FAUNAL AND FLORAL DIVERSITY AND HABITAT ASSESSMENTS:

FOR THE PROJECT:

Lutzburg Solar Power Plant (Pty.) Ltd. near Postmasburg

ON:

THE REMAINING EXTENT OF PORTION 2 OF THE FARM RUBY VALE NO. 266, REGISTRATION DIVISION GORDONIA, NORTHERN CAPE PROVINCE.

March 2016

Report prepared by:

ENVIRONMENT RESEARCH CONSULTING

ERC forms part of **Benah Con cc**

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Highest tertiary qualification: M.Sc. *cum laude* (Phytosociology & Restoration Ecology)

Professional affiliation: SACNASP (reg. no. 400011/08)

Background & expertise:

I have been consulting as a professional ecologist, botanist and soil scientist since 2002. I gained valuable experience in the fields of vegetation classification, various restoration disciplines, faunal trapping, soil surveying and wetland surveying during my post graduate studies and later as fieldwork mentor for post graduate ecology students of the Northwest University, Potchefstroom Campus (2008 - 2014), on occasion for game ranch management students of the Tshwane University of Technology. As independent ecological consultant I have experience in various types of scientific floral and faunal studies in the grassland and savannah in Gauteng, North West, Limpopo, Mpumalanga, Free State, Eastern and Northern Cape. I have also on occasion performed vegetation studies in the KwaZulu-Natal savannah and Indian Ocean Coastal Belt, the Eastern Cape thicket, the Western Cape fynbos, Namaqualand, the Karoo and Swaziland. I have 13 years experience in specialist biodiversity, soil and wetland studies and have performed numerous (at least 95) such studies since 2002. I have authored two and co-authored four scientific papers for various local scientific publications since 2004.

Secondary specialist investigator: Leon Kotze

Highest tertiary qualification: BSc (Conservation Ecology)

Professional affiliation: None

Background & expertise:

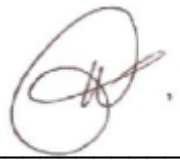
I am currently studying towards a M.Sc. in Small Mammal Ecology at the University of Witwatersrand and have captured, handled and recorded individual information for close to 500 small mammals to date. My highest qualification is a B.Sc. in Conservation Ecology (obtained at Stellenbosch University) in which Biome ecology and Zoology were my major subjects.

2 PROFESSIONAL DECLARATION

The specialist investigators responsible for conducting this particular specialist faunal and floral and habitat assessment declare that:

- We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP).

- At the time of conducting the study and compiling this report we did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in our professional capacity.
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favorable to the client/applicant, we will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public.
- We declare that there are no circumstances that may compromise our objectivity in performing this specialist investigation. We do not necessarily object to or endorse the proposed development, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data.
- We do not have any influence over decisions made by the governing authorities.
- Should we, at any point, consider ourselves to be in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.
- We undertake to disclose all material information in our possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant.
- We have expertise and experience in conducting specialist reports relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity.
- This document and all information contained herein are and will remain the intellectual property Benah Con cc (Environment Research Consulting) and the specialist investigator(s) responsible for conducting the study. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigator(s).
- We will comply with the Act, regulations and all other applicable legislation.
- All the particulars furnished in this document are true and correct.
- We realize that a false declaration is an offence in terms of Regulation 71 of NEMA and is punishable in terms of section 24F of the Act.



A.R. Götze (M.Sc.; *Pr.Sci.Nat.*)

Leon Kotze (B.Sc.)

3 EXECUTIVE SUMMARY

Based on the findings of this study it is the opinion of the specialist investigators that from a faunal, floral and general ecological point of view, the proposed development is considered favourably on the preferred site, provided that due care is taken to minimise and properly mitigate all identified impacts.

Introduction & Site Description

This study aims to assess the impact that the development of a Photovoltaic Solar Power Plant, on farmland in the Northern Cape about 35 km southwest of Olifantshoek and about 45 km west of Postmasburg, will have on the faunal and floral diversity within the site concerned (development footprint of approximately 250ha – with one preferred and one alternative site), with special reference to Threatened or Protected Species (ToPS). *Environment Research Consulting* (*ERC*) was contracted to conduct a biodiversity (faunal & floral) and general habitat assessment of portions of the Remaining portion of Portion 2 of the farm Ruby Vale near Olifantshoek in the Northern Cape Province. This report presents the findings of a once off, summer assessment that was conducted over a three day period from 03 to 05 March 2016.

The study site falls within the Eastern Kalahari Bushveld Bioregion of the Savanna Biome (Rutherford et al. 2006). Livestock and wildlife ranching dominate the immediate surrounds and human habitations are few and far between. Neither permanent nor semi-permanent water bodies were identified from satellite images or after ground-truthing the sites.

Topography is more or less homogeneous throughout the study site with no radical changes in slope. The area is visibly transformed with clearer signs of overgrazing on the preferred- than on the alternative site. The soil remains sandy for the most part with apparent absence of rockiness. The preferred site has less ground cover and more karroid shrub compared to the alternative site.

Faunal Assessment

Four small mammal trap lines (live trapping) were placed in four distinct habitat types on 300 m transects. Additionally, non-invasive walk transects were performed daily, documenting all animal sightings (including spoor and / or scat) in writing or by photographs. Drive transects were also conducted, twice per day, along the same 10km route.

Three Murid species were captured during the study period. Only transects 1 and 3 were successful, with mean trap success = 3.06%, and the min. / max. = 2 / 5. Twenty four non-invasive walk transects were performed and at least two hours was spent inspecting the area around each trap transect, during which three mammal species were recorded. Drive transects, averaging in excess of 10km per day, delivered three mammal sightings.

According to literature research, and considering the bioregion, landscape and habitat characteristics, the plausible species richness of the study site is as indicated in Table A according to a ratio of total species vs. total protected and data deficient species.

Table A: Plausible species richness of the study site

Faunal type	Ratio = total species : total protected and data deficient species
Mammals	44 : 6
Reptiles	39 : 0
Amphibians	4 : 0
Butterflies	2

Literature research revealed that no animals were restricted or endemic to the area. Species with a low likelihood of occurring within the site are nonetheless listed if their habits and habitat requirements overlap with the study findings. No physical records of the protected butterflies occurring in the site exist, but have been listed as their entire distribution ranges have not yet been confirmed.

Floristic & Habitat Assessment

A plotless sampling method was used to record floristic and general habitat data. Plant species observed in the study area during the time of the study were recorded and included in plant species lists. The floristic composition of each of the identified broad vegetation units and/or application area are described and discussed.

According to Mucina & Rutherford (2006) the study area falls in the Gordonia Plains Shrubland (SVk16) vegetation type. The habitat characteristics of the study area somewhat resembles the description given for SVk16. The areas studied (i.e. the preferred and alternative sites) differ slightly in terms of landscape features and habitat characteristics. The preferred site is mostly a flat plain with shrubs and low trees and the alternative site is situated on an area with a low hill with gradual north-eastern and south-western facing slopes and a higher density of tall woody vegetation. No clearly defined drainage lines were recorded on the preferred or alternative sites.

The soil surface of all sites is sandy with no visible rocks. In general, the soil on both sites can be described as sand to loamy sand. Floristically two of the three broad vegetation units (VU's) closely resemble the description of SVk16. One of the three VU's, however, is somewhat different from the description of SVk16 from a floristic point of view.

76 plant species are recorded on the POSA data base of SANBI for the relevant QDS 2822BA, the study area is situated in. This list contains species at least two or three different vegetation types.

A total of only 101 plant species (from 38 plant families and 83 genera) (Table B) were recorded in the study area during the time of the study and indicates moderate species diversity.

Table B: Summary of plant families, genera and species recorded in the study area

	Families	Genera	Species
ANGIOSPERMAE (seed plants): ***Monocotyledonae:***	6	18	24
Dicotyledonae:	32	65	77
Total:	**38**	**83**	**101**

Three broad Vegetation Units (VU's) were identified and subsequently described. These are:

- VU 1: *Acacia haematoxylon* open woodland
- VU 2: *Acacia mellifera* semi-closed woodland
- VU 3: *Schmidtia pappophoroides* open plains

Eleven **plant species of specific conservation significance** were recorded in the study area during the study period. One of these species is listed as a Threatened or Protected Species (ToPS) by the National Environmental Management: Biodiversity Act's (Act No. 10 of 2004) list of ToPS as published in Government Gazette no. 36375 of 16 April 2013. Two are listed by Raimondo *et al* (2009) in the South African Red Data list as declining species. Three trees are included in the protected tree species list as published in the National Forests Act (Act no.84 of 1998) (NFA, 1998), and eight of the eleven are listed as protected and one as specially protected by the Northern Cape Nature Conservation Act (Act no. 9 of 2009) (NCNCA, 2009).

Due to the high numbers of nationally protected trees (NFA, 1998) (i.e. *Acacia erioloba, A. haematoxylon and Boscia albitrunca*) the individual positions of these species were not individually geo-referenced during this study. Instead a number of belt transects were conducted in each different VU to determine the density at which these species occur in the study area and just beyond. 22 Belt transects of 100 x 40 m (4000 m^2) were conducted (7 in VU1, 7 in VU2 and 8 in VU3). All specimens of these species within the belt transect were counted and noted together with the height of each specimen. Differentiation was made between specimens higher than 2 m (> 2 m) and those shorter than 2 m but not less than 1 m (< 2 m = 1 m). Specimens shorter than 1 m were not counted.

During the study only one exotic plant species were recorded, i.e. the alien invasive woody species *Prosopis glandulosa* var. *torreyana*.

No ecosystems that are threatened and in need of protection according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) was recorded in or in the vicinity of the study area.

Impact Assessment

Based on an impact assessment it is evident that there are three expected impacts on the floral ecology within the study area. Table C summarises the findings indicating the significance of the impact before mitigation and management takes place and the likely impact if mitigation and management takes place. From Table C it is evident that prior to management measures being put in place, the impacts are negative-medium or negative-high level impacts. If effective management takes place, all impacts will be reduced to lower level impacts.

Table C: A summary of the results from the impact assessments

Impact	Not mitigated / managed	Mitigated / managed
1. Loss of habitat for faunal and floral species	negative medium impact	negative low impact
2. Loss of indigenous faunal and floral species diversity	negative medium impact	negative low impact
3. Loss of faunal and floral species of conservation significance	negative high impact	negative medium to low impact

Due the destructive nature of the proposed development to the floristic diversity occurring in the directly affected area and the direct impact it will also have on the faunal diversity of the area on a local scale, the **no-go alternative** will see the area stay in the current condition. The current impacts exerted on the area from an agricultural point of view (not assessed in this study) will remain and, depending on the management strategies employed by the land owner and natural climatic conditions, the current natural condition may improve or deteriorate in future.

A number of monitoring requirements are listed.

Concluding remarks

The low faunal and moderate floristic species richness and density recorded would equate to an insignificant impact to the regional diversity of plants, mammals, reptiles and amphibians. Although the number of protected faunal species possibly occurring on or in close proximity to the site is low, these deserve consideration.

When considering the different sites (preferred and alternative sites) that were investigated during this study, from a faunal, floral and general ecological point of view, it is concluded that the preferred site may be accepted for the proposed development.

4 INTRODUCTION

4.1 Background

Under the National Environmental Management Act (107 of 1998) any development that may cause significant damage to the natural environment is by law required to undergo stringent evaluation with the aim of reducing and mitigating the potential environmental impact (www.eia.org.za). This study aims to assess the impact that the development of a Photovoltaic Solar Power Plant, on farmland about 35 km southwest of the Northern Cape town of Olifantshoek (Figure 1), will have on the faunal and floral diversity within the site concerned (development footprint of approximately 250ha – with one preferred and one alternative site) (Figure 2), with special reference to Threatened or Protected Species (ToPS).

Environment Research Consulting (*ERC*) was contracted to conduct a biodiversity (faunal & floral) and general habitat assessment of portions of the Remaining portion of Portion 2 of the farm Ruby Vale near Olifantshoek in the Northern Cape Province. This report presents the findings of a once off, summer assessment that was conducted over a three day period from 03 to 05 March 2016.

Figure 1: Google earth image indicating the regional setting of the study area

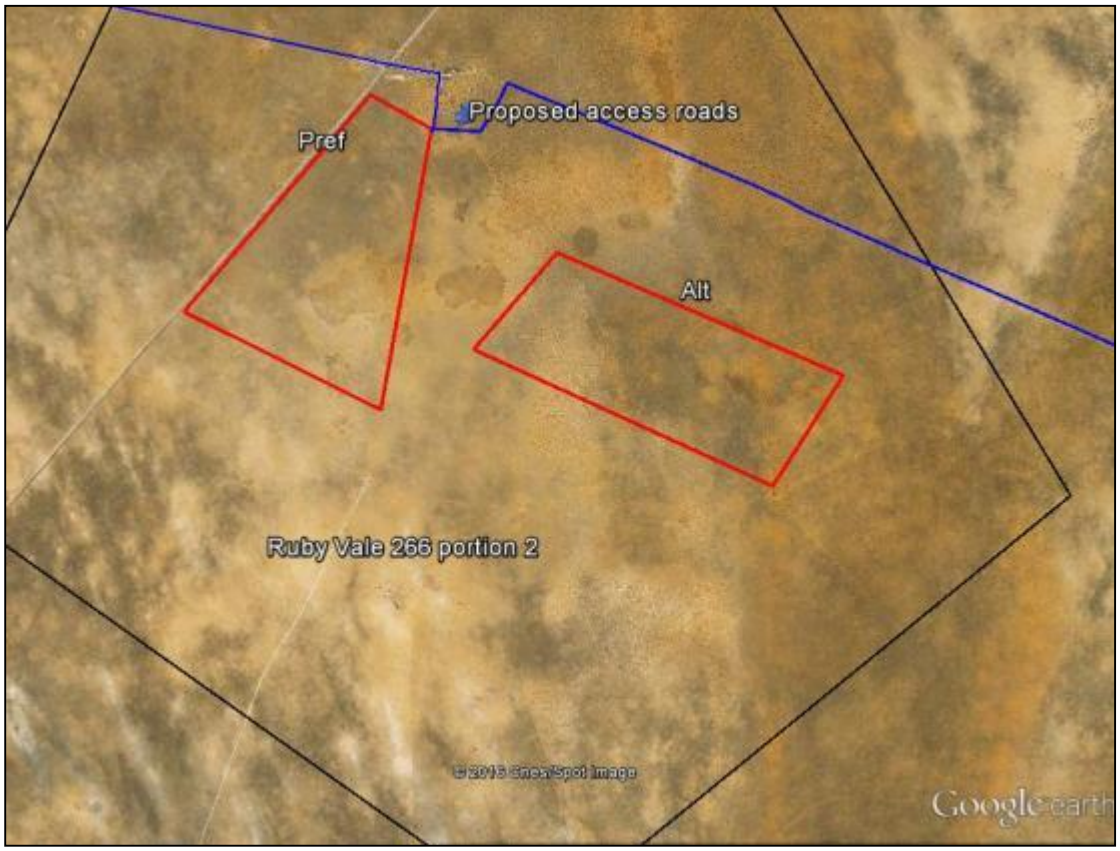


Figure 2: Image indicating the preferred and alternative development sites

4.2 Terms of Reference & General Requirements

The scope of the assessment included the PV Solar Energy Facility and its associated structures and infrastructure (such as the power line and access route). The impacts associated with the power line and access route that run beyond the site are considered to be negligible since the actual footprints of disturbance of the power lines is confined to the pylon bases. Furthermore, the power line and access route are aligned with existing roads as far as possible to avoid any negative environmental impacts.

The following ToR and general requirements were supplied by the client:

Specialists in their field of expertise will consider baseline data and identify and assess impacts according to predefined rating scales – refer to attached method of assessment. Specialists will also suggest optional or essential ways in which to mitigate negative impacts and enhance positive impacts. Further, specialists will, where possible, take into consideration the cumulative effects associated with this and other projects which are either developed or in the process of being developed in the local area.

Specialists' reports must comply with Appendix 6 of GNR982 published under sections 24(5), and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and whereby the following are to be included:

- The details of:
    - the specialist who prepared the report; and
    - the expertise of that specialist to compile a specialist report including a curriculum vitae;
- A declaration that the specialist is independent in a form as may be specified by the competent authority;
- An indication of the scope of, and the purpose for which, the report was prepared;
- The date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- A description of the methodology adopted in preparing the report or carrying out the specialised process; the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
- An identification of any areas to be avoided, including buffers;
- A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;
- Any mitigation measures for inclusion in the EMPr;
- Any conditions for inclusion in the environmental authorisation;
- Any monitoring requirements for inclusion in the EMPr or environmental authorisation;
- A reasoned opinion-
    - as to whether the proposed activity or portions thereof should be authorised; and
    - if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- A description of any consultation process that was undertaken during the course of preparing the specialist report;
- A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- Any other information requested by the competent authority.

In addition to the above, specialists were expected to:

- Review Scoping Reports, with specific reference to the Comments and Response Report to familiarize with all relevant issues or concerns relevant to their field of expertise;
- In addition to the impacts listed in the Scoping Report, identify any issue or aspect that needs to be assessed and provide expert opinion on any issue in their field of expertise that they deem necessary in order to avoid potential detrimental impacts;
- Assess the degree and extent of all identified impacts (including cumulative impacts) that the preferred project activity and its proposed alternatives, including that of the no-go alternative, may have;
- Identify and list all legislation and permit requirements that are relevant to the development proposal in context of the study;
- Reference all sources of information and literature consulted; and
- Include an executive summary to the report.

4.3 Aims of the study

- Provide a detailed fauna and flora habitat survey.
- Provide a detailed habitat survey of possible threatened or localised plant species and vertebrates.
- Take count and map the location (and provide coordinates) of any protected species or sensitive habitats found on site.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Record possible host plants or food plants of fauna such as butterflies.
- Conduct a literature investigation of possible species that may occur on site.
- Identify potential ecological impacts on fauna and flora that could occur as a result of the development.
- An assessment of the potential direct and indirect impacts resulting from the proposed development during the construction, operation and decommission phases.
- Make recommendations to reduce or minimise impacts, should the development be approved.
- Comment on plant species that can be utilized socially (medicine, food or other cultural or social purposes).

4.4 Assumptions and Limitations

- It was assumed that 3 trap days would be near sufficient for capturing a representative sample of small mammal diversity within the study site (the optimal period being 4 days) (Avenant & Cavallini 2007). The study area, however, was too large to sample thoroughly for either mammals or reptiles in the time available. Also, faunal observations during the midday heat were unlikely as temperatures ranged between 30°C and 40°C during the time of the study, evoking most animals to reduce activity and seek shelter. Detection was further constrained by the inherently cryptic and/or evasive nature of most wildlife.
- No attempt was made towards sampling Amphibia, due to the small amount of species possibly occurring on the site (Appendix A, Table 11-3) and the complete absence of permanent water bodies.
- Regarding the faunal species lists (Appendix A), it is important to note that distribution maps are often constructed with limited ecological knowledge available for the species under question and are thus not consistently reliable in predicting a species' occurrence (Hernandez et al. 2006; Newbold 2010). Furthermore, some uncertainty remains regarding the conservation priority for a great deal of southern African species as not all have been assessed and may classify as "Not evaluated" or "Data deficient".
- As no other insect conservation assessments are available we were limited to assessing only butterfly occurrence. In addition, Mecenero et al. (2013) found that butterfly research is lacking in the region concerned.
- It is assumed that plant species flowering only during specific times of the year could be confused with a very similar species of the same genus.
- Some plant species that emerge and bloom during another time of the year or under very specific circumstances may have been missed entirely.
- Due to the conditions encountered during the time of this study some species (faunal & floral) could only be identified up to genus level.
- All species included in the plant species list (Appendix B) were actually observed and recorded in the study area during the time of the study.
- No scientific data was collected or analyzed for the calculation of ecological veld condition. Any comments or observations made in this regard are based on observations, the expert knowledge and relevant professional experience of the specialist investigators.
- *ERC* reserves the right to amend this report, recommendations and/or conclusions at any stage should any additional or otherwise significant information come to light.

4.5 General Site Description

The study sites (S28° 13' 10.65" E22° 35' 23.50", alt.1200 m) are located 35 km southwest of Olifantshoek and 90 km from the nearest major watercourse (Orange River to the southwest). The site falls within the Eastern Kalahari Bushveld Bioregion of the Savanna Biome, with annual precipitation and temperature averaging 362 mm and 17.8 °C, respectively. The bioregion naturally includes xeric shrubland habitat (Rutherford et al. 2006). Livestock and wildlife ranching dominate the immediate surrounds and human habitations are few and far between (*pers. obs*.). Topography remains homogeneous throughout both sites with no obvious change in slope. Neither permanent nor semi-permanent water bodies were identified from satellite images or after ground-truthing the sites. The large black stains evident in both sites (Figure 3) are dense homogenous shrub patches.

Both sites are visibly transformed with the preferred site showing clearer signs of overgrazing than the alternative site. The soil remains sandy for the most part with apparent absence of rockiness (see Figures 4 and 5). The preferred site has minimal ground cover and an abundance of trees and karroid shrubs. Unlike the preferred site, the alternative site is structurally more diverse with decent ground cover in most parts (Figure 3). Note, the noticeable red and light brown hues in Figure 3 indicate little to no ground cover (*pers. obs.*).

5 FAUNAL ASSESSMENT

5.1 Methodology

Before our initial visit, satellite images (Google Earth) of the site were studied and the different habitat types identified (uniform features from an aerial perspective). Upon arrival the sites were ground-truthed. The small mammal trap transects were then placed, at least one transect per habitat type, and each trap baited with a mixture of peanut-butter, oats, sunflower oil and marmite (Avenant & Cavallini 2007). Transects consisted of 30 traps, placed 10 m apart and were checked every morning at 08h00, again at 15h00 and were re-baited daily. Species, sex and reproductive status were recorded for each animal captured, although only species data has been reported here.

Non-invasive walk transects were performed daily, documenting all animal sightings (including spoor and / or scat) in writing or by photograph. Non-invasive walk transects were done along the small mammal trap transects (Figure 3). The area ahead of the observer was observed attentively, specifically for animals flushed from shelter, and stretched a minimum of 250 m. After each trap check a minimum of 20 minutes was designated to examining the environment around each transect, during which I would frequently investigate the area surrounding me with binoculars.

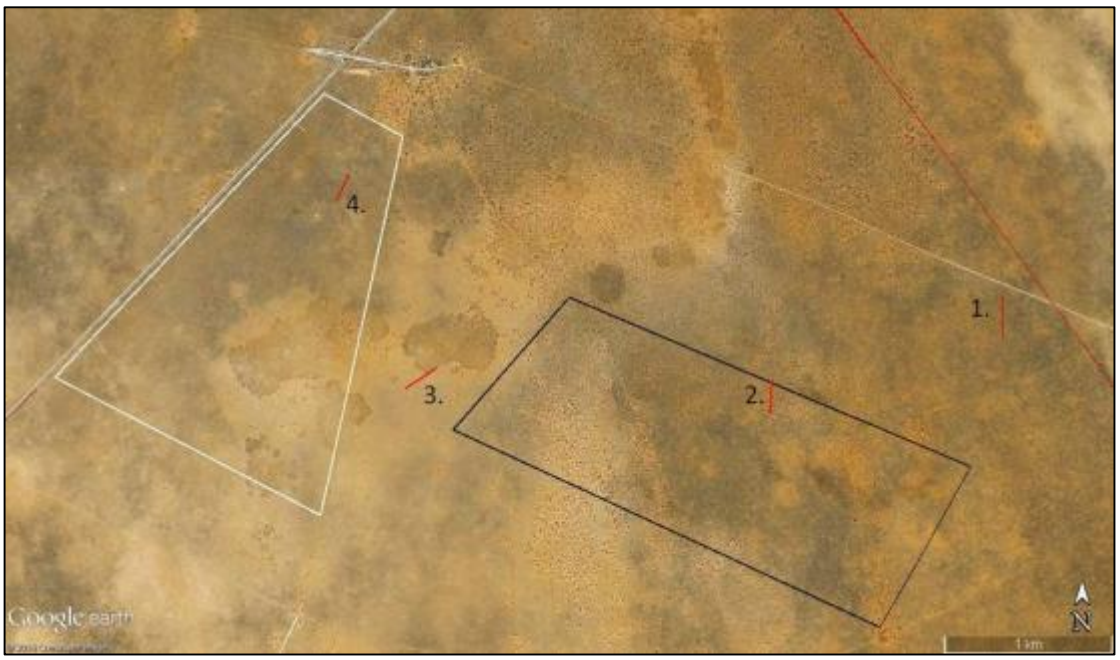


Figure 3: A local scale map. The white and black borders delineate the preferred and alternative sites, respectively. The numbered red lines represent small mammal trap transects. Distinctive black speckles are trees.

Drive transects were also conducted, twice per day, along the same 10 km route. Driving 20-40 km/h the driver would report any animal observed ahead of the vehicle and the passenger would record any animal seen in a 15 m belt to his side of the vehicle. The area surrounding the study site was also extensively travelled throughout the study period and sampled in a similar fashion. This method of sampling served to record the more conspicuous fauna (e.g. tortoises, large mammals and active snakes).

Species lists (Appendix A, Tables 11-1 to 11-4) were constructed using field guides, Red Data Books and Species Atlases (see 'References') complementarily. Only butterflies were considered in constructing an insect species list as they are the subject of the only existing South African insect conservation assessment. As far as information was available, species habitat requirements were also taken into account to substantiate the likelihood of their occurrence. Hence, veldt condition (i.e. pristine or disturbed), vegetation structure and other habitat characteristics contributed to determining the likelihood of a species' occurrence.

No formal consultation prosess was conducted as part of this faunal study as it was not deemed necessary at the time of the study.

5.2 Results

The study period lasted 3 days and nights with no less than 8 hours spent on the site per day. Four small mammal trap lines were placed in four distinct habitat types (Figures 4, 5, 6 and 8). Traps were removed following the third evening. In an effort to record landscape elements as well as faunal tracks and signs, extensive notes and photographs were taken throughout this period.

Figure 4: The direct surrounds of trap transect 1.

Figure 5: The direct surrounds of trap transect 2.

Figure 6: The direct surrounds of trap transect 3.

Figure 7: Homogeneous shrub patch at the northern tip of trap transect 3 (see Figure 3). Shrubs range in height between 1.5 and 2 m.

Figure 8: The direct surrounds of trap transect 4.

5.2.1 Trap transects (Direct sampling)

Three Murid species were captured during the study period (Appendix A, Table 11-1). Transects 1 and 3 (see Figure 3) were successful, with mean daily trap success (i.e. average amount of occupied traps per day) = 3.06%, and the min. / max. animals captured on a single day = 2 / 5.

5.2.2 Walk transects (Indirect sampling)

Twelve non-invasive walk transects were performed and at least two hours was spent inspecting the area surrounding each transect. Consequently, three mammal species were recorded (Orders Canidae and Bovidae; Appendix A Table 11-1).

5.2.3 Drive transects (Indirect sampling)

Drive transects, within and between sites, averaged in excess of 10 km per day and near similar distances was covered outside the study site daily. Three mammals were recorded during this period: Southern African Ground Squirrel (*Xerus inauris*), Suricate (*Suricata suricatta*) and Steenbok (*Raphicerus campestris*).

5.2.4 Desktop Study

According to literature research, and considering the bioregion, landscape and habitat characteristics, the plausible species richness of the study site is as indicated in Table 5-1 according to the ratio of total species vs. total protected and data deficient species.

Table 5-1: Plausible species richness of the study site

Faunal type	Ratio = total species : total protected and data deficient species
Mammals	44 : 6
Reptiles	39 : 0
Amphibians	4 : 0
Butterflies	2

Literature research revealed that no animals were restricted or endemic to the area. Some species listed, for example Brown Hyaena (*Hyaena brunnea*) due to frequent human activity, have a low likelihood of occurring within the site, but are nonetheless listed if their habits, habitat requirements and estimated distribution ranges agree with the study findings. Greater Kudu (*Tragelaphus strepsiceros*) and Eland (*Taurotragus oryx*) have been included as the livestock fencing would not stop them entering and exiting the site. The likelihood of any amphibians occurring on the site is low due to the complete lack of local water bodies. No physical records of the protected butterflies occurring in the site exist (Appendix A, Table 11-4), but have been included as their entire distribution ranges have not yet been confirmed. Further, both butterfly species are endemic to the region; have habitat preferences corresponding with habitat characteristics of the alternative site and the larval host plant of Linda's Hairtail (*Anthene lindae*) is *Acacia erioloba*, which occurs in both sites. Overall butterfly species richness is expected to be low compared to other South African vegetation types (Mecenero et al. 2013).

6 FLORISTIC AND GENERAL HABITAT ASSESSMENT

6.1 Methodology

Prior to visiting the site, a list of species that could potentially occur at the site was downloaded from "Plants of Southern Africa" (POSA) on the South African Biodiversity Institute's (SANBI) website at http://posa.sanbi.org. This list is provided at the quarter degree square (QDS) level of accuracy for the QDS 2822BA and included in Appendix B. At this broad scale, the list often includes many species that may not be found at the proposed site. However, any species of conservation concern will be indicated in the list and was researched before the site visit in order to know what species of conservation concern should be looked out for.

A visual reconnaissance of the study area was done before surveying commenced. Different homogenous vegetation units were identified and subsequently surveyed on foot and by vehicle in order to determine the floristic composition of each. The following data was recorded:

- All identifiable indigenous plant species (Appendix B) including red data or specially protected and also exotic plant species in each identified vegetation unit.
- General ecological and habitat data that may assist in the description of the floristic component of the study area.

A plotless sampling method was used to record data. Plant species observed in the study area during the time of the study were recorded and included in the plant species lists (Appendix B). The floristic composition of each of the identified broad vegetation units and/or application area are described and discussed. Plant species identification was done following the checklist of Germishuizen & Meyer (2003). Plant material was collected for identification purposes and where necessary the South African National Biodiversity Institute (SANBI) in Pretoria and other specialists were consulted in order to assist in plant species identification. All collected plant material will, if so requested by them, be donated to the South African National Herbarium of SANBI in Pretoria for inclusion into their extensive collection.

No formal consultation prosess was conducted as part of this floristic study as it was not deemed necessary at the time of the study.

6.2 General floristic and habitat information

According to Mucina & Rutherford (2006) the study area falls in the Gordonia Plains Shrubland vegetation type (SVk16). The following description of SVk16 has been summarized from Mucina & Rutherford (2006):

> **Gordonia Plains Shrubland**
>
> The Gordonia Plains Shrubland (SVk16) occurs in the Northern Cape Province in a broad band on flats wets of the Korannaberg and Langeberg Mountains and east of the main Kalahari duneveld area. SVK16 is distributed from Van Zylsrus in the north to southwest of Witsand in the south and also in

patches embedded in the duneveld area between Auob and Nossob Rivers in the Kgalagadi Transfrontier Park as well as in the valley containing Groot and Klein Mier south of the park. Summer and autumn rains (MAP: 180-280 mm) and cold, dry winters with frequent frost, and hot summers generally characterizes the climate. From a geological and soil perspective, aeolian sand, underlain by calcrete of the Kalahari Group with deep, lose sandy soils of the Namib soil form dominate. Main land types occurring in SVk16 are Ah and Af with some Ae.

The landscape is characterized by flat plains with virtually no dunes. The vegetation is dominated by open grasslands with occasional *Rhigozum trichotomum* and *Grewia flava* shrubs, sometimes including *Acacia haematoxylon* and scattered individuals of *Acacia erioloba*. Dominant trees and tall shrubs include the aforementioned four species as well as *Acacia mellifera* subsp. *detinens.* Graminoids are dominated by the grasses *Aristida meridionalis, Brachiaria glomerata, Centropodia glauca, Eragrostis lehmanniana, E. pallens, Schmidtia kalahariensis, Stipagrostis uniplumis* and the sedge *Bulbostylis hispidula*. Low shrubs and herbs include *Acanthosicyos naudinianus, Cucumis africanus, Dicoma capensis, Elephantorrhiza elephantina, Harpagophytum procumbens* subsp*. procumbens, Heliotropium ciliatum, Hermannia tomentosa, Ipomoea hackeliana, Jatropha erythropoda, Limeum argute-carinatum, Oxygonum dregeanum* subsp*. canescens, Plinthus sericeus, Reqienia sphaerosperma, Senna italica* subsp*. arachoides* and *Sericorema remotiflora.* Biogeographically important species include the Kalahari endemics *Acacia haematoxylon* (tall shrub), *Hermannia burchellii* (low shrub) and *Anthephora argentea,* (grass).

The conservation status of SVk16 is Least Threatened. A conservation target of 16% is envisioned by conservation authorities and about 9% of SVk16 is already statutorily conserved in the Kgalagadi Transfrontier Park. Very little is totally transformed and erosion is very low. This vegetation type resembles the description of Acocks' (1953) *Kalahari Thornveld and Shrub Bushveld* (VT 16) and also the description in Low and Rebelo (1996) of *Shrubby Kalahari Dune Bushveld* (LR 28).

The habitat characteristics of the study area somewhat resembles the description given for SVk16 above. The areas studied (i.e. the preferred and alternative sites – see Figure 2) differ slightly in terms of landscape features and habitat characteristics. The preferred site is mostly a flat plain with shrubs and low trees and the alternative site is situated on an area with a low hill with gradual north-eastern and south-western facing slopes and a higher density of tall woody vegetation. No clearly defined drainage lines were recorded on the preferred or alternative sites.

The soil surface of all sites is sandy with no visible rocks. In general, the soil on both sites can be described as sandy to loamy sand. Floristically two of the three broad vegetation units (VU's) closely resemble the description of SVk16. One of the three VU's, however, is somewhat different from the description of SVk16 from a floristic point of view.

76 plant species are recorded on the POSA data base of SANBI for the relevant QDS 2822BA and is included in Appendix B, Table 12-6. Keep in

mind that this list contains species at least two or three different vegetation types.

6.3 Floristic diversity recorded in the study area

A total of only 101 plant species (from 38 plant families and 83 genera) (Table 6-1 & Appendix B, Table 12-1) were recorded in the study area during the time of the study and indicates moderate species diversity. The woody layer (trees & shrubs) is represented by 12 woody species and the herbaceous layer is made up of 15 graminoids and 74 herbaceous shrubs, dwarf shrubs, geophytes and other herbs. 99% (100 of 101) of the recorded plant species are indigenous to South Africa. From available literature (Pujol 1988; Pooley, 1998; Schmidt *et* al 2002; Shearing & Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003) it was established that at least 32 of the recorded plant species in the study area are used for some or other social activities (medicinal, food/nourishment and/or cultural).

Table 6-1: Summary of plant families, genera and species recorded in the study area

	Families	Genera	Species
PTERIDOPHYTA (ferns):	0	0	0
GYMNOSPERMAE (Coniferous plants):	0	0	0
ANGIOSPERMAE (seed plants): ***Monocotyledonae:***	6	18	24
Dicotyledonae:	32	65	77
Total:	**38**	**83**	**101**

During the survey, which was done on foot and by vehicle, only taxa that were identifiable during the time of the study were noted and included in the plant species lists in Appendix B (Tables 12-1 to 12-5). The possibility exists that some plant species that emerge and bloom during another time of the year or under very specific circumstances, or species that are locally rare could have been missed during the survey, but on the other hand, the specialist is convinced that the majority of the species occurring in the study area were identified and recorded. The mentioned species lists contain the plant family name and scientific and common names of all plant species that was observed in the study area during the time of the study. Also included is, where applicable, the status of a species, which provides information on endemism, red data status or exotic status. Information on whether a species is utilized for medicinal, cultural or nutritional uses is also provided in the mentioned species lists.

Appendix B, Table 12-1 presents the diversity of plant families, genera and species recorded in the study area. A check list of plant species recorded during this study is included in Tables 12-2 through 12-5 of Appendix B.

6.4 Description of Broad Vegetation Units in the Study Area

Three broad Vegetation Units (VU's) were recorded and are described in the sections below (Figure 9). The three VU's are:

- VU 1: *Acacia haematoxylon* open woodland
- VU 2: *Acacia mellifera* semi-closed woodland
- VU 3: *Schmidtia pappophoroides* open plains

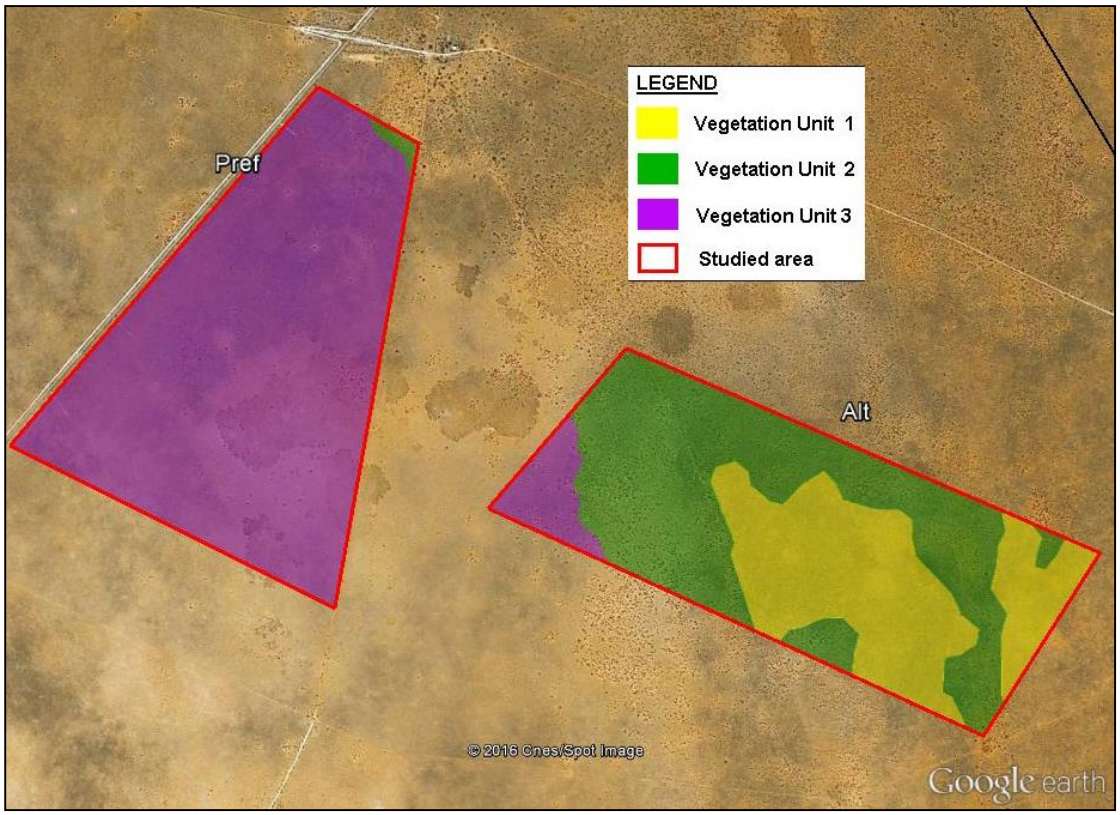


Figure 9: Image depicting the three vegetation units recorded in the study area

6.4.1 VU1: *Acacia haematoxylon* open woodland

This VU (Figure 10) occurs only on the alternative site on slightly undulating terrain on deep sandy soils with no rocks on the soil surface. The vegetation is dominated by grass and woody shrubs and trees. Ecologically speaking VU1 is in a moderate to good veld condition with many high quality grazing plants available in the habitat. The grass cover is moderate to poor. Very few signs of bush encroachment

The tree species *Acacia haematoxylon* totally dominates the woody cover in this VU. Other tree species and woody shrubs of significance are *Acacia erioloba, A. hebeclada, A. mellifera* subsp*. detinens*, *Lycium hirsutum* and

Grewia flava. Dominant graminoids* are *Bulbostylis hispidula, Eragrostis pallens, Aristida stipitata, Schmidtia pappophoroides, S. kalahariensis, Stipagrostis uniplumis* and *Anthephora pubescens*. Herbaceous forbs and shrubs that mostly occur in VU1 are *Heliotropium ciliatum, Plinthus sericeus, Gisekia africana, Senna italica* subsp*. arachoides, Elephantorrhiza elephantina, Crotalaria orientalis, Merremia verecunda, Limeum viscosum, Requienia sphaerosperma Hermannia tomentosa* and *Tephrosia purpurea.*

Figure 10: VU1 – portion of *Acacia haematoxylon* open woodland on the alternative site.

During the time of this study 59 plant species (all indigenous) were recorded in VU1. These included seven woody species (exotic), 12 graminoids (none exotic) and 40 herbaceous and dwarf shrubs and other forbs (0 exotic) were recorded. From available literature (Pujol 1988; Pooley 1998; Schmidt *et* al 2002; Shearing &Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003), it was established that at least 14 of the plant species recorded in VU1 are to some extent utilized for some or other social activity or use (medicinal, nourishment/food, and/or cultural).

6.4.2 VU2: *Acacia mellifera* semi-closed woodland

As VU1, this vegetation unit (Figures 11 & 12) occurs on both the preferred and alternative sites on deep sandy with virtually no surface rocks on slightly undulating terrain. The vegetation is dominated by trees and tall shrubs. From an ecological point of view VU2 is in a poor veld condition due to overgrazing in the past. Although generally the same grass species were recorded as in VU1, the grass cover is poor (Figure 11) and even absent in large patches (Figure 12). High levels of bush encroachment, by especially

* graminoids = grass like plants (grasses and sedges)

Acacia mellifera subsp*. detinens,* were also observed in some areas of VU2 (Figure 12).

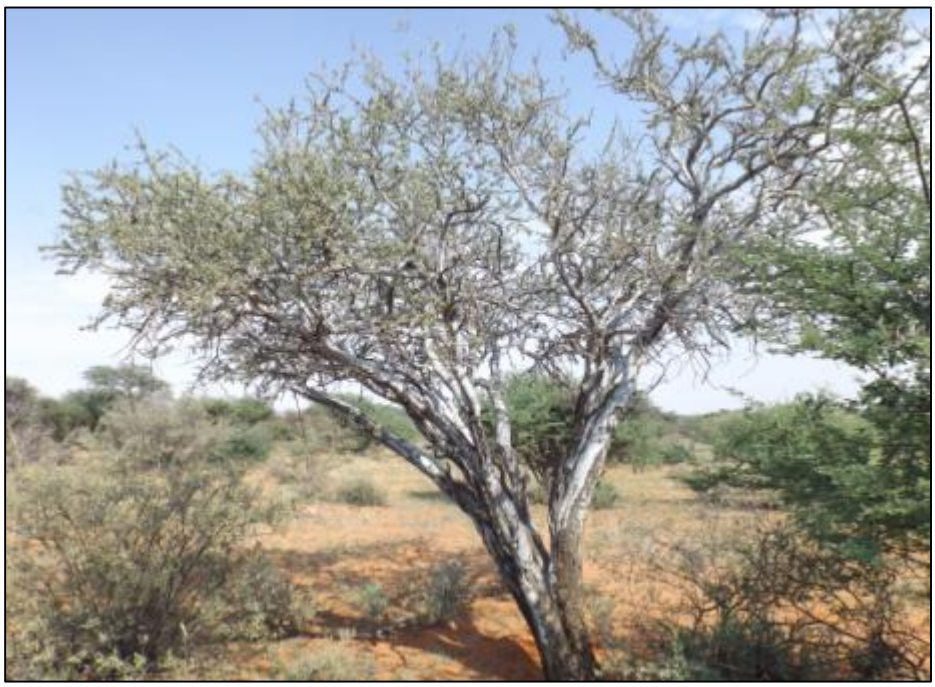


Figure 11: VU2 – portion of *Acacia mellifera* semi-closed woodland with some grass cover (background) and a specimen of the protected *Boscia albitrunca* (foreground).

Figure 12: VU2 – portion of *Acacia mellifera* semi-closed woodland with virtually no grass cover and high level of bush encroachment.

Dominant tree species in VU2 include *Acacia mellifera* subsp*. detinens, A. erioloba, Boscia albitrunca, Grewia flava* and *Lycium cinereum.* Dominant graminoids are *Aristida stipitata, Centropodia glauca, Schmidtia pappophoroides, S. kalahariensis, Eragrostis lehmanniana and Enneapogon cenchroides*. Herbaceous shrubs and forbs include *Elephantorrhiza elephantina, Senna italica* subsp*. arachoides, Cleome gynandra, Tephrosia purpurea, Solanum supinum, Asparagus bechuanicus* and *Eriocephalus ericoides.*

During the time of this study 62 plant species (61 indigenous, 1 exotic) were recorded in VU2. These included 12 woody species (1 exotic), 10 graminoids (none exotic) and 40 herbaceous and dwarf shrubs and other forbs (0 exotic) were recorded. It was established from available literature (Pujol 1988; Pooley 1998; Schmidt *et* al 2002; Shearing &Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003), that at least 23 of the plant species recorded in this VU are to some extent utilized for some or other social activity or use (medicinal, nourishment/food, and/or cultural).

6.4.3 VU3: *Schmidtia pappophoroides* open plains

This VU (Figures 13 & 14) occurs only on the preferred site on a flat plain with no visible changes in topography. Soils are deep sandy to loamy sand with no observable rocks on the soil surface. Structurally the vegetation is dominated by grasses, dwarf shrubs and forbs with a low to moderate cover of trees and tall shrubs. From an ecological point of view VU3 varies from a moderately good to poor condition. The grass cover is fairly good on the open plains (Figure 13), but totally absent in dense bush encroached patches of the tall shrub *Rhigozum trichotomum* (Figure 14). These patches vary from a few square meters to as large as more than16 ha in extent. Overgrazing is probably the main driver behind this bush encroachment, which seems to be ever increasing on the natural plainsland.

The dominant tree species in VU3 are *Acacia erioloba, A. haematoxylon, Rhigozum trichotomum, Grewia flava* and *Ziziphus mucronata*. The most significant graminoids are *Schmidtia pappophoroides, S. kalahariensis, Stipagrostis uniplumis Aristida stipitata, Centropodia glauca* and *Bulbostylis hispidula*. The dwarf shrubs *Monechma incanum* and *Eriocephalus ericoides* as well as the herbaceous shrubs and forbs *Merremia verecunda, Senna italica* subsp*. arachoides, Hermannia vestita, Jatropha erythropoda, Tephrosia purpurea, Talinum crispatulum, Gnidia polycephala, Limeum fenestratum, L. viscosum* and *Gisekia pharnacioides*.

This VU is the most diverse in terms of floristic composition compared to the other two described VU's. 80 plant species (79 indigenous, 1 exotic) were recorded in VU3. 12 are woody trees/shrubs (1 exotic), 11 are graminoids (none exotic) and 57 are dwarf and herbaceous shrubs and other forbs (0 exotic). It was also established from available literature (Pujol 1988; Pooley, 1998; Schmidt *et* al 2002; Shearing & Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003), that at least 26 of the recorded plant species

in VU3 are to some extent utilized for some or other social activity or use (medicinal, nourishment/food, and/or cultural).

Figure 13: VU3 – *Schmidtia pappophoroides* open plains with fairly good grass and low tree cover.

Figure 14: VU3 – a *Rhigozum trichotomum* bush encroached patch with very poor grass cover.

6.5 Red Data, Protected and Endemic Plant Species

Eleven plant species of specific conservation significance were recorded in the study area during the study period. One of these species is listed as a Threatened or Protected Species (ToPS) by the National Environmental Management: Biodiversity Act's (Act No. 10 of 2004) list of ToPS as published in Government Gazette no. 36375 of 16 April 2013 (NEMBA ToPS, 2013). Two are listed by Raimondo *et al* (2009) in the South African Red Data list as Declining species. Three trees are included in the protected tree species list as published in the National Forests Act (Act no.84 of 1998) (NFA, 1998), and eight of the eleven are listed as protected and one as specially protected by the Northern Cape Nature Conservation Act (Act no. 9 of 2009) (NCNCA, 2009).

Table 6-2 lists the recorded ToPS, Red Data listed and protected species relative to the different vegetation units they were recorded in during the time of this study. In Appendix C, Table 13-1 a list appears with the coordinates of recorded protected plant species in the study area. Figure 15 shows the positions of the recorded specimens in relation to the different studied areas. More specimens of these species, which are not listed in Appendix C, do occur in the study area, but due to time constraints these could not be referenced during this study. **It is strongly advised** that once the exact position of development activities and infrastructure has been planned and finalized that a full population study of each affected area be done to determine the population size and extent of these and possibly other protected species within the study area and the relevant appropriate action is then taken.

Table 6-2: List of protected plant species recorded in the study area

Note: abbreviations used in Table 6-2 are as follows:
D – Declining (Raimondo *et al*, 2009); P(SA) – nationally protected tree species (NFA, 1998); P(NC) – provincially protected species (NCNCA, 2009); SP(NC) – provincially specially protected species (NCNCA, 2009); ToPS - threatened or protected species (NEMBA ToPS, 2013).

SPECIES NAME	FAMILY	SPECIES STATUS	GROWTH FORM	VEGETATION UNIT		
				1	2	3
Acacia erioloba	FABACEAE	D, P(SA)	Tree	X	X	X
Acacia haematoxylon	FABACEAE	P(SA)	Tree	X	X	X
Asclepias aurea	APOCYNACEAE	P(NC)	Geophytic herb	X		X
Boophone disticha	AMARYLLIDACEAE	D; P(NC)	Herb, geophyte			X
Boscia albitrunca	CAPPARACEAE	P(SA), P(NC)	Tree	X	X	X
Gomphocarpus fruticosus subsp. *fruticosus*	APOCYNACEAE	P(NC)	Herbaceous shrub		X	X
Harpagophytum procumbens subsp. *procumbens*	PEDALIACEAE	TOPS, SP(NC)	Herb			X
Huernia zebrina subsp. *magniflora*	APOCYNACEAE	P(NC)	Succulent			
Pentarrhinum insipidum	APOCYNACEAE	P(NC)	Herb, climber		X	
Pergularia daemia var. *daemia*	APOCYNACEAE	P(NC)	Herb, climber	X	X	X
Sarcostemma viminale subsp. *Viminale*	APOCYNACEAE	P(NC)	Succulent climber	X	X	X

Figure 15: Recorded positions of protected plant species in the study area

Note: The numbered labels on Figure 15 correspond to the serial number (S/N) in the first column of Table 13-1 of Appendix C.

Due to the high numbers of nationally protected trees (NFA, 1998) (i.e. *Acacia erioloba, A. haematoxylon and Boscia albitrunca*) the individual positions of these species were not individually geo-referenced during this study. Instead a number of belt transects were conducted in each different VU to determine the density at which these species occur in the study area and just beyond.

22 belt transects of 100 x 40 m (4000 m^2) were conducted in the area (7 in VU1, 7 in VU2 and 8 in VU3) and only the numbers of the three nationally protected trees were considered. All specimens of these species within the belt transect were counted and noted together with the height of each specimen. Differentiation was made between specimens higher than 2 m (> 2 m) and those shorter than 2 m but not less than 1 m (< 2 m = 1 m). Specimens shorter than 1 m were not counted. Table 6-3 gives a summary of the results of this survey. In Appendix C, Table 13-2 presents the results in detail.

An example for the interpretation of Table 6-3 is as follows: The total number of specimens of, for example, *Acacia haematoxylon* in VU2 is 2565. This number of specimens is the sum of the *A. haematoxylon* shrubs (1 to < 2 m) i.e. 570, and the trees (> 2 m) i.e. 1995. The total calculated number of *A. haematoxylon* specimens to occur in the study area (250 ha preferred site + 250 ha alternative site) is 12560. To calculate the number of specimens of any one of the three species for any given surface area, one will take the

surface area (in ha) and multiply it with the average species density/ha of the relevant species and VU.

Table 6-3: Protected tree species frequency, density/ha & number of specimens/VU

VU	VU area (ha)	Average species frequency (as counted on 4000 m²)								
		Acacia erioloba			*Acacia haematoxylon*			*Boscia albitrunca*		
		1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total
1		0.4	1.6	2.0	7.4	20.3	27.7	0.1	0.3	0.4
2		2.4	9.4	11.9	0.9	3.0	3.9	0.1	3.1	3.3
3		3.0	5.5	8.5	2.0	5.1	7.1	0.0	0.1	0.1
Average species density / ha										
1		1.28	4.68	5.96	22.13	60.43	82.55	0.43	0.85	1.28
2		6.07	23.57	29.64	2.14	7.50	9.64	0.36	7.86	8.21
3		7.50	13.75	21.25	5.00	12.81	17.81	0.00	0.31	0.31
Number of specimens per VU										
1	83	106	389	494	1837	5015	6852	35	71	106
2	164	996	3866	4861	351	1230	1581	59	1289	1347
3	253	1898	3479	5376	1265	3242	4507	0	79	79
	Total:			**10732**			**12940**			**1532**

6.6 Exotic Plant Species

During the study the alien invasive woody species *Prosopis glandulosa* var. *torreyana* was recorded in the study area. According to Hoffman *et al* (1999) (in Mucina & Rutherford, 2006) *P. glandulosa* is one of the 12 agriculturally most important invasive alien plants in South Africa. According to the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA, 1983) in Henderson (2001) and the National Environmental Management Biodiversity Act's 2014 list of proposed weeds and invaders (NEMBA, 2014), this species is classified as an alien invader species. *P. glandulosa* was the only exotic species to be recorded during the time of this study.

Exotic plant species in the species lists (Appendix B: Tables 12-1 to 12-5) are preceded by an asterisk (*) and/or indicated by the letter "E" in the Species Status column in the case of uncategorized exotic species. In the case of declared or proposed weeds or invaders the invasive status of the species, according to (CARA, 1983) (Table 6-4) and (NEMBA, 2014) (Table 6-5) are indicated in the Conservation Status column of the species lists in Appendix B as follows:

- C1 – declared weed category 1 (CARA, 1983).
- C2 – declared invader category 2 (CARA, 1983).
- C3 – declared invader category 3 (CARA, 1983).

- CX1, CX2 or CX3 – proposed weed or invader (CARA, 1983).
- N1b – NEMBA (2014) category 1b
- N2 – NEMBA (2014) category 2
- N3 – NEMBA (2014) category 3

Table 6-4: Description of the invasive status of exotic plant species according to Henderson (2001)

Invasive status (category)	Description
Declared weed (category 1) **– C1** Proposed weed **– CX1**	• Prohibited on any land or water surface in South Africa. • Must be controlled or eradicated were possible (except in biological control reserves).
Declared invader (category 2) **– C2** Proposed invader **– CX2**	• Allowed only in demarcated areas under controlled conditions. • Import of propagative material and trading allowed only by permit holders. • Outside demarcated areas, it must be controlled, or eradicated where possible (except in biological control reserves). • Prohibited within 30 m of the 1:50 year flood-line of watercourses or wetlands unless authorization is obtained.
Declared invader (category 3) **– C3** Proposed invader **– CX3**	• No further plantings of these species are allowed (except with special permission). • Trade of propagative material is strictly prohibited. • Existing plants may remain but must be prevented from spreading. • Prohibited within 30 m of the 1:50 year flood-line of watercourses or wetlands, or as directed.

Table 6-5: Description of the invasive status of exotic plant species according to NEMBA (2014)

Invasive status (category)	Description
Category 1b **– N1b**	• Invasive species requiring compulsory control as part of an invasive species control program • Remove and destroy • These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management program • No permits will be issued

Invasive status (category)	Description
Category 2 **– N2**	• Invasive species regulated by area • A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants • No permits will be issued for these plants to exist in riparian zones
Category 3 **– N3**	• Invasive species regulated by activity • An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species • No permits will be issued for Cat 3 plants to exist in riparian zones

7 THREATENED AND PROTECTED ECOSYSTEMS

No ecosystems that are threatened and in need of protection according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) was recorded in or in the vicinity of the study area.

8 IMPACT ASSESSMENT

8.1 Assessment of expected impacts and relevant mitigation

The five tables in the section below (Tables 8-1 to 8-5) serve to summarise the significance of expected and potential impacts on the faunal, floral and habitat features occurring on or directly adjacent to the study area. A summary of expected construction, operational and decommissioning phase impacts are provided. No significant impacts are expected during the pre-construction phase. Tables 8-2, 8-3 and 8-4 present the descriptions of impacts as well as impact assessments according to the method and rating system described in Table 8-1. In addition, Tables 8-2 to 8-4 also indicates mitigatory and management measures needed to minimise the expected ecological impacts.

Table 8-1: Rating system for the evaluation of impacts related to the proposed development

NATURE		
A brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire

		operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative	The impact would result in minor cumulative effects.

	impact	
4	High cumulative impact	The impact would result in significant cumulative effects

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.
The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

Table 8-2: Assessment of Impact: Loss of habitat for faunal and floral species

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 1: Loss of habitat for faunal and floral species.	Site clearing and the removal of vegetation leading to loss of faunal & floral habitat.	Ongoing disturbance of soils, with general operational activities, and control of woody vegetation leading to altered faunal & floral habitat.	Disturbance of soils as part of demolition activities may alter faunal & floral habitat.
	Site clearing and the disturbance of soils leading to increased erosion.	Increased run off from paved areas and access roads causing erosion in adjacent areas; Insufficient maintenance of runoff systems leading to erosion.	Disturbance of soils as part of demolition activities leading to increased erosion; Insufficient aftercare and maintenance leading to erosion.
	Compaction of soils by construction vehicles.	Ongoing compaction of soils by maintenance vehicles.	Compaction of soils by construction vehicles as part of demolition and rehabilitation activities.
	Movement of construction vehicles impacting on habitat through pollution by noise, fuel, oils, hydraulic fluids, etc.	Continued movement of vehicles in the area impacting on habitat through pollution by noise, fuel, oils, hydraulic fluids, etc.	Movement of construction vehicles as part of demolition and rehabilitation activities impacting on habitat through pollution by noise, fuel, oils, hydraulic fluids, etc.

	Disturbance of the soil will transform the vegetation in the study area and create conditions favorable for the establishment of populations of alien and invader plant species as well as common weeds.	Lack of management of transformed habitat will create favorable conditions for the spread of populations of alien and invader plant species to neighboring natural habitats causing further transformation.	Ineffective rehabilitation of impacted areas and failure to implement a comprehensive alien weed control plan may lead to ongoing loss of habitat.
	With the development of any infrastructure the fragmentation of natural habitats can occur with the negative effect that the flow of ecosystem services (seed dispersal, pollination, gene flow, etc.) may be interrupted having a negative long term effect on isolated fragments.	Solar panels trap solar energy, effectively altering the microclimate and habitat beneath them.	

Impact assessment:

Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	4	3	3	2	2	2	**45** (negative medium impact)

Mitigation of Impact 1:

Injudicious and unnecessary destruction of natural vegetation, other than the footprint area of the proposed development, must be avoided at all cost. To minimise unnecessary disturbances the construction phase should not exceed its scheduled period.

To prevent the erosion of topsoil, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion. Water control structures should be constructed and well maintained to minimize erosion and to create a favorable habitat for the establishment of vegetation during the operation of the development and after decommissioning and rehabilitation.

Wherever possible, any soil that can serve as a growth medium for plants must be stripped and stockpiled for future landscaping and/or rehabilitation after or during the construction phase and should be used as soon as possible after "harvesting" to ensure that seed sources does not become worthless due to decomposition of the seed over time. It must be ensured that such topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion or siltation. Stockpiles should also be placed away from areas known to contain hazardous substances such as fuel.

All soils compacted as a result of construction activities falling inside the development footprint areas should be ripped and profiled after the construction phase. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development and decommissioning phases to prevent loss of floral habitat.

Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development/ decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled. A management plan and proper follow-up strategy for the prevention of the establishment and/or further spread of new populations of such species should be developed and enforced.

Vehicles should be well maintained to prevent oil and other chemically based materials to enter the area. Refueling points should be well managed and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

After the construction phase and also during the decommissioning/rehabilitation phase, reseeding of indigenous grasses should be done in between the developed infrastructure and all affected areas to re-establish microclimates and niche habitats. These re-seeded areas should be well maintained during the operational phase. Upon decommissioning, all fencing should be removed to re-establish landscape connectivity.

Table 8-3: Assessment of Impact: Loss of indigenous faunal and floral species diversity

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 2: Loss of indigenous faunal and floral species diversity.	Site clearance and removal of vegetation for construction of infrastructure and access roads through natural areas leading to a loss of natural species diversity.	Ongoing edge effects from operating the SPP impacting on natural species diversity.	Disturbance of soils as part of demolition activities and ineffective rehabilitation of impacted areas further impacting on natural species diversity.
	Proliferation of alien species may alter plant community structure. Failure to implement a comprehensive alien weed control plan leading to an increase in alien vegetation encroachment.	An increase in alien species leading to altered plant community structure and composition especially in neighboring habitats.	Ineffective rehabilitation of impacted areas and failure to implement a comprehensive alien weed control plan may lead to ongoing loss of natural species diversity.
		Erosion and sedimentation as a result of operational activities leading to a loss of natural species diversity.	Continued erosion and sedimentation during closure and decommissioning leading to a loss of natural species diversity.

Impact assessment:							
Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	2	4	2	4	3	2	**34** (negative medium impact)

Mitigation of Impact 2:
An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the developed and surrounding area. Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, closure/decommissioning and rehabilitation/ maintenance phases. Care should be taken with the choice of herbicides to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicides used. Proper training should be given to contractors/applicators to avoid spraying indigenous vegetation. Landscaping with local indigenous species is preferable and could include forage and host plants required by pollinators. After the construction phase and also during the decommissioning/rehabilitation phase, reseeding of local indigenous plant species should be done in between the developed infrastructure and all affected areas to re-establish plant species diversity, which in turn will create habitat for the return of faunal species, especially small mammals and invertebrates. These re-seeded areas should be well maintained during the operational phase. To prevent the erosion of topsoil, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion. Water control structures should be constructed and well maintained to minimize erosion and to create a favorable habitat for the establishment of vegetation during the operation of the development and after decommissioning and rehabilitation.

Table 8-4: Assessment of Impact: Loss of faunal and floral species of conservation significance

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 3: Loss of faunal and floral species of conservation significance.	Site clearance and removal of vegetation leading to a loss of any recorded and unrecorded species of conservation significance such as ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value.	An increase in alien plant species leading to loss of species of conservation significance such as ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value by outcompeting these species.	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien weed control plan leading to ongoing loss of species of conservation significance.
		Erosion and sedimentation as a result of operational activities leading to a loss of species of conservation significance.	Continued erosion and sedimentation during closure and decommissioning leading to a loss of species of conservation significance.

Impact assessment:							
Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	4	4	3	4	2	3	**57** (negative high impact)

Mitigation of Impact 3:
According to SANBI's Guidelines for Environmental Impact Assessments (http://redlist.sanbi.org/eiaguidelines.php), *in situ* conservation of species of conservation significance is vital and is recommended as the only option for conserving species of conservation concern. *Ex situ* conservation, i.e. the removal of a subpopulation from its natural habitat to an artificial environment, a practice often termed "search and rescue", will result in the erosion of the inherent genetic diversity and characteristics of that species and increase its risk of extinction in the wild. Similarly, translocation of subpopulations is an unacceptable conservation measure. Translocations are expensive and rarely successful. Even if they are successful, translocated individuals may harm other species within the receiving environment, the translocated individuals may transmit pathogens and/or parasites, and translocation may result in rapid changes in the species itself. In spite of the above point, if species of conservation significance, and more specifically plant species, are going to be destroyed due to the construction of the proposed development it may be recommended that these species, especially geophytes, be located and "rescued" by transplanting specimens into a nursery or other safe site until they can be used during rehabilitation and/or landscaping. Populations of species of conservation significance (ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value) occurring outside the areas that will be directly impacted by the proposed development needs to be actively conserved in order to conserve a viable, non-fragmented gene pool of these species in the local area. If possible, developments that jeopardize any large populations of species of conservation significance should be planned in such a way as to avoid the populations and their habitat. Any specimens of protected plant species known to occur in the vicinity of the development footprint and may potentially be impacted by the development activities, are to be fenced off for the duration of the activity. If these species fall within the development footprint special authorisation is to be obtained from relevant conservation authorities for such species to be cut, disturbed, damaged or destroyed. Applications for such activities should be made to the responsible official within the relevant Northern Cape Nature Conservation Agency.

Based on the above assessment it is evident that there are three expected impacts on the floral ecology within the study area. Table 8-5 summarises the findings indicating the significance of the impact before management takes place (as described in Tables 8-2 to 8-4) and the likely impact if management and mitigation takes place. From Table 8-5 it is evident that prior to management measures being put in place, the impacts are negative-medium or negative-high level impacts. If effective management takes place, all impacts will be reduced to low level impacts.

Table 8-5: A summary of the results from the impact assessments

Impact	Not mitigated / managed	Mitigated / managed
1. Loss of habitat for faunal and floral species	negative medium impact	negative low impact
2. Loss of indigenous faunal and floral species diversity	negative medium impact	negative low impact
3. Loss of faunal and floral species of conservation significance	negative high impact	negative medium to low impact

8.2 Assessment of the no-go alternative

Due the destructive nature of the proposed development to the floristic diversity occurring in the directly affected area and the direct impact it will also have on the faunal diversity of the area on a local scale, the no-go alternative will see the area stay in the current condition. The current impacts exerted on the area from an agricultural point of view (not assessed in this study) will remain and, depending on the management strategies employed by the land owner and natural climatic conditions, the current natural condition may improve or deteriorate in future.

8.3 Monitoring requirements

From a floristic point of view the following should be monitored during all phases of the proposed development:

- Floristic diversity of the development area as well as areas directly adjacent.
- Populations of ToPS, Red Data and other protected plant species on neighbouring properties / areas must be assessed and monitored during all project phases.
- The removal of any ToPS, Red Data and other protected plant species must be well monitored and managed. Authorisation, through a provincial and/or national permitting system, is to be obtained from relevant conservation authorities for such species to be cut, disturbed, damaged or destroyed.

From a faunal point of view the following should be monitored:

- Faunal diversity of the areas directly adjacent to the develpoment area.
- During construction any faunal species caught up in the midst of activities, which can be tanslocated to neighbouring open areas, such as tortoises, should be handled by trained professionals and strictly monitored.
- During the operational phase, as the floristic habitat recovers, the return of especially small mammals should be promoted as these species play an important role in the natural health of an ecosystem. This process can also be monitored by annual or bi-annual monitoring.

9 CONCLUDING REMARKS

The low faunal and moderate floristic species richness and density recorded would equate to an insignificant impact to the regional diversity of plants, mammals, reptiles and amphibians. Although the number of protected faunal species possibly occurring on or in close proximity to the site is low, these deserve consideration. It must be stressed that the short study period may affect the generation of a representative sample (see also 'Assumptions and Limitations'). We are nonetheless confident in the sampling methods employed as the methodology was designed with the study limitations in mind.

The loss of topsoil and fragmentation of natural habitats that is virtually unavoidable with any type of development, has a negative impact on the regional ecosystem as it disrupts the natural flow of ecosystem services and affects all fauna and flora that are dependent on those habitats. Linear ridges, water courses, wetlands, drainage lines, etc. are especially sensitive to and easily fragmented. A high conservation value is attributed to the plant communities and faunal assemblages of these areas as they contribute significantly to the biodiversity of a region. Care should be taken not to unnecessarily clear or destroy natural vegetation and where possible the rehabilitation of transformed areas and restoration of degraded natural veld should take place in order to improve the ecological health of the floristic component on the property. Development should therefore be planned in such a way that totally transformed areas are chosen for major developments and natural veld, even if it is already degraded and/or fragmented, is avoided as far as possible. A legitimate and well-designed rehabilitation plan must be set in place before mining commences and be strictly enforced on an on-going basis throughout the life of the mine and thereafter.

When considering the different sites (preferred and alternative sites) that were investigated during this study, from a faunal, floral and general ecological point of view, it is concluded that the preferred site may be accepted for the proposed development.

10 REFERENCES

10.1 Literature referred to in this report

Acocks, J.P.H. 1953. Veld Types of South Africa. *Memoirs of the Botanical Survey of South Africa No. 57*. Department of Agriculture and Water Supply, South Africa.

Avenant, N.L. & Cavallini, P. 2007. Correlating rodent community structure with ecological integrity, Tussen-die-Riviere Nature Reserve, Free State province, South Africa. *Integrative Zoology* 2, pp. 212-219.

Cowling, R.M., Richardson, D.M. & Pierce, S.M. 2004. *Vegetation of Southern Africa*, p. 167. Cambridge University Press, London.

Francis, C.D. & Barber, J.R. 2013. A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and the Environment* 11, pp. 305-313.

Henderson, L. 2001. Alien weeds and Invasive Plants. Plant Protection Research Institute, Agricultural Research Council. Paarl Printers, Cape Town.

Hernandez, P.A., Graham, C.H., Master, L.L. & Albert, D.L. 2006. The effect of sample size and species characteristics on performance of different species distribution modeling methods. *Ecography* 29, pp. 773-785.

Hoffman, M.T., Todd, S., Ntshona, Z. & Turner, S. 1999. *Land degradation in South Africa*. South African National Botanical Institute, Kirstenbosch.

http://www.eia.org.za/introduction.html (accessed 24/03/2016 at 11:00AM).

https://www.dwa.gov.za/orange/low_orange/prieska.htm(accessed 24/03/2016 at 14:00PM).

http://redlist.sanbi.org/eiaguidelines.php

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

McCrary M.D., McKernan P.A.F. & Wagner W.D. 1982. Wildlife interactions at solar one: final report. Rosemead, California.

Mucina, L. & Rutherford, C. 2006. The vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute. Tien Wah Press, Singapore.

NCNCA, 2009. Northern Cape Nature Conservation Act no. 9 of 2009. *Provincial Gazette no 1566, 19 December 2011*.

NEMBA, 2004. National Environmental Management: Biodiversity Act (Act no. 10 of 2004). *Government Gazette No. 26436, Vol. 467, of 7 June 2004*, Pretoria.

NEMBA, 2014. National Environmental Management: Biodiversity Act (Act no. 10 of 2004): Alien and Invasive Species Lists. *Government Gazette No. 37886, Vol. 599, of 01 August 2014*, Pretoria.

NEMBA TOPS, 2013. National Environmental Management: Biodiversity Act (Act 10 of 2004): Publication of Lists of Species that are Threatened or

Protected, Activities that are Prohibited and Exemption from Restrictions. *Government Gazette No. 36375, of 16 April 2013. Notice no. 389 of 2013*.

Newbold, T. 2010. Applications and limitations of museum data for conservation and ecology, with particular attention to species distribution models. *Progress in Physical Geography* 34.

NFA, 1998. List of protected tree species under the National Forests Act of 1998 (Act no.84 of 1998), Dept. of Water affairs and Forestry. *Government Gazette No. 30253, Vol. 817*, Pretoria.

Pooley, E. 1998. A Field Guide to Wild Flowers of Kwazulu-Natal and the Eastern Region. Natal Flora Publications Trust, Durban.

Pujol, J. 1988. The Herbalist Handbook – African Flora Medicinal Plants.NaturAfrica, Jean Pujol Natural Healers Foundation, Durban.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. and Manyama, P.A. 2009. Red List of South African Plants.Strelitzia 25. South African National Biodiversity Institute, Pretoria.

Rutherford, M.C., Mucina, L. & Powrie, L.W. 2006. Biomes and Bioregions of Southern Africa. *Strelitzia 19: Vegetation of South Africa, Lesotho & Swaziland*, chapter 3. SANBI, Pretoria.

Schmidt, E., Lötter, M. & McCleland, W. 2002. Trees and Shrubs of Mpumalanga and Kruger National Park.Jacana, Johannesburg.

Shepard, D.B., Kuhns, A.R., Dreslik, M.J. & Phillips, C.A. 2008. Roads as barriers to animal movement in fragmented landscapes. *Animal Conservation* 11, pp. 288-296.

Shearing, D. & Van Heerden, K. 1994. Karoo.South African Wild Flower Guide 6. Botanical Society of South Africa, Kirstenbosch, Claremont.

Turney, D. & Fthenakis, V. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. *Renewable and Sustainable Energy Reviews* 15, pp. 3261-3270.

Van Wyk, Ben-Erik & Gericke, N. 2003. Peoples Plants, a Guide to Useful Plants of Southern Africa, Briza Publications, Pretoria.

Van Wyk, Ben-Erik, Van Oudtshoorn, B. & Gericke, N. 1997. Medicinal Plants of South Africa, Briza Publications, Pretoria.

10.2 Other Literature and Field Guides Consulted

The following were used for desktop studies and identification of faunal and floral species in the field and not necessarily referred to in the text of this document:

Alexander, G.J. & Marais, J. 2007. *A Guide to Reptiles of Southern Africa*. Struik Nature, Cape Town.

Bates, M.F., Branch, W.R, Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. 2014. *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland*. SANBI, Pretoria.

Bromilow. C. 1995. Problem Plants of South Africa. Briza Publications cc, Arcadia.

Du Preez, L. & Carruthers, V. 2009. *A Complete Guide to Frogs of Southern Africa*. Struik Nature, Cape Town.

Friedmann, Y. & Daly, B, 2004. *Red Data Book of the Mammals of South Africa: A Conservation Assessment*. Endangered Wildlife Trust. South Africa.

Germishuizen, G. & Fabian, A. 1997. Wild Flowers of Northern South Africa. Fernwood Press, Cape Town.

Manning, J. 2003. SASOL *Eerste Veldgids tot Parasitiese en Vleis-etende Plante van Suider Afrika*. Struik Publishers, Cape Town.

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 and the Animal Demography Unit, University of Cape Town.

Republic of South Africa, 2007. *Government Gazette No. 29657, No. R 151*, Pretoria.

Schradin, C., Krackow, S., Schubert, M., Keller, C., Schradin, B. & Pillay, N. 2007. Regulation of Activity in Desert-Living Striped Mice: The Importance of Basking. *Ethology* 113, pp. 606-614.

Stuart, C. & Stuart, M. 2015. *Stuart's Field Guide to Mammals of Southern Africa*. Struik Nature, Cape Town.

Van der Walt, R. 2009. Wild Flowers of the Limpopo Valley. Retha Van der Walt, Ludwigslust Game Farms, Musina.

Van Oudtshoorn, F. 1999. Guide to the grasses of Southern Africa. Briza Publications, Pretoria.

Van Rooyen, N., Bezuidenhout, H. & De Kock, E. 2001. Blomplante van die Kalahari-duineveld. Ekotrust cc, Lynwood.

Van Wyk, A.E. & Malan, S.J. 1997. Field Guide to the Wild Flowers of the Highveld (2nd edn.). Struik Publishers, 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, Hatfield, Pretoria.

Van Wyk, B. & Smith, G.F. 1996. Guide to Aloes of South Africa. Briza Publications, Pretoria.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to Trees of Southern Africa, Struik Publishers, Cape Town.

11 APPENDIX A: lists of faunal species that may occur in the study area

Table 11-1: Mammal species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Macroscelidea	Macroscelididae	Round-eared Sengi	*Macroscelides proboscideus*	Least concern
Eulipotyphla	Erinaceidae	Southern African Hedgehog	*Atelerix frontalis*	Near threatened
Pholidota	Manidae	Ground Pangolin	*Smutsia temminckii*	Vulnerable
Lagomorpha	Leporidae	Cape Hare	*Lepus capensis*	Least concern
		Scrub Hare	*Lepus saxatilis*	Least concern
Rodentia	Sciuridae	Southern African Ground Squirrel	*Xerus inauris*	Least concern
	Pedetidae	Southern African Springhare	*Pedetes capensis*	Least concern
	Bathyergidae	Common Mole-rat	*Cryptomys hottentotus*	Least concern
	Hystricidae	Cape Porcupine	*Hystrix africaeaustralis*	Least concern
	Muridae	Woosnam's Desert Mouse	*Zelotomys woosnami*	Least concern
		Pouched Mouse	*Saccostumus campestris*	Least concern
		Grey Climbing Mouse	*Dendromus melanotis*	Least concern
		Large-eared Mouse	*Malacothrix typica*	Least concern
		Cape Short-tailed Gerbil	*Desmodillus auricularis*	Least concern
		Pygmy Hairy-footed Gerbil	*Gerbillurus paeba*	Least concern
		Bushveld Gerbil	*Gerbilliscus leucogaster*	Data deficient
		Highveld Gerbil	*Gerbilliscus brantsii*	Least concern
		Red Veld Rat	*Aethomys chrysophilus*	Least concern
		Four-striped	*Rhabdomys* spp	Least

		Grass Mouse		concern
		Black-tailed Tree Rat	*Thallomys nigricauda*	Least concern
		Southern Multimammate Mouse	*Mastomys Coucha*	Least concern
		Brant's Whistling Rat	*Parotomys brantsii*	Least concern
Carnivora	Canidae	Cape Fox	*Vulpes chama*	Least concern
		Bat-eared Fox	*Otocyon megalotis*	Least concern
		Black-backed Jackal	*Canis mesomelas*	Least concern
	Mustelidae	Honey Badger	*Mellivora capensis*	Near threatened
		African Striped Weasel	*Poecilogale albinucha*	Data deficient
		Striped Polecat	*Ictonyx striatus*	Least concern
	Herpestidae	Slender Mongoose	*Galerella sanguinea*	Least concern
		Yellow Mongoose	*Cynictis penicillata*	Least concern
		Suricate	*Suricata suricatta*	Least concern
	Viverridae	Small-spotted Genet	*Genetta genetta*	Least concern
	Hyaenidae	Brown Hyaena	*Hyaena brunnea*	Near threatened
		Aardwolf	*Proteles cristatus*	Least concern
	Felidae	African Wild Cat	*Felis silvestris cafra*	Least concern
		Small Spotted Cat	*Felis nigripes*	Least concern
		Caracal	*Caracal caracal*	Least concern
		Leopard	*Panthera pardus*	Least concern
Tubulidentata	Orycteropodidae	Aardvark	*Orycteropus afer*	Least concern
Cetartiodactyla	Bovidae	Common Eland	*Taurotragus oryx*	Least concern
		Greater Kudu	*Tragelaphus strepsiceros*	Least concern
		Springbok	*Antidorcas marsupialis*	Least concern

		Steenbok	*Raphicerus campestris*	Least concern
		Common Duiker	*Sylvicapra grimmia*	Least concern

Table 11-2: Reptile species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Testudines	Testudinidae	Serrated Tent Tortoise	*Psammobates oculifer*	Least concern
		Leopard Tortoise	*Stigmochelys pardalis*	Least concern
Squamata	Gekkonidae	Common Giant Gecko	*Chondrodactylus angulifer angulifer*	Least concern
		Kalahari Ground Gecko	*Colopus wahlbergii wahlbergii*	Least concern
		Cape Gecko	*Pachydactylus capensis*	Least concern
		Quartz Gecko	*Pachydactylus latirostris*	Least concern
		Common Rough Gecko	*Pachydactylus rugosus*	Least concern
		Common Barking Gecko	*Ptenopus garrulus garrulus*	Least concern
		Spotted Barking Gecko	*Ptenopus garrulus maculatus*	Least concern
	Amphisbaenidae	Pestle-tailed Worm Lizard	*Dalophia pistillum*	Least concern
		Dusky Worm Lizard	*Monopeltis infuscata*	Least concern
		Maurice's Worm Lizard	*Monopeltis mauricei*	Least concern
	Lacertidae	Bushveld Lizard	*Heliobolus lugubris*	Least concern
		Savanna Lizard	*Meroles squamulosus*	Least concern
		Spotted Desert Lizard	*Meroles suborbitalis*	Least concern
		Spotted Sandveld Lizard	*Nucras intertexta*	Least concern
		Spotted Sand Lizard	*Pedioplanis lineoocellata lineoocellata*	Least concern

		Namaqua Sand Lizard	*Pedioplanis namaquensis*	Least concern
	Scincidae	Thin-tailed Legless Skink	*Acontias gracilicauda*	Least concern
		Kgalagadi Legless Skink	*Acontias kgalagadi kgalagadi*	Least concern
		Western Three-striped Skink	*Trachylepis occidentalis*	Least concern
		Speckled Sand Skink	*Trachylepis punctulata*	Least concern
		Karasburg Tree Skink	*Trachylepis sparsa*	Least concern
		Kalahari Tree Skink	*Trachylepis spilogaster*	Least concern
	Chamaeleonidae	Common Flap-neck Chameleon	*Chamaeleo dilepis dilepis*	Least concern
	Agamidae	Western Ground Agama	*Agama aculeata aculeata*	Least concern
	Viperidae	Puff Adder	*Bitis arietans arietans*	Least concern
	Lamprophiidae	Bibron's Stiletto Snake	*Atractaspis bibronii*	Least concern
		Bicoloured Quill-snouted Snake	*Xenocalamus bicolor bicolor*	Least concern
		Common House Snake	*Boaedon capensis*	Least concern
		Cape Wolf Snake	*Lycophidion capense capense*	Least concern
		Karoo Sand Snake	*Psammophis notostictus*	Least concern
		Fork-marked Sand Snake	*Psammophis trinasalis*	Least concern
		Sundevall's Shovel-snout	*Prosymna sundevalli*	Least concern
		Mole Snake	*Pseudaspis cana*	Least concern
	Elapidae	Common Shield Cobra	*Aspidelaps scutatus scutatus*	Least concern
		Cape Cobra	*Naja nivea*	Least concern
	Colubridae	Boomslang	*Dispholidus typus*	Least concern
		Eastern Tiger Snake	*Telescopus semiannulatus semiannulatus*	Least concern

Table 11-3: Amphibian species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Anura	Brevicipitidae	Bushveld Rain Frog	*Breviceps adspersus*	Least concern
	Pyxicephalidae	Boettger's Caco	*Cacosternum boettgeri*	Least concern
		Tremolo Sand Frog	*Tomopterna cryptotis*	Least concern
		Tandy's Sand Frog	*Tomopterna tandyi*	Least concern

Table 11-4: Protected butterfly species likely to occur on or in close proximity to the site.

Order	Family	Common Name	Species Name	Conservation Status
Lepidoptera	Lycaenidae	Griqua Black Pie	*Tuxentius melaena griqua*	Data deficient
		Linda's Hairtail	*Anthene lindae*	Vulnerable

12 APPENDIX B: lists of plant families, genera and species recorded in the study area

INDEX

Abbreviations used in Tables 12-2 to 12-5 are declared as follows:

Under the column SPECIES STATUS:

ToPS	Threatened or Protected Species (NEMBA ToPS, 2013)
D	Red data – Declining (Raimondo et al, 2009)
P(SA)	Protected nationally (NFA, 1998)
P(NC)	Protected in Northern Cape Province (NCNCA, 2009)
SP(NC)	Specially Protected in Northern Cape Province (NCNCA, 2009)
N2	Exotic – Category 2 (NEMBA 2014)
C2	Exotic – Declared invader category 2 (Henderson 2001)

NOTE: All exotic plant taxa are preceded by an asterisk (e.g. **Ricinus communis*) in the species lists of Appendix B (Tables 12-1 to 12-5).

Under the column SOCIAL USE:

F – Food/nourishment

M – Medicinal

C – Cultural

Table 12-1: Plant Families and Genera recorded in the study area

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU		
					1	2	3
ANGIOSPERMAE							
MONOCOTYLEDONAE							
AMARYLLIDACEAE	1	1	*Boophone*	1			1
ASPARAGACEAE	1	1	*Asparagus*	3	3	3	3
COMMELINACEAE	1	1	*Commelina*	1			1
CYPERACEAE	1	3	*Bulbostylis*	1	1	1	1
			Cyperus	1	1		
			Kyllinga	1			1
HYACINTHACEAE	1	3	*Albuca*	1			1
			Dipcadi	2	1		2
			Ledebouria	1			1
POACEAE	1	9	*Anthephora*	1	1	1	1
			Aristida	2	2	1	1
			Cenchrus	1		1	
			Centropodia	1	1	1	1
			Enneapogon	1	1	1	1
			Eragrostis	2	1	1	1
			Schmidtia	2	2	1	2
			Stipagrostis	1	1	1	1
			Tragus	1	1	1	1
Sub-Total:	6	18		24	16	13	20
DICOTYLEDONAE							
ACANTHACEAE	1	1	*Monechma*	1			1
AIZOACEAE	1	1	*Plinthus*	1	1		
AMARANTHACEAE	1	1	*Sericorema*	1			1
APOCYNACEAE	1	6	*Asclepias*	1	1		1
			Gomphocarpus	1		1	1
			Huernia	1			
			Pentarrhinum	1		1	
			Pergularia	1	1	1	1
			Sarcostemma	1	1	1	1
ASTERACEAE	1	9	*Chrysocoma*	1		1	
			Dicoma	1			1
			Eriocephalus	1	1	1	1
			Felicia	1			1
			Geigeria	2	1	2	1
			Helichrysum	1		1	1
			Kleinia	1		1	
			Osteospermum	1	1		1

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU		
					1	2	3
			Pentzia	1		1	1
BIGNONIACEAE	1	1	*Rhigozum*	1		1	1
BORAGINACEAE	1	2	*Ehretia*	1		1	1
			Heliotropium	1	1	1	1
CAPPARACEAE	1	2	*Boscia*	1	1	1	1
			Cleome	2	1	2	
CONVOLVULACEAE	1	3	*Ipomoea*	1	1	1	1
			Merremia	1	1	1	1
			Xenostegia	1	1		
CUCURBITACEAE	1	3	*Citrullus*	1			1
			Momordica	1	1		
			Trochomeria	1	1	1	1
EUPHORBIACEAE	1	2	*Euphorbia*	1	1		1
			Jatropha	1			1
FABACEAE	1	11	*Acacia*	4	4	4	4
			Crotalaria	1	1	1	
			Cullen	1			1
			Elephantorrhiza	1	1	1	1
			Hoffmannseggia	1	1		1
			Indigofera	1		1	1
			**Prosopis*	1		1	1
			Requienia	1	1		1
			Rhynchosia	1		1	
			Senna	1	1	1	1
			Tephrosia	1	1	1	1
GERANIACEAE	1	1	*Monsonia*	1			1
GISEKIACEAE	1	1	*Gisekia*	2	1	1	2
ILLECEBRACEAE	1	1	*Pollichia*	1	1	1	1
LAMIACEAE	1	1	*Acrotome*	1	1	1	1
LORANTHACEAE	1	1	*Tapinanthus*	1	1	1	1
MALVACEAE	1	1	*Abutilon*	1		1	
MENISPERMACEAE	1	1	*Antizoma*	1	1	1	
MOLLUGINACEAE	1	1	*Limeum*	3	2	1	3
PEDALIACEAE	1	2	*Harpagophytum*	1			1
			Sesamum	1	1	1	1
PHYTOLACCACEAE	1	1	*Lophiocarpus*	1			1
PORTULACACEAE	1	1	*Talinum*	1			1
RHAMNACEAE	1	1	*Ziziphus*	1		1	1
SCROPHULARIACEAE	1	1	*Peliostomum*	1		1	1
SOLANACEAE	1	2	*Lycium*	2	1	2	2

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU		
					1	2	3
			Solanum	1	1	1	1
STERCULIACEAE	1	2	*Hermannia*	3	1		3
			Melhania	1	1		
THYMELAEACEAE	1	1	*Gnidia*	1	1	1	1
TILIACEAE	1	1	*Grewia*	1	1	1	1
VIOLACEAE	1	1	*Hybanthus*	1	1	1	1
VISCACEAE	1	1	*Viscum*	1		1	1
ZYGOPHYLLACEAE	1	1	*Tribulus*	2	2	1	1
Sub-Total:	32	65		77	43	49	61
Total:	38	83		101	59	62	81

Table 12-2: Woody Species – ANGIOSPERMAE – Dicotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
BIGNONIACEAE	*Rhigozum trichotomum* Burch.	Tree	Driedoring					X	X
BORAGINACEAE	*Ehretia rigida* (Thunb.) Druce subsp. *rigida*	Tree	Deurmekaarbos	Puzzle-bush		F/C		X	X
CAPPARACEAE	*Boscia albitrunca* (Burch.) Gilg & Gilg-Ben.	Tree	Witgat	Shepherd's Tree	P(SA), P(NC)	M/F/C	X	X	X
FABACEAE	*Acacia erioloba* E.Mey.	Tree	Kameeldoring	Camel Thorn	D, P(SA)	M/F/C	X	X	X
FABACEAE	*Acacia haematoxylon* Willd.	Tree	Vaalkameeldoring	Grey Camel Thorn	P(SA)		X	X	X
FABACEAE	*Acacia hebeclada* DC. subsp. *hebeclada*	Tree	Trassiedoring	Candle Thorn			X	X	X
FABACEAE	*Acacia mellifera* (Vahl) Benth. subsp. *detinens* (Burch.) Brenan	Tree	Swarthaak	Black Thorn		M/C	X	X	X
FABACEAE	**Prosopis glandulosa* Torr. var. *torreyana* (Benson) Johnst.	Tree	*Heuningprosopis	*Honey Mesquite	C2 / N2			X	X
RHAMNACEAE	*Ziziphus mucronata* Willd. subsp. *mucronata*	Tree	Blinkblaar-wag-'n-bietjie	Buffalo-thorn		M/F/C		X	X
SOLANACEAE	*Lycium cinereum* Thunb.	Shrub	Kleinkriedoring / Slangbessie	Small Honey-thorn		C		X	X
SOLANACEAE	*Lycium hirsutum* Dunal	Shrub	Rivierkareedoring / Wolwedoring				X	X	X
TILIACEAE	*Grewia flava* DC.	Tree	Fluweelrosyntjie	Velvet Raisin		F/C	X	X	X

Table 12-3: Graminoids – ANGIOSPERMAE – Monocotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
CYPERACEAE	*Bulbostylis hispidula* (Vahl) R.W.Haines subsp. *pyriformis* (Lye) R.W.Haines	Herb, cyperoid		Veld Bulrush			X	X	X
CYPERACEAE	*Cyperus obtusiflorus* Vahl var. *obtusiflorus*	Herb, cyperoid	Witbiesie	White-flowered Sedge			X		
CYPERACEAE	*Kyllinga alba* Nees	Herb, cyperoid	Witbiesie	White Button Sedge		C			X
POACEAE	*Anthephora pubescens* Nees	Grass	Borseltjiegas	Wool Grass			X	X	X
POACEAE	*Aristida meridionalis* Henrard	Grass	Langbeensteekgras	Giant Three-awn			X		
POACEAE	*Aristida stipitata* Hack.	Grass	Langnaaldsteekgras	Long-awned Grass			X	X	X
POACEAE	*Cenchrus ciliaris* L.	Grass	Bloubuffelgras	Foxtail Buffalo Grass				X	
POACEAE	*Centropodia glauca* (Nees) Cope	Grass	Gha-gras	Gha Grass			X	X	X
POACEAE	*Enneapogon cenchroides* (Roem. & Schult.) C.Eragrostis Hubb.	Grass	Negenaaldgras	Nine-awned Grass			X	X	X
POACEAE	*Eragrostis lehmanniana* Nees *var. lehmanniana*	Grass	Knietjiesgras	Lehmann's Love Grass		C		X	X
POACEAE	*Eragrostis pallens* Hack.	Grass	Besemgras	Broom Love Grass			X		
POACEAE	*Schmidtia kalahariensis* Stent	Grass	Kalahari Suurgras	Kalahari Sour Grass / Bushman Grass			X		X
POACEAE	*Schmidtia pappophoroides* Steud.	Grass	Sandkweek	Sand Quick			X	X	X
POACEAE	*Stipagrostis uniplumis* (Licht.) De Winter var. *uniplumis*	Grass	Blinkblaar-boesmangras	Silky Bushman Grass			X	X	X
POACEAE	*Tragus koelerioides* Asch.	Grass					X	X	X

Table 12-4: Herbaceous Shrubs & Forbs – ANGIOSPERMAE – Monocotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
AMARYLLIDACEAE	*Boophone disticha* (L.f.) Herb.	Herb, geophyte	Kopseerblom / Gifbol	Poison Bulb	D; P(NC)	M/C			X
ASPARAGACEAE	*Asparagus bechuanicus* Baker	Herbaceous shrub					X	X	X
ASPARAGACEAE	*Asparagus nelsii* Schinz	Herbaceous shrub	Sandveldkatbos			F	X	X	X
ASPARAGACEAE	*Asparagus suaveolens* Burch.	Herbaceous shrub	Gewone Katbos / Katdoring	Bushveld Asparagus		M/F/C	X	X	X
COMMELINACEAE	*Commelina africana* L. var. *lancispatha* C.B.Clarke	Herb	Geeleendagsblom	Yellow Commelina		M			X
HYACINTHACEAE	*Albuca* species	Geophyte	Slymuintjie						X
HYACINTHACEAE	*Dipcadi gracillimum* Baker	Geophyte	Ouma-se-groottoon				X		X
HYACINTHACEAE	*Dipcadi* species	Geophyte							X
HYACINTHACEAE	*Ledebouria* c.f. *undulata* (Jacq.) Jessop	Geophyte				M			X

Table 12-5: Herbaceous Shrubs & Forbs – ANGIOSPERMAE – Dicotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
ACANTHACEAE	*Monechma incanum* (Nees) C.B.Clarke	Dwarf shrub	Netvetbossie / Blouganna /Skaapganna						X
AIZOACEAE	*Plinthus sericeus* Pax	Dwarf shrub	Sandganna				X		
AMARANTHACEAE	*Sericorema remotiflora (Hook.f.) Lopr.*	Herb	Kwasbossie / Wolhaarbossie						X
APOCYNACEAE	*Asclepias aurea* (Schltr.) Schltr.	Geophytic herb			P(NC)		X		X
APOCYNACEAE	*Gomphocarpus fruticosus* (L.) Aiton f. subsp. *fruticosus*	Herbaceous shrub	Melkbos / Balbossie	Milkweed	P(NC)			X	X
APOCYNACEAE	*Huernia zebrina* N.E.Br. subsp. *magniflora* (E.Phillips) L.C.Leach	Succulent			P(NC)				
APOCYNACEAE	*Pentarrhinum insipidum* E.Mey	Herb, climber	Donkieperske	African Heartvine	P(NC)	M/F		X	
APOCYNACEAE	*Pergularia daemia* (Forssk.) Chiov. var. *daemia*	Herb, climber		Trellis Vine	P(NC)	M	X	X	X
APOCYNACEAE	*Sarcostemma viminale* (L.) R.Br. subsp. *viminale*	Succulent climber	Melktou /Wolfsmelk	Caustic Vine	P(NC)	M	X	X	X
ASTERACEAE	*Chrysocoma ciliata* L.	Dwarf shrub	Bitterbos					X	
ASTERACEAE	*Dicoma capensis* Less.	Herb	Karmedik			M			X
ASTERACEAE	*Eriocephalus ericoides* (L.f.) Druce	Shrub	Gewone Kapokbos	Common Kapok Bush			X	X	X
ASTERACEAE	*Felicia filifolia* (Vent.) Burtt Davy subsp. *Filifolia*	Dwarf shrub	Draaibossie	Needle-leafed Felicia					X
ASTERACEAE	*Geigeria filifolia* Mattf.	Herb	Vermeerbos					X	
ASTERACEAE	*Geigeria ornativa* O.Hoffm.	Herb	Vermeerbos				X	X	X
ASTERACEAE	*Helichrysum* species	Dwarf shrub						X	X

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
ASTERACEAE	*Kleinia longiflora* DC.	Succulent shrub	Sambokbos			M		X	
ASTERACEAE	*Osteospermum microphyllum* DC.	Herb	Wolfolie				X		X
ASTERACEAE	*Pentzia globosa* Less.	Dwarf shrub	Vaalkaroo			M		X	X
BORAGINACEAE	*Heliotropium ciliatum* Kaplan	Herb					X	X	X
CAPPARACEAE	*Cleome gynandra* L.	Herb	Snotterbelletjie	Spider-wisp		F		X	
CAPPARACEAE	*Cleome rubella* Burch.	Herb	Mooinooientjie	Pretty Lady			X	X	
CONVOLVULACEAE	*Ipomoea bolusiana* Schinz subsp. *bolusiana*	Herb / dwarf shrub		Narrow-leaved Pink Ipomoea		F	X	X	X
CONVOLVULACEAE	*Merremia verecunda* Rendle (1)	Herb, climber					X	X	X
CONVOLVULACEAE	*Xenostegia tridentata* (L.) D.F.Austin & Staples subsp. *angustifolia* (Jacq.) Lejoly & Lisowski	Herb, climber		Miniature Morning Glory			X		
CUCURBITACEAE	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Herb, climber	Karkoer / Tsamma	Tsamma		F/C			X
CUCURBITACEAE	*Momordica balsamina* L.	Herb, climber	Laloentjie			M/F	X		
CUCURBITACEAE	*Trochomeria debilis* (Sond.) Hook.f.	Herb, climber	Laloentjie				X	X	X
EUPHORBIACEAE	*Euphorbia inaequilatera* Sond. var. *inaequilatera*	Herb	Rooi-opslag	Smooth Creeping Milkweed			X		X
EUPHORBIACEAE	*Jatropha erythropoda* Pax & K.Hoffm.	Herbaceous shrub	Rooikambro						X
FABACEAE	*Crotalaria orientalis* Burtt Davy ex I.Verd. subsp. *orientalis*	Herb	Besembossie				X	X	
FABACEAE	*Cullen tomentosum* (Thunb.) J.W.Grimes	Herb	Blouklawer / Rivierklawer	Blue Clover					X
FABACEAE	*Elephantorrhiza elephantina* (Burch.) Skeels	Dwarf shrub	Baswortel	Dwarf Elephant-root		M/C	X	X	X

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
FABACEAE	*Hoffmannseggia burchellii* (DC.) Benth. Ex Oliv. subsp. *Burchellii*	Dwarf shrub, herb					X		X
FABACEAE	*Indigofera charlieriana* Schinz var. *charlieriana*	Herb						X	X
FABACEAE	*Requienia sphaerosperma* DC.	Herb					X		X
FABACEAE	*Rhynchosia totta* (Thunb.) DC. var. *totta*	Herb, climber				F		X	
FABACEAE	*Senna italica* Mill. subsp. *arachoides* (Burch.) Lock	Herb	Elandsertjie	Eland's Pea		M	X	X	X
FABACEAE	*Tephrosia purpurea* (L.) Pers.	Herb		Silver Tephrosia			X	X	X
GERANIACEAE	*Monsonia angustifolia* E. Mey ex A. Rich.	Herb	Angelbossie	Crane's Bill					X
GISEKIACEAE	*Gisekia africana* (Lour.) Kuntze var. *africana*	Herb					X	X	X
GISEKIACEAE	*Gisekia pharnacioides* L. var. *pharnacioides*	Herb							X
ILLECEBRACEAE	*Pollichia campestris* Ait.	Herbaceous shrub	Teesuikerbossie	Waxberry / Barley Sugar Bush		F	X	X	X
LAMIACEAE	*Acrotome inflata* Benth.	Herb					X	X	X
LORANTHACEAE	*Tapinanthus oleifolius* (J.C.Wendl.) Danser	Shrub / Hemi-parasite	Namakwakersies	Desert Tapinanthus			X	X	X
MALVACEAE	*Abutilon* c.f. *angulatum* (Guill. & Perr.) Mast. var. *angulatum*	Herb						X	
MENISPERMACEAE	*Antizoma angustifolia* (Burch.) Miers ex Harv.	Herb, climber					X	X	
MOLLUGINACEAE	*Limeum fenestratum* (Fenzl) Heimerl var. *fenestratum*	Herb							X
MOLLUGINACEAE	*Limeum sulcatum* (Klotzsch) Hutch var. *sulcatum*	Herb	Klosaarbossie				X		X

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VEGETATION UNIT		
			AFRIKAANS	ENGLISH			1	2	3
MOLLUGINACEAE	*Limeum viscosum* (J.Gay) Fenzl subsp. *viscosum* var. *viscosum*	Herb	Klosaarbossie				X	X	X
PEDALIACEAE	*Harpagophytum procumbens* (Burch.) DC. ex Meisn. subsp. *procumbens*	Herb	Duiwelsklou / Ghamaghoe	Devil's Claw / Grapple Plant	TOPS, SP(NC)	M/C			X
PEDALIACEAE	*Sesamum triphyllum* Welw. ex Asch. var. *triphyllum*	Herb	Wildesesam	Wild Sesame		F	X	X	X
PHYTOLACCACEAE	*Lophiocarpus polystachyus* Turcz.	Herb							X
PORTULACACEAE	*Talinum crispatulum* Dinter ex Poelln.	Succulent herb	Wildevygie			M/F			X
SCROPHULARIACEAE	*Peliostomum leucorrhizum* E.Mey. ex Benth.	Dwarf shrub	Springbokkos / Karooviooltjie	Veld Violet				X	X
SOLANACEAE	*Solanum supinum* Dunal var. *supinum*	Herb					X	X	X
STERCULIACEAE	*Hermannia modesta* (Ehrenb.) Mast.	Herb							X
STERCULIACEAE	*Hermannia tomentosa* (Turcz.) Schinz ex Engl.	Herbaceous shrub					X		X
STERCULIACEAE	*Hermannia vestita* Thunb.	Herb	Swaelbossie						X
STERCULIACEAE	*Melhania acuminata* Mast. var. *agnosta* (K.Schum.) Willd	Herb					X		
THYMELAEACEAE	*Gnidia polycephala* (C.A.Mey.) Gilg	Herb	Januariebos				X	X	X
VIOLACEAE	*Hybanthus* c.f. *densifolius* Engl.	Herb		Lady's Slipper			X	X	X
VISCACEAE	*Viscum rotundifolium* L.f.	Hemi-parasite	Rooibessie / Voëlent	Red-berried Mistletoe		M/C		X	X
ZYGOPHYLLACEAE	*Tribulus terrestris* L.	Herb	Dubbeltjie	Devil's Thorn			X	X	X
ZYGOPHYLLACEAE	*Tribulus zeyheri* Sond. subsp. *zeyheri*	Herb	Grootblomdubbeltjie	Devil's Thorn			X		

Table 12-6: Species list downloaded from POSA (http://posa.sanbi.org) on March 31, 2016, 2:35 pm for QDS 2822BA

Family	Species	Threat status	SA Endemic	Growth forms	Lifecycle
ACANTHACEAE	Justicia thymifolia (Nees) C.B.Clarke	LC	No	Dwarf shrub, shrub	Perennial
ACANTHACEAE	Barleria lichtensteiniana Nees	LC	No	Herb	Perennial
AIZOACEAE	Plinthus sericeus Pax	LC	No	Dwarf shrub	Perennial
ANACARDIACEAE	Searsia burchellii (Sond. ex Engl.) Moffett	LC	No	Shrub, tree	Perennial
ANACARDIACEAE	Searsia tridactyla (Burch.) Moffett	LC	No	Shrub, tree	Perennial
APIACEAE	Deverra denudata (Viv.) Pfisterer & Podlech subsp. aphylla (Cham. & Schltdl.) Pfisterer & Podlech	LC	No	Shrub	Perennial
APOCYNACEAE	Sarcostemma viminale (L.) R.Br. subsp. viminale	LC	No	Climber, succulent	Perennial
ASTERACEAE	Nolletia arenosa O.Hoffm.	LC	No	Dwarf shrub	Perennial
ASTERACEAE	Pegolettia retrofracta (Thunb.) Kies	LC	No	Dwarf shrub	Perennial
ASTERACEAE	Helichrysum spiciforme DC.	LC	No	Dwarf shrub, shrub	Perennial
ASTERACEAE	Helichrysum zeyheri Less.	LC	No	Dwarf shrub, shrub	Perennial
ASTERACEAE	Dicoma capensis Less.	LC	No	Herb	Perennial
ASTERACEAE	Dimorphotheca polyptera DC.	LC	No	Herb	Annual (occ. perennial)
ASTERACEAE	Helichrysum arenicola M.D.Hend.	LC	No	Herb	Perennial
ASTERACEAE	Helichrysum argyrosphaerum DC.	LC	No	Herb	Annual
ASTERACEAE	Helichrysum cerastioides DC. var. cerastioides	LC	No	Herb	Perennial
ASTERACEAE	Hirpicium echinus Less.	LC	No	Herb	Perennial
ASTERACEAE	Senecio consanguineus DC.	LC	No	Herb	Annual
ASTERACEAE	Garuleum schinzii O.Hoffm. subsp. schinzii	LC	No	Herb, suffrutex	Perennial
ASTERACEAE	Eriocephalus ericoides (L.f.) Druce subsp. griquensis M.A.N.Müll.	LC	No	Shrub	Perennial
ASTERACEAE	Eriocephalus merxmuelleri M.A.N.Müll.	LC	No	Shrub	Perennial
ASTERACEAE	Psiadia punctulata (DC.) Vatke	LC	No	Shrub	Perennial

Family	Species	Threat status	SA Endemic	Growth forms	Lifecycle
ASTERACEAE	Kleinia longiflora DC.	LC	No	Shrub, succulent	Perennial
ASTERACEAE	Lopholaena cneorifolia (DC.) S.Moore	LC	No	Shrub, succulent	Perennial
AYTONIACEAE	Plagiochasma rupestre (J.R.& G.Forst.) Steph. var. rupestre		No	Bryophyte (moss)	Perennial
BIGNONIACEAE	Rhigozum obovatum Burch.	LC	No	Shrub, tree	Perennial
BORAGINACEAE	Heliotropium ciliatum Kaplan	LC	No	Herb	Perennial
BRASSICACEAE	Heliophila trifurca Burch. ex DC.	LC	No	Herb	Annual
BRYACEAE	Bryum capillare Hedw.		No	Bryophyte (moss)	Perennial
CAPPARACEAE	Boscia microphylla Oliv.		No	Shrub, tree	Perennial
CELASTRACEAE	Putterlickia pyracantha (L.) Szyszyl.	LC	No	Shrub	Perennial
CONVOLVULACEAE	Ipomoea oenotheroides (L.f.) Raf. ex Hallier f.	LC	No	Shrub, succulent	Perennial
CUCURBITACEAE	Cucumis africanus L.f.	LC	No	Herb	Perennial
CUCURBITACEAE	Acanthosicyos naudinianus (Sond.) C.Jeffrey	LC	No	Herb, creeper	Perennial
CYPERACEAE	Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke	LC	No	Cyperoid, herb, mesophyte	Perennial
DICRANACEAE	Campylopus introflexus (Hedw.) Brid.		No	Bryophyte (moss)	Perennial
EUPHORBIACEAE	Euphorbia ephedroides E.Mey. ex Boiss. var. ephedroides	LC	No	Dwarf shrub, succulent	Perennial
EUPHORBIACEAE	Euphorbia avasmontana Dinter var. avasmontana	LC	No	Shrub, succulent	Perennial
EUPHORBIACEAE	Croton gratissimus Burch. var. gratissimus	LC	No	Shrub, tree	Perennial
FABACEAE	Sutherlandia frutescens (L.) R.Br.	LC	No	Dwarf shrub, shrub	Perennial
FABACEAE	Lessertia pauciflora Harv. var. pauciflora	LC	No	Herb	Perennial
FABACEAE	Lotononis parviflora (P.J.Bergius) D.Dietr.	LC	No	Herb	Annual
FABACEAE	Crotalaria virgultalis Burch. ex DC.	LC	No	Shrub	Perennial
FABACEAE	Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan	LC	No	Shrub, tree	Perennial
FISSIDENTACEAE	Fissidens erosulus (Müll.Hal.) Paris		No	Bryophyte (moss)	Perennial

Family	Species	Threat status	SA Endemic	Growth forms	Lifecycle
FISSIDENTACEAE	Fissidens submarginatus Bruch		No	Bryophyte (moss)	Perennial
IRIDACEAE	Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.	LC	No	Geophyte, herb	Perennial
LORANTHACEAE	Tapinanthus oleifolius (J.C.Wendl.) Danser	LC	No	Parasite, shrub, succulent	Perennial
MALVACEAE	Hermannia bryoniifolia Burch.	LC	No	Dwarf shrub	Perennial
MALVACEAE	Melhania rehmannii Szyszyl.	LC	No	Dwarf shrub	Perennial
MALVACEAE	Sida cordifolia L. subsp. cordifolia	LC	No	Dwarf shrub	Annual (occ. perennial)
MALVACEAE	Hermannia burchellii (Sweet) I.Verd.	LC	No	Dwarf shrub, shrub	Perennial
MALVACEAE	Hermannia comosa Burch. ex DC.	LC	No	Herb	Perennial
MALVACEAE	Hermannia tomentosa (Turcz.) Schinz ex Engl.	LC	No	Herb	Perennial
MALVACEAE	Hibiscus fleckii Gürke	LC	No	Herb	Perennial
MALVACEAE	Grewia flava DC.	LC	No	Shrub	Perennial
MOLLUGINACEAE	Limeum aethiopicum Burm.f. var. intermedium Friedrich	Not Evaluated	No	Herb	[No lifecycle defined]
MORACEAE	Ficus cordata Thunb. subsp. cordata	LC	No	Tree	Perennial
OXYMITRACEAE	Oxymitra cristata Garside ex Perold		No	Bryophyte (moss)	Perennial
PAPAVERACEAE	*Argemone mexicana L. forma mexicana	Not Evaluated	No	Herb	Annual
POACEAE	Brachiaria serrata (Thunb.) Stapf	LC	No	Graminoid	Perennial
POACEAE	Eragrostis echinochloidea Stapf	LC	No	Graminoid	Perennial
POTTIACEAE	Trichostomum brachydontium Bruch		No	Bryophyte (moss)	Perennial
POTTIACEAE	Syntrichia laevipila Brid.		No	Bryophyte, epiphyte (moss)	Perennial
RHAMNACEAE	Ziziphus mucronata Willd. subsp. mucronata	LC	No	Shrub, tree	Perennial
RICCIACEAE	Riccia okahandjana S.W.Arnell		No	Bryophyte (moss)	Perennial

Family	Species	Threat status	SA Endemic	Growth forms	Lifecycle
RICCIACEAE	Riccia volkii S.W.Arnell		No	Bryophyte (moss)	Annual
SANTALACEAE	Thesium hystrix A.W.Hill	LC	No	Dwarf shrub, parasite, shrub	Perennial
SCROPHULARIACEAE	Aptosimum elongatum Engl.	LC	No	Dwarf shrub	Perennial
SCROPHULARIACEAE	Aptosimum marlothii (Engl.) Hiern	LC	No	Dwarf shrub	Perennial
SCROPHULARIACEAE	Jamesbrittenia atropurpurea (Benth.) Hilliard subsp. pubescens Hilliard	LC	No	Dwarf shrub	Perennial
SCROPHULARIACEAE	Peliostomum leucorrhizum E.Mey. ex Benth.	LC	No	Dwarf shrub	Perennial
SINOPTERIDACEAE	Cheilanthes eckloniana (Kunze) Mett.	LC	No	Geophyte, herb, lithophyte (fern)	Perennial
SINOPTERIDACEAE	Pellaea calomelanos (Sw.) Link var. calomelanos	LC	No	Geophyte, herb, lithophyte (fern)	Perennial
SOLANACEAE	Lycium cinereum Thunb.	LC	No	Dwarf shrub, shrub	Perennial
THYMELAEACEAE	Gnidia polycephala (C.A.Mey.) Gilg	LC	No	Dwarf shrub, herb	Perennial

13 APPENDIX C: Recorded positions of red data or protected species

Table 13-1: Coordinates of some recorded ToPS, red data and protected plant species

Note: The numbered labels on Figure 15 (p. 31) correspond to the serial number (S/N) in the first column of Table 13-1.

S/N	SPECIES	Coordinates		No of Specimens
		S	E	
1	*Harpagophytum procumbens*	28° 12' 58.2"S	22° 34' 26.4"E	3
2	*Harpagophytum procumbens*	28° 13' 01.3"S	22° 34' 10.7"E	1
3	*Boophone disticha*	28° 13' 01.2"S	22° 34' 18.5"E	1
4	*Huernia zebrina* subsp. *magniflora*	28° 13' 01.0"S	22° 34' 30.6"E	1
5	*Sarcostemma viminale* subsp. *viminale*	28° 13' 33.2"S	22° 35' 41.3"E	1
6	*Pergularia daemia* var. *daemia*	28° 13' 48.9"S	22° 35' 51.5"E	1
	Asclepias aurea			1
7	*Pergularia daemia* var. *daemia*	28° 14' 14.5"S	22° 36' 18.4"E	1
8	*Harpagophytum procumbens*	28°13'17.8"S	22°33'56.7"E	2

Table 13-2: Calculations of protected tree density in the study area

Veg Unit	Transect No.	Species frequency (as counted on 4000 m²)								
		Acacia erioloba			*Acacia haematoxylon*			*Boscia albitrunca*		
		1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total
1 (90ha)	1	0	1	1	4	11	15	0	0	0
	2	0	0	0	5	21	26	0	0	0
	3	0	1	1	8	9	17	0	0	0
	4	2	3	5	11	30	41	1	0	1
	5	0	2	2	4	12	16	0	1	1
	6	1	2	3	8	19	27	0	1	1
	7	0	2	2	12	40	52	0	0	0
	Ave.	**0.4**	**1.6**	**2.0**	**7.4**	**20.3**	**27.7**	**0.1**	**0.3**	**0.4**
2 (266ha)	1	0	7	7	0	1	1	1	5	6
	2	3	6	9	3	6	9	0	2	2
	3	2	5	7	0	0	0	0	6	6
	4	0	1	1	0	2	2	0	2	2
	5	12	22	34	2	4	6	0	1	1
	6	0	6	6	0	7	7	0	4	4
	7	0	19	19	1	1	2	0	2	2
	Ave.	**2.4**	**9.4**	**11.9**	**0.9**	**3.0**	**3.9**	**0.1**	**3.1**	**3.3**
3 (144ha)	1	3	4	7	0	1	1	0	0	0
	2	3	10	13	1	3	4	0	0	0
	3	5	8	13	5	11	16	0	0	0

Veg Unit	Transect No.	Species frequency (as counted on 4000 m²)								
		Acacia erioloba			*Acacia haematoxylon*			*Boscia albitrunca*		
		1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total	1 to <2 m	>2 m	Total
	4	0	2	2	3	8	11	0	0	0
	5	2	5	7	1	5	6	0	0	0
	6	1	3	4	1	1	2	0	0	0
	7	1	1	2	1	8	9	0	1	1
	8	9	11	20	4	4	8	0	0	0
	Ave.	**3.0**	**5.5**	**8.5**	**2.0**	**5.1**	**7.1**	**0.0**	**0.1**	**0.1**
Species density / ha										
1 (90ha)	1	0	4	4	16	44	60	0	0	0
	2	0	0	0	20	84	104	0	0	0
	3	0	4	4	32	36	68	0	0	0
	4	5	7.5	12.5	27.5	75	102.5	2.5	0	2.5
	5	0	5	5	10	30	40	0	2.5	2.5
	6	2.5	5	7.5	20	47.5	67.5	0	2.5	2.5
	7	0	5	5	30	100	130	0	0	0
	Ave.	**1.28**	**4.68**	**5.96**	**22.13**	**60.43**	**82.55**	**0.43**	**0.85**	**1.28**
2 (266ha)	1	0	17.5	17.5	0	2.5	2.5	2.5	12.5	15
	2	7.5	15	22.5	7.5	15	22.5	0	5	5
	3	5	12.5	17.5	0	0	0	0	15	15
	4	0	2.5	2.5	0	5	5	0	5	5
	5	30	55	85	5	10	15	0	2.5	2.5
	6	0	15	15	0	17.5	17.5	0	10	10
	7	0	47.5	47.5	2.5	2.5	5	0	5	5
	Ave.	**6.07**	**23.57**	**29.64**	**2.14**	**7.50**	**9.64**	**0.36**	**7.86**	**8.21**
3 (144ha)	1	7.5	10	17.5	0	2.5	2.5	0	0	0
	2	7.5	25	32.5	2.5	7.5	10	0	0	0
	3	12.5	20	32.5	12.5	27.5	40	0	0	0
	4	0	5	5	7.5	20	27.5	0	0	0
	5	5	12.5	17.5	2.5	12.5	15	0	0	0
	6	2.5	7.5	10	2.5	2.5	5	0	0	0
	7	2.5	2.5	5	2.5	20	22.5	0	2.5	2.5
	8	22.5	27.5	50	10	10	20	0	0	0
	Ave.	**7.50**	**13.75**	**21.25**	**5.00**	**12.81**	**17.81**	**0.00**	**0.31**	**0.31**
Number of specimens per VU										
1		115	421	536	1991	5438	7430	38	77	115
2		1615	6270	7885	570	1995	2565	95	2090	2185
3		1080	1980	3060	720	1845	2565	0	45	45
	Total:			**11481**			**12560**			**2345**