i>Enneapogon desvauxii</i>		POACEAE
<i>Eragrostis lehmanniana</i>		POACEAE
<i>Heteropogon contortus</i>	Spear Grass	POACEAE
<i>Stipagrostis uniplumis</i>		POACEAE
<i>Tragus berteronianus</i>		POACEAE
<b>ANGIOSPERMS: DICOTYLEDONS</b>		
* <i>Alternanthera pungens</i>	Dubbeltjie	AMARANTHACEAE
<i>Aptosimum procumbens</i>		SCROPHULARIACEAE
<i>Aptosimum spinescens</i>		SCROPHULARIACEAE
* <i>Argemone ochroleuca</i>	White-flowered Mexican poppy	PAPAVERACEAE
* <i>Atriplex lindleyi</i>	Sponge-fruit Saltbush	AMARANTHACEAE
* <i>Atriplex nummularia</i>	Old Man Salt Bush	AMARANTHACEAE
* <i>Atriplex semibaccata</i>	Creeping Saltbush	AMARANTHACEAE

* <i>Bidens bipinnata</i>	Spanish Black Jack	ASTERACEAE
<i>Chrysocoma ciliata</i>	Bitterbos	ASTERACEAE
* <i>Chenopodium album</i>	White Goosefoot	CHENOPODIACEAE
* <i>Cylindropuntia imbricata</i>	Imbricate Prickly Pear	CACTACEAE
* <i>Datura ferox</i>	Thorn Apple	SOLANACEAE
* <i>Datura stramonium</i>		SOLANACEAE
<i>Eriocephalus ericoides</i> subsp. <i>ericoides</i>	Kapokbush	ASTERACEAE
* <i>Eucalyptus camaldulensis</i>	Red Gum	MYRTACEAE
<i>Felicia muricata</i>		ASTERACEAE
<i>Hertia pallens</i>		ASTERACEAE
* <i>Ligustrum lucidum</i>	Glossy Privet	OLEACEAE
<i>Lycium cinereum</i>	Kriedoring	SOLANACEAE
<i>Lycium horridum</i>	Kriedoring	SOLANACEAE
<i>Melianthus comosus</i>	Kruidjie-roer-my-nie	MELIANTHACEAE
<i>Osteospermum leptolobum</i>		ASTERACEAE
<i>Osteospermum scariosum</i>		ASTERACEAE
<i>Pentzia incana</i>		ASTERACEAE
<i>Rosenia humilis</i>	Perdekaroo	ASTERACEAE
<i>Ruschia intricata</i>		AIZOACEAE
* <i>Salsola kali</i>	Tumbleweed	AMARANTHACEAE
<i>Salsola tuberculata</i>	Ganna	AMARANTHACEAE
<i>Senecio inaequidens</i>		ASTERACEAE
<i>Senecio latifolius</i>		ASTERACEAE
<i>Senecio leptophyllus</i>		ASTERACEAE
* <i>Schinus molle</i>	Pepper Tree	ANACARDIACEAE
<i>Searsia lancea</i>	Karee	ANACARDIACEAE
<i>Searsia pyroides</i>	Firethorn Crowberry	ANACARDIACEAE
* <i>Tagetes minuta</i>	Tall Khaki Weed	ASTERACEAE
<i>Thesium lineatum</i>		SANTALACEAE

<b><i>Tribulus terrestris</i></b>	Devil's Thorn	ZYGOPHYLLACEAE
<b><i>Vachellia karroo</i></b>	Sweet Thorn	FABACEAE
<b>* <i>Verbena bonariensis</i></b>	Purple Top	VERBENACEAE