ECOLOGICAL SCOPING REPORT

PROPOSED ORYX SOLAR ENERGY FACILITY NEAR VIRGINIA

FREE STATE

MARCH 2013

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Executive Summary

FRV Energy South Africa (Pty) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the application for a photovoltaic Solar Energy Facility near Virginia, Free State. The development will be constructed on the farm Kalkoen-Krans 225 portion 2, about 11 km south-west of Virginia. The area of the farm not under cultivation is referred to as the study area, and is covered by the ecological scoping report.

This report discusses the approach and findings of a brief screening visit to the site during January 2013, as well as a desktop survey carried out for the study area. The main objective of this scoping investigation is to assess the likelihood of ecological sensitivities occurring on the study area in an effort to identify any issues regarding fauna and flora that should receive further attention during the EIA assessment phase.

The selected property falls mostly within the original extent of Vaal-Vet Sandy Grassland as described by Mucina and Rutherford (2006), of which a large portion on the property has been previously transformed by cultivation. The remaining extent of this vegetation type has been listed in the threatened terrestrial ecosystems for South Africa (2011) as Endangered. Beyond the proposed development area, closer to larger drainage lines and small rivers, the grassland vegetation merges into Highveld Alluvial Vegetation, which is considered as least threatened.

Approximately two-thirds of the area regarded as suitable for the PV facility is situated on disused, previously cultivated lands. Cultivation was stopped on these areas due to excessive soil capping, erosion and low productivity. In an attempt to increase the vegetation cover on these relatively barren areas, the landowner has ripped these areas and introduced the grass *Digitaria eriantha*, but vegetation remains sparse (Figure 3 section 3).

The north-western portion of the study area consist of remnants of natural vegetation (Figure 6), mostly mapped by Mucina and Rutherford (2006) as Highveld Alluvial Vegetation. This strip of vegetation, however, should rather be considered as remnants of the Vaal-Vet Sandy Grassland, which gradually merges into Highveld Alluvial Vegetation around larger drainage lines and the Bosluisspruit and Doring River. The state of this remaining grassland needs to be assessed during the EIA vegetation survey, but appears to be relatively degraded.

It must be noted that portions of the study area has been mapped as remaining portions of the threatened Vaal-Vet Sandy Grassland. This delineation is, however, contradictory to mapped landcover classes as well as cultivation history confirmed on the ground (Figure 5). The discrepancy is most likely a result of

insufficient ground-truthing of remotely sensed images during the mapping program of nationally threatened ecosystems. A full description of plant communities on the site and associated habitats can only be provided after a field study conducted during the growing season, which will also reveal where remaining threatened grassland vegetation may occur. The screening study already confirmed that most of the proposed development site is situated on previously transformed areas. Most of these areas have been ripped and sown with *Digitaria eriantha* to increase the vegetation cover after cultivation was stopped due to low productivity.

Overall, no significant ecological flaws that could pose a problem to the proposed PV facility development could be identified during a desktop study and brief screening field visit to the site. This will have to be confirmed during a detailed field study of the vegetation of the area.

Most of the area regarded as suitable for the development has been transformed to a large extent in the past, it is not expected that it comprises any restricted habitat for any endangered species. It is, however, possible that protected species have become re-established on the site and need to be relocated if they will be affected by the proposed development. The impact is thus expected to be limited to vegetation and soil only, whilst impact on any vertebrates that may occur on site is so far assumed to be minimal or negligible.

The largest concerns identified up to date are:

- All indigenous and alien invasives and potential invasives within the development area will have to be entirely cleared prior to development
- An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives
- Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed
    - Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer. In addition, the use of contour buffer strips on sloping areas may be beneficial.
    - Locally occurring grass species become moribund and die off if not grazed regularly. It is thus recommended to allow seasonal sheep grazing to reduce dead biomass accumulation on grass tufts. This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

Wetland issues:

- No river or other wetland could be detected on the site selected for the proposed development despite a wetland being mapped as such by the

BGIS database, but wetlands do occur in close proximity (within 1 km) to the project area

» A small seasonal seepage area in the north-western section of the study area has formed over years from runoff of the degraded higher-lying areas. This moisture sustains a large population of *Ammocharis coranica* plants (and other species requiring higher moisture levels), and drains, into the Bosluisspruit 1 km north-west of the farm. The developer has already indicated that this area would be excluded from the development footprint area.
    - Erosion and contamination from the proposed development must be prevented to avoid degradation and contamination of these lower-lying wetlands

Recommendations for ecological studies:

» In line with the average rainfall patterns in the area, vegetation/ecological studies should ideally be carried out between February and late April to yield the most representative and accurate results.

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1. General Information

1.1. Applicant

FRV Energy South Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to manage the EIA process for a photovoltaic Solar Energy Facility near Virginia, Free State.

Project
Oryx Solar Energy Facility

Proposed Activity

- » Mounting structures for the solar panels to be either rammed steel piles or piles with pre-manufactured concrete footings to support the PV panels.
- » Cabling between the project components, to be lain underground where practical.
- » A new on-site substation to evacuate the power from the facility into the Eskom grid (loop in loop out connection to the 132kv line on the farm and this connects to the Oryx 132/44/11 kV substation)
- » Internal access roads and fencing.
- » Workshop area for maintenance, storage, and offices.

1.2. Declaration of Independence

A signed declaration of independence for the investigating specialist is attached in Appendix A.

1.3. Specialist Investigator

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A *Curriculum Vitae* and summary of expertise of the compiler is attached as Appendix B of this document

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Desert Net International (www.european-desertnet.eu)

1.4. Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. The author, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

Scope and Purpose of Report
To conduct an ecological desktop study for a scoping assessment of the selected target area where the establishment of a Solar Energy Facility is proposed and provide a professional opinion on ecological issues listed pertaining to the target area to aid in future decisions regarding the proposed project.

1.5. Legislation

This study has been conducted in accordance with the following legislation:

1.5.1. Provincial

- The Nature Conservation Ordinance 19 of 1974 and subsequent amendments
- The Free State Conservation Bill 23 of 2010

1.5.2. National

- National Environmental Management Act / NEMA (Act No 107 of 1998), and all amendments and supplementary listings and/or regulations
- Environment Conservation Act (ECA) (No 73 of 1989) and amendments
- National Environmental Management Act: Biodiversity Act (NEMA:BA) (Act No. 10 of 2004), including all regulations and amendments
- National list of ecosystems that are threatened and in need of protection (Government Notice 1002 of 2011)
- National Veld and Forest Fire Act (Act No. 101 of 1998)
- Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983) and amendments

1.5.3. International

- Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
- Convention on Biological Diversity, 1995

2. Introduction

South Africa is committed to the Conservation of Biological Diversity, and has introduced several legislative mechanisms to ensure that the preservation and sustainable use of all biological diversity, including ecosystem, species, and genetic diversity, is guaranteed for the benefit of current and future generations in South Africa and beyond. The impact of past and present conversion of natural habitat types by cultivation, grazing, urban developments, forestation, mining, dams, industries, and alien plant invasions continues to have a substantial impact on South African biodiversity, with significant portions of South Africa's flora and fauna being threatened (Wynberg 2002). Arid, semi-arid and dry sub-humid areas, covering an estimated 91% of South African land area (Hoffman and Ashwell 2001), including the study area, are particularly prone to degradation arising from human activities, leading to the acceleration of soil erosion, deterioration of the biotic, abiotic and economic properties of soil, and the long-term loss of natural vegetation (UNCCD 1995) and associated habitats for fauna. Rapid recovery of degradation is inhibited by the loss of topsoil and natural seed banks, low rainfall regimes and the unpredictability of rainfall events.

This report lists the findings of a scoping evaluation of the site selected by FRV for the development of a photovoltaic energy facility to help evaluate the possible impacts of such a development on the affected environment.

3. Study Area

3.1. Locality

The proposed photovoltaic (PV) solar energy facility is located on the farm Kalkoen-Krans 225 portion 2, about 11 km south-west of Virginia within the Mathjabeng Local Municipality, Free State. The specific site selected for the project is indicated on Figure 1.

The largest portion of the farm has been transformed to cultivated lands. The proposed project area is mostly situated on disused, previously cultivated lands.

3.2. Surrounding environment

3.2.1. Climate and rainfall

The climate for Oryx has been derived from climatic data summarised for Welkom (SA Explorer), located about 20 km north of Oryx. The area receives about 400 mm of rain on average per year. From May to September, rainfall is minimal, with most rainfall occurring from November to March, peaking between January and March. Temperatures in summer peak during December and January at a daily average of 29°C, with an average of 17°C for June. During July, night temperatures are on average 0°C, with frosts during winter common.

Plant species resprouting from storage tubers (geophytes) will take advantage of the first rains, stored reserves and low grass cover after the dry season to grow and flower during early summer (November to January) and then die back.

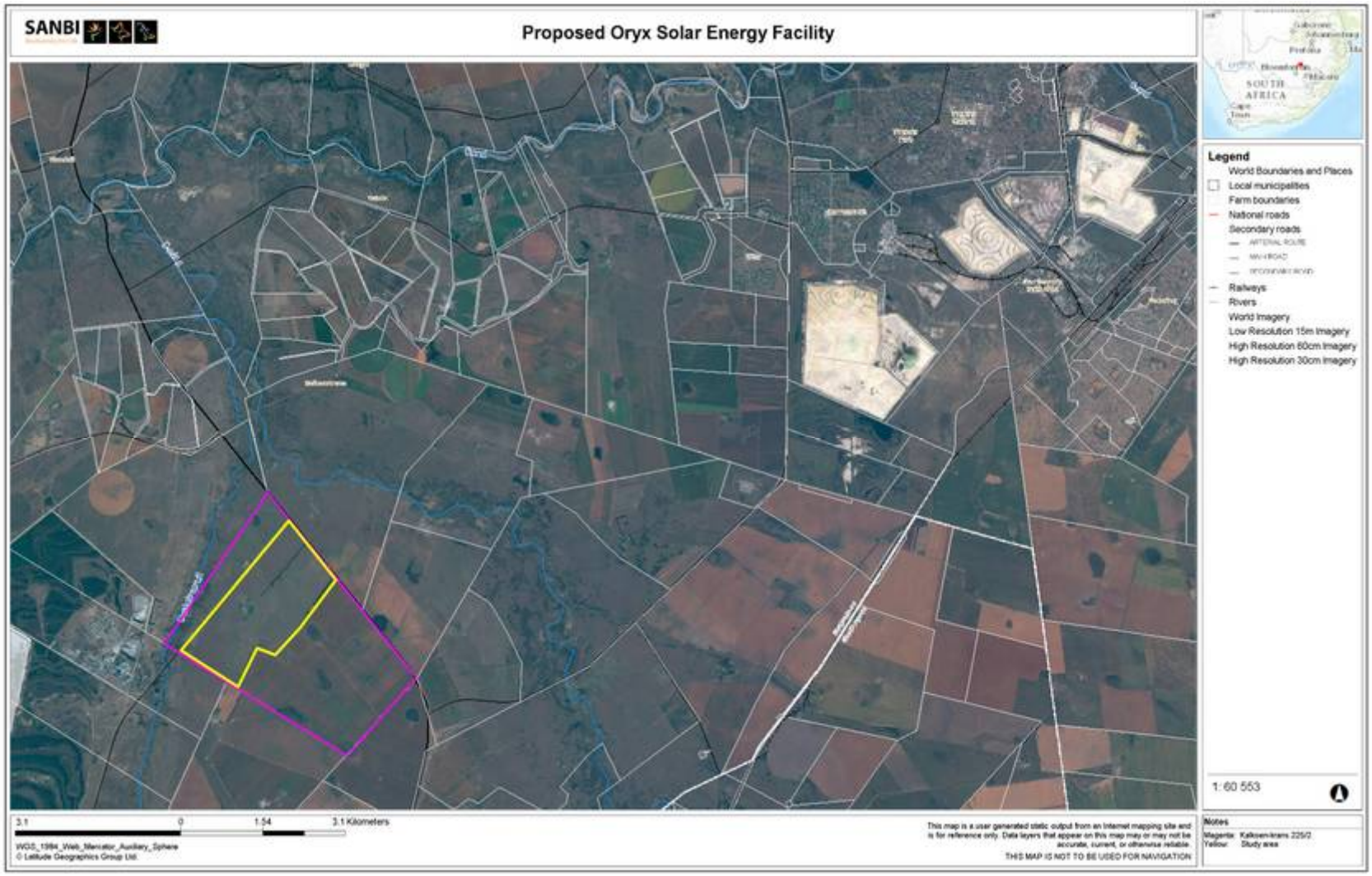

Figure 1: Locality of the farm Kalkoen-Krans 225 portion 2 (magenta) and the study area (yellow), south-west of Virginia.

Herbs, forbs, and grasses first need adequate rainfall before being able to fully grow and flower between January and March. Geophytes, forbs, succulents, and grasses can only be fully identified if they are actively growing AND have either flowers or fruit. By April, most species will have produced seed and most of the herbaceous flora will die back to below-ground storage or seed reserves to survive the cold winters in a dormant state.

3.2.2. Topography and drainage

The site can be described as gently undulating to flat, sloping from south-east to north-west. North-west of the selected area and the entry road, continued drainage from the proposed project site has created a seasonal wetland (Figure 2), that drains further into the Bosluisspruit flowing about 1 km north of the farm. The areas surrounding this small seepage area/seasonal wetland are also natural vegetation, and this portion of the farm should thus be treated as CBA and No Go Area (details in section 5.4). Within this seepage area are several protected bulbous species, and it appears to be frequented by birds such as herons and egrets that typically use wetlands for foraging.

Figure 2: The small seepage or seasonal wetland area just north of the area selected for the proposed Oryx development. The significantly higher moisture levels here can be seen from the stark difference in vegetation vigour (and species composition) from the surrounding, much dryer vegetation.

Within the study area, there are no wetlands or distinct drainage lines. It must be noted, however, that runoff collecting towards the centre of the northern portion of the study area (and having already formed erosion channels there) drains directly into the above small wetland area, and contamination and erosion must thus be strictly prevented and/or contained whenever it occurs.

No man-made wetlands were observed on the selected project area itself, but there are vleys, watering points and small dams outside the proposed development area.

3.2.3. Existing Land Use and Infrastructure

The largest portion of the area selected and regarded suitable for the development was previously cultivated, then left fallow before being ripped and sown with *Digitaria eriantha*, and is currently used as cattle grazing.

An existing Eskom powerline runs diagonally across the selected site (Figure 3), enabling a short distance for grid connection with minimal possible impact on avifauna or ecology.

The farm overall is used for mixed agriculture, consisting of cultivated areas and grazing areas.

Figure 3: View of some of the previously transformed grasslands of the area on Farm Kalkoen-Krans earmarked for the proposed Oryx PV development.

3.2.4. Access

The R30 runs adjacent to the north-eastern boundary of the property. There are large graded access roads from the R30 onto the farm that can be used for the proposed development.

3.2.5. Vegetation overview

The selected property falls within the original extent of the Vaal-Vet Sandy Grassland (Unit Gh10) as defined by Mucina and Rutherford (2006), merging into Highveld Alluvial Vegetation on the banks of larger drainage lines and the Bosluisspruit (Figure 4).

Landscapes of the Vaal-Vet Sandy Grassland consist of slightly irregular undulating plains with vegetation dominated by low-growing tussock grasses and an abundance of karroid shrubs and succulents. The grass layer consists of a high diversity of grasses, of which species such as *Themeda triandra, Anthephora pubescens, Elionurus muticus, Eragrostis* and *Digitaria* species are typical. The low shrub component is dominated by *Felicia muricata, Helichrysum* species, *Pentzia globosa,* and *Anthospermum rigidum* (Mucina and Rutherford 2006). The diversity of the herbaceous layer may vary significantly from year to year depending on utilisation and rainfall amount and timing, which influence the germination of annuals and resprouting of species with woody below-ground rootstocks.

The remaining extent of the Vaal-Vet Sandy Grassland has been listed in the threatened terrestrial ecosystems for South Africa (2011) as Endangered, as more than 63% of this vegetation type has been irreversibly transformed. Less than 0.3% of the ecosystem is protected in the Bloemhof Dam, Schoonspruit, Sandveld, Faan Meintjies, Wolwespruit, and Soetdoring Nature Reserves.

The landscape and vegetation features of the Highveld Alluvial Vegetation (Unit Aza5) can best be described as a flat topography, supporting riparian thickets dominated by *Acacia karroo* and accompanied by seasonally flooded grasslands. The grasslands on the floodplains are increasingly reduced to disturbed herb lands that are prone to invasion by alien plants. Important trees in this vegetation type include *Acacia karroo, Salix mucronata* subsp. *mucronata,* and *Ziziphus mucronata*. Characteristic shrubs are: *Searsia pyroides, Lycium hirsutum, Ehretia rigida,* and *Grewia flava*. Common grasses include *Setaria verticillata, Panicum maximum, Agrostis lachnantha,* and *Eragrostis plana* (Mucina & Rutherford 2006).

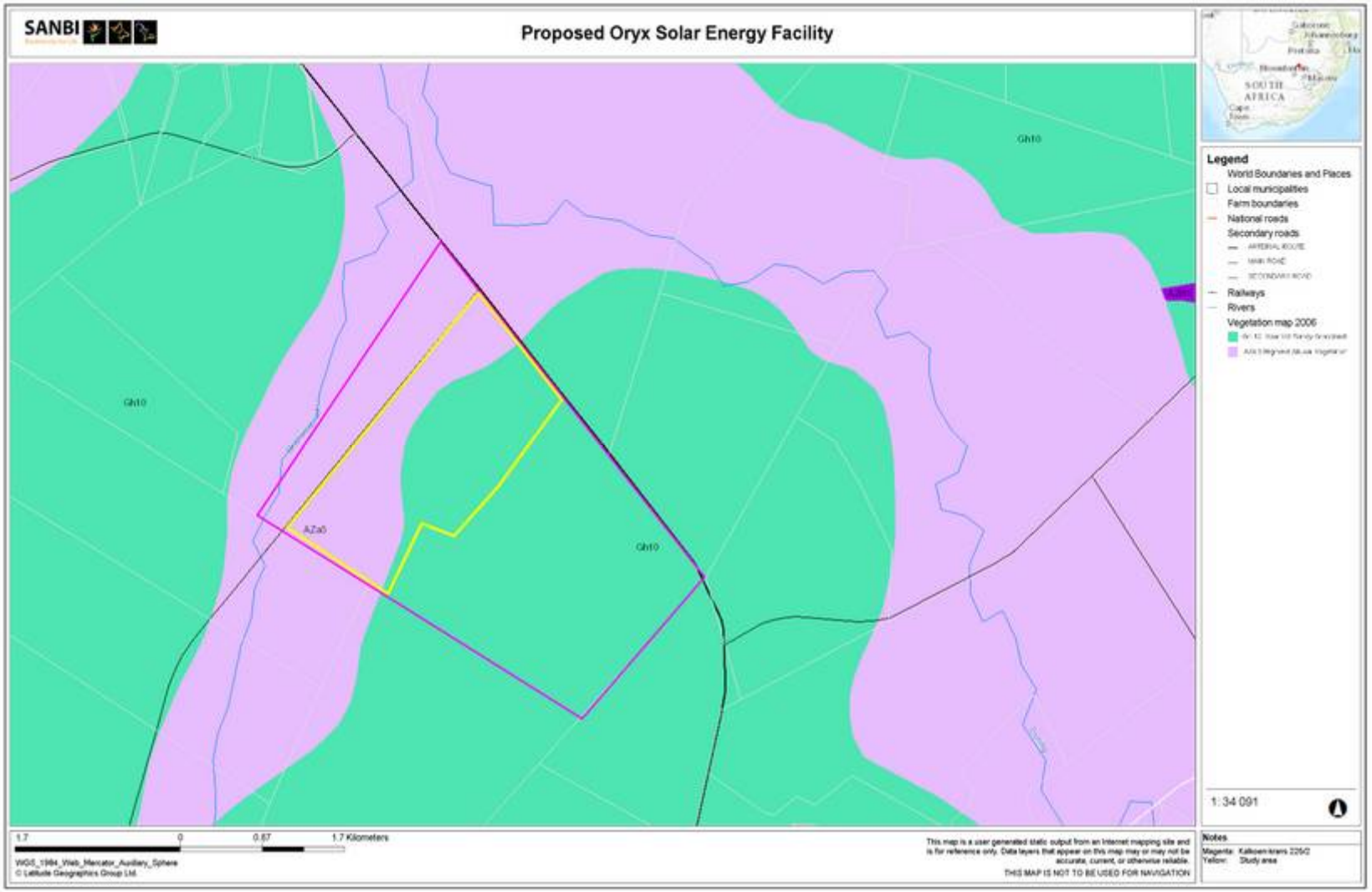

Figure 4: The original extent of the vegetation types on the study area, after Mucina and Rutherford (2006).

The conservation status of the Highveld Alluvial Vegetation is considered least threatened. The conservation target set for this vegetation unit is 31%, of which almost 10% is statutorily conserved in Baberspan (Ramsar site), Bloemhof Dam, Christiana, Faan Meintjies, Sandveld, Schoonspruit, Soetdoring, and Wolwespruit Nature Reserves. Dams as well as cultivation practices pose the biggest threats to this vegetation type. Weeds and invasive species readily establish in these riparian areas due to more favourable soil moisture and nutrient status, and such weeds are largely introduced from seeds washed down from smaller tributaries and upstream disturbed areas (Mucina & Rutherford 2006).

4. Methods

4.1. Screening survey

The site was visited for a screening study on 16 January 2013. Issues investigated included:

- Nature and condition of the vegetation on site
- Possible sensitive or endangered vegetation habitats or areas with protected species that could be affected
- Land use and nature of existing infrastructure on or bordering the proposed project area
- Nature and quality of existing wetlands on or bordering the proposed project area
- Existing access routes beyond the R30 going to the specific project site

4.2. Plant Scoping Survey

A species list from POSA (http://posa.sanbi.org, March 2013, Grid reference: 2826) containing the species that might occur in the area was obtained. POSA generated species lists also contain updated Red Data species status according to the Red List of South African Plants 2009 published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009).

A list of species of conservation concern that may occur on the site have been extracted from the POSA list, with the status of plant species indicated by using the following symbols:

P = Protected species
end = endemic to South Africa (or green text)
Red data listed plants are indicated by their status (red text)

4.3. Explanations of Red Data classes

(After Raimondo *et al.* 2009):

Critically Endangered (CR): A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.

Endangered (EN): A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.

Vulnerable (VU): A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.

Near Threatened (NT): A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.

Critically Rare: A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.

Rare: A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.

Declining: A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.

Least Concern: A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

Data Deficient - Insufficient Information (DDD): A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

Data Deficient - Taxonomically Problematic (DDT): A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.

Plant species nomenclature follows Germishuizen and Meyer (2003).

4.4. Plant Survey Methods for the EIA phase

As part of the EIA process, a detailed field survey of the vegetation will be undertaken, preferably between mid-November to April, and results will include:

» A phytosociological classification of the vegetation found on the study area according to a detailed vegetation survey and TWINSPAN analysis of survey data
» A corresponding description of all defined plant communities and their typical habitats, including a full species list for each plant community and a representative photographic record taken on site of each community
» A map of all plant communities within the boundaries of the study area
» A description of the sensitivity of each plant community, based on sensitivity criteria outlined in section 4.6
» A full assessment of impacts according to section 4.7

4.5. Vertebrate Scoping Survey

The SANBI SIBIS and ADU databases were queried regarding vertebrates historically recorded in the study area and surroundings. The likelihood of such species still occurring in the area was verified according to Apps (2000), and species of conservation concern or that are protected and most likely to occur in the study area listed.

4.6. Sensitivity Analysis and Criteria

Determining ecosystem services and sensitivity of ecosystem components, both biotic and abiotic, is rather complex, and no single overarching criteria will apply to all habitats studied. The main aspects of an ecosystem that need to be incorporated in a sensitivity analysis, however, include the following:

- Describing the nature and amount of species present, taking into consideration their conservation value as well as the probability of such species to survive or re-establish itself following disturbances of various magnitudes
- Identifying the species or habitat features that are 'key ecosystem providers' and characterising their functional relationships (Kremen 2005)

- Determining the aspects of community structure that influence function, especially aspects influencing stability or rapid decline of communities (Kremen 2005)
- Assessing key environmental factors that influence the provision of services (Kremen 2005)
- Gaining knowledge about the spatio-temporal scales over which these aspects operate (Kremen 2005)

4.6.1. Sensitivity criteria relating to Conservation Value

Species diversity

The number and abundance of species strongly influences key ecosystem processes such as pollination, air quality, primary production, nutrient and water cycling and soil formation and retention. All these processes provide ecosystem services such as shelter, potable water, and nutrients to higher trophic levels. The species composition, including dominant, minor and keystone species, is critical in maintaining ecosystem services (Chapin *et al.* 2000).

A higher number of species insures a stable supply of ecosystem goods and services as spatial and temporal variability increases, which typically occurs over longer time periods. Within a community several species may have similar functions, but react differently to environmental variables, thus can buffer ecosystem function to some degree during short-term environmental fluctuations (Hooper *et al.* 2005, Chapin *et al.* 2000). Further, coexisting plants with very different but complementary resource use strategies will use available resources more effectively, and a larger species pool is more likely to contain more groups of complementary species. Overall, productivity, nutrient retention, and resistance to invasion tend to increase with increasing species number, especially in environments where overall species cover is relatively low.

Expected species diversity

Species diversity ranges enormously between habitats, thus what may seem low species diversity in one habitat, may in fact be maximal species diversity in another, hence a standardisation of number of species across large areas to rank conservation value of an area will be misleading. Added to this, most standard methods for collecting plant species data miss many species, especially species that are less common, patchily distributed or dormant – either in the form of seeds or underground storage organs – at the time of survey. To compensate for this, species-area curves are drawn from the data to estimate total species richness (Chong and Stohlgren 2007, Garrard *et al.* 2008). This is considered a useful tool in conservation biology, because information from the curves allows a comparison of different communities without the absolute knowledge of all species present in unsampled areas (Chong and Stohlgren 2007). Should the

area surveyed differ considerably from surrounding areas, such surrounding areas should also be surveyed to obtain a more realistic measure of expected species diversity.

Species that are less common or endemic

It is often difficult to identify what exactly limits the distribution of a species. Factors that have been identified as playing a major role, either on their own or together, are habitat limitation and dispersal limitation (Münzbergová 2006), as well as minimum number of individuals required to enable a viable population. Rare taxa often have specialised habitat requirements and are thus restricted to rare environmental conditions, of which rock outcrops and narrow water channels are typical (Keith 1998). A restricted availability of a habitat may also reduce the dispersal capability of a species. Species of conservation concern be it due to their restricted numbers, decreasing habitat availability and/or exploitation are protected from provincial to international level, and hence their Red Data and protection status can be used as a surrogate to assess the sensitivity of an area to man-made disturbances.

Within a community, the species composition is often as or more important than the species number in affecting ecosystem processes. Changes in species compositions can occur indirectly by an altered resource supply due to anthropogenic influence e.g. change of moisture flows. Although a reduction in the number of species may initially have small effects, even minor losses may indicate that the capacity of the ecosystem to adjust to a changing environment is being lost (Chapin *et al.* 2000, Hooper *et al.* 2005). Species are allocated an official conservation status to prevent their further decline due to identified threats (Keith 1998). Protected or red-data species, as well as endemic species, apart from their conservation status, are a first indicator of the health of an ecosystem. They will most probably be the first to show a sudden decline should their environment be changed beyond a specific threshold, e.g. by excessive erosion.

4.6.2. Sensitivity criteria relating to ecosystem function

Soil water availability

The most limiting factor in arid and semi-arid systems is moisture. Soil water availability is limited not only by timing and amount of rainfall events, but also by low infiltration rates of water into the soil. Vegetation itself, however, promotes the rate of infiltration due to increasing soil surface roughness as well as soil surface porosity, providing a further positive feedback between increased infiltration and increased plant growth. Thus with increasing plant density, the rate of infiltration into the soil will increase significantly, instead of most water being lost as runoff during infrequent rain showers (Dekker *et al.* 2007). Soil

surface roughness can also be provided by various degrees of surface rockiness, living soil crusts and micro topography - including the fertile-island effect created by shrubs (Esler *et al.* 2006), which aid as resource traps for runoff and nutrients. Compacted, denuded soils are often prone to surface capping – even more so if the soils have a fine texture due to higher clay or loam contents. Such capped soils are prone to ever increasing erosion, creating a leaky ecosystem that rapidly loses soil, nutrients and seeds from the ecosystem (Tongway and Hindley 2004).

Niches

Relief, topography, and micro-topography are important features of the habitat, because evapotranspiration and photosynthesis correlate with the resultant solar radiation and temperatures, and the variability of in soil attributes and water flows highly depend on these features (Dirnböck *et al.* 2002). Topography has a major influence on the redistribution of rainfall, affecting moisture limitations for plant present, and the effect of this on vegetation increases significantly with aridity, but is also coupled to the geology of the terrain (Dirnböck *et al.* 2002).

Habitat

Several studies have shown that the vegetation units contributing the most to regional species diversity cover the smallest areas because these species are concentrated on and some also limited to particular habitats (Chong and Stohlgren 2007, Keith 1998). However, these communities or habitats may contain species that are of high importance to the entire ecosystem, and an extinction of such a local plant population, or their reduction to a point where they become functionally extinct, can have dramatic consequences on the regulation and support of ecosystem services. The diversity and size of a landscape unit also influences ecosystem services – species on the edges of a habitat are more vulnerable to environmental stresses, and the more a habitat is fragmented, the higher this stressful edge effect becomes, in addition to habitat loss. Habitat loss and/or fragmentation can thus have disproportionately large effects on ecosystem services.

Overall, the properties of species, together with the species composition is often more critical in retaining the function of an ecosystem than species numbers or total cover (Chapin *et al.* 2000). Many of these species will, however, only establish if the habitat is suitable (Carrick and Krüger 2007). Added to that, rehabilitation in arid and semi-arid zones has been difficult either due to difficulties in establishment because of low, erratic and unpredictable rainfall or the lack of available seed material (Le Houérou 2000).

4.7. Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

The **nature** of the impact refers to the causes of the effect, what will be affected and how it will be affected.

Extent (E) of impact

Local (site or surroundings)
Regional (provincial)
Rating = 1 (low) to 5 (high).

Duration (D) rating is awarded as follows:
Whether the life-time of the impact will be:

- Very short term – up to 1 year: Rating = 1
- Short term – >1 – 5 years: Rating = 2
- Moderate term - >5 – 15 years: Rating = 3
- Long term – >15 years: Rating = 4

The impact will occur during the operational life of the activity, and recovery may occur with mitigation (restoration and rehabilitation).

- Permanent – Rating = 5

The impact will destroy the ecosystem functioning and mitigation (restoration and rehabilitation) will not contribute in such a way or in such a time span that the impact can be considered transient.

Magnitude (M) (severity):
A rating is awarded to each impact as follows:

- Small impact – the ecosystem pattern, process and functioning are not affected.
  Rating = 0
- Minor impact - a minor impact on the environment and processes will occur.
  Rating = 2
- Low impact - slight impact on ecosystem pattern, process and functioning.
  Rating = 4
- Moderate intensity – valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way.
  Rating = 6

- High intensity – environment affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected.
  Rating = 8
- Very high intensity – environment affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease.
  Rating = 10

Probability (P) (certainty) describes the probability or likelihood of the impact actually occurring, and is rated as follows:

- Very improbable – where the impact will not occur, either because of design or historic experience.
  Rating = 1
- Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience.
  Rating = 2
- Probable -there is a distinct probability that the impact will occur (<50% chance of occurring).
  Rating = 3
- Highly probable - most likely that the impact will occur (50 – 90% chance of occurring).
  Rating = 4
- Definite – the impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring).
  Rating = 5

Significance (S) - Rating of low, medium or high. Significance is determined through a synthesis of the characteristics described above where:
S = (E+D+M)*P

The **significance weighting** should influence the development project as follows:

- Low significance (significance weighting: <30 points)

If the negative impacts have little real effects, it should not have an influence on the decision to proceed with the project. In such circumstances, there is a significant capacity of the environmental resources in the area to respond to change and withstand stress and they will be able to return to their pre-impacted state within the short-term.

- Medium significance (significance weighting: 30 – 60 points)

If the impact is negative, it implies that the impact is real and sufficiently important to require mitigation and management measures before the proposed project can be approved. In such circumstances, there is a reduction in the capacity of the environmental resources in the area to withstand stress and to return to their pre-impacted state within the medium to long-term.

- High significance (significance weighting: >60 points)

The environmental resources will be destroyed in the area leading to the collapse of the ecosystem pattern, process and functioning. The impact strongly influences the decision whether or not to proceed with the project. If mitigation cannot be effectively implemented, the proposed activity should be terminated.

5. Results

5.1. Plant Survey

A total of 371 plant species have been recorded in the Welkom/Virginia Area according to the SANBI database. It is unlikely that all of these species will occur within the project area, whilst species not previously recorded may be present.

Of the previously recorded species, 24 are endemic to South Africa and 4 species have a red-data status. The presence of these species on site will have to be verified during a detailed field study.

During the screening visit it could be verified that several bulbous and some succulent Mesembryanthemaceae species are present, of which several may be protected. It should be possible to remove and successfully relocate these specimens. Low indigenous trees and high shrubs found on site are relatively common and not protected.

Plant species that are of conservation concern that have been recorded in the area and that may occur within the development area are listed below (Table 1). Their conservation status is indicated as: red-listed species are indicated in red, species endemic to South Africa are indicated in green (and/or 'end'), and P indicates protected species.

It must be noted that portions of the study area has been mapped as remaining portions of the threatened Vaal-Vet Sandy Grassland. This delineation is, however, contradictory to mapped landcover classes as well as cultivation history confirmed on the ground (Figure 5). The discrepancy is most likely a result of insufficient ground-truthing of remotely sensed images during the mapping program of nationally threatened ecosystems. A full description of plant

communities on the site and associated habitats can only be provided after a field study conducted during the growing season, which will also reveal where remaining threatened grassland vegetation may occur. The screening study already confirmed that most of the proposed development site is situated on previously transformed areas.

Table 1: Species of conservation concern that could be expected on the project area:

Species	Status
Succulents	
Aloe grandidentata	P
Anacampseros subnuda subsp. subnuda	P
Brachystelma comptum	**end, VU, P**
Brachystelma glenense	**end, DDT, P**
Chasmatophyllum musculinum	P
Corpuscularia taylori	**end, P**
Cotyledon orbiculata var. dactylopsis	**end**
Crassula capitella subsp. capitella	**end**
Crassula lanceolata subsp. lanceolata	**end**
Euphorbia caterviflora	**end, P**
Euphorbia mauritanica var. mauritanica	P
Euphorbia mixta	**end, P**
Malephora smithii	**end, P**
Mesembryanthemum stenandrum	**end, P**
Mestoklema arboriforme	P
Nananthus vittatus	**DDT**
Ruschia hamata	P
Trichodiadema pomeridianum	P
Trichodiadema setuliferum	**end, P**
Low shrubs	
Abutilon piloso-cinereum	**end**
Acalypha caperonioides var. caperonioides	**DDT**

Species	Status
Aptosimum indivisum	**end**
Atriplex erosa	**end**
Atriplex vestita var. inappendiculata	**end**
Eriocephalus karooicus	**end**
Felicia fascicularis	**end**
Galenia procumbens	**end**
Galenia prostrata	**end**
Garuleum pinnatifidum	**end**
Helichrysum dregeanum	P
Helichrysum paronychioides	P
Helichrysum pentzioides	**end, P**
Helichrysum zeyheri	P
Hermannia linearifolia	**end**
Jamesbrittenia albiflora	**end**
Osteospermum lanceolatum	**end, DDT**
Osteospermum leptolobum	**end**
Pentzia punctata	**end**
Pentzia viridis	**end**
Salsola calluna	**end**
Salsola geminiflora	**end**
Selago albida	**end**
Selago geniculata	**end**
Wahlenbergia nodosa	**end**
High shrubs and trees	
Heteromorpha arborescens var. arborescens	**end**
Olea europaea subsp. africana	P
Searsia tridactyla	**end**

Species	Status
Herbs and forbs	
Amellus tridactylus subsp. tridactylus	**end**
Aster pleiocephalus	**end**
Berkheya pinnatifida subsp. pinnatifida	**end**
Choritaenia capensis	**end**
Convolvulus boedeckerianus	**end**
Convolvulus dregeanus	**end**
Cotula bipinnata	**end**
Cyperus capensis	**end**
Dianthus micropetalus	**end**
Helichrysum argyrosphaerum	P
Helichrysum aureum var. monocephalum	P
Helichrysum cerastioides var. cerastioides	P
Helichrysum lineare	P
Helichrysum rugulosum	P
Hibiscus marlothianus	**end**
Nemesia floribunda	**end**
Sebaea compacta	**end**
Senecio glanduloso-pilosus	**end**
Senecio laevigatus var. integrifolius	**end**
Senecio reptans	**end**
Sesbania notialis	**end**
Vahlia capensis subsp. capensis	**end**
Cotula bipinnata	**end**
Geophytes	
Ammocharis coranica	P
Boophone disticha	**Declining, P**

Species	Status
Brunsvigia radulosa	P
Bulbine abyssinica	P
Bulbine frutescens	P
Bulbine narcissifolia	P
Daubenya comata	**end**
Drimia elata	**DDT**
Drimia macrantha	**end**
Duthieastrum linifolium	**end, P**
Eucomis autumnalis subsp. clavata	P
Gethyllis transkarooica	P
Gladiolus permeabilis subsp. edulis	P
Haemanthus humilis subsp. humilis	P
Haemanthus montanus	P
Harpagophytum procumbens subsp. procumbens	NEMA: BA
Kniphofia ensifolia subsp. autumnalis	**end, EN, P**
Lapeirousia plicata	P
Moraea debilis	**end, EN, P**
Moraea pallida	P
Moraea polystachya	P
Moraea simulans	P
Nerine laticoma	P
Ornithogalum juncifolium var. juncifolium	**end**
Tulbaghia acutiloba	P
Tulbaghia cernua	P
Grasses	
Cynodon incompletus	**end**
Sporobolus oxyphyllus	**end, NT**

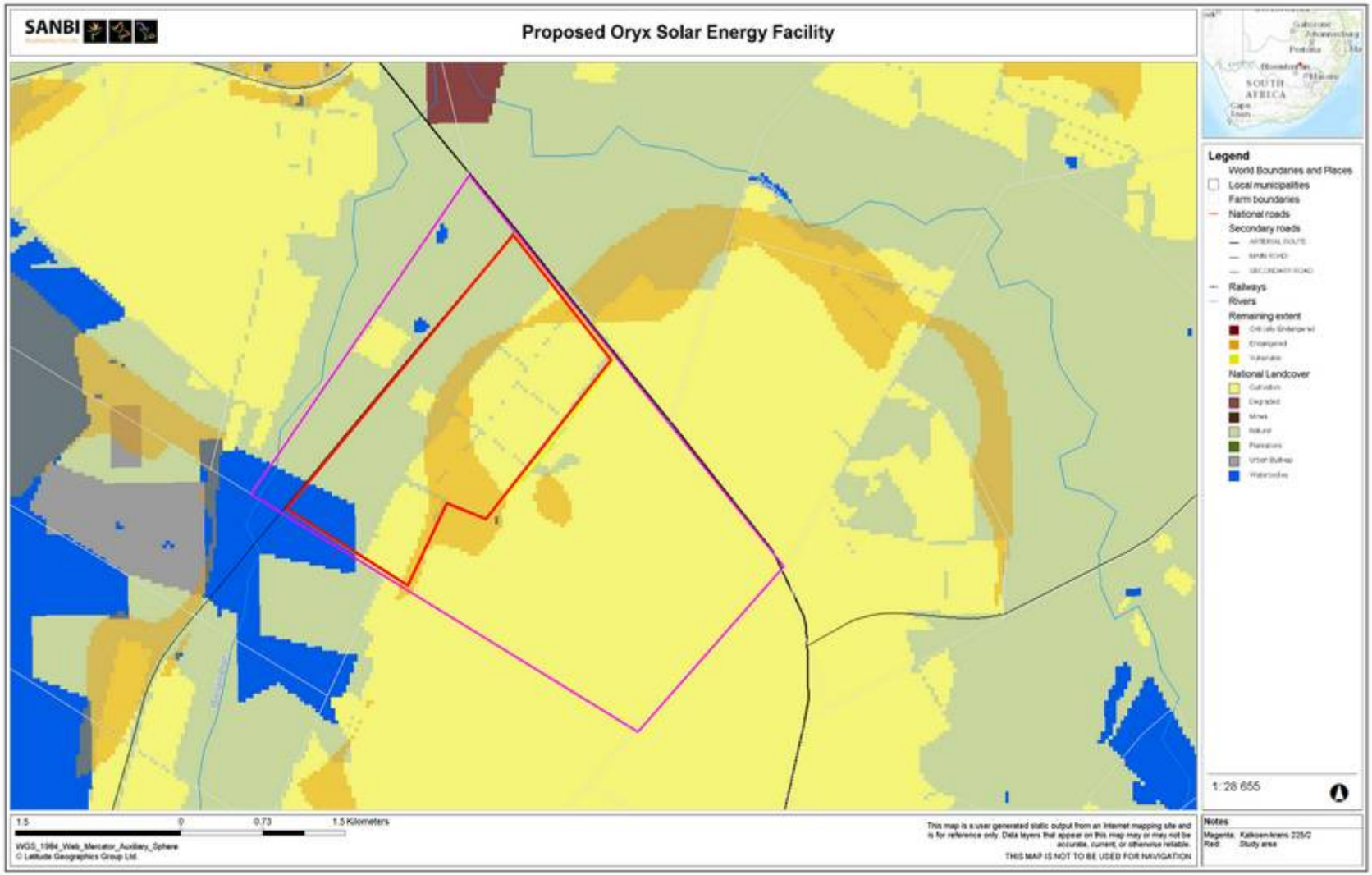

Figure 5: Contradictory BGIS mapping of transformed areas and remaining extent of listed threatened ecosystems.

5.2. Vertebrates

A list of protected vertebrate species (reptiles, birds, and mammals) that could occur in the study area according to the ADU and SANBI databases, as well as Apps (2000) is presented in Table 2. Several amphibians have been recorded for the area, but these are not listed here as none of the species recorded are of any conservation concern. Whilst fauna species are mobile and the impact of new structures does not destroy animals as it does plants, they do depend on specific habitats. For all species that have a red-data status as indicated in the list, the presence and suitable habitat of such species must be verified by a suitably qualified specialist to ensure that the habitat of such species will not be impacted on by the proposed development. Due to the previous transformation and disturbance on the proposed project site, it is not expected that any of the listed species breed or depend on the proposed project area for survival.

Table 2: Protected vertebrates that could occur in the study area

Common Name	Species Name	Threat Status
Reptiles - Geckos		
Cape Gecko	*Pachydactylus capensis*	
Marico Gecko	***Pachydactylus mariquensis***	**end**
Reptiles - Agamas		
Distant's Ground Agama	***Agama aculeata subsp. distanti***	**end**
Southern Rock Agama	*Agama atra*	
Reptiles – Lizards and skinks		
Thin-tailed Legless Skink	***Acontias gracilicauda***	**end**
Wahlberg's Snake-eyed Skink	*Afroablepharus wahlbergii*	
Yellow-throated Plated Lizard	*Gerrhosaurus flavigularis*	
Karoo Girdled Lizard	*Karusasaurus polyzonus*	
Cape Worm Lizard	*Monopeltis capensis*	
Holub's Sandveld Lizard	*Nucras holubi*	
Spotted Sandveld Lizard	*Nucras intertexta*	
Burchell's Sand Lizard	***Pedioplanis burchelli***	**end**
Spotted Sand Lizard	*Pedioplanis lineoocellata subsp. lineoocellata*	
Giant Girdled Lizard	***Smauggi ganteus***	**end, VU**
Cape Skink	*Trachylepis capensis*	
Speckled Rock Skink	*Trachylepis punctatissima*	

Common Name	Species Name	Threat Status
Speckled Sand Skink	*Trachylepis punctulata*	
Variable Skink	*Trachylepis varia*	
Reptiles - Serpents		
Black-headed Centipede-eater	*Aparallactus capensis*	
Puff Adder	*Bitis arietans subsp. arietans*	
Brown House Snake	*Boaedon capensis*	
Red-lipped Snake	*Crotaphopeltis hotamboeia*	
Rhombic Egg-eater	*Dasypeltis scabra*	
Highveld Garter Snake	*Elapsoidea sundevallii subsp. media*	
Striped Harlequin Snake	***Homoroselaps dorsalis***	**NT, end**
Aurora House Snake	***Lamprophis aurora***	**end**
Peters' Thread Snake	*Leptotyphlops scutifrons subsp. scutifrons*	
Cape Wolf Snake	*Lycophidion capense subsp. capense*	
Cape Cobra	*Naja nivea*	
Sundevall's Shovel-snout	*Prosymna sundevallii*	
Cross-marked Grass Snake	*Psammophis crucifer*	
Fork-marked Sand Snake	*Psammophis trinasalis*	
Spotted Grass Snake	*Psammophylax rhombeatus subsp. rhombeatus*	
Striped Grass Snake	*Psammophylax tritaeniatus*	
Mole Snake	*Pseudaspis cana*	
Delalande's Beaked Blind Snake	*Rhinotyphlops lalandei*	
Reptiles - tortoises		
Greater Padloper	***Homopus femoralis***	**end**
Marsh Terrapin	*Pelomedusa subrufa*	
Serrated Tent Tortoise	*Psammobates oculifer*	
Leopard Tortoise	*Stigmochelys pardalis*	
Aves - Birds		
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	
Malachite Kingfisher	*Alcedo cristata*	
Egyptian Goose	*Alopochen aegyptiaca*	
Red-headed Finch	*Amadina erythrocephala*	

Common Name	Species Name	Threat Status
African Pipit	*Anthus cinnamomeus*	
African Rock Pipit	*Anthus crenatus*	
Plain-backed Pipit	*Anthus leucophrys*	
Long-billed Pipit	*Anthus similis*	
Buffy Pipit	*Anthus vaalensis*	
Little Swift	*Apus affinis*	
Common Swift	*Apus apus*	
African Black Swift	*Apus barbatus*	
White-rumped Swift	*Apus caffer*	
White-rumped Swift	*Apus horus*	
Tawny Eagle	*Aquila rapax*	
Verreaux's Eagle	*Aquila verreauxii*	
Grey Heron	*Ardea cinerea*	
Goliath Heron	*Ardea goliath*	
Black-headed Heron	*Ardea melanocephala*	
Squacco Heron	*Ardeola ralloides*	
Kori Bustard	***Ardeotis kori***	**Vulnerable**
Marsh Owl	*Asio capensis*	
Pririt Batis	*Batis pririt*	
Hadeda Ibis	*Bostrychia hagedash*	
Little Rush-Warbler	*Bradypterus baboecala*	
Spotted Eagle-Owl	*Bubo africanus*	
Cattle Egret	*Bubulcus ibis*	
Spotted Thick-knee	*Burhinus capensis*	
Jackal Buzzard	*Buteo rufofuscus*	
Steppe Buzzard	*Buteo vulpinus*	
Red-capped Lark	*Calandrella cinerea*	
Sabota Lark	*Calendulauda sabota*	
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	
Burchell's Coucal	*Centropus burchellii*	
Familiar Chat	*Cercomela familiaris*	
Sickle-winged Chat	*Cercomela sinuata*	
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	
Kalahari Scrub-Robin	*Cercotrichas paena*	
Cape Long-billed Lark	*Certhilauda curvirostris*	

Common Name	Species Name	Threat Status
Pied Kingfisher	*Ceryle rudis*	
Common Ringed Plover	*Charadrius hiaticula*	
Kittlitz's Plover	*Charadrius pecuarius*	
Three-banded Plover	*Charadrius tricollaris*	
Spike-heeled Lark	*Chersomanes albofasciata*	
Diderick Cuckoo	*Chrysococcyx caprius*	
White Stork	*Ciconia ciconia*	
Black Stork	*Ciconia nigra*	
White-bellied Sunbird	*Cinnyris talatala*	
Black Harrier	*Circus maurus*	
African Marsh-Harrier	*Circus ranivorus*	
Desert Cisticola	*Cisticola aridulus*	
Wing-snapping Cisticola	*Cisticola ayresii*	
Neddicky	*Cisticola fulvicapilla*	
Zitting Cisticola	*Cisticola juncidis*	
Wailing Cisticola	*Cisticola lais*	
Cloud Cisticola	*Cisticola textrix*	
Levaillant's Cisticola	*Cisticola tinniens*	
Great Spotted Cuckoo	*Clamator glandarius*	
Jacobin Cuckoo	*Clamator jacobinus*	
African Olive-pigeon	*Columba arquatrix*	
Speckled Pigeon	*Columba guinea*	
Rock Dove	*Columba livia*	
European Roller	*Coracias garrulus*	
White-necked Raven	*Corvus albicollis*	
Cape Robin-Chat	*Cossypha caffra*	
Common Quail	*Coturnix coturnix*	
Wattled Starling	*Creatophora cinerea*	
White-throated Canary	*Crithagra albogularis*	
Black-throated Canary	*Crithagra atrogularis*	
Yellow Canary	*Crithagra flaviventris*	
Red-chested Cuckoo	*Cuculus solitarius*	
Burchell's Courser	*Cursorius rufus*	
Temminck's Courser	*Cursorius temminckii*	
Cardinal Woodpecker	*Dendropicos fuscescens*	

Common Name	Species Name	Threat Status
Great Egret	*Egretta alba*	
Little Egret	*Egretta garzetta*	
Yellow-billed Egret	*Egretta intermedia*	
Black-shouldered Kite	*Elanus caeruleus*	
Cape Bunting	*Emberiza capensis*	
Golden-breasted Bunting	*Emberiza flaviventris*	
Lark-like Bunting	*Emberiza impetuani*	
Cinnamon-breasted Bunting	*Emberiza tahapisi*	
Yellow-bellied Eremomela	*Eremomela icteropygialis*	
Chestnut-backed Sparrowlark	*Eremopterix leucotis*	
Grey-backed Sparrowlark	*Eremopterix verticalis*	
Common Waxbill	*Estrilda astrild*	
Yellow-crowned Bishop	*Euplectes afer*	
Long-tailed Widowbird	*Euplectes progne*	
Karoo Korhaan	*Eupodotis vigorsii*	
Lanner Falcon	*Falco biarmicus*	
Lesser Kestrel	***Falco naumanni***	**Vulnerable**
Rock Kestrel	*Falco rupicolis*	
Greater Kestrel	*Falco rupicoloides*	
Large-billed Lark	*Galerida magnirostris*	
African Snipe	*Gallinago nigripennis*	
Ground Woodpecker	*Geocolaptes olivaceus*	
Bald Ibis	***Geronticus calvus***	**Vulnerable**
Cape Vulture	***Gyps coprotheres***	**Endangered**
White-throated Swallow	*Hirundo albigularis*	
Greater Striped Swallow	*Hirundo cucullata*	
Pearl-breasted Swallow	*Hirundo dimidiata*	
Rock Martin	*Hirundo fuligula*	
Barn Swallow	*Hirundo rustica*	
Red-breasted Swallow	*Hirundo semirufa*	
South African Cliff-Swallow	*Hirundo spilodera*	
Greater Honeyguide	*Indicator indicator*	
Lesser Honeyguide	*Indicator minor*	
Red-throated Wryneck	*Jynx ruficollis*	
Cape Glossy Starling	*Lamprotornis nitens*	

Common Name	Species Name	Threat Status
Common Fiscal	*Lanius collaris*	
Red-backed Shrike	*Lanius collurio*	
Cape Longclaw	*Macronyx capensis*	
Rufous-eared Warbler	*Malcorus pectoralis*	
Southern Black Flycatcher	*Melaenornis pammelaina*	
Southern Pale Chanting Goshawk	*Melierax canorus*	
European Bee-eater	*Merops apiaster*	
White-fronted Bee-eater	*Merops bullockoides*	
Swallow-tailed Bee-eater	*Merops hirundineus*	
Rufous-naped Lark	*Mirafra africana*	
Cape Clapper Lark	*Mirafra apiata*	
Melodious Lark	*Mirafra cheniana*	
Short-toed Rock-Thrush	*Monticola brevipes*	
Sentinel Rock-Thrush	*Monticola explorator*	
Cape Rock-Thrush	*Monticola rupestris*	
African Pied Wagtail	*Motacilla aguimp*	
Cape Wagtail	*Motacilla capensis*	
Spotted Flycatcher	*Muscicapa striata*	
Yellowbilled Stork	*Mycteria ibis*	
Anteating Chat	*Myrmecocichla formicivora*	
Malachite Sunbird	*Nectarinia famosa*	
Ludwig's Bustard	***Neotis ludwigii***	**Vulnerable**
Helmeted guineafowl	*Numida meleagris*	
Black-crowned Night-Heron	*Nycticorax nycticorax*	
Namaqua Dove	*Oena capensis*	
Mountain Wheatear	*Oenanthe monticola*	
Capped Wheatear	*Oenanthe pileata*	
African Quailfinch	*Ortygospiza atricollis*	
Osprey	*Pandion haliaetus*	
Layard's Tit-Babbler	*Parisoma layardi*	
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	
Ashy Tit	*Parus cinerascens*	
Southern Grey-headed Sparrow	*Passer diffusus*	
Green Wood-Hoopoe	*Phoeniculus purpureus*	
Willow Warbler	*Phylloscopus trochilus*	

Common Name	Species Name	Threat Status
Spur-winged Goose	*Plectropterus gambensis*	
Glossy Ibis	*Plegadis falcinellus*	
White-browed Sparrow-Weaver	*Plocepasser mahali*	
Martial Eagle	***Polemaetus bellicosus***	**Vulnerable**
Black-chested Prinia	*Prinia flavicans*	
Drakensberg Prinia	*Prinia hypoxantha*	
Natal Spurfowl	*Pternistis natalensis*	
Swainson's Spurfowl	*Pternistis swainsonii*	
Namaqua Sandgrouse	*Pterocles namaqua*	
Green-winged Pytilia	*Pytilia melba*	
Scimitar-bill Hoopoe	*Rhinopomastus cyanomelas*	
Double-banded Courser	*Rhinoptilus africanus*	
Three-banded Courser	*Riparia cincta*	
Brown-throated Martin	*Riparia paludicola*	
Sand Martin	*Riparia riparia*	
Secretarybird	*Sagittarius serpentarius*	
African Stonechat	*Saxicola torquatus*	
Grey-wing Francolin	*Scleroptila africanus*	
Red-wing Francolin	*Scleroptila levaillantii*	
Orange River Francolin	*Scleroptila levaillantoides*	
Hamerkop	*Scopus umbretta*	
Cape Canary	*Serinus canicollis*	
Fiscal Flycatcher	*Sigelus silens*	
Cape Grassbird	*Sphenoeacus afer*	
Pink-billed Lark	*Spizocorys conirostris*	
Scaly-feathered Finch	*Sporopipes squamifrons*	
Pied Starling	*Spreo bicolor*	
Fairy Flycatcher	*Stenostira scita*	
Cape Turtle-Dove	*Streptopelia capicola*	
Red-eyed Turtle-Dove	*Streptopelia semitorquata*	
Laughing Dove	*Streptopelia senegalensis*	
Ostrich	*Struthio camelus*	
Dickson's Brown	*Stygionympha irrorata*	
Alpine Swift	*Tachymarptis melba*	
Brown-crowned Tchagra	*Tchagra australis*	

Common Name	Species Name	Threat Status
Bokmakierie	*Telophorus zeylonus*	
Mocking Cliff-Chat	*Thamnolaea cinnamomeiventris*	
African Sacred Ibis	*Threskiornis aethiopicus*	
Crested Barbet	*Trachyphonus vaillantii*	
Acacia Pied Barbet	*Tricholaema leucomelas*	
Olive Thrush	*Turdus olivaceus*	
Barn Owl	*Tyto alba*	
African Grass-Owl	***Tyto capensis***	**Vulnerable**
African Hoopoe	*Upupa africana*	
Blue Waxbill	*Uraeginthus angolensis*	
Blacksmith Lapwing	*Vanellus armatus*	
Crowned Lapwing	*Vanellus coronatus*	
Pin-tailed Whydah	*Vidua macroura*	
Orange River White-eye	*Zosterops pallidus*	
Chiroptera - Bats		
Lesueur's Wing-gland Bat	*Cistugo lesueuri*	
Geoffroy's Horseshoe Bat	*Rhinolophus clivosus*	
Insectivora - Insectivores		
South African Hedgehog	*Atelerix frontalis*	
Reddish-grey Musk Shrew	*Crocidura cyanea*	
Tiny Musk Shrew	*Crocidura fuscomurina*	
Maquassie Musk Shrew	*Crocidura maquassiensis*	
Swamp Musk Shrew	*Crocidura mariquensis*	
Lesser Grey-brown Musk Shrew	*Crocidura silacea*	
Least Dwarf Shrew	*Suncus infinitesimus*	
Lesser Dwarf Shrew	*Suncus varilla*	
Macroscelidae – Elephant Shrews		
Rock Elephant-shrew	*Elephantulus myurus*	
Rodentia - Rodents		
Red Veld Rat	*Aethomys chrysophilus*	
Tete Veld Rat	*Aethomys ineptus*	

Common Name	Species Name	Threat Status
Namaqua Rock Mouse	*Aethomys namaquensis*	
Common Molerat	*Cryptomys hottentotus*	
Grey Climbing Mouse	*Dendromus melanotis*	
Short-tailed Gerbil	*Desmodillus auricularis*	
Woodland Dormouse	*Graphiurus murinus*	
Cape Porcupine	*Hystrix africaeaustralis*	
Large-eared Mouse	*Malacothrix typica*	
Natal Multimammate Mouse	*Mastomys natalensis*	
Pygmy Mouse	*Mus minutoides*	
White-tailed Rat	*Mystromys albicaudatus*	
Vlei Rat	*Otomys irroratus*	
Saunder's Vlei Rat	*Otomys saundersiae*	
Springhare	*Pedetes capensis*	
Striped Mouse	*Rhabdomys pumilio*	
Highveld Gerbil	*Tatera brantsii*	
Bushveld Gerbil	*Tatera leucogaster*	
Cape Ground Squirrel	*Xerus inauris*	
Lagomorpha – Rabbits and Hares		
Desert/Cape Hare	*Lepus capensis*	
Savannah/Scrub Hare	*Lepus saxatilis*	
Artiodactyla – even-toed ungulates		
Springbuck	*Antidorcas marsupialis*	
Black Wildebeest	*Connochaetes gnou*	
Blesbuck	*Damaliscus pygargus phillipsi*	
Klipspringer	*Oreotragus oreotragus*	
Steenbuck	*Raphicerus campestris*	
Common Duiker	*Sylvicapra grimmia*	
Carnivora - Carnivores		
Yellow Mongoose	*Cynictis penicillata*	
Black-footed Cat	***Felis nigripes***	**Rare**
African Wild Cat	***Felis silvestris***	**Vulnerable**
Small Grey Mongoose	*Galerella pulverulenta*	

Common Name	Species Name	Threat Status
Slender Mongoose	*Galerella sanguinea*	
Small-spotted Genet	*Genetta genetta*	
White-tailed Mongoose	*Ichneumia albicauda*	
Striped Polecat	*Ictonyx striatus*	
Bat-eared Fox	*Otocyon megalotis*	
Suricate	*Suricata suricatta*	
Cape Fox	*Vulpes chama*	
Tubilidentata - Aardvark		
Antbear / Aardvark	***Orycteropus afer***	**Vulnerable**

5.3. Invasive Plants

On either side of the selected area, rows of the alien invasive *Eucalyptus* have been planted in the past. These trees should be removed. The wood and leaves of these trees contain high amounts of turpentines, which makes them unsuitable for use in erosion control. It would thus be advisable to destroy leaves and smaller branches, whilst the remainder of the wood can be removed from site and disposed of – even sold or distributed as firewood (as it is alien).

A more serious concern arises from plants of *Opuntia* species that are becoming established on the farm. These need to be eradicated completely and their further spread prevented.

Other species that will require control include *Cereus* species (also a type of cacti), *Tribulus,* and possibly *Emex* species (prostrate annual herbs with spiny seeds - the latter two so far only observed as seed).

Additional alien invasive species do occur in the surrounding area along major transport routes, which could be accidentally introduced to the project site during construction. Regular monitoring and early eradication should enable a cost-effective control of invasives.

5.4. Sensitivity analysis

At the time of compilation of this report, no detailed field study had been carried out, but the site had been visited during a screening study.

Approximately two-thirds of the area regarded as suitable for the PV facility is situated on disused, previously cultivated lands. Cultivation was stopped on these areas due to excessive soil capping, erosion and low productivity. In an attempt to increase the vegetation cover on these relatively barren areas, the landowner has ripped these areas and introduced the grass *Digitaria eriantha*, but vegetation remains sparse (Figure 3 section 3).

The north-western portion of the study area consist of remnants of natural vegetation (Figure 6), mostly mapped by Mucina and Rutherford (2006) as Highveld Alluvial Vegetation. This strip of vegetation, however, should rather be considered as remnants of the Vaal-Vet Sandy Grassland, which gradually merges into Highveld Alluvial Vegetation around larger drainage lines and the Bosluisspruit and Doring River. The state of this remaining grassland needs to be assessed during the EIA vegetation survey, but appears to be relatively degraded.

Potentially sensitive areas were delineated from visual inspection of Google imagery and observations from the screening study. The areas identified as sensitive (Figure 6) are seepage areas and wetlands such as larger drainage lines, dams and vleys as mapped by the BGIS database, seepage areas observed during the screening visit and the remaining natural vegetation (shown in orange in Figure 6). The observed seepage area (navy in Figure 6) is habitat to a high number of the bulb *Ammocharis coranica*, as well as other species that usually require a moister habitat as provided around seasonal pans. The developer has already indicated that this seepage area will not be included in the PV array development area.

All wetlands within the study area as delineated by the BGIS database will need to be verified. Wetland habitats and remaining natural vegetation are sensitive because of their ecosystem functions – providing specialised niches for fauna, creating corridors in the landscape, filtering water, catching sedimentation and concentrating water runoff from catchments.

The sensitivity analysis provided may only be considered as a *preliminary* assessment that will be updated after a field visit, which can only take place once the majority of plant species in the area are actively growing.

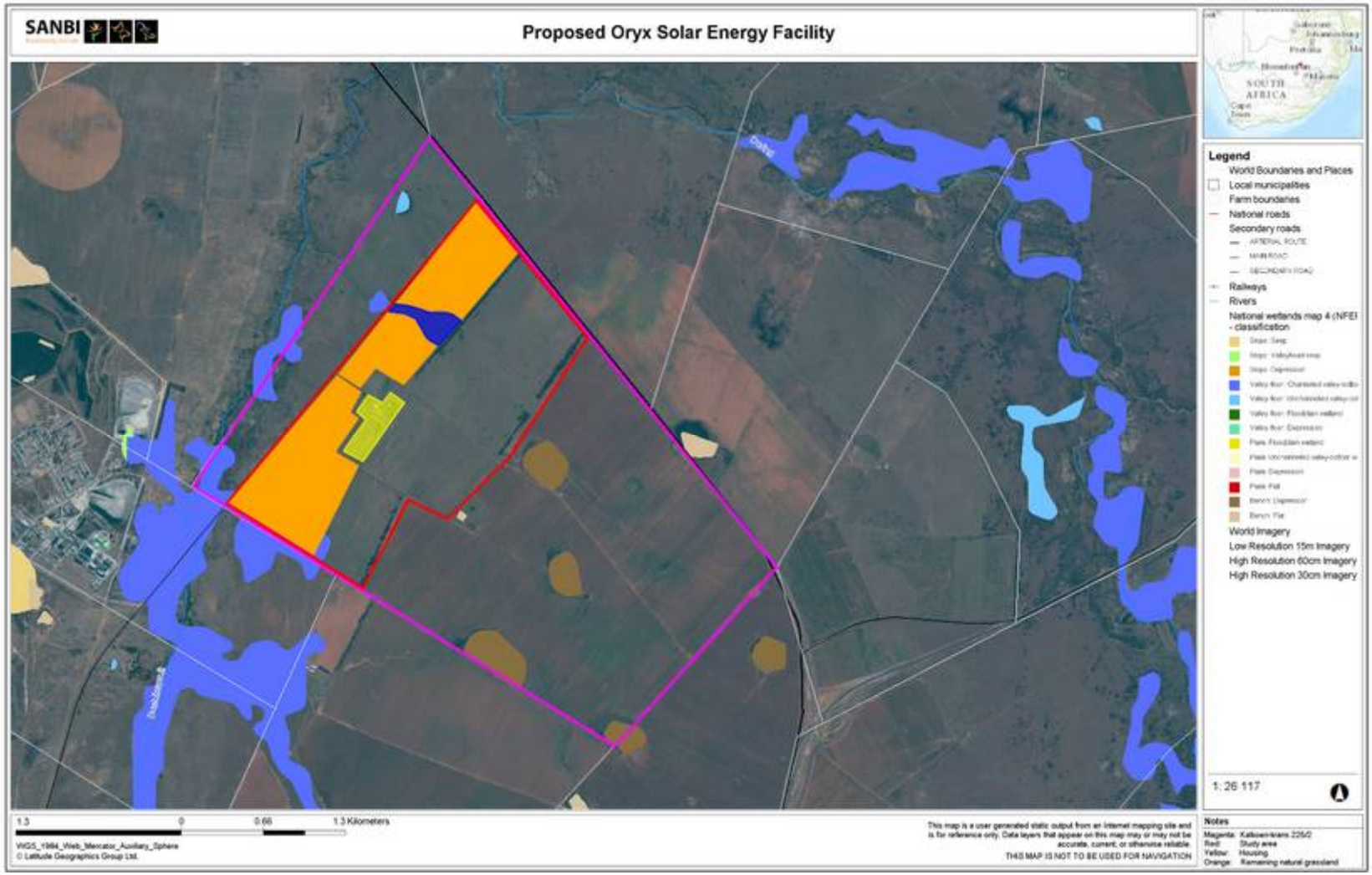

Figure 6: Preliminary sensitivity map of the study area (red outline), showing potential (BGIS mapped) wetlands that will need to be confirmed, seepage areas (blue), and remaining grassland vegetation (orange) to be assessed.

5.5. Assessment of potential impacts

Impacts of the proposed development will be mostly on the vegetation and supporting substrate. Potential expected impacts are listed below, but it must be stressed that this evaluation is preliminary and will only be finalised after a detailed field study of the area. Impacts on animals are regarded as minimal unless it affects their specific (limited) habitat, as animals are capable of moving.

Overview of habitat The selected property falls mostly within the original extent of Vaal-Vet Sandy Grassland as described by Mucina and Rutherford (2006). On the project site, most of this vegetation has been previously transformed by cultivation. The remaining extent of this vegetation type has been listed in the threatened terrestrial ecosystems for South Africa (2011) as Endangered. Beyond the proposed development area, closer to larger drainage lines and small rivers, the grassland vegetation merges into Highveld Alluvial Vegetation, which is considered as least threatened.			
Issue	**Nature of Impact during Construction**	**Extent of Impact**	**No-Go Areas**
Disturbance or loss of indigenous natural vegetation	Construction of infrastructure may lead to direct loss of semi-natural vegetation, causing a reduction in the overall extent of specific species and vegetation cover. Consequences of the potential impact of loss of indigenous semi-natural vegetation occurring may include: » Increased vulnerability of remaining vegetation portions to future disturbance, including erosion; » General loss of habitat for sensitive species; » General reduction in biodiversity; » Disturbance to processes maintaining biodiversity and ecosystem goods and services; or » Direct loss of ecosystem goods and services.	Local	No "no-go" areas have been identified at this stage; areas of potential high sensitivity are shown in Figure 6. A more detailed investigation will be undertaken as part of the EIA phase.
Disturbance or loss of threatened / protected	Several protected or threatened plant species could potentially occur on and adjacent to the proposed development site. Flora is affected by loss or change of habitat due	Local	A small patch of very dense *Ammocharis coranica* bulbs

plants	to infrastructure development, as plants are immobile. In the case of threatened plant species, a loss of a population or individuals could lead to a direct change in the conservation status of the species, possibly extinction. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations. Consequences of this may include: » Fragmentation of populations of affected species » Reduction in area of occupancy of affected species » Loss of genetic variation within affected species		(protected) have been found. The developer already indicated that this area should be excluded from the energy facility. Information on other species of conservation concern requires further investigation in the EIA phase. Due to the previous transformation of most of the area, the presence of critical habitats for any species is expected to be low
Loss of habitat for threatened and /or protected vertebrates	Threatened animal species are indirectly affected primarily due to loss or alteration of habitat. Animals are generally mobile and, in most cases, can move away from a potential threat. Threatened species include those classified as critically endangered, endangered, or vulnerable. For any other species, a loss of individuals or localised populations is unlikely to lead to a change in the conservation status of the species. However, in the case of threatened animal species, loss of a population or individuals could lead to a direct change in the conservation status of the species. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations or the habitat that they depend on. Consequences may include:	Local	No "no-go" areas have been identified at this stage; areas of potential high sensitivity are shown in Figure 6. A more detailed investigation will be undertaken as part of the EIA phase. Due to the previous transformation of most of

	» Reduction in area of occupancy of affected species; and » Loss of genetic variation within affected species. These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species overall survival chances. There are a number of vulnerable and one endangered species that could occur in the study area, but there are no threatened, near threatened or protected species that occur in restricted habitats in the proposed study area, although this will be confirmed in the EIA phase.		the proposed development area, the presence of critical habitats for any fauna species is unlikely.
Impacts on wetlands	The site is in a semi-arid area. There is one small drainage line draining off the proposed development area (within the study area). Several small wetlands are situated within 1 km of the study area, but will not be directly impacted. Construction however, if it occurred within the immediate catchments of any of these wetland areas, would lead to some direct or indirect changes to the surface hydrology of these areas. This may affect the hydrology of the larger landscape or lead to loss of habitat for species that depend on this habitat type.	Local	No "no-go" areas have been identified on the proposed development site at this stage; however, some wetland areas and rivers do occur in close proximity as shown in Figure 6. A more detailed investigation will be undertaken as part of the EIA phase.
Establishment and spread of declared weeds and alien invader plants.	Major factors contributing to the invasion by alien invader plants includes high disturbance (such as clearing for construction activities or past cultivation) and unsustainable grazing practices. Exotic species are often more prominent near infrastructural disturbances than within less disturbed natural vegetation.	Local	Several alien species were observed on and around the project site at this stage.

	Consequences of this may include: » Loss of indigenous vegetation; » Change in vegetation structure leading to change in various habitat characteristics; » Change in plant species composition; » Change in soil chemical properties; » Loss of sensitive habitats; » Loss or disturbance to individuals of rare, endangered, endemic and/or protected species; » Fragmentation of sensitive habitats; » Change in flammability of vegetation, depending on alien species; » Hydrological impacts due to increased transpiration and runoff; and » Impairment of wetland function.		

Gaps in knowledge & recommendations for further study

» The initial desk-top and screening investigation of the study area indicates that placement of components of the solar energy facility is expected to be to a large extent on previously transformed semi-natural areas. Several protected and red-data species potentially occur on and around the site. However, it is unlikely that the development, once the final layout has been designed in accordance to findings of a field investigation, will compromise the survival of any of the species of conservation concern.

» Plant species of conservation concern will only be identifiable during the growing season, thus any field survey of vegetation should be conducted between January and April.

» It must be noted that there is a possibility of species that have not been captured in the POSA SANBI species database for the area up to date, may in fact be found within the study area.

» **A detailed ecological survey and sensitivity assessment will be undertaken during the EIA phase according to the methods outlined in section 4**

Issue	Nature of Impact during the Operational Phase	Extent of Impact	No-Go Areas
Disturbance or loss of indigenous natural vegetation due to shading	PV panels create large areas of intensive shade that will not be tolerated by most of the species present on site, as these have evolved with a high daily irradiance. As a consequence, it can be expected that within the Solar Energy Facility footprint, species composition will change significantly. No locally representative studies or experiments have been undertaken up to date, thus it cannot be predicted which and what density of vegetation may persist. The majority of indigenous grasses, having the C_4 carbon-fixing mechanism, are adapted to very high levels of irradiance. A sparser or less stable vegetation beneath the PV panels may: » Increase the magnitude of negative effects of disturbances to remaining vegetation, including erosion- and invasion risk; » Lead to a reduction in biodiversity and ecosystem resilience; » Increase habitat fragmentation (depending on location of impact); » Disturb processes maintaining biodiversity and ecosystem goods and services; or » Lead to a direct loss of ecosystem goods and services.	Local	No "no-go" areas have been identified for the proposed development area at this stage and will require further investigation in the EIA phase.
Altered runoff patterns due to rainfall interception by PV panels and compacted areas	PV panels create large surfaces of rainfall interception, concentrating rainfall at the edges from where it flows onto the ground in larger, concentrated quantities opposed to small drops being directly absorbed by the ground or intercepted by vegetation. This may lead to a localised increase in runoff during rainfall events, which may result in accelerated erosion. Likewise, access roads and areas where soils have been compacted during construction will have a low rainfall infiltration rate, hence creating an increase in runoff. Runoff will thus have to be monitored and channelled	Local and surroundings	No "no-go" areas have been identified at this stage and require further investigation in the EIA phase.

Issue	Nature of Impact during the Operational Phase	Extent of Impact	No-Go Areas
	where necessary to prevent erosion or degradation of lower-lying drainage lines and rivers beyond the development area.		
Gaps in knowledge & recommendations for further study » A detailed ecological survey and assessment will be undertaken during the EIA phase according to methods outlined in section 4 » Studies to determine which plant species can tolerate artificial high shade levels to help reduce the erosion potential of different landscapes are lacking. Predictions about altered runoff patterns and possible species composition after shading will thus be based on best knowledge available, not on actual facts.			

5.6. Limitations of study

There is a key difference between the approach of the ecological consultant and that of the ecological researcher. In consultancy, judgements have to be made and advice provided that is based on the best available evidence, combined with collective experience and professional opinion. The available evidence may not be especially good, potentially leading to over-simplification of ecological systems and responses, and do contain a considerable deal of uncertainty. This is opposed to ecological research, where evidence needs to be compelling before conclusions are reached and research is published (Hill & Arnold 2012). The best option available to the consulting industry is to push for more research to be conducted to address its questions. However, such research is often of a baseline nature and thus attracts little interest by larger institutions that need to do innovative research to be able to publish and attract the necessary funding. Clients in need of ecological assessments are used to funding such assessments, but are seldom willing to fund further research to monitor the effects of developments. Furthermore, a review to test the accuracy of the predictions of an ecologist following completion of the development is very rarely undertaken, which means the capacity to predict the future is not tested and therefore remains unknown (Hill & Arnold 2012).

Predictions on future changes on ecosystems and populations once a development has happened are seldom straightforward, except in cases of such as the total loss of a habitat to development. However, most development impacts are indirect, subtle, and cumulative or unfold over several years following construction or commencement of the operation of the development. Whilst a possible mechanism for an impact to occur can usually be identified, the actual likelihood of occurrence and its severity are much harder to describe (Hill & Arnold 2012).

A closely related issue is that of the effectiveness of ecological mitigation which stems from ecological assessments, as well as in response to legal and planning policy requirements for development. Many recommendations may be incorporated into planning conditions or become conditions of protected species licences, but these recommendations are implemented to varying degrees, with most compliance being for the latter category, protected species, because there is a regulatory framework for implementation. What is often missing is the follow-up monitoring and assessment of the mitigation with sufficient scientific rigour or duration to determine whether the mitigation, compensation or enhancement measure has actually worked in the way intended (Hill & Arnold 2012).

6. Discussion and Conclusion

The selected property falls mostly within the original extent of Vaal-Vet Sandy Grassland as described by Mucina and Rutherford (2006), of which a large portion on the property has been previously transformed by cultivation. The remaining extent of this vegetation type has been listed in the threatened terrestrial ecosystems for South Africa (2011) as Endangered. Beyond the proposed development area, closer to larger drainage lines and small rivers, the grassland vegetation merges into Highveld Alluvial Vegetation, which is considered as least threatened.

Approximately two-thirds of the area regarded as suitable for the PV facility is situated on disused, previously cultivated lands. Cultivation was stopped on these areas due to excessive soil capping, erosion and low productivity. In an attempt to increase the vegetation cover on these relatively barren areas, the landowner has ripped these areas and introduced the grass *Digitaria eriantha*, but vegetation remains sparse (Figure 3 section 3).

The north-western portion of the study area consist of remnants of natural vegetation (Figure 6), mostly mapped by Mucina and Rutherford (2006) as Highveld Alluvial Vegetation. This strip of vegetation, however, should rather be considered as remnants of the Vaal-Vet Sandy Grassland, which gradually merges into Highveld Alluvial Vegetation around larger drainage lines and the Bosluisspruit and Doring River. The state of this remaining grassland needs to be assessed during the EIA vegetation survey, but appears to be relatively degraded.

Overall, no significant ecological flaws that could pose a problem to the proposed PV facility development could be identified during a desktop study and brief screening field visit to the site. This will have to be confirmed during a detailed field study of the vegetation of the area.

Most of the area regarded as suitable for the development has been transformed to a large extent in the past, it is not expected that it comprises any restricted habitat for any endangered species. It is, however, possible that protected species have become re-established on the site and need to be relocated if they will be affected by the proposed development. The impact is thus expected to be limited to vegetation and soil only, whilst impact on any vertebrates that may occur on site is so far assumed to be minimal or negligible.

The largest concerns identified up to date are:

- All indigenous and alien invasives and potential invasives within the development area will have to be entirely cleared prior to development
- An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives

- » Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed
    - o Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer. In addition, the use of contour buffer strips on sloping areas may be beneficial.
    - o Locally occurring grass species become moribund and die off if not grazed regularly. It is thus recommended to allow seasonal sheep grazing to reduce dead biomass accumulation on grass tufts. This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

Wetland issues:

- » No river or other wetland could be detected on the site selected for the proposed development despite a wetland being mapped as such by the BGIS database, but wetlands do occur in close proximity (within 1 km) to the project area
- » A small seasonal seepage area in the north-western section of the study area has formed over years from runoff of the degraded higher-lying areas. This moisture sustains a large population of *Ammocharis coranica* plants (and other species requiring higher moisture levels), and drains, into the Bosluisspruit 1 km north-west of the farm. The developer has already indicated that this area would be excluded from the development footprint area.
    - o Erosion and contamination from the proposed development must be prevented to avoid degradation and contamination of these lower-lying wetlands

Recommendations for ecological studies:

- » In line with the average rainfall patterns in the area, vegetation/ecological studies should ideally be carried out between February and late April to yield the most representative and accurate results.

7. References

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Legislation:

The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

The Environment Conservation Act, 1989 (Act No. 73 of 1989)

The National Environment Management Act, 1998 (Act No. 107 of 1998)

The National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004). Government Gazette RSA Vol. 467, 26436, Cape Town, June 2004.

The National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004). National List of Ecosystems that are threatened and in need of protection. Government Gazette RSA Vol. 1002, 348093, Cape Town, 9 Dec 2011.

The Natural Scientific Professions Act (Act 27 of 2003)

Nature and Environmental Conservation Ordinance 19 of 1974 and amendments

The Free State Conservation Bill (Provincial Act 23 of 2010)

Websites:

BGIS: http://bgis.sanbi.org/website.asp
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http://posa.sanbi.org/searchspp.php
http://SIBIS.sanbi.org
ADU databases: http://vmus.adu.org.za

8. Appendix A: Declaration of Independence

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Oryx Solar Energy Facility

Specialist:	Marianne Strohbach		
Contact person:	Marianne Strohbach		
Postal address:	PO Box 148, Sunninghill		
Postal code:	2157	Cell:	
Telephone:	*(011) 656 3237*	Fax:	*086 684 0547*
E-mail:	marianne@savannahsa.com		
Professional affiliation(s) (if any)	SACNASP (Reg No 400079/10) Desert Net International South African Association of Botanists		

Project Consultant:	Savannah Environmental (Pty) Ltd		
Contact person:	Jo-Anne Thomas		
Postal address:	PO Box 148, Sunninghill		
Postal code:	2157	Cell:	
Telephone:	*(011) 656 3237*	Fax:	*086 684 0547*
E-mail:	Joanne@savannahsa.com		

4.2 The specialist appointed in terms of the Regulations_

I, Marianne Strohbach , declare that --

General declaration:

- I act as the independent specialists in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- **all the particulars furnished by me in this form are true and correct; and**
- **I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.**

Signature of the specialist:

Savannah Environmental (Pty) Ltd

Name of company (if applicable):

25 March 2013

Date:

9. Appendix B: Curriculum Vitae of Specialist

CURRICULUM VITAE

MARIANNE STROHBACH
SAVANNAH ENVIRONMENTAL (PTY) LTD

Profession : Specialist Scientist
Specialisation: Plant Ecology and Botany, with special reference to vegetation mapping, vegetation state assessment, dynamics of arid and semi-arid vegetation and population dynamics of harvested plants, conservation planning
Work experience: Twenty (20) years active in Plant Ecology

SKILLS BASE AND CORE COMPETENCIES

- Four years Plant Conservation (Namibia)
- 16 years active research in vegetation mapping, vegetation state assessment, vegetation and plant population dynamics, long-term vegetation monitoring
- Advisory to International Standards for plant species that are harvested for commercial purposes
- Research Project Management
- Ecological assessments for developmental purposes (BAR, EIA)
- Working knowledge of environmental planning policies, regulatory frameworks and legislation
- Identification and assessment of potential environmental impacts and benefits
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to project execution
- Experienced in environmental monitoring
- Completed projects in several Provinces of South Africa, as well as Zimbabwe and Namibia
- Several publications in peer-reviewed journals, book chapters, scientific conference presentations and popular articles

EDUCATION AND PROFESSIONAL STATUS

Degrees:
2003: M.Sc. in Botany, University of Pretoria, Pretoria, RSA
1991: B.Sc. Hons in Botany, Nelson Mandela Metropolitan University, Port Elizabeth, RSA
1990: B.Sc. in Biological Sciences, Nelson Mandela Metropolitan University, Port Elizabeth

Short Courses:
2008: Landscape Functional Analysis for vegetation condition and restoration monitoring
2002: Satellite Image Analysis for Vegetation Mapping, German Aerospace Centre (DLR) in Cologne/Würzburg, Germany
1994: Methods and Techniques of Environmental Management, Deutsche Stiftung für Internationale Entwicklung, Berlin, Germany
1993: Conservation Law Enforcement, Ministry of Environment and Tourism, Namibia

Professional Society Affiliations:

- South African Association for Botanists
- Association of Desert Net International
- The South African Council for Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400079/10 (Botany and Ecology)

Publications:

- 7 Articles in peer-reviewed scientific journals
- 5 Book-chapters in scientific publications
- 10 Popular articles
- 9 presentations at scientific conferences
- 2 contributions to TV documentaries on nature

Ongoing outputs:

- Project-specific specialist reports for Ecological Screening Studies, Basic Assessments, Environmental Scoping and Impact Assessments and Ecological Footprint Investigations
- Compilation of Environmental Management Plans: Invasive Plant management, Plant Search and Rescue, Revegetation, Erosion Control

EMPLOYMENT

- **Current**: Ecologist, Savannah Environmental (Pty) Ltd
- 2011: Lecturer, Plant Ecology, University of Pretoria
- 1997 onwards: working as vegetation ecologist on a freelance basis, involved in part-time positions and contractual research as outlined below
- 1995 to 1996: Agricultural Researcher at the National Botanical Research Institute, Windhoek, Namibia
- 1992 to 1995: Vegetation ecologist at the Ministry of Environment and Tourism, Namibia, Directorate of Scientific Services

Past Affiliations and Research

2001 – 2010: contractual work with BIOTA (BIOdiversity Transect analysis in Africa) as affiliate to the National Botanical Research Institute, Namibia.

Deliverables:

Project management, including research proposal, financial management and project implementation.

Modelling of Savanna Dynamics:

Collating and summarising available phytosociological data for ecological modellers to use in creating a generic savanna model for the Namibian savannas

Defining plant functional types to simplify vegetation data and to use as indicators in monitoring techniques by livestock farmers

Vegetation Patterns and Processes in Namibian Savannas:
Small scale monitoring of vegetation dynamics over a range of soil conditions and seasons
Determine ecological barriers to and best practice for rangeland restoration

Vegetation classification and mapping in Central Namibia:
Collection and analysis of phytosociological baseline data for the central Thornbush Savanna in Namibia, delineation of vegetation types with the aid of satellite imagery

2006: German Scientific Authority to CITES, Plants, Federal Agency for Nature Conservation
International Standard for the Sustainable Wild Collection of Medicinal & Aromatic Plants
Assisting in the compilation of a reference guide for minimum research standards necessary to ensure sustainable use of economically utilised plants (updated in FairWild Standard Version 2, 2010)

2004: contractual work for Desert Research Foundation of Namibia
Vegetation description and mapping of the Namibian Eastern Communal Areas and assess possible development options using indigenous plant resources

1997 to 2010: contractual work with CRIAA-SADC as ecologist.
Deliverables:

The Sustainably Harvested Devil's Claw Project:
Annual surveys of *Harpagophytum* populations to determine harvesting quotas for rural communities
Determine and monitor impact of harvesting frequency and techniques on survival of *Harpagophytum procumbens*
Educate harvester communities on issues of resource management
In collaboration with the German Federal Agency for Nature Conservation
This work was extended in 2006 to the Hwange Area, NW Zimbabwe, together with Africa Now

Pilot Devil's Claw cultivation trials:
Increase available resources of *Harpagophytum procumbens*
Give communities ownership and better access of their resources to improve their income

Namibian National Devil's Claw Situation Analysis:
Design and implement a country-wide survey of *Harpagophytum* species to assess resource availability compared to annual export figure

1999 to 2001: Assistant curator at the Swakopmund Museum (part-time position)
Help maintain existing collections and exhibits , design and create new exhibits for the museum in collaboration with the Museum Hannover, Germany

Specialist Scientist Vegetation Surveys and related Impact Assessments were done for following clients:

Langer Heinrich Uranium Pty (Ltd): Central Namib Desert, Namibia
University of Namibia, Hentiesbay Research Centre: West Coast, Namibia
Sasol – Limpopo Province
EcoAgent – Northern Cape, Eastern Cape, Limpopo and Mpumalanga
Namwater – Karst aquifers, north-central Namibia
ENVASS (for AfriDevo) – Northern Cape
Savannah Environmental – Northern Cape, Eastern Cape, Free State, North-West Province, Western Cape, Limpopo