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DRAFT Environmental Impact Assessment Report for the proposed Arriesfontein Concentrated Solar Power Plant on the farm 267, near Danielskuil in the Northern Cape

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Part 3 - Appendices

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Appendix E–Avifaunal Environmental Impact Assessment

PROPOSED ARRIESFONTEIN SOLAR THERMAL ENERGY POWER PLANT DEVELOPMENT

SPECIALIST AVIFAUNAL IMPACT ASSESMENT

EIA REPORT
February 2012

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EXECUTIVE SUMMARY

Solar Reserve SA (Pty) Ltd is planning a Solar Thermal Energy Power Plant (or otherwise known as a Concentrated Solar Power (CSP) plant), as well as a multi-phase Solar Photovoltaic (PV) Project within a single development site, the farm Arriesfontein 267, in the Northern Cape, South Africa. The Endangered Wildlife Trust (EWT) was subsequently appointed to conduct an avifaunal specialist study. Very few CSP plants have been constructed worldwide to date, and knowledge on the associated avifaunal impacts remains limited.

The site consists mainly of uniform, arid vegetation types. Few permanent water bodies were observed on site. The proposed site falls within the Quarter Degree Grid Square (QDGS), 2823BD, while data from three additional squares, 2823BA, 2823BB, and 2823BC was also considered due to their close proximity to the site. The South African Bird Atlas Project (SABAP) recorded 12 Red Listed Species across all four squares, of which 5 are classified as Vulnerable, and 7 as Near Threatened. One additional species, the White Stork, is also included as it is protected internationally under the Bonn Convention on Migratory Species. Various other species relevant to the project were identified and include raptors, doves, pigeons and aerial foragers such as swallows and swifts.

In general, SABAP2 data showed low counting effort for study site and immediate surrounds, however it did reveal the presence of an additional two Red Listed Species. The focal species for the study were determined to be the following: Lesser Kestrel, Lanner Falcon, Kori Bustard, Secretarybird, Greater Flamingo, White Stork, Martial Eagle, Northern Black Korhaan, Namaqua Dove, Rock Martin, Little Swift, Barn Swallow, European Bee-eater, Namaqua Sandgrouse, Sothern Pale-chanting Goshawk, and South African Shelduck .

Potential impacts of the project on avifauna may include collision of birds with heliostats, the central receiver tower, and the PV Panels as well as burning of birds in the focal points or at the central receiver tower. All of these impacts were found to have a high significance, due mainly around the uncertainty of their magnitudes and probabilities. Additional impacts include habitat destruction and disturbance of sensitive birds, and these were generally found to be of moderate significance.

Further impacts with associated infrastructure may also occur such as, collision and/or electrocution of birds with any new overhead power lines as well as habitat destruction

and disturbance of birds during the construction of new roads and/or pipelines. All impacts were rated according to set criteria, and recommended mitigation measures were proposed where possible. The presence of open water ponds close to the CSP plant could drastically increase the potential for avifaunal impacts.

Various project alternatives were considered and of three possible heliostat field layout positions on the proposed site, Option A was slightly preferred over Option B while Option C was least preferred. A final recommendation is that a detailed monitoring protocol, for the operational phase of the project, be incorporated in to the final project EMP.

DECLARATION OF INDEPENDANCE

Specialist Investigator

The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith."

"Only a registered person may practice in a consulting capacity" – Natural Scientific Professions Act of 2003 (20(1)-pg 14)

Investigator:	Andrew Pearson (Pri.Sci.Nat)
Qualification:	BSc (hons) Conservation Ecology
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400423/11
Fields of Expertise:	Ecological Science
Registration:	Professional Member

Andrew Pearson is employed by the Endangered Wildlife Trust's Wildlife and Energy Programme as a specialist investigator for conducting avifaunal specific specialist reports. Andrew has a Four Year BSc in Conservation Ecology, certificates in Environmental Law, as well as five years experience in the environmental management field. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information.

Declaration of Independence

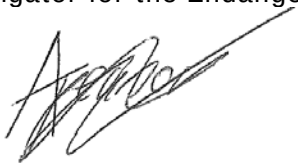
All specialist investigators specified above declare that:

- We act as independent specialists for this project.
- We consider ourselves bound by the rules and ethics of the South African Council for Natural Scientific Professions.
- We do not have any personal or financial interest in the project except for financial compensation for specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2006.
- We will not be affected by the outcome of the environmental process, of which this report forms part of.
- We do not have any influence over the decisions made by the governing authorities.
- We do not object to or endorse the proposed developments, but aim to present facts and our best scientific and professional opinion with regard to the impacts of the development.
- We undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan, or document required in terms of the Environmental Impact Assessment Regulations, 2006.
- Should we 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.

Terms and Liabilities

- This report is based on a short term investigation using the available information and data related to the site to be affected. No long term investigation or monitoring was conducted.
- The Precautionary Principle has been applied throughout this investigation.
- The specialist investigator, and the Endangered Wildlife Trust, for whom he/she works, does not accept any responsibility for the conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from these assessments or requests made to them for the purposes of this assessment.
- Additional information may become known or available during a later stage of the process for which no allowance could have been made at the time of this report.
- The specialist investigator withholds the right to amend this report, recommendations and conclusions at any stage should additional information become available.
- Information, recommendations and conclusions in this report cannot be applied to any other area without proper investigation.
- This report and all of the information contained herein remain the intellectual property of the Endangered Wildlife Trust.
- This report, in its entirety or any portion thereof, may not be altered in any manner or form or for any purpose without the specific and written consent of the specialist investigator as specified above.
- Acceptance of this report, in any physical or digital form, serves to confirm acknowledgment of these terms and liabilities.

Signed on the 27th February 2012 by Andrew Pearson in his capacity as specialist investigator for the Endangered Wildlife Trust's Wildlife and Energy Programme.



INTRODUCTION

Background

Solar Reserve SA (Pty) Ltd is planning a Solar Thermal Energy Power Plant (or otherwise known as a Concentrated Solar Power (CSP) plant), as well as a multi-phase Solar Photovoltaic Project, within a single development site in the Northern Cape, South Africa. WorleyParsons RSA was appointed as independent environmental consultants to conduct the Environmental Impact Assessment (EIA) process for the proposed development, and the Endangered Wildlife Trust (EWT) was subsequently appointed to conduct an avifaunal specialist study. A site visit was conducted on the 3rd and 4th November 2011. The proposed project is located on the farm Arriesfontein 267, Barkley Wes R.d, Siyanda District Municipality, near Danielskuil in the Northern Cape Province.

Solar Reserve is assessing the feasibility of constructing both a CSP plant, as well as Photovoltaics, with the following phased approach:

- Phase 1: Arriesfontein Photovoltaic Power Plant- 75MW Development
- Phase 2: Arriesfontein Photovoltaic Power Plant -75MW Development
- Phase 3: Arriesfontein Photovoltaic Power Plant- 75MW Development
- Phase 4: Arriesfontein Concentrated Solar Power Plant 100MW Development

The CSP plant being considered is a Molten-Salt type, Central Receiver (tower) technology, and will primarily consist of the following four components: Solar Field (including numerous reflective heliostats); Molten Salt Circuit; The Power Block; and auxiliary facilities and infrastructure. The CSP plant will require approximately 6 square kilometres (i.e. 600ha) of terrain. The PV development will consist of photo-voltaic (PV) solar panels that will occupy up to 450ha of the site in total. Three blocks of PV will be developed each covering 150ha, and producing 75MW, giving the total PV development 225MV of power producing capability.

The proposed site falls within the Quarter Degree Grid Square (QDGS), 2823BD, while data from three additional squares, 2823BA, 2823BB, and 2823BC was also considered due to their close proximity to the site. The South African Bird Atlas Project (SABAP) recorded 12 Red Listed Species (Harrison *et al*, 1997), across all four squares, of which 5 are classified as Vulnerable, and 7 as Near Threatened. SABAP2 data revealed the historical presence of two additional listed species in the broader area, namely White-backed Vulture and Ludwig's Bustard. This avifaunal study used a set methodology (discussed elsewhere) as well as various data sets. The focal species for the study were determined, and then, by looking at

the focal Species which could occur in the area, as well as assessing the availability of bird micro habitats, the possible impacts of the development were then predicted. The impacts were then rated according to pre-determined set of criteria.

Terms of reference

The following terms of reference for the EWT avifaunal study were adopted:

- **Identification of sensitive sites:** The bird sensitive sections of the study area will be identified.
- **Describe affected environment and determine status quo:** The existing environment will be described and the bird communities most likely to be impacted will be identified. Different bird micro-habitats will be described as well as the species associated with those habitats.
- **Describe focal species:** Threatened bird species (as per red data book status), will be identified, and species most likely to be impacted upon will be identified.
- **Identification of impacts:** The potential impact on the birds will be identified.
- **Assess and rate the identified impacts.** The significance of the potential impacts will be rated according to a set of pre-determined criteria.
- **Assess alternatives.** A comparative assessment of the avifaunal impacts related to proposed project alternatives.
- **Propose and explain mitigation measures:** Practical mitigation measures will be recommended and discussed.

METHODS

Methodology

The following section describes the process and criteria used to assess the site during the scoping phase in terms of avifaunal impact.

- The study was initially conducted from a desk top level. Using various GIS layers, 1:50 000 topographical maps and Google earth images, key features within the study area were identified and a map of the site and surrounding area was created using ARCGIS 9.3.
- The various data sets discussed below under “sources of information” were collected and examined.
- This data was examined to determine presence of sensitive Red Data species in the study area.

- Abundance of the species most sensitive to this project (not necessarily red listed species) was determined.
- The area was visited, and thoroughly traversed, to obtain a first-hand perspective of the site, and to determine which bird micro-habitats are present and relevant to the study. This involved driving the study area, taking photographs, recording species at various observation points, and walking certain accessible areas.
- Proximity of the site to water was assessed, as was the presence of small water features (e.g. dams, pans or water troughs) within the site boundary.
- The impacts of the proposed project on birds were then predicted.
- Impact were assessed using a standard set of criteria (see Appendix A), as supplied by the project consultants, Worley Parsons RSA (Pty) Ltd.
- Possible mitigation measures for significant impacts were discussed.

Sources of information

The study made use of the following data sources:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997) obtained from the Avian Demography Unit of the University of Cape Town, in order to ascertain which species occur in the study area.
- The conservation status of all bird species occurring in the aforementioned degree squares was then determined with the use of The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland (Barnes, 2000).
- The Southern African Bird Atlas Project 2 data for certain pentads in the study area was examined.
- Data from the Co-ordinated Waterbird Count (CWAC) project was also consulted to determine whether any CWAC sites exist in the study area (Taylor, Navarro, Wren-Sargent, Harrison & Kieswetter, 1999).
- Data from the Co-ordinated Avifaunal Road count project (CAR – Young, Harrison, Navarro, Anderson & Colahan, 1997) for the “Mpumalanga Precinct”.
- The Important Bird Areas of southern Africa (IBA) project data (Barnes 1998) was consulted to determine its relevance to this project.
- A classification of the vegetation types in the study area was obtained from Mucina and Rutherford (2006).
- Information on the micro-habitat level was obtained through visiting the area and obtaining a firsthand perspective.
- Electronic 1:50 000 maps were obtained from the Surveyor General.
- Satellite Imagery of the area was studied using Google Earth ©2010.

Limitations & assumptions

This study made the assumption that the above sources of information are reliable. The following factors may potentially detract from the accuracy of the predicted results:

- In assessing the impacts of the associated infrastructure such as a new power line – the EWT is hugely experienced. However, with regard to the impacts of the CSP plant itself, this is largely new territory – quite possibly the case for all consultants on this project. With the exception of the one paper already cited, very little information on avifaunal impacts at existing solar plants could be found**. The level of confidence with which the various impacts are discussed is therefore relatively low**. However it must also be stated that many of the impacts of the CSP plant itself cannot readily be mitigated for in any case. For example if birds mistake the heliostats for water sources and are burnt in the focal points, mitigation for this would be very difficult.
- Unfortunately the Southern African Bird Atlas Project (Harrison et al 1997) data is now relatively outdated. This results in a low confidence in the report rates of the various species in the study area. Furthermore, updated data for the second bird atlas project (SABAP2), revealed a low number of counts for the relevant pentad.
- The site visit was conducted in early summer, over which time various species may not have been present in the study area.
- The final and exact position and nature of the associated infrastructure such as pipelines, power lines and roads was not available during the site visit.
- **Associated overhead powerlines, extending out of the site boundary, to connect with the Eskom Grid, may have large impacts; these however were not assessed in this study.**
- The SABAP data covers the period 1986-1997. Bird distribution patterns fluctuate continuously according to availability of food and nesting substrate.
- Predictions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will hold true under all circumstances.
- During the site visit it was not possible to access the entire area and all potential micro-habitats of the proposed site.
- Google Earth ©2010 Imagery may not always reflect the true situation on the ground, as some images may be outdated.

Figure 1: Google Earth image indicating the locality of the site (red polygon) in relationship to towns and major roads.

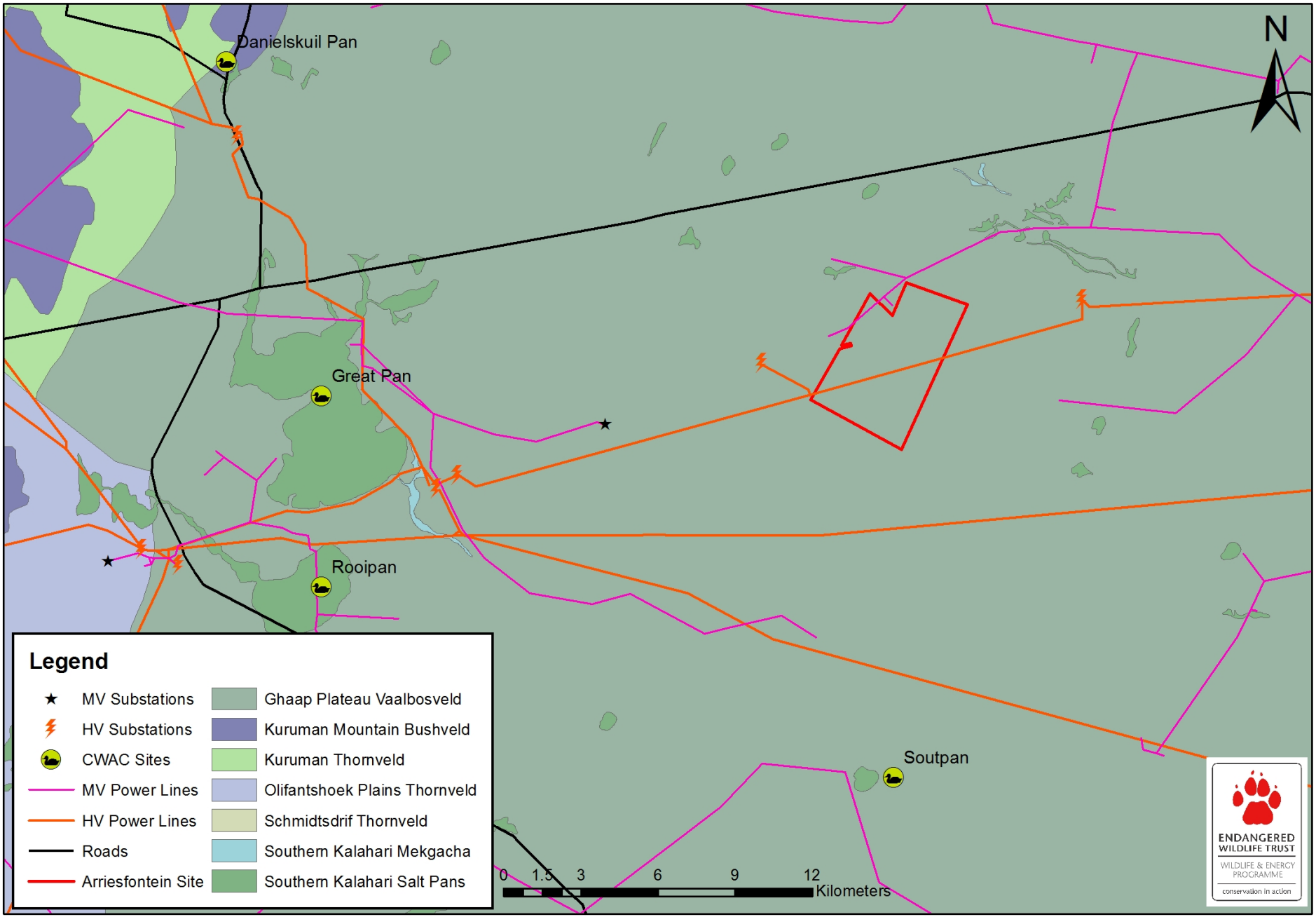


Figure 2: Map indicating existing electrical infrastructure, main roads, CWAC sites, as well as the vegetation classification for the study area according to Mucina & Rutherford, 2006.

REVIEW OF POTENTIAL AVIFAUNAL ISSUES

CSP is being widely commercialized and the CSP market has seen about 740 MW of generating capacity added between 2007 and the end of 2010 worldwide. More than half of this (about 478 MW) was installed during 2010, bringing the global total to 1095 MW. Spain added 400 MW in 2010, taking the global lead with a total of 632 MW, while the US ended the year with 509 MW after adding 78 MW (Wikipedia- November 2011).

Figure 3: Solar Two in Daggett, CA, USA, is a 10-MW solar thermal electric power plant (Wikipedia, 2011).

Extensive review of the available literature on the internet relating to avifaunal interactions at solar energy power plants revealed very little, particularly in comparison to the literature available on avifaunal interactions with other forms of power generation. Possible reasons for this include the following:

- Little knowledge on these impacts exists since so few solar plants have been constructed to date.
- The two plants previously constructed were experimental sites, not commercial. All information related to the experiments would therefore have been private and not released into the public domain.
- The impacts of solar power plants of this type on avifauna are in fact relatively minor.

One paper entitled “Avian mortality at a solar energy power plant” (McCrary, McKernan, Schreiber, Wagner & Sciarrotta 1986) was discovered. This paper describes the results of their weekly monitoring over a two year period at Solar One. The main results of this study are summarized below:

- Forty visits (one week apart) to the facility over a two year period revealed 70 bird carcasses involving 26 species. It was estimated that between 10 and 30% of carcasses were removed by scavengers in between visits, so the actual number of mortalities may have been slightly higher. It is important to note that extensive agricultural lands and evaporation ponds (53 ha) were situated adjacent to the facility, which probably resulted in a higher abundance of many bird species than would otherwise have been the case.
- Fifty seven (81%) of the birds died through collision with infrastructure, mostly (>75%) colliding with the heliostats. Species killed in this manner included water birds, small raptors, gulls, doves, sparrows and warblers.
- Thirteen (19%) of the birds died through burning in the standby points. Species killed in this manner were mostly swallows and swifts.

Briefly, some of the anticipated avifaunal issues involved with the Humansrus Solar Thermal Energy project are now described below.

Issues relating to the CSP plant itself:

- Collision with the heliostats (mirrors):
  Reflective surfaces are particularly prone to collisions in the same way as household windows. The CSP plant will consist of hundreds or thousands of heliostat mirrors and can be expected to result in some collisions.
- Collision with the central receiver tower:
  Almost any infrastructure that stands proud in the landscape will result in a certain number of collisions by birds. In this case, the central receiver tower will stand approximately 200 m tall, a significant height, particularly in this landscape. A mitigating factor is that it will be a solid concrete tower and should be relatively visible to birds.
- Roosting on the central receiver tower:
  Birds could potentially use the top of the tower as a roosting site at night. It is likely that they would only come in to roost after the plant has been shut down in the evenings, and would leave the roost before the plant starts up in the morning.
- Burning when in vicinity of the central receiver:

The central receiver will glow white hot when the plant is operational which might potentially result in birds in the vicinity being burnt.

- Burning when entering the "standby focal points":
  During testing, maintenance and daily start up procedures, the heliostats are focused in groups onto focal or standby points in the sky, usually at roughly the same height as the central receiver (approximately 200 m). In the case of the CSP plant, there will be numerous standby points. McCrary et al found that 19% of the birds that were found dead at Solar One were burned in standby points. Avian foragers such as swifts and swallows accounted for 46% of these mortalities. The more time a bird spends in the air the more chance there is of it flying into a standby point. The height at which species fly is also critical, species likely to fly at this height include the swifts, swallows, and martins.
- Loss of habitat:
  The CSP plant will take up an area of approximately 6 km^2. This would obviously be habitat previously available to the birds in the area.
- Disturbance
  Resident bird species may be disturbed by construction, operational and maintenance activities associated with the CSP plant, particularly whilst breeding
- Pollution caused by leaching of chemical substances into waste water evaporation ponds. This could be lethal to birds using these ponds. Artificial evaporation ponds serve as an additional attractant to water birds, which could increase cumulative collision, burning or poisoning impacts.
- Nesting of Sociable Weavers and other species on the plant infrastructure:
  Experience in this arid region has shown that Sociable Weavers are quick to nest on any manmade infrastructure and they may utilize infrastructure at the CSP site.

It is important to stress that most of the above impacts – and certainly the first five listed impacts – will probably only become significant when large numbers of birds are in the vicinity of the CSP plant. For example one swallow being burnt in a focal point would hardly be considered a significant impact. However, if a large flock of swallows congregated – perhaps due to a nearby roost site – a large number of birds could be burnt and the significance would be greatly amplified. For this reason, the more sensitive species in terms of the above impacts are likely to be the gregarious, flocking species.

Issues relating to the 225MV PV plant:

CSP farms potentially have greater impact on birds than PV farms because of the associated central receiver tower, standby focal points and heliostats, however, PV plants may still have the following impacts (Birdlife South Africa).

- Collision with the PV Panels:
- Loss of habitat:

  The PV plant will take up an area of approximately 450ha. This would obviously be habitat previously available to the birds in the area.
- Disturbance:

  Resident bird species may be disturbed by construction, operational and maintenance activities associated with the PV plant, particularly whilst breeding.

Issues relating to the associated infrastructure:

The EWT believes that the impacts of the associated infrastructure such as overhead power lines on birds may in fact outweigh the impacts of the CSP plant itself, depending on the length of new infrastructure that needs to be constructed. The proximity of site to the existing power line and road infrastructure is therefore very important. The closer the final site is to existing infrastructure, the less new infrastructure will need to be built. Briefly, the impacts of the associated infrastructure are as follows:

New power line:

- Collision with associated power line infrastructure.
- Electrocution on associated power line infrastructure.
- Nesting on associated power line infrastructure.
- Disturbance through construction and maintenance activities of new power line.
- Habitat destruction through construction activities of new line.

New road/s:

- Disturbance of avifauna through construction and maintenance activities.
- Habitat destruction through construction activities.

New pipe line/s:

- Disturbance of avifauna through construction and maintenance activities.
- Habitat destruction through construction activities.

Issues or factors that may attract birds to the vicinity of the Solar plant thereby amplifying the above interactions/impacts:

In this arid, relatively uniform landscape, large congregations of birds are unlikely unless a strong attractant exists, such as water.

- Birds attracted to open water evaporation ponds:

  In this landscape, any source of water is hugely important for all animals - including birds. If the CSP plant involves any open water sources such as evaporation ponds, this will attract more birds into the immediate area thus heightening the risk of the above impacts occurring. McCrary *et al* (1986) found a number of water birds (teal, grebes, coots) that had collided with heliostats at Solar One and this is almost certainly related to the presence of large (53 ha) evaporation ponds nearby. This is supported by the fact that 45% of all species recorded in 150 ha around Solar One, were only recorded at the ponds. The importance of the evaporation ponds at Solar One to birds is further illustrated by the fact that 107 bird species were recorded in the vicinity of Solar One, whilst the avian community in similar habitat elsewhere is usually less than 20 species. It is clear then that the presence of open water ponds close to the CSP plant would drastically increase the potential for avifaunal impacts.

- Birds mistakenly attracted to heliostats or PV panels:

  In these arid regions the daily activity schedule of many animals and birds revolves around securing their required daily intake of water. For example, Namaqua Sandgrouse (medium report rate in the study area) fly in flocks to water sources during mid to late morning. There is a possibility that birds such as these may mistake the heliostats or PV panels for water sources when flying high above and descend to investigate. In the case of the Sandgrouse, they would typically circle several times once they have located a water source, before descending. If the heliostats are mistaken for water, these birds would most likely circle through one or more focal points and may well be burnt to death.

DESCRIPTION OF AFFECTED ENVIRONMENT

The Northern Cape region is one of the most arid in southern Africa. In examining the region as a whole in terms of avifauna, it is important to relate the avifauna to the biomes and vegetation types present in the area. Harrison *et al* (1997) in "The Atlas of Southern African Birds" provide an excellent description of the various biomes represented in the region and the associated bird species. It is widely accepted within the ornithological community that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (in Harrison *et al* 1997). Therefore, this vegetation description focuses on factors which are relevant to bird distribution and is not a complete account of plant species. While this report is an avifaunal specialist report, vegetation and micro habitats are very important in determining avifaunal abundances and likelihood of occurrences. As such a map has been produced above (Figure 2) showing the vegetation classification of the broader area (Mucina & Rutherford, 2006).

Nama karoo biome: This biome comprises mainly low shrubs and grasses, trees such as *Acacia karoo* and exotic species such as *Prosopis glandulosa* are restricted to watercourses. Compared to "succulent karoo", "nama karoo" has a much higher proportion of grass and tree cover. The "karoo" used loosely to mean both "nama" and "succulent karoo", supports a particularly high diversity of species endemic to southern Africa. Avifauna characteristically comprises ground dwelling species of open habitats. The tree lined watercourses allow penetration of several species typical of arid woodland such as the Kori Bustard and Karoo Korhaan. Several species are almost entirely confined to the "Nama karoo" such as the Red Lark and Sclaters Lark. Because rainfall in the "nama karoo" is in summer and the neighbouring "succulent karoo" has winter rainfall, there is opportunity for species to migrate seasonally between the two. Two species suspected to do so (on the basis of atlas data) are the Ludwig's Bustard and Larklike Bunting.

Woodland biome: Woodland covers much of the northern and eastern parts of the country and is defined as having a distinct grassy under story and a woody upper story of trees and shrubs. Tree cover can range from sparse such as in the southern Kalahari, to almost closed. The more arid woodland types such as the Kalahari vegetation types are typically fine leaved and dominated by acacias and typically occur on nutrient rich, often alluvial soils in the western regions.

Vegetation Types (Mucina & Rutherford, 2006)

The dominant vegetation type in the study area is “Ghaap Plateau Vaalbosveld”. This vegetation type falls within the Eastern Kalahari Bushveld Bioregion, and occurs in the Northern Cape and North-West Provinces, around Campbell in the south, east of Danielskuil , through Reivilo, to around Vryburg in the north. The entire proposed project site falls within this vegetation type. “Kuruman Mountain Bushveld”, “Kuruman Thornveld”, and “Olifantshoek Plains Thornveld” vegetation types are also present in the broader area, to the west of the site, while numerous salt pans are scattered throughout, and are classified as “Southern Kalahari Salt Pans”.

Bird micro habitats

In addition to the description of vegetation, it is important to understand the habitats available to birds at a smaller spatial scale, i.e. micro habitats. Micro habitats are shaped by factors other than vegetation, such as topography, land use, food sources and man-made factors. Investigation of this study area revealed the following bird micro habitats.

Man-made Dams

Figure 4: A small dam or wetland areas that appears to be man-made, close to the western boundary of the farm, near to the Arriesfontein farm house.

Figure 5: The same “dam” as in Figure 4, looking across to the nearby farm-house. Water has collected or “dammed” against the road side.

Artificially constructed dams have become important attractants to various bird species in the South African landscape. Various waterfowl frequent these areas and crane species often use dams to roost in communally. Birds such as flamingos and African Spoonbills may make use of these areas. Therefore dams are a key element of this study.

Grassland

Figure 6: Grassland observed on site.

Although not within the true Grassland Biome, open “Grassy” are extensive throughout the site, and even more so in the broader study area, especially around pans that are dry. Grasslands represent a significant feeding area for many bird species such as White Stork, Secretarybird, Kori Bustard, Red-crested Korhaan and Northern Black Korhaan. The grassland patches are also a favourite foraging area for game birds such as francolins and Helmeted Guineafowl, as well as small mammals. This in turn may attract raptors because of both the presence and accessibility of prey. Listed species such as Lanner Falcon, Lesser Kestrel, African Marsh Harrier and Martial Eagle, may often hunt in open grassland areas.

Woodland and Thicket patches

Figure: 7: A woodland and Thicket patch observed on site, in vicinity of a windmill water pump.

Figure: 8: A small water reservoir associated with a wind pump. This water will attract various birds to drink.

Figure: 9: Cattle tend to congregate in thicket areas with small trees, usually close to water.

Patches of thickets, trees and bushes were observed, usually close to disturbed areas such as homesteads and kraals. This was also evident around Windmill water pumps. These areas attract smaller passerine species such as Robins and Shrikes. Weavers and Sparrow-weavers use the tree as structures for nesting and Raptors such the Southern Pale Chanting Goshawk may use these areas for perching.

Natural Pans

Figure 10: On open, dry pan observed within the study site.

Figure 11: Open, short grassy area (foreground), associated with a small dry pan (background) within the study site.

The broader area is scattered with numerous natural pans. May of these depressions do not always fill with water, and are only obvious pans in the rainy season. Although the majority of pans on site are most likely dry for much of the year, they still provide open “grassy” habitat that will be favoured by certain species such as Korhaans, Bustards, Spurfowl and

Coursers. Pans, when wet, are important attractants to various bird species in the South African landscape. Various waterfowl frequent these areas and crane species may often use pans to roost in communally. Birds such as Coots, Grebes, Ducks, Geese, Terns, Flamingos and African Spoonbills may make use of these areas. GIS mapping data showed the presence of up to seven natural wetland/pans within the study site. Four of these were observed during the site visit, the majority of which were dry, but which may have water and attract birds during, and soon after, the rainy season. Various large pans, to the west and south of the site, are designated CWAC sites, and are discussed in more detail below.

Bushveld Savanna

Figure 12: An example of bushveld on the site, with a high proportion of grassy areas.

Figure 13: An example of bushveld on the site, with a high proportion of small trees, woody plants and large shrubs/bushes.

This was the most widely observed micro-habitat during the site visit, in varying forms, consisting of bushes, woody plants, small trees and a "grassy" element. The bushes are frequented by smaller bird species such as Prinias, Tit-babblers, and Robin-chats, while larks and pipits are found on the ground.

Table 2 below shows the micro habitats that each Red Data bird (identified in Table 1 below) typically frequents in the study area. Many species however, in table 2 below, are unlikely to be found on site for a variety of reasons including low abundance and lack of suitable habitat. The likelihood of occurrence of each species within the development site is also predicted in the table below. It must be stressed that birds can and will, by virtue of their mobility, utilize almost any areas in a landscape from time to time. However, the analysis below represents each species' most preferred or normal habitats. These locations are where most of the birds of that species will spend most of their time – so logically that is where impacts on those species will be most significant.

Relevant bird populations

Southern African Bird Atlas Project 1

The primary data source used to determine the distribution and abundance of bird species in the study area was the Southern African Bird Atlas Project data (Harrison *et al*, 1997). This data was collected over an 11 year period between 1986 and 1997. Although it is now quite old, it remains the best long term data set on bird distribution and abundance available to

us at present. This data was collected on the basis of quarter degree squares, which is also a relatively large spatial scale. The proposed site falls within the Quarter Degree Grid Square (QDGS), 2823BD, while data from three additional squares, 2823BA, 2823BB, and 2823BC was also considered due to their close proximity to the site. The South African Bird Atlas Project (SABAP) recorded 12 Red Listed Species (Harrison *et al*, 1997), across all four squares, of which 5 are classified as Vulnerable, and 7 as Near Threatened. One additional species, the White Stork, is also included as it is protected internationally under the Bonn Convention on Migratory Species. The species recorded in the relevant quarter degree squares could have been recorded anywhere within these squares and not necessarily in the exact study area for the proposed developments. It does however provide a good indication of what could be found in the study area.

Table 1: Red Data species recorded in the relevant quarter degree squares covering the study site (2823BD) and surrounding areas (2823BA, 2823BB, and 2823BC).

Total species		59	164	88	161
# cards submitted		4	76	14	51
Species	**Cons. status**	**2823BD**	**2823BC**	**2823BB**	**2823BA**
Tawny Eagle	VU	-	-	7	-
Martial Eagle	VU	-	3	7	2
Lesser Kestrel	VU	-	3	-	2
Kori Bustard	VU	-	-	29	-
African Marsh Harrier	VU	-	1	-	2
Lanner Falcon	NT	-	1	-	-
Black Stork	NT	-	5	-	2
Yellow-billed Stork	NT	-	1	-	-
Secretarybird	NT	-	3	7	-
Greater Flamingo	NT	50	38	-	14
Lesser Flamingo	NT	50	7	-	-
Chestnut-banded Plover	NT	-	1	-	-
White Stork	Bonn	-	3	14	2

CE = Critically endangered, E = Endangered, VU = Vulnerable, NT = Near threatened, Bonn = Protected Internationally under the Bonn Convention on Migratory Species.

Table 2: Preferred Micro-habitats and likelihood of occurrence on site of Red Data species recorded in the relevant QDGS (SABAP1).

Species	Preferred Micro-habitat	Likelihood of occurrence on site
Tawny Eagle	Woodland and Bushveld	Unlikely
Martial Eagle	Woodland, savannah and Shrublands	Possible
Lesser Kestrel	Arable lands and Grasslands	Possible
Kori Bustard	Grasslands and Bushveld	Possible
African Marsh Harrier	Wetlands and adjacent moist grasslands	Unlikely
Lanner Falcon	Open grasslands; Woodland	Unlikely
Black Stork	Rivers and Kloofs	Unlikely
Yellow-billed Stork	Lakes, Dams, Rivers, Wetlands.	Unlikely
Secretarybird	Cultivated lands and Grasslands	Likely
Greater Flamingo	Pans and wetlands	Highly likely
Lesser Flamingo	Pans and Wetlands	Likely
Chestnut-banded Plover	Saltpans	Unlikely
White Stork	Grassland; Cultivated Fields; Open woodland	Possible

Southern African Bird Atlas Project 2

Table 3 below indicates report rates, based on the number of cards submitted, for the red data species identified in Table 1, as well as additional relevant species (i.e. larger species vulnerable to collision and/or electrocution, as well as aerial forages, doves, crows, and waterfowl species that may be attracted to the developments evaporation ponds). The study site fall within Pentad 2815_2345, which had only been counted once in the SABAP2 survey, and therefore all species recorded in this pentad will reflect a 100 % report rate (1 out of 1). In general, the surrounding areas close to the site have been relatively poorly counted, and therefore other selected pentads in the broader study area were also examined and their data is included below. Although some distance from the study site, these areas are likely to contain similar micro-habitats, and can give a good indication of the general bird life in the area, and which species may be present or pass through the study site. Pentads 2820_2330 and 2820_2325, were more extensively counted (22 and 65 cards respectively), as they include the settlement of Lime Acres, and the CWAC site of Rooipan.

Table 3: Report rates from Southern African Bird Atlas Project 2, for relevant species.

	Pentad Report Rate (%)					
Pentad	**2815_2345**	**2810_2330**	**2815_2330**	**2820_2330**	**2820_2325**	**2820_2320**
No Cards	*1*	*10*	*3*	*22*	*71*	*15*
Total Species	*49*	*97*	*60*	*110*	*150*	*127*
Recorded in SABAP1						
Tawny Eagle	-	-	-	-	1.4	-
Martial Eagle	-	-	-	-	-	-
Lesser Kestrel	-	-	-	4.5	1.4	13.3
Kori Bustard	-	-	-	-	-	-
African Marsh Harrier	-	-	-	-	-	-
Lanner Falcon	-	-	-	-	1.4	-
Black Stork	-	-	-	4.5	-	-
Yellow-billed Stork	-	-	-	-	-	-
Secretarybird	-	-	-	-	-	-
Greater Flamingo	-	-	-	-	-	-
Lesser Flamingo	-	-	-	-	-	-
Chestnut-banded Plover	-	-	-	-	-	-
White Stork	100	-	-	-	-	-
Additional Relevant Species						
Ludwig's Bustard	-	-	-	4.5	-	-
White-backed Vulture	-	-	-	-	-	6.7
Non Listed Relevant						
Northern Black Korhaan	100	80	66.7	18.2	2.8	93.3
Red-crested Korhaan	100	-	33.3	-	7	-
Orange River Francolin	-	30	-	4.5	14.1	26.7
Speckled Pigeon	-	90	-	59.1	83.1	-
Red-eyed Dove	-	100	33.3	68.2	8	40
Laughing Dove	-	100	-	100	98.6	93.3
Cape Turtle Dove	100	60	100	95.5	66.2	86.7
Namaqua Dove	-	90	66.7	18.2	15.5	40
Rock Martin	-	90	33.3	59.1	94.4	33.3
Banded Martin	-	20	-	-	2.8	26.7
Brown-throated Martin	-	-	-	-	28.2	40
Little Swift	100	80	66.7	77.3	83.1	66.7
Alpine Swift	-	-	33.3	4.5	21.1	26.7
White-rumped Swift	-	30	-	9.1	29.6	46.7
Greater Striped Swallow	-	80	100	63.6	66.2	66.7
Red-breasted Swallow	100	70	33.3	4.5	-	-
Barn Swallow	100	30	66.7	9.1	25.4	46.7
White-throated Swallow	-	10	-	-	14.1	-
European Bee-eater	-	50	33.3	13.6	45.1	26.7
White-fronted Bee-eater	-	-	-	-	47.9	-
Namaqua Sandgrouse	-	10	66.7	31.8	5.6	-
Pied Crow	100	100	100	100	85.9	46.7
Verreaux's Eagle	-	-	-	4.5	2.8	-
Gabar Goshawk	-	-	33.3	4.5	21.1	13.3
Black-Shouldered Kite	-	90	-	-	28.2	13.3
Rock Kestrel	-	30	-	13.6	22.5	6.7
Greater Kestrel	-	30	*incidental*	40.9	5.6	20
Black-chested Snake Eagle	-	10	-	-	1.4	-
Southern Pale-chanting Goshawk	100	-	66.7	27.3	7	40
South African Shelduck	100	10	-	18.2	14.1	100
Egyptian Goose	-	20	-	36.4	19.7	20
Red-billed Teal	100	-	33.3	-	28.2	93.3
Cape Teal	100	-	-	-	21.1	93.3
Yellow-billed Duck	-	-	-	-	31	80
African Sacred Ibis	100	-	-	4.5	-	53.3

The SABAP2 data revealed the presence of two additional Red Listed Species (not recorded in SABAP1) in the broader area, namely Ludwig's Bustard (VU) and White-backed Vulture (VU). Interestingly, of the 13 listed species recorded in the SABAP 1 data, 8 have not been recorded in the SABAP 2 data for the pentads examined, and only the White Stork has been recorded in the Pentad covering the development site. This however, does not necessarily mean that the other species do not occur in the study area, or that they have moved from the area, post SABAP1, but may merely be due to the low counting effort of the pentads, or selective micro habitat counting by the SABAP2 field counters. Furthermore, one must be cautious when comparing these data sets, as the pentads represent far smaller sampling areas than the QDGS's.

Coordinated Avifaunal Road-count (CAR) data

An evaluation of CAR data revealed that there are no Co-ordinated Avifaunal Road-count routes through or near to the site

Coordinated Waterbird count (CWAC) data

Four Coordinated Waterbird Count (CWAC) areas, which are regarded as sites important for water birds either by virtue of the species present or the numbers in which they are represented, are within close proximity to the study area, namely Danielskuil Pan, Great Pan, Rooipan and Soutpan, and their locations are shown in Figure 2 above. Data was not available for Great Pan, and neither for Rooipan, as both sites are classed as private, and individual cards are not available for public viewing. The species occurring at these sites are expected to be similar to those present at Danielskuil Pan and Sout Pan, discussed below.

Figure 14: Rooipan, shown above, was dry at the time of the site visit, yet still provides extensive open grassland habitat.

Danielskuil Pan

Danielskuil Pan actually consists of two dams and a dam/pan with open shoreline, some shorebird habitat, and almost no fringing vegetation. Counts are available for 1996 and 1997, when mainly small numbers of 17 species were recorded, 16 species in summer (only South African Shelduck being missing) and only 3 in winter (SA Shelduck, Threebanded Plover and Cape Wagtail). The most numerous birds in summer were Whitefaced Duck, Blacksmith Plover (a good count of 47 birds in 1997), Curlew Sandpiper and Little Stint. *This site was observed to be dry, with no presence of water-birds, during the site visit to the study area.*

Sout Pan

Cape Teal, Red-billed Teal, Yellow-billed Duck, South African Shelduck, Egyptian Goose, Greater Flamingo, as well as various other waders have all been recorded here.

Important Bird Areas (IBA's)

The site does not fall within an Important Bird Area (IBA) and there were no IBA's within close proximity to the site.

Focal Species List

After determining the red data species and other relevant species that are likely or may possibly be found on site, as well as identifying the microhabitats, the focal species for the study were identified.

Determining the focal species for this study, i.e. the most important species to be considered, is a four step process. Firstly, the micro-habitats available on site were identified. An analysis of the above existing avifaunal data represents the second step, i.e. which species occur in the area at significant abundances. The third step is to identify those species (which may be present based on the above two steps), and are more likely to be impacted upon by the proposed development and associated infrastructure. In terms of associated infrastructure, especially powerlines, this step called on the vast experience of the EWT in evaluating and investigating electrical infrastructure impacts on birds (these impacts are discussed in more detail below). In general, large, heavy flying birds are more vulnerable to collision with over-head powerlines, while perching Raptors are more vulnerable to electrocution. Knowledge of the species sensitive to the CSP and PV infrastructure is more scarce, however the following species groups are considered to have particular relevance to this study and include: raptors, doves, pigeons and aerial foragers such as swallows and swifts, as well as waterfowl species that may be attracted to the developments evaporation ponds. The fourth and final step was to consider the species conservation status or other reasons for protecting the species. This involved primarily consulting the Red List bird species (Barnes 2000) as in Table 1.

The resultant list of 'target/focal species' for this study is as follows: Lesser Kestrel, White-backed Vulture, Kori Bustard, Secretarybird, Greater Flamingo, White Stork, Martial Eagle, Northern Black Korhaan, Namaqua Dove, Rock Martin, Little Swift, Barn Swallow, European Bee-eater, Namaqua Sandgrouse, Sothern Pale-chanting Goshawk, and South African Shelduck .

In many cases, the above species serve as surrogates for other similar species (as mitigation will be effective for both), examples being Lesser Kestrel for Greater Kestrel, White Stork for Black Stork, Martial Eagle for Tawny and Verreaux's Eagles, Greater Flamingo for Lesser Flamingo, Kori Bustard for Ludwig's Bustard, Namaqua Dove for all other recorded dove species and so on. Assorted more common species will also be relevant to this study (shown in table 3 above), but it is believed that the above target species will to a large extent serve as surrogates for these in terms of impact assessment and management.

IDENTIFICATION OF AVIFAUNAL IMPACTS

The following identified impacts have been rated (according to a set of pre-determined criteria which can be seen in Appendix 1) in tables 4 to 6 below.

Issues relating to the CSP and PV plant itself:

Collision with the heliostats (mirrors):
This is likely to impact on birds, but the extent to which it will occur is unknown at this stage. The impact on bird populations worldwide through them colliding with windows of buildings has been well documented (see www.flap.org). At Solar One, 81% of bird mortalities were through collision with structures, with >75% of these collisions having occurred with the heliostat mirrors themselves (McCrary *et al* 1986).

Collision with the PV panels
This is likely to impact on birds, but the extent to which it will occur is unknown at this stage.

Collision with the central receiver tower:
Bird collisions with tall infrastructure have also been well documented worldwide. However, this typically occurs with migratory species in flocking behaviour and has usually involved low visibility conditions such as fog. There are unlikely to be sufficient numbers of any particular bird species at the site of the CSP plant to constitute flocking behaviour thereby resulting in this risk. It is however likely that the occasional bird will collide with the tower.

Roosting on the central receiver tower:
The tower will be a prominent structure in the landscape and may be an attractive roost for certain bird species. Although it will be too hot during operation, as it cools down during the evenings it may be a very attractive (particularly during winter) if it retains some warmth (although the temperature it retains remains to be seen). If it is well lit at night, this may attract insects, thereby attracting birds. If birds do roost on the tower, this is likely to simply be a nuisance for plant staff, as bird pollution will build up on any available surfaces.

Burning when in vicinity of the central receiver:

It seems unlikely to be a significant impact as birds would presumably be repelled by the heat before they get within burning range. Certain particularly fast flying species may be impacted on, such as the doves, swifts, martins and swallows identified in table 3. Research at Solar One did not detect any mortalities through this mechanism (McCrary *et al* 1986).

Burning when entering the "standby focal points":

This impact is likely to occur at the CSP plant. The significance of the impact will depend on a number of factors which are unclear at this stage, for example: exactly how many focal points will exist; what size will they be; how long will they be in operation for each day. At this stage it is safe to say that some birds will in all likelihood be killed in the focal points. The significance of the impact will depend on just how many birds, and what species are killed. Furthermore, it seems unlikely that any mitigation for this impact will be possible. Monitoring at Solar One recorded that 19% of all bird mortalities were through burning in standby or focal points – mostly swifts and swallows (McCrary *et al* 1986).

Loss of habitat:

Approximately three square kilometres will be taken up by the CSP plant in total. The vegetation in this area will should not be fully cleared automatically. Rather, only the areas where infrastructure has to be constructed should be cleared. Obviously construction activities on site will flatten and impact on certain areas of vegetation even if it is not cleared. Similar habitat is abundant in the greater area and it is anticipated that the bird species will move to surrounding areas.

Disturbance:

Construction activities will no doubt disturb the birds in the area, particularly breeding birds – however due to the uniformity of the broader area, these birds can quite easily move off and find similar habitat nearby.

Nesting of Sociable Weavers and other species on the plant infrastructure:

The extent to which this occurs will need to be monitored closely. This is an impact of the birds on the plant rather than the plant on the birds. It is hoped that the constant moving and cleaning of the heliostats will make them unattractive nesting substrate for the birds. No nests were observed within the site boundaries.

Issues relating to associated infrastructure:

New power lines:

Collision of large terrestrial birds with any new overhead power lines is likely to occur and is anticipated to be the most significant threat posed by associated infrastructure. Species most likely to be affected are flamingos, bustards, korhaans and other large terrestrial species. The significance of this impact depends on the length and routing of any new lines to be built. **The exact routings of associated new lines were not available at the time of writing, and the impact therefore cannot be fully assessed at this stage.**

Electrocution of birds on pylons will depend entirely upon the exact pylon structure that for the new line – **detail of which was not available at the time of this study.** Electrocution risk is determined by the phase-phase and phase-earth clearances on a pole structure which differ greatly between different structures. Again, if the structure used is dangerous to birds, the significance of this impact will vary with the length of the line.

Nesting of birds on pylons is in fact a positive impact on avifauna, but may impact negatively on the quality of electrical supply by causing electrical faults. In the case of Sociable Weaver nests, the nest material may pose problems to the pylons structural integrity through added weight, and there is an increased fire risk due to the fuel load of these massive nests.

Disturbance of avifauna through construction and maintenance activities associated with the power line is not likely to be significant.

Habitat destruction by construction activities is likely to occur, but not likely to be significant.

New roads:

Disturbance of avifauna is likely to occur to some extent, but not likely to be too significant as there is already a gravel district road (along the rail line to the west of the site) as well as various tracks through the farm and it is unlikely that extensive new roads would be, again depending on the exact layout of the CSP and PV plants within the farm.

Habitat destruction caused by road construction will have some impact on avifauna, but as discussed elsewhere the habitat in this landscape is relatively uniform and so this impact is unlikely to be too significant.

New pipe lines:

This infrastructure is likely to have very similar impacts to the roads discussed above, except on a smaller scale. Should new pipelines be required for water supply to the CSP plant impacts of this on avifauna will be minor habitat destruction and minor disturbance.

Table 4: Rating of *Construction Phase* impacts:

Impact	Scale	Duration	Magnitude	Probability	PS pre-mitigation	Recommended Mitigation	PS after mitigation
Habitat Loss (CSP Plant)	1	4	6	5	55 (Moderate)	Not possible	55 (Moderate)
Habitat Loss (PV plant-all 3 phases)	1	4	6	5	55 (Moderate)	Not Possible	55 (Moderate)
Habitat Loss (New roads)	1	4	4	5	45 (Moderate)	Not Possible	45 (Moderate)
Habitat Loss (Pipelines)	1	2	4	5	35 (Moderate)	Not Possible	35 (Moderate)
Habitat Loss (Overhead Power lines)	1	4	4	5	45 (Moderate)	Not Possible	45 (Moderate)
Disturbance (during construction of all phases and infrastructures)	2	2	6	4	40 (Moderate)	Strict control should be maintained over all activities during construction, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible. It is difficult to mitigate properly for this as some disturbance is inevitable. During Construction, if any of the “Focal Species” identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction.	32 (Moderate)

Table 5: Rating of *Operational Phase* impacts:

Impact	Scale	Duration	Magnitude	Probability	PS pre-mitigation	Recommended Mitigation	PS after mitigation
Collision with heliostats	1	4	10	5	75 (High)	Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained	75 (High)
Collision with central receiver tower	1	4	10	5	75 (High)	Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained	75 (High)
Collision with PV panels	1	4	10	5	75 (High)	Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained	75 (High)
Burning in vicinity of central receiver tower	1	4	10	5	75 (High)	Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained	75 (High)
Burning in focal points	1	4	10	5	75 (High)	Unlikely that mitigation of this impact will be possible. This will need to be confirmed once the plant is operational and some experience is gained	75 (High)
Disturbance of sensitive species (e.g. during maintenance and operations).	2	4	6	4	48 (Moderate)	Strict control should be maintained over all activities during operation, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible. It is difficult to mitigate properly for this as some disturbance is inevitable. If any of the "Focal Species" identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction.	40 (Moderate)
Nesting	1	4	4	3	27 (Low)	Positive impact on avifauna. No mitigation required.	27 (Low)
Collision of large terrestrial birds with overhead power lines	1	4	10	4	60 (High)	*Wherever possible, lines connecting turbines should be placed underground*. Mark relevant sections of line (i.e. within the Medium-High Sensitivity zones- fig10 above) with appropriate marking devices. The exact spans will be finalised as part of the EMP phase, once power-line routes are finalised and pylon positions are pegged.	30 (Moderate)
Electrocution of birds on pylons	1	4	10	3	45 (Moderate)	*Wherever possible, lines connecting turbines should be placed underground* Any overhead power lines which are built, and which are 132kV or lower, should use a "bird friendly" monopole structure, fitted with a bird perch, as per Eskom standard guidelines.	15 (Low)

Table 6: Rating of *Closure Phase* impacts:

Impact	Scale	Duration	Magnitude	Probability	PS pre-mitigation	Recommended Mitigation	PS after mitigation
Disturbance of sensitive species	2	2	4	4	32 (Moderate)	Strict control should be maintained over all activities during decommissioning, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible. If any of the “Focal Species” identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction.	16 (Low)

COMPARISON OF ALTERNATIVES

For the purpose of the proposed EIA only the following types of alternative options will be considered:

- The layout of the heliostat field.
- The CSP technology to be used.
- The option of not implementing the activity (i.e. “No-go”).

For the proposed CSP Plant, three possible layout positions on the proposed site will be assessed as alternatives. Three possible technology alternatives have been identified as development options and will be considered and assessed. The no-go alternative will also be assessed in order to reflect the potential impact if the proposed project will not be implemented.

No-go Alternative

The current status quo would be maintained by not implementing the proposed CSP and PV Plant. The current farming activities will continue and the land use will not change. Presence and abundance of bird species, as described in the Avifaunal Scoping Report, would remain the same. Purely in terms of impacts on avifauna, this option would have the least impacts.

Location and Layout Options

The options for the proposed location of the CSP plant are limited to the farm Arriesfontein 267. No alternative site locations have been assessed. However more than one position for the layout of the heliostat field within the farm have been presented and are discussed briefly below. All four options are shown in figures 15 to 17 below, and are to the south of the sites, south of the railway line.

Option A is positioned as far south and east as possible within the site. Its centre point (i.e. the Central Receiver Tower) will be positioned on or very close to an existing farm track, which may result in less disturbance and habitat destruction during initial construction. It will impact upon two small pans. Option B is positioned as far west as possible within the site. It will impact upon two small pans, as well as one medium sized pan. Option C is positioned centrally and more to the north. It will impact upon two small pans and one medium pan, and is also located closest to the relatively large pan/wet area that lies to the north of the farm road that runs east to west through the centre of the site.

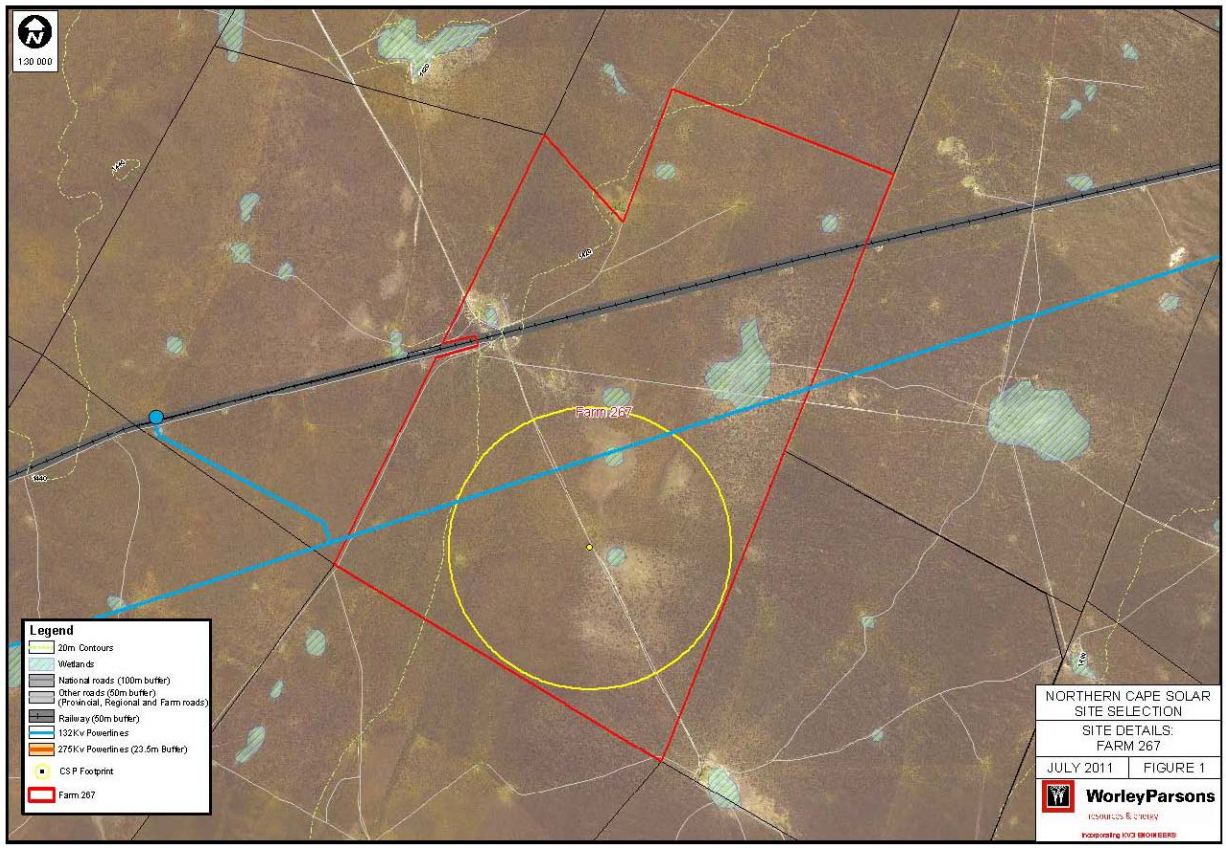


Figure 15: Layout Option A for the heliostat field within the proposed development site (SOURCE: Worley Parsons).

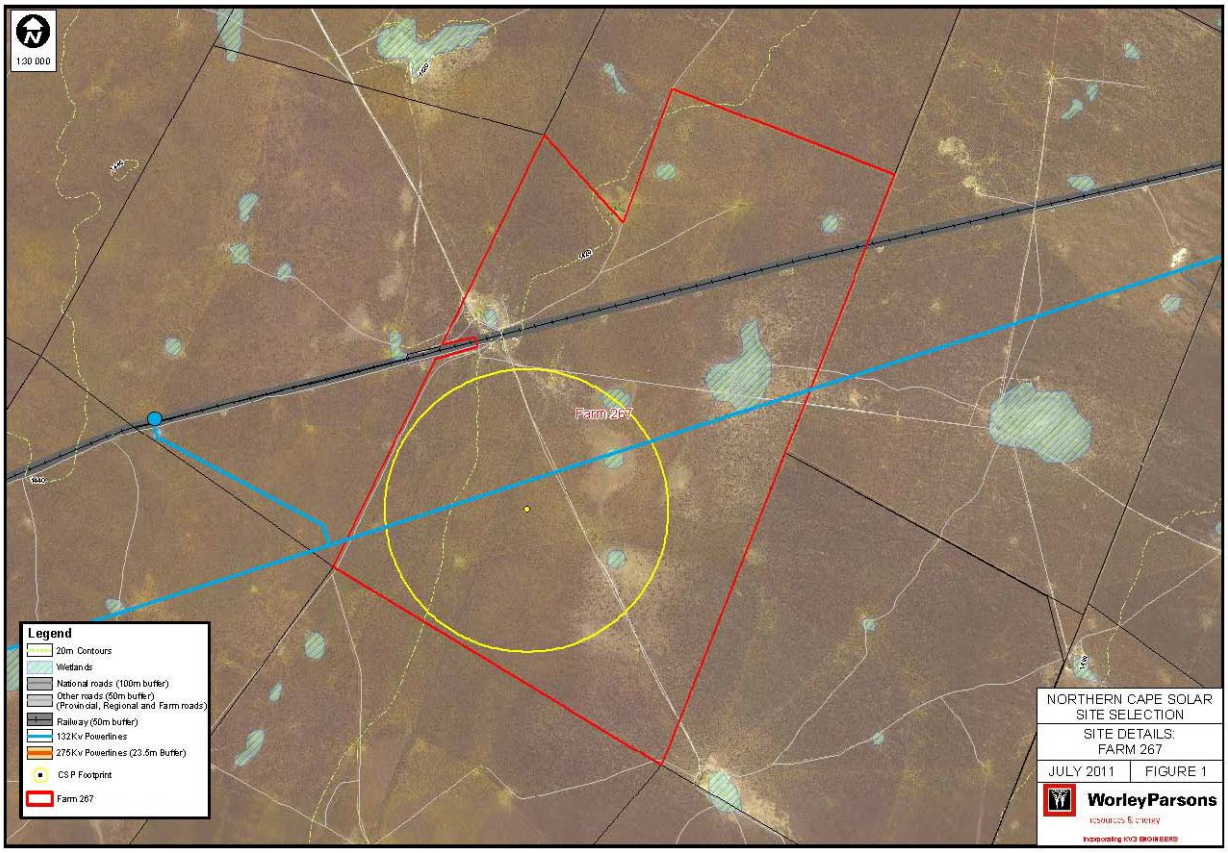


Figure 16: Layout Option B for the heliostat field within the proposed development site (SOURCE: Worley Parsons).

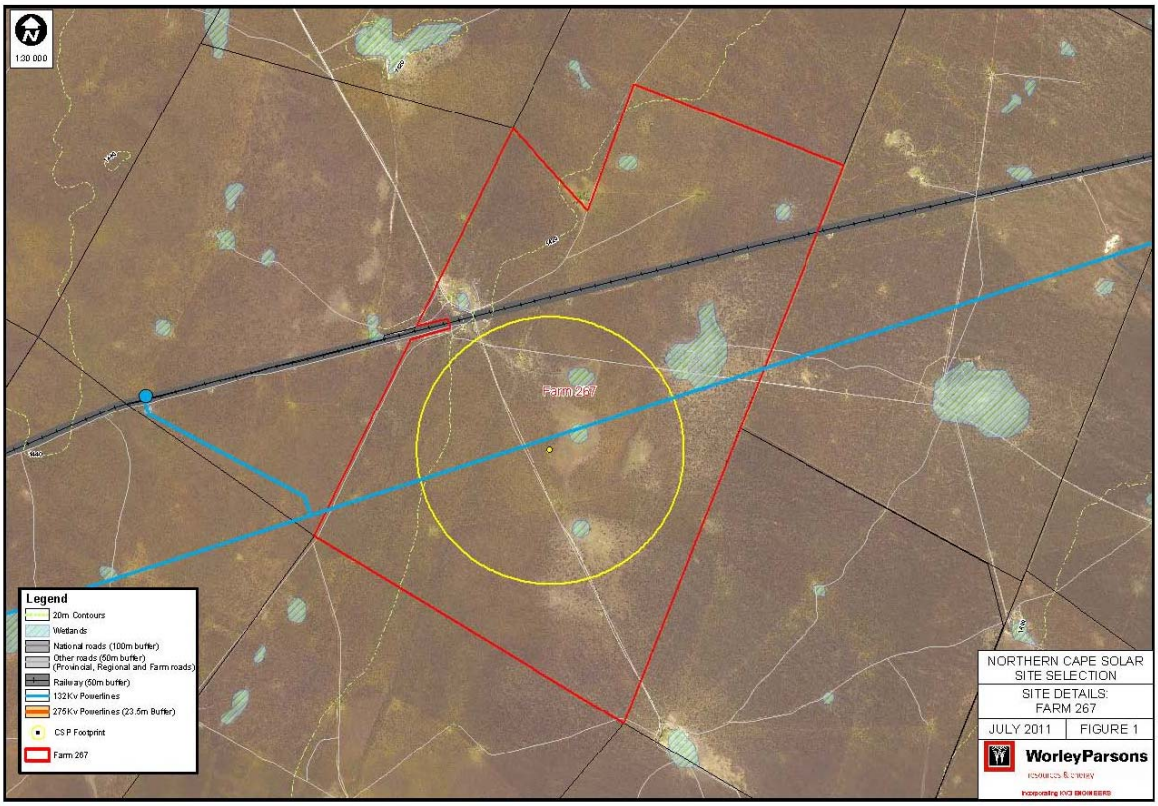


Figure 17: Layout Option C for the heliostat field within the proposed development site (SOURCE: Worley Parsons)

In order to rank these layout options a table was compiled and the options were given a rating on a scale of 1 to 5, with 1 being the least preferred and 5 being the most highly preferred option.

Table 7: Preference rating for the 3 CSP layout options.

Layout Option	Preference Rating
Option A	4
Option B	3
Option C	1

As can be seen from the discussions and table above, Option A is slightly preferred over Option B, both of which are acceptable from an avifaunal perspective, while Option C is least preferred.

Technology Options

The three technology alternatives that are being considered relates to the water consumption of the plant and particularly the consumption of the cooling systems. The cooling system is the only variable in terms of water consumption. The three cooling system

options are dry, wet and hybrid cooling. The estimated water consumption during the construction phase remains constant irrespective of the cooling option chosen. The consumption during operation however will be influenced by the selected cooling system. The dry system consumes approximately 90% less water than the wet system and moderately less than the hybrid cooling system and the availability of water will be a determining factor of the option to be selected (Solar Reserve, 2011-BID).

It is unlikely that there will be any direct impacts on avifauna, relating to the type of cooling system chosen. However, as birds are dependent on water, the wet system may have more negative, indirect impacts on avifauna, through the possible depletion of water availability and wetland habitats. This of course is dependent on the source of the water used.

IDENTIFICATION OF SENSITIVE AREAS WITHIN THE PROPOSED SITE

An avifaunal sensitivity map has been compiled (see figure 18 below), showing areas of medium-high, low and unknown sensitivities. Recommendations with regard to these sensitivity “zones” has been discussed below. It is recommended that infrastructure is not built or developed in the zone of medium to high sensitivity.

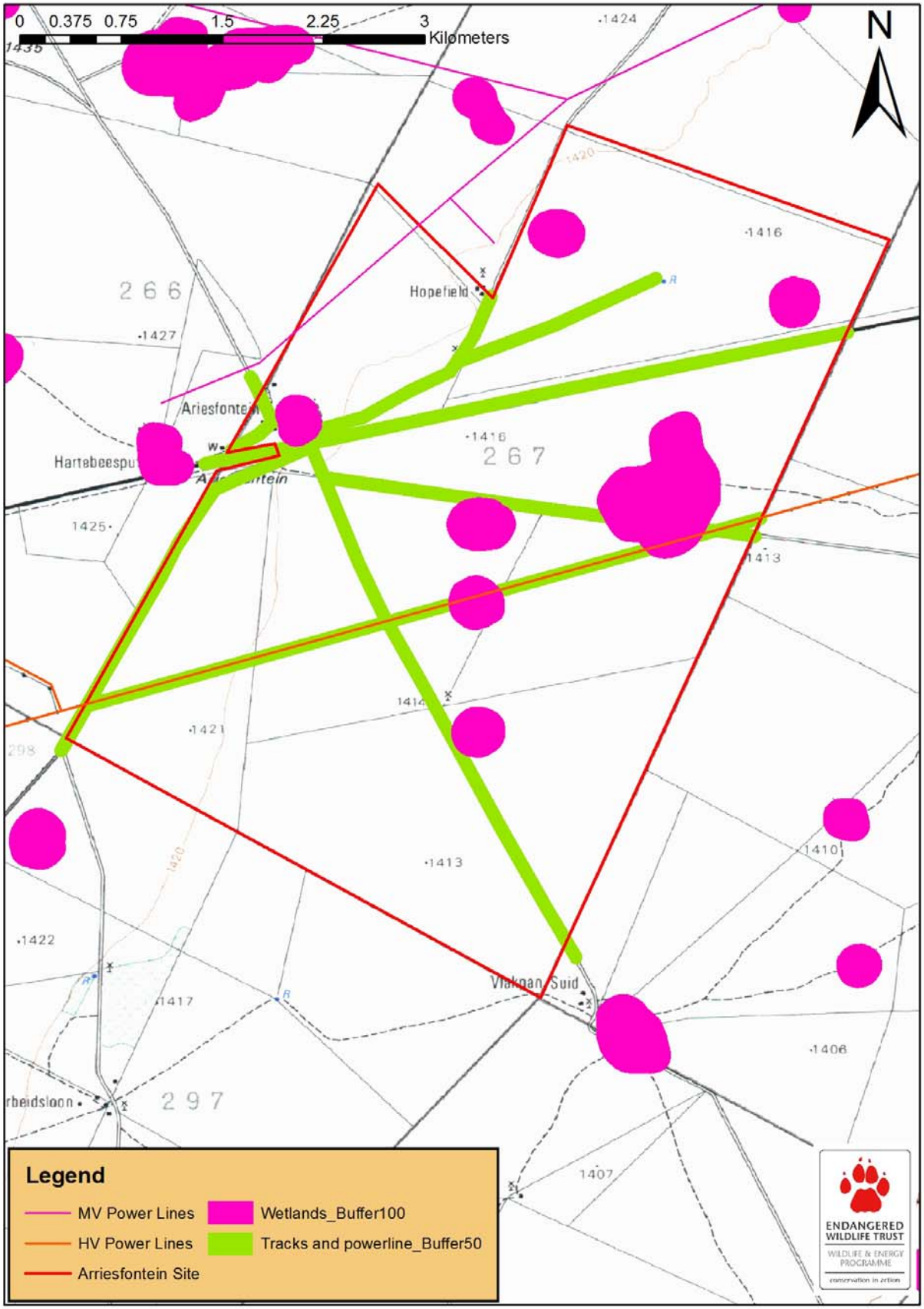


Figure 18: A map showing various avifaunal sensitivity zones within the proposed development site.

Medium-High sensitivity: These zones include 100m buffers around water bodies, such as dams and pans, No construction of infrastructure in these areas (as indicated in the map above- Figure 14) should be permitted. **However, upon consultation with EWT, construction of infrastructure may be possible, with caution, within certain areas of these zones.** Should associated infrastructure, such as pipe-lines or power lines pass through these areas, mitigation as discussed elsewhere must be implemented. Importantly, should any over-head powerlines pass through these areas; they should be fitted with collision mitigation in the form of "bird flight diverters". The confidence with which these "Medium-High sensitive" areas were identified was moderate to low.

Low Sensitivity: These zones are made up of a linear infrastructure corridors. Existing roads/tracks and power lines have been buffered by 50m, on each side, to indicate these zones. These zones are likely to be of low sensitivity; however any species may pass through these zones, especially the roads, if levels of human movement are low. New linear infrastructure should follow these corridors where possible.

Unknown Sensitivity: These are the remaining areas of the study site. These are designated "unknown" sensitivity for the following reasons: no obvious avifaunal features or patterns could be identified during the study; any of the identified focal species may at some point utilize or pass through these areas, and; the precautionary principle has been adopted. It is likely that the majority of these areas are *"Low"* sensitivity for birds. These unknown sensitivity areas are preferred for construction.

CONCLUSIONS

The site is in the arid Northern Cape, with uniform vegetation of only one types (Ghaap Plateau Vaalbosveld) found on the study site. The uniformity of the site resulted in few microhabitats available for birds. However, an important microhabitat present was that of natural seasonal pans, which are more extensive in the broader area. This fact, along with the presence of CWAC sites to the West of the study area, means that it is possible for waterfowl and other bird species associated with water, may be attracted to additional water sources (e.g. evaporation ponds) created by the CSP project. It is also possible, although no such studies have yet been conducted in South Africa, that bids may mistake the PV field for water, and collide with the panels. Species of most concern in the area, include the following identified Focal Species: Lesser Kestrel, White-backed Vulture, Kori Bustard, Secretarybird, Greater Flamingo, White Stork, Martial Eagle, Northern Black Korhaan, Namaqua Dove, Rock Martin, Little Swift, Barn Swallow, European Bee-eater, Namaqua Sandgrouse, Sothern Pale-chanting Goshawk, and South African Shelduck. An assessment of the impacts of the proposed CSP and PV plants on avifauna at the proposed Arriesfontein site revealed the following key findings:

Impacts associated with CSP and PV plant:

- Collisions of birds with heliostats and/or the central receiver tower of the CSP plant, both had a high significance rating. It is unlikely that mitigation of these impacts will be possible, but this will need to be confirmed once the plant is operational and some experience is gained.
- Collision of birds with PV Panels had a high significance rating. It is unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained.
- Burning of birds in focal points and/or in the vicinity of the central receiver tower of the CSP plant has a high significance rating. Again, it is unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained.
- Habitat destruction and disturbance of bird will be of moderate significance. This can be mitigated by ensuring that the construction Environmental Management Plan incorporates guidelines as to how best to minimize this impact.

Note: The impacts above with a high significance, were rated so due to the "unknown" rating of 5 associated with their magnitude and probabilities, as per the rating criteria. It is possible that, realistically, the probability of these impacts occurring may be lower.

Impacts associated with new power lines:

- Collision of birds with overhead power lines is likely to be of high significance without mitigation. This will be mitigated for by marking the relevant sections of line with appropriate marking devices, thus reducing the impact to that of moderate significance. These sections of line will be identified as part of the Environmental Management Programme (EMP) phase.
- Assuming that “bird-friendly” monopole structures are used, as detailed elsewhere in this report, electrocution of birds on pylons is likely to be of low significance.

Impacts associated with new roads, pipe lines:

- Habitat destruction and disturbance of birds will be of moderate significance. This will be mitigated by ensuring that the construction EMP incorporates guidelines as to how best to minimize this impact.

An avifaunal sensitivity analysis of the site found areas of “medium-high”, “low” and “unknown” sensitivities. Medium-High sensitivity zones are associated with seasonal pans and wetlands, and it is recommended that where possible infrastructure is not built or developed in these zones. The majority of the site was found to be of “unknown” sensitivity. It was recommended that where possible, new linear infrastructure should follow existing linear infrastructure, which was designated as a “low” sensitivity zone. For the proposed CSP Plant, three possible heliostat field layout positions on the proposed site were assessed as alternatives. Option A was slightly preferred over Option B, both of which are acceptable from an avifaunal perspective, while Option C was least preferred.

A final recommendation is that a detailed monitoring protocol, for the operational phase of the project, be incorporated in to the final project EMP. The EWT should be consulted during the EMP phase, to assist in compiling such a monitoring program. The monitoring will involve regular inspections of the plant, to collect any bird carcasses. This will insure that any bird mortalities are recorded and reported, and may assist with the implementation of future, additional mitigation strategies.

In conclusion, the lack of any operational CSP plants or PV plants of this nature in South Africa, make the assessment of impacts of this project difficult. However, the EWT believes that it is necessary to adopt renewable energy technologies in South Africa, and it is necessary to construct such projects, and monitor their impacts (if any) on avifauna. This will allow pro-active learning, which can inform additional mitigation where necessary on the project, as well as informing future avifaunal studies of similar projects. Therefore, without finding any fatal flaws and if the mitigations recommended in this report are followed, the development is acceptable from an avifaunal perspective, and it is recommended that this project proceeds.

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APPENDIX 1

IMPACT ASESSMENT METHODOLOGY

Determination of Impact Significance

The information presented above in terms of identifying and describing the aspects and impacts is summarised in tabular form and significance is assigned with supporting rational.

The environmental significance rating is an attempt to evaluate the importance of a particular impact, the consequence and likelihood of which has already been assessed by the relevant specialist as and when required. In order to assess the significance of each impact, the following ranking scales will be employed:

Table 1: Impact Significance Ranking Scales

PROBABILITY:	DURATION:
5 - Definite/don't know 4 - Highly probable 3 - Medium probability 2 - Low probability 1 - Improbable 0 - None	5 - Permanent 4 - Long-term (impact ceases after the operational life of the activity) 3 - Medium-term (5-15 years) 2 - Short-term (0-5 years) 1 - Immediate
SCALE:	**MAGNITUDE:**
5 - International 4 - National 3 - Regional 2 - Local 1 - Site only	10 - Very high/don't know 8 - High 6 - Moderate 4 - Low 2 - Minor 0 - None

Once the above factors had been ranked for each impact, the overall significance of each impact was assessed using the following formula:

(Potential Significance) = (*Magnitude* + *Duration* + *Scale*) x *Probability*

The potential significance (PS) has a maximum rating of 100 points. Environmental impacts are rated as having either a High(H), a Moderate(M) or a Low(L) significance according to the following scale:

PS ≥ 60 = High Environmental Significance

60 < PS ≥ 30 = Moderate Environmental Significance

PS < 30 = Low Environmental Significance

Significance will thus be classified according to the following:

- **Low:** Low Environmental Significance – Mitigation easily achieved or little is required;
- **Moderate:** Moderate Environmental Significance – Mitigation is both feasible and fairly easily possible; and
- **High:** High Environmental Significance – Adverse Impact. Mitigation, if possible, is often difficult, expensive and time consuming.

The Potential Environmental Impact Significance can then be calculated for each impact at the various stages of the project before and after mitigational measures are implemented. The various stages of the project can be classified as follows:

- Construction Phase before mitigation,
- Construction Phase after mitigation,
- Operational Phase before mitigation,
- Operational Phase after mitigation,
- Closure Phase before mitigation,
- Closure Phase after mitigation.

The Potential Environmental Impact Significance will be calculated using the following matrix:

POTENTIAL ENVIRONMENTAL	CRITERIA					S	SIGNIFICANCE		
IMPACT	Nature	P	D	S	M	TOTAL	L	M	H
CONSTRUCTION	-	3	4	2	4	30		M	
CONSTRUCTION MITIGATION	+	3	1	1	2	12	L		
OPERATON	-	3	1	1	4	18	L		
OPERATION MITIGATION	-	3	1	1	2	12	L		
CLOSURE	+	2	1	1	2	8	L		
CLOSURE MITIGATION	+	2	1	1	2	8	L		

Appendix F–Biodiversity Environmental Impact Assessment

BEC Report Reference:	WLP – AFT – 2012/24
Version:	1.12.03.13
Report Status	DRAFT REPORT
DEA Reference	

Terrestrial Biodiversity Impact Assessment for the proposed Arriesfontein Solar Thermal Energy Power Plant near Danielskuil, Northern Cape Province

compiled by

Bathusi Environmental Consulting

March 2012

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I PROJECT DETAILS

Client:	Worley Parsons RSA, on behalf of SolarReserve SA (Pty) LTD
Report name:	Terrestrial Biodiversity Impact Assessment for the proposed Arriesfontein Solar Thermal Energy Power Plant near Danielskuil, Northern Cape Province
Report type:	Biodiversity Impact Assessment Report
Report status:	**DRAFT REPORT**
BEC Project number:	WLP – AFT – 2012/24
Report Version:	1.12.03.13
Authority Reference:	N/A
Compiled by:	Riaan A. J. Robbeson (Pr.Sci.Nat.), Bathusi Environmental Consulting
Project Co-ordinator:	Mr. Francois Humphries (francois.humphries@WorleyParsons.com)

II SPECIALIST INVESTIGATORS

The Natural Scientific Professions Act of 2003 aims to '*provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP), and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith'.*

Quoting the Natural Scientific Professions Act of 2003: '*Only a registered person may practice in a consulting capacity*' (20(1) – pg 14).

The following specialists contributed to this report:

Botanical Investigator:	**Riaan Robbeson (Pr.Sci.Nat.)**
Qualification:	M.Sc. (Botany), UP
Affiliation:	South African Council for Natural Scientific Professions
Fields of Expertise:	Botanical Scientist & Ecological Scientist
Registration Number:	*400005/03*
Affiliation:	Grassland Society of Southern Africa
Membership Status:	Professional Member
Membership Number:	*667.08/08*
Faunal Investigator:	**Dewald Kamffer (Pr.Sci.Nat.)**
Qualification:	M.Sc. (Conservation Biology), UP
Affiliation:	South African Council for Natural Scientific Professions
Fields of expertise:	Ecological Scientist & Zoological Scientist
Registration number:	*400204/05*

III RESERVED COPYRIGHT

IV DECLARATION OF INDEPENDENCE

Individual declarations attached as addendums. All specialist investigators, project investigators and members of companies employed for conducting this biodiversity investigation declare that:

- We act as independent specialist consultants conducting the assessment and compiling the report;
- We consider ourselves bound to the rules and ethics of the South African council for natural scientific professions;
- Bathusi Environmental Consulting cc is not a subsidiary, legally or financially, of either the proponent or GCS (Pty) Ltd;
- At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development or activity as outlined in this document, other than fair financial compensation for work performed in a professional capacity;
- We will not be affected in any manner by the outcome of the environmental process of which this assessment forms part of, other than being part of the general public;
- We do not necessarily object to or endorse the proposed development, but aim to present facts and recommendations based on scientific data and relevant professional experience; and
- We do not have any influence over decisions made by the governing authorities;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the environmental impact assessment regulations, 2005;
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- Should we 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 register as an Interested and Affected Party.

Signature of principal ecologist:

Bathusi Environmental Consulting cc (CK1999/052182/23)

Name of company:

13th March 2012

Date:

V LIMITATIONS OF THIS INVESTIGATION

- Findings, results, observations, conclusions and recommendations presented in this report are based on the authors' best scientific and professional knowledge as well as information available to them at the time of compiling this report.
- This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.
- Results presented in this report are based on a snapshot investigation of the study area and not on detailed and long-term investigations of all environmental attributes and the varying degrees of biological diversity that may be present in the study area.
- In particular, rare and endemic species normally do not occur in great densities and, because of customary limitations in the search and identification of Red Listed species, the detailed investigation of these species was not possible. Results are ultimately based on estimations and specialist interpretation of imperfect data.
- It is emphasised that information, as presented in this document, only have bearing on the site as indicated on accompanying maps. This information cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.
- Furthermore, additional information may become known during a later stage of the process or development. The authors therefore reserve the right to modify aspects of the report including the recommendations should new information may become available from ongoing research or additional work in this particular area, or pertaining to this investigation.
- This report should always be considered as a whole. Reading and representing portions of the report in isolation could lead to incorrect conclusions and assumptions. In case of any uncertainty, the authors should be contacted to clarify any viewpoints, recommendations and/ or results.
- Not all areas could be accessed during the respective site investigations. Results are extrapolated to include these properties, but no responsibility could be taken should discrepancies be indicated at a later stage. It is strongly recommended that these areas be subjected to a basic site investigation to confirm initial results.

VI LEGISLATION

This report has been prepared in terms of the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 385 Section 33 – Specialist reports and reports on specialised processes under the Act. Relevant clauses of the above regulation include:

Regulation 33.(1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialised process.

Regulation 33.(2): A specialist report or a report on a specialised process prepared in terms of these Regulations must contain:

(a) Details of (i) The person who prepared the report, and
(ii) The expertise of that person to carry our the specialist study or specialised process;
(b) A declaration that the person is independent in a form as may be specified by the competent authority;
(c) An indication of the scope of, and the purpose for which, the report was prepared;
(d) A description of the methodology adopted in preparing the report of carrying out the specialised process;
(e) A description of any assumptions made and any uncertainties or gaps in knowledge;

(f) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
(g) Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;
(h) A summary and copies of any comments that were received during any consultation process;
(i) Any other information requested by the competent authority.

Compliance with provincial, national and international legislative aspects is strongly advised during the planning, assessment, authorisation and execution of this particular project. Legislative aspects of which cognisance were taken during the compilation of this report are summarised in, but not necessarily limited to, Table 2.

Table 1: Legislative guidance for this project	
Biodiversity Act (No. 10 of 2004)	To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act 1998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith.
Conservation of Agricultural Resources Act 43 of 1983	The conservation of soil, water resources and vegetation is promoted. Management plans to eradicate weeds and invader plants must be established to benefit the integrity of indigenous life.
Constitution of the Republic of South Africa (Act 108 of 1996)	The Bill of Rights, in the Constitution of South Africa (No. 108 of 1996), states that everyone has a right to a non-threatening environment and requires that reasonable measures are applied to protect the environment. This protection encompasses preventing pollution and promoting conservation and environmentally sustainable development. These principles are embraced in NEMA and given further expression.
Convention on Biological Diversity, 1995	International legally binding treaty with three main goals; conserve biological diversity (or biodiversity); ensure sustainable use of its components and the fair and equitable sharing of benefits arising from genetic resources.
Convention on International Trade in Endangered Species of Wild Life and Fauna	International agreement between governments, drafted because of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to more than 33,000 species of animals and plants.
Environmental Conservation Act (No. 73 of 1989)	To provide for the effective protection and controlled utilization of the environment and for matters incidental thereto.
Northern Cape Nature Conservation Act, No. 9 of 2009	Provides for the sustainable utilisation of wild animals, aquatic biota and plants, provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Amongst other regulations, the following may apply to the current project: • Boundary fences may not be altered in such a way as to prevent wild animals from freely moving into or off of a property; • Aquatic habitats may not be destroyed or damaged; and • The Act provides lists of protected species for the Province.
National Environmental Management Act (No. 107 of 1998)	Requires adherence to the principles of Integrated Environmental Management (IEA) in order to ensure sustainable development, which, in turn, aims to ensure that environmental consequences of development proposals be understood and adequately considered during all stages of the project cycle and that negative aspects be resolved or mitigated and positive aspects enhanced.

National Environmental Management Act (No 10 of 2004)	Restriction of activities involving alien species, restricted activities involving certain alien species totally prohibited and duty care relating to listed invasive species.
Protected Areas Act (No. 57 of 2003)	To provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; and for matters in connection therewith.

VIII LIST OF TABLES

IX LIST OF FIGURES

1 EXECUTIVE SUMMARY

SolarReserve SA (Pty) LTD has appointed Worley Parsons RSA (Pty) Ltd as independent Environmental Assessment Practitioners (EAP) to the project in fulfilment of legislative requirements. Bathusi Environmental Consulting (BEC) has been appointed on behalf of Worley Parsons to conduct the terrestrial flora and fauna assessments (biodiversity/ ecology) for the proposed project. Riaan Robbeson will conduct the botanical assessment; Dewald Kamffer will conduct the faunal assessment.

The study area is situated on the Farm Arriesfontein, Barkley Wes RD, Siyanda District Municipal Region approximately 30km east of Lime Acres. A general PGS point for the study area is S28°17' and E23°47'. The study site comprises approximately 1,830ha.

1.1 BIOPHYSICAL ATTRIBUTES

The surrounding region exhibits low levels of transformation, comprising extensive areas of natural habitat, categorised as Shrubland and Bushland. The greater region is similarly characterised by low levels of habitat fragmentation and isolation, typical to a rural environment.

The study area falls within the Vaal Primary Catchment area. Several relative small endorheic pans are present within the study area and immediate surrounds. The southern Kalahari pans are characterised as 'dry or ephemeral lakes'. These areas may have bare clay or more or less vegetated surfaces, contained in isolated enclosed depressions. Inundation is characteristically ephemeral. In the most arid regions, pans can stand dry for years between temporary flooding. Water loss is largely due to evaporation, and the high evaporation rates in the western part of the country contribute as much as low precipitation to the usual desiccated state (Allan, et al.). Smaller rivers in the region include the Klein Riet River (Southwest) and Steenbok River (Northeast). These rivers are unlikely to be affected by the proposed development.

The topography of the study area is categorized as 'Plains and Pans' characterized by a gently undulating landscape. Various shallow drainage lines intersect the landscape. Altitude varies around 1,400 meters above sea level. No significant topographical features are present in the immediate vicinity of the study area.

The regional geology comprises mostly sand, with portions of Dolomite located in the western section of the study area. Land types Ae9 and Fc4 are represented in the study area.

The study area is situated within Griqualand West Centre of Endemism. *Tarchonanthus camphoratus* is a particularly common woody species in these two bushveld types. Typical

mountain species include *Searsia tridactyla, Croton gratissimus* and *Buddleja saligna.* Pockets of Karoo-type vegetation increase towards the south and west, especially in overgrazed areas. Succulents of the Asclepiadaceae, Euphorbiaceae and Mesembryanthemaceae are well represented in the centre. The vegetation of the GWC is still fairly intact, although extremely poorly conserved. Bush encroachment, which is due to inappropriate management practices (mainly overgrazing by domestic livestock), is a major problem in many parts of the region.

1.2 BOTANICAL ASSESSMENT

The regional vegetation is described as Ghaap Plateau Vaalbosveld (Mucina & Rutherford, 2006), with a Least Threatened conservation status ascribed; only about 1% is transformed. Information obtained from the SANBI database indicate the known presence of only 8 plant species within the ¼ degree grid that is sympatric to the study area, reflecting a poor floristic knowledge of the region.

A total of 116 plant species were recorded during the field investigations and appears to be representative of the regional vegetation type. The physiognomically dominant woody stratum is represented by 10 tree and 16 shrub species. A well-developed herbaceous stratum is represented by 56 forbs and 23 grass species. The perennial spring is occupied by 7 sedge species. The floristic diversity comprises 44 families, dominated by Poaceae, Asteraceae and Fabaceae.

No Red Data species are known to occur in the ¼ degree grids in which the study areas are located, reflecting poor sampling records for the region. No plant species that are included in any of the threatened categories (Critically Endangered - Possibly Extinct, Critically Endangered, Endangered, Vulnerable) were encountered during the survey period. Furthermore, habitat types encountered in the study area are typical of the region and no habitat type of unique quality is present that is particularly apposite for the potential presence of Red Data flora species. The following species are present in the study area and are protected under the National Forests Act of 1998:

- *Acacia erioloba;* and
- *Olea europaea* subsp*. africana*

It is therefore necessary to conduct a survey that will determine the number and relevant details pertaining to protected tree species on the property for the submission of application forms to NCDENC and DAFF prior to the disturbance of these individuals.

Results of the photo analysis and site investigations revealed the presence of the following macro habitat types and habitat variations:

- Degraded Habitat, including;
  - Excavations/ Spoils heaps (Low floristic Sensitivity);
  - Road Infrastructure/ Railways/ Homestead (Low floristic Sensitivity);

- Natural Woodland Habitat, including
  - (*Searsia lancea*) Open Woodland (Medium floristic Sensitivity);
  - (*Tarchonanthus camphoratus*) Closed Shrubveld (Medium floristic Sensitivity);
- Wetland Habitat, including:
  - Natural Spring (High floristic Sensitivity); and
  - Endorheic Pans & Wetlands (Medium-high floristic Sensitivity).

The study area comprises extensive areas of shrubveld/ woodland that is representative of the regional vegetation type. The general woodland vegetation exhibit little signs of degradation, but also little sensitive floristic attributes. This woodland habitat is well represented in the surrounding region. Contained within the major terrestrial woodland community are small endorheic pans that represent an azonal habitat form. These areas are characterised by temporary and intermittent inundation subsequent to severe rain showers. A perennial spring is situated in the central-western part of the study area, representing the only feature of high floristic sensitivity. It is unlikely that this feature will be affected by the proposed development, but every precaution should be taken to prevent peripheral impacts from affecting the status of this feature. Degraded and transformed habitat of the study area does not contain any floristic features of sensitivity, in fact, alien and invasive species predominate in these areas. The control of these species is strongly recommended.

The following impacts are relevant to floristic attributes of the study area:

- Direct impacts on flora species of conservation importance;
- Loss or degradation of natural vegetation, sensitive or protected habitat;
- Loss/ degradation of surrounding habitat;
- Impacts on SA's conservation obligations & targets;
- Increase in local and regional fragmentation/ isolation of habitat; and
- Increase in environmental degradation, pollution (soils, surface water).

Results of the impact assessment indicate that moderately significant impacts are likely to occur during the construction phase. These impacts are mostly associated with habitat clearance prior to the commencement of construction. Impacts associated with the operational and decommissioning phases are regarded localised and of relative low significance. The loss of this natural, terrestrial woodland is not expected to result in significant impacts on the floristic environment beyond the boundaries of the site. The implementation of generic mitigation measures is expected to ameliorate likely impacts to an acceptable level. Wetland habitat types, because of a higher floristic sensitivity ascribed to them, as well as a lower representation in the surrounding region, should be excluded from the propose development as far as technically feasible. Other mitigation measures recommended to protect these features mostly include the prevention of contamination from surrounding developments.

Please take note that the faunal assessment in this document excludes avifauna as it presented as a separate report. General aspects pertaining to avifauna are however mentioned as it does relate to the faunal diversity of the site.

Animals known to be present in the Q-grid 2823BD were considered potential inhabitants of the study area (all species known from the Northern Cape Province were therefore included in the assessment to limit the known effects of sampling bias; except for birds where sampling has been comprehensive in the last decade.

A total of 80 animal species was recorded during the site investigation. This diversity includes one scorpion, one dragonfly, one termite, one beetle, three butterflies, one bee, one frog, 8 reptiles, 45 birds and 18 mammals. The 80 species found to occur in the study area did not include any Red Data species. Additionally, invertebrates of 22 families were also confirmed to occur in the study area. The animals (species and families) observed in the study area are, for the most part, typical arid savanna species and representative of savanna animal communities that are widespread in the regional areas of the Ghaap Plateau Vaalbosveld and in the larger extent of the Eastern Kalahari Bushveld Bioregion.

A total of 96 Red Data animals are known to occur in the Northern Cape Province (butterflies, frogs, reptiles and mammals) and birds in the Q-grid 2823BD. This includes 18 listed as Data Deficient (DD), 31 as Near Threatened (NT), 36 as Vulnerable (VU), 5 as Endangered (EN) and 6 as Critically Endangered (CR). It is estimated that 74 of the 96 animals listed have a low probability of occurring in the study area, 12 have a moderate-low probability, 6 a moderate probability, 3 a moderate-high and 1 species a high probability of occurring in the study area.

The following habitat types are indicated:

- Degraded Habitat, including;
  - Excavations/ Spoils heaps (Low faunal Sensitivity);
  - Road Infrastructure/ Railways/ Homestead (Low faunal Sensitivity);
- Natural Woodland Habitat, including
  - (*Searsia lancea*) Open Woodland (Medium faunal Sensitivity);
  - (*Tarchonanthus camphoratus*) Closed Shrubveld (Medium faunal Sensitivity);
- Wetland Habitat, including:
  - Natural Spring (High faunal Sensitivity); and
  - Endorheic Pans & Wetlands (Medium-high faunal Sensitivity).

Very little of the study has been transformed and the habitat contained within the study area is largely representative of the regional habitat. Over-grazing has resulted in some degradation of the natural woodland and endorheic pans, but most of the original ecological characteristics and ecosystem processes of the Ghaap Plateau Vaalbosveld is still found in

the study area. The natural woodland and wetland habitats found in the study area is also well connected to other untransformed woodland areas; the region in which the study area is located is characterised by large areas of untransformed faunal habitat of varying levels of degradation (mostly as a result of overgrazing).

The animals observed in the study area during the field investigation did not include any unique species as far as the region of the study area is concerned. Most of the species recorded in the study area are in fact also present in extensive parts of South Africa. A high proportion is also present in the arid regions of the country. Except for the livestock present in the study area, no introduced or alien animal species were observed during the field investigation.

During the field investigation, none of the calcareous pans had significant surface water; it is reasonable to assume that the species richness of these areas will increase significantly when the presence of surface water attracts a variety of water birds and invertebrates.

The following impacts resulting from the proposed development are expected to affect the faunal attributes of the study area:

- Direct impacts on Red Data fauna species;
- Loss or Degradation of natural faunal habitat & in surrounding areas;
- The disruption of ecological connectivity and migration routes of larger, flightless animals as well as territorial infringement; and
- Direct impacts on common fauna species & interactions with structures & personnel.

The objective of this Biodiversity Impact Assessment is to establish the presence/absence of ecologically sensitive areas or species within the proposed project area. In order to assist with the planning of the proposed development it is necessary to assess potential impacts of the development on the biological environment (terrestrial biodiversity), comment on the suitability of the area for the proposed project and to provide development guidance to limit impacts as far as possible.

The Terms of Reference for the floristic assessment are as follows:

- Obtain all relevant Précis and Red Data flora information;
- Conduct a photo analysis of the proposed area;
- Identify floristic variations;
- Survey habitat types to obtain a broad understanding of the floristic diversity;
- Assess the potential presence of Red List flora species according to information obtained from SANBI;
- Incorporate existing knowledge of the region into the assessment;
- Describe broad habitat variations present in the study area in terms of biophysical attributes and phytosociological characteristics;
- Compile a floristic sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects;
- Provide pertinent recommendations; and
- Present all results in a suitable format.

The Terms of Reference for the faunal assessment are as follows:

- Obtain available faunal distribution records and Red Data faunal information
- Survey the site to obtain a broad overview of available faunal habitat types;
- Assess the potential presence of Red Data fauna species;
- Incorporate existing knowledge of the region;
- Describe the status of available habitat in terms of faunal attributes, preferences and conservation potential;
- Compile a faunal sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects; and
- Present all results in a suitable format.

3 INTRODUCTION

Destructive activities in a natural environment require vigilance to ensure that the biological and cultural heritage of future generations is not adversely affected by activities of today. Concern is growing about the consequences of biodiversity losses, for ecosystem functioning, for the provision of ecosystem services and for human well being.

Why is Biodiversity Conservation Important? Biodiversity sustains life on earth. An estimated 40 percent of the global economy is based on biological products and processes. Biodiversity has allowed massive increases in the production of food and other natural materials, which in turn have fed the (uncontrolled) growth and development of human societies. Biodiversity is also the basis of innumerable environmental services that keep humans and the natural environment alive, from the provision of clean water and watershed services to the recycling of nutrients and pollination.

Current pressures on and losses of biodiversity are unfortunately threatening to undermine the functionality of natural ecological processes and adaptive responses of the environment. The last few centuries have witnessed brutal increases in the rate at which biodiversity is being altered by humanity. With uncontrolled growth of human population, consumption needs have increased exponentially as well as the drive to extract more economically valuable resources at ever-faster rates. Natural habitats that harbour some of the world's most valuable biodiversity are being lost at increasingly faster and over progressively wider areas, while managed lands are undergoing increasing simplification. Adopting 'biodiversity friendly' practices remains challenging within the entire developmental sphere, especially for smaller companies and peripheral players. This is partly because governments, while perhaps committed on paper to biodiversity, have found it difficult to create the right incentives and apply the necessary regulations in a way that could encourage all players to conserve biodiversity.

Humanity faces the challenge of supporting the needs of growing populations from a rapidly shrinking natural resource base. Achieving a balance while doing this will require a better understanding and recognition of conservation and development imperatives and this is only a step towards more strategic and integrated approach to land use planning and management that helps societies make better-informed decisions. Evidence illustrate how management tools, rehabilitation and restoration processes, together with improved scientific knowledge, can help conserve biodiversity; also highlighting that mutual benefits can result from stronger collaboration between the mining and conservation sectors. Good practice, collaboration and innovative thinking can advance biodiversity conservation worldwide while ensuring that the minerals and products that society needs are produced responsibly.

In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90% of all members of the United Nations. The enactment of the National

Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

4 BRIEF PROJECT OVERVIEW

The intention of SolarReserve SA (Pty) LTD (SolarReserve) is to develop numerous large-scale commercial renewable energy projects to diversify the local energy generation 'mix' and reduce South Africa's dependency on non-renewable fossil fuel resources (i.e. coal). In an effort to utilise renewable energy resources, SolarReserve is proposing to construct a 325 MegaWatt (MW) Solar Energy Power Park on the farm Arriesfontein Siyanda District, Northern Cape Province. The development will comprise of both Photovoltaic (PV) and Concentrated Solar Power (CSP) Technology.

The CSP plant being considered is a molten salt-type, Central Receiver (tower) technology and will primarily comprise of the following four components:

- **Solar Field** - consists of all services and infrastructure related to the management and operation of the heliostats (reflective mirrors);
- **Molten Salt Circuit** - includes the thermal storage tanks for storing liquid salt, a concentration receiver/tower, pipelines and heat exchangers;
- **The Power Block** – housing the steam turbine; and
- **Auxiliary facilities and infrastructure** - includes a condenser-cooling system, electricity transmission lines to allow for grid connection, access routes, water treatment and supply amenities and a CSP plant start-up energy supply unit (gas or diesel generators).

The Solar photovoltaic (PV) system will produce energy by converting solar irradiation into electricity. PV facilities use panels comprising many individual cells that absorb solar energy. Appurtenant infrastructure that will be required for the project includes the following:

- one or more meteorological stations to collect data on the solar resource;
- a small site office and storage facility, including security and associated facilities;
- visitor centre;
- security system- closed circuit video-surveillance system;
- site fencing;
- car park;
- temporary construction camp (to house up to 300 people); and
- a lay-down area for the temporary storage of materials during the construction activities

SolarReserve SA (Pty) LTD has appointed Worley Parsons RSA (Pty) Ltd as independent Environmental Assessment Practitioners (EAP) to the project in fulfilment of legislative requirements. BEC has been appointed on behalf of Worley Parsons to conduct the terrestrial flora and fauna assessments (biodiversity/ ecology) for the proposed project. Riaan Robbeson will conduct the botanical assessment; Dewald Kamffer will conduct the faunal assessment.

4.1 ALTERNATIVES

In terms of the NEMAEIA Regulations, feasible alternatives need to be considered during the EIA Process. The following alternatives will be considered for the project:

- Site Layout Alternatives; and
- 'No-Go' Option.

5 METHOD STATEMENT

5.1 ASSESSMENT PHILOSOPHY

Inherent characteristics of a project of this nature implies that no method will be foolproof, mainly as a result of shortcomings in available databases and lack of site specific detail that could be obtained from limited detailed site investigations conducted over a short period of time. This is an unfortunate limitation of every scientific study; it simply is not possible to know everything or to consider aspects to a level of molecular detail. However, to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of the study area in terms of the proposed development, all opinions and statements presented in this document are based on the following aspects, namely:

- A desk-top assessment of all available biological and biophysical data;
- Augmentation of existing knowledge by means of site specific and detailed field surveys;
- Specialist interpretation of available data, or known sensitivities of certain regional attributes; and
- An objective impact assessment, estimating potential impacts on biological and biophysical attributes.

The Ecosystem Approach employed for the purpose of this assessment is advocated by the Convention on Biological Diversity. It recognizes that people and biodiversity are part of the broader ecosystems on which they depend, and that it should thus be assessed in an integrated way. Principles of the Ecosystem Approach include the following:

- The objectives of ecosystem management are a matter of societal choice;
- Ecosystem managers should consider the effects of their activities on adjacent and other systems;

- Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target;
- Ecosystems must be managed within the limits of their functioning;
- The approach must be undertaken at appropriate spatial and temporal scales;
- Objectives for ecosystem management should be set for the long-term;
- Management must recognise that change is inevitable;
- The approach should seek an appropriate balance between, and integration of, conservation and use of biodiversity;
- All forms of relevant information should be considered; and
- All relevant sectors of society and scientific disciplines should be involved.

The Ecosystem Approach includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that causes disturbance to these attributes. Species conservation is therefore largely replaced by the concept of habitat conservation. This investigation will therefore aim to:

- Determine the biological sensitivity of the receiving natural environment as it relates to the construction and operation of the plant and associated infrastructure in a natural environment;
- Highlight the known level of biodiversity for the study area;
- Highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- Estimate the level of potential impacts of the construction, operation and decommissioning of the proposed development on the biological resources of the study area;
- Apply the Precautionary Principal throughout the assessment[1].

Available databases of biophysical attributes that are known to be associated with biodiversity aspects of importance, conservation potential or natural status of the environment were implemented to compile the ecological sensitivity analysis of the study area. This includes, but is not necessarily limited to the following:

- Areas of known biological importance (ENPAT);
- Geology and soil types;
- Areas of surface water (ENPAT);
- Degradation classes (ENPAT Land Cover Classes);
- Regional vegetation types (VEGMAP); and
- Land cover categories (ENPAT).

[1] (www.pprinciple.net/the_precautionary_principle.html).

The floristic assessment was conducted by R. A. J. Robbeson (Pr.Sci.Nat.).

5.2.1 *General Floristic Attributes*

The botanical assessment is based on a variation of the Braun-Blanquet method whereby vegetation is stratified on aerial images with physiognomic[2] characteristics as a first approximation. These initial stratifications are then surveyed for floristic and environmental diversity during a site investigation and ultimately subjected to a desktop analysis to establish differences/ similarities between observed units. In preparation for the site survey, physiognomic homogenous units are identified and delineated on digital aerial photos, using standard aerial photo techniques (downloaded from www.googleearth.com and georectified on Arcview 3.2). A site visit was conducted to examine the general floristic attributes and -diversity of the study area.

A desktop analysis of sample data was conducted to establish differences/ similarities between delineated vegetation units, which were subsequently described in terms of species composition and dominance as well as driving (developmental) environmental parameters. Preliminary results and species lists that are provided should be interpreted with normal liabilities in mind. It is not the intention to provide exhaustive and comprehensive lists of all species that occur on this site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation worthy species and habitat associated with these species are considered the highest priority, the presence of which is most likely to result in significant negative effects on the ecological environment.

5.2.2 *Red Data Flora*

The purpose of listing Red Data plant species is firstly to provide information on the potential occurrence of species of special concern in the study area that may be affected by the proposed infrastructure. Secondly, the potential occurrence of these species can then be assessed in terms of their habitat requirements in order to determine whether they have a likelihood of occurring in habitats that may be affected by the proposed infrastructure. Red Listed flora information, as presented by SANBI was used as a point of departure for this assessment. A snapshot investigation of an area, such as this particular investigation, represents a severe limitation in terms of locating and identification potential Red Listed flora species. Particular emphasis was therefore placed on the identification and assessment of habitat deemed suitable for the potential presence of Red Listed.

[2] Physiognomy refers to the visual appearance of vegetation in terms of different growth classes, biomass, height, etc.

It should be noted that Red List species are, by nature, usually rare and difficult to locate. Compiling a list of species that could potentially occur in an area is generally limited by the paucity of collection records and species-specific information, rendering presence predictions extremely complex. All factors considered, the likelihood of encountering Red Data species that are not currently included in available information, cannot be excluded.

5.2.3 Floristic Sensitivity

The aim of this exercise is to determine the inherent sensitivity of vegetation communities or habitat types by means of the comparison of weighted floristic attributes. Results of this exercise are not 'stand-alone' and will eventually be presented in conjunction with results obtained from the faunal investigation.

Each vegetation unit is subjectively rated on a scale of 1 to 10 in terms of the following attributes:

- The confirmed presence of flora species of conservation importance, the known presence of flora species of conservation importance or the presence of protected flora species (provincially or other legislation);
- Conservation status of the regional vegetation type;
- The observed ecological status, based on degradation gradients, utilisation, habitat fragmentation and isolation, etc.
- The observed (or potential) floristic diversity, compared to surrounding areas and also compared to a pristine status of the particular habitat type within the regional vegetation type; and
- The functionality of the habitat type in a larger landscape that may, or not, be dominated by degradative and transformative anthropogenic activities.

These values are weighted in order to emphasise the importance/ triviality that the individual Sensitivity Criteria have on the status of each community. Ranked Values are expressed as a percentage of the maximum possible value (Floristic Sensitivity Value) and placed in a particular class.

5.3 FAUNAL ASSESSMENT

The faunal assessment was conducted by D. Kamffer (Pr.Sci.Nat.). The faunal assessment is based on holistic ecological principles and includes qualitative surveys across the major habitat types of the study area. This approach prefers holistic biodiversity conservation to single species conservation; the focus is therefore on sensitive faunal habitats rather than single Red Data species; these two approaches often coincide, but not always. It is important to note that the study area was not considered in isolation, linkage to surrounding natural faunal habitats represents an important consideration in the assessment of conservation value of an area. Within an ecological consideration, there is no difference in

importance between species found in a system and the interactions between these species. Therefore, this assessment also focused on assessing the status of available faunal habitats; the sensitivities of these habitats are therefore based on the status of each habitat as well as the level of isolation because of habitat transformation and fragmentation.

5.3.1 General Faunal Observations

Animals found within the study area's boundaries were identified using visual observations, ecological indicators (tracks, dung, diggings, etc.), morphological characteristics (colour, size, shape etc.) and species-specific calls (especially for birds and frogs).

5.3.2 Data analysis

- All GPS acquired data is converted from text to shapefiles to allow GIS analyses.
- Shapefiles of environmental attributes such as geology, soil, hydrology and vegetation are incorporated in the analyses of available faunal habitats.
- Sensitivity maps are compiled, where relevant, subsequent to data analyses.
- Species lists are compiled for relevant taxa using fieldwork data, literature and data supplied by various other institutions and specialists.

5.3.3 Red Listed fauna Probabilities

Three parameters are used to assess the Probability of Occurrence for Red Listed species:

- Habitat requirements (HR) - Red Listed animals have specific habitat requirements and the presence of these habitat characteristics in the study area is evaluated.
- Habitat status (HS) - The status or ecological condition of available habitat in the study area is assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Listed species (especially wetland-related habitats where water quality plays a major role); and
- Habitat linkage (HL) - Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Listed species within the study area.

5.3.4 Faunal Habitat Sensitivities

Faunal habitat sensitivities are subjectively estimated based on the following criteria:

- Habitat status;
- Connectivity;
- Observed species composition & RD Probabilities; and
- Functionality.

5.4 IMPACT EVALUATION

Impact assessments will be compiled for each of the disciplines respectively. In order to assess relevant impacts, the following ranking scales are implemented (Table 2):

Table 2: EIA Ratings used in this assessment

Probability	Duration	Scale	Magnitude
5 - Definite/ don't know	5 - Permanent	5 - International	10 - Very high/ don't know
4 - Highly probable	4 - Long term (ceases with the operational life)	4 - National	8 - High
3 - Medium probability	3 - Medium term (5-15 years)	3 - Regional	6 - Moderate
2 - Low Probability	2 - Short Term (0-5 years)	2 - Local	4 - Low
1 - Improbable	1 - Immediate	1 - Site only	2 - Minor
0 - None		0 - None	

Once the above factors have been ranked for each impact, the environmental significance of each impact can be assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). Environmental effects were rated as either of high, moderate or low significance on the following basis:

- More than 60 SP indicate High (H) environmental significance.
- Between 30 and 60 SP indicate Moderate (M) environmental significance.
- Less than 30 SP indicate Low (L) environmental significance.

6 BACKGROUND TO THE ECOLOGY[3]

The Savanna Biome is the largest biome in southern Africa, covering about 46% of its area. The term savanna is widely accepted as describing a vegetation type with a well-developed grassy layer and an upper layer of woody plants. Many environmental factors correlate with the distribution of different savanna vegetation types, including landform, climate, soil types, fire and a very specific fauna. South African savannas of nutrient-poor substrates are characteristically broad-leaved and without thorns, while those of nutrient-rich substrates are fine-leaved and thorny. Nutrient-rich savannas have high grass layer productivity and the grasses are acceptable to grazers, resulting in a high grazing capacity.

The diversity of African savanna is exceptional, comprising more than 13,000 plant species, of which 8,000 are savanna endemics. Specifically, dry savannas have more than 3,000. This diversity equals that of the South African grasslands and is only exceeded by Fynbos. Similarly, in respect of animal diversity, savannas are without peer. South African savannas

[3] Taken from '*The magnificent Natural Heritage of South Africa*' (Knobel, 1999).

have more recorded species of amphibians (57 in moist and 52 in dry savannas), reptiles (162 in moist and 17 in dry savannas), birds (540 in moist and 519 in dry savannas) and mammals (153 in moist and 171 in dry savannas), than any other biome.

Conservation within and of the savanna biome is good in principle, mainly due to the presence of a number of wildlife reserves. Urbanisation is not a threat, perhaps because the hot, dry climate and diseases prominent in the savanna areas have hindered urban development. Much of the area is used for game farming and the importance of tourism and big-game hunting in the conservation areas must not be underestimated. Savannas are the basis of the African wildlife and ecotourism industry and play a major role in the meat industry.

The Savanna Biome is split in three sections; the study site is sympatric to the Kalahari savanna – a sandy, arid region in the western interior. The Kalahari is one of Africa's last wilderness areas. The name Kalahari originates from the Kgalagadi people, which inhabit central Botswana. The word has many interpretations, including 'wilderness', 'the land that has dried up', or 'salt pans'. Although frequently referred to as the 'Kalahari Desert', it is not a true desert – rainfall, although low in some areas and with large areas covered by deep, loose sand, it does not approach the extreme aridity of true deserts. Rain is the driving force behind the Kalahari ecosystem and plants and animals respond dramatically to available moisture.

Within the extensive Kalahari system, seven major vegetation types have been described, including the Karroid Kalahari bushveld, which comprehends the study area. This vegetation type is found on flat, gravelly plains north of the Gariep River. The trees layer is almost non-existent, but a shrub layer is prominent in parts.

7 THE BIOPHYSICAL ENVIRONMENT

7.1 LOCATION

The regional setting of the study area is illustrated in Figure 1. A composite of georeferenced Google Earth images of the site is presented in Figure 2. Aerial images were downloaded from the Google Earth website (www.googleearth.com) and georeferenced using Arcview GIS 3.2.

The study area is situated on the Farm Arriesfontein, Barkley Wes RD, Siyanda District Municipal, approximately 30km east of Lime Acres. The R31 road is situated approximately 10km to the north of the site. The Ulco – Lime Acres railway line bisects the study area from east to west. A general PGS point for the study area is S28°17' and E23°47'.

7.2 LAND COVER & LAND USE OF THE REGION

Land use often determines land cover; it is an important factor contributing to the condition of the land. Different uses have varying effects on the integrity of the land. Land cover categories of the general region are illustrated in. For the purpose of this assessment, land cover are loosely categorised into classes that represent natural habitat and land cover categories that originated from habitat degradation and transformation on a local or regional scale. Areas that are characterised by high levels of transformation and habitat degradation are generally more suitable for development purposes as it is unlikely that biodiversity attributes of conservation importance will be present or affected by development. Conversely, areas that are characterised by extensive untransformed and pristine habitat are generally not regarded suitable options for development purposes.

The region exhibits low levels of transformation, comprising extensive areas of natural habitat, categorised as Shrubland and Bushland. The greater region is similarly characterised by low levels of habitat fragmentation and isolation, typical to a rural environment.

Figure 1: Regional setting of the study area

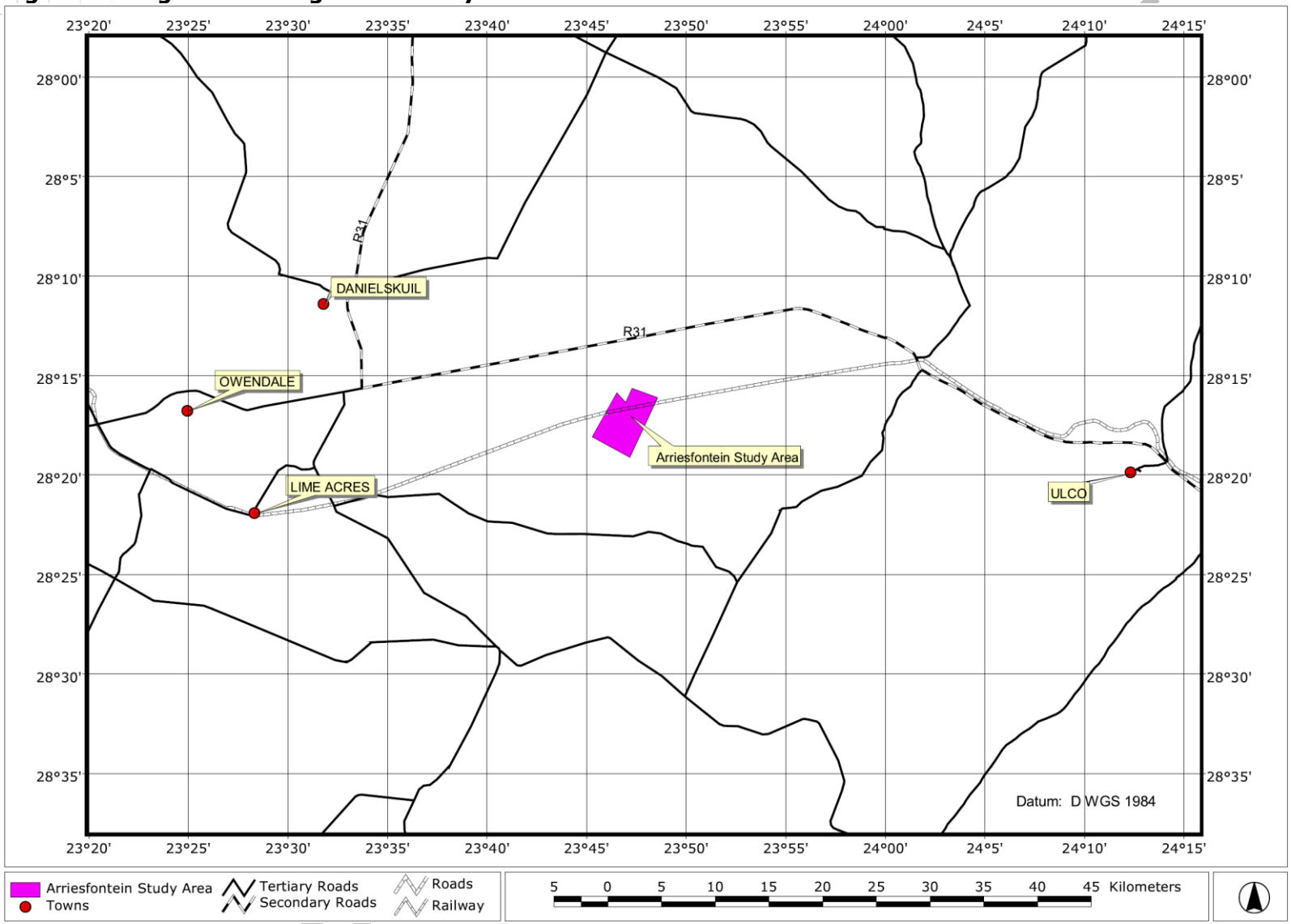


Figure 2: Composite aerial image of the study area (courtesy of www.googleearth.com)

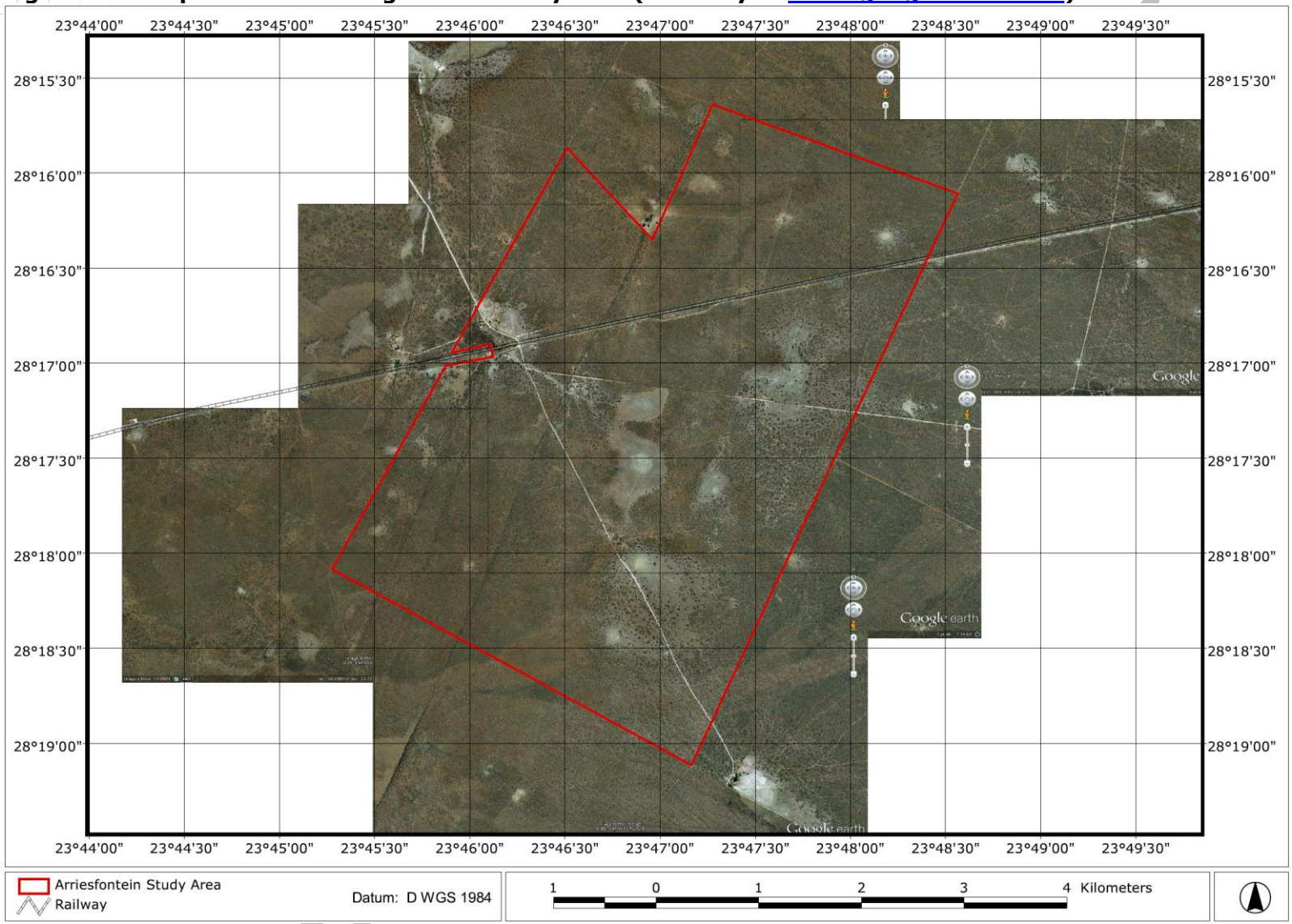
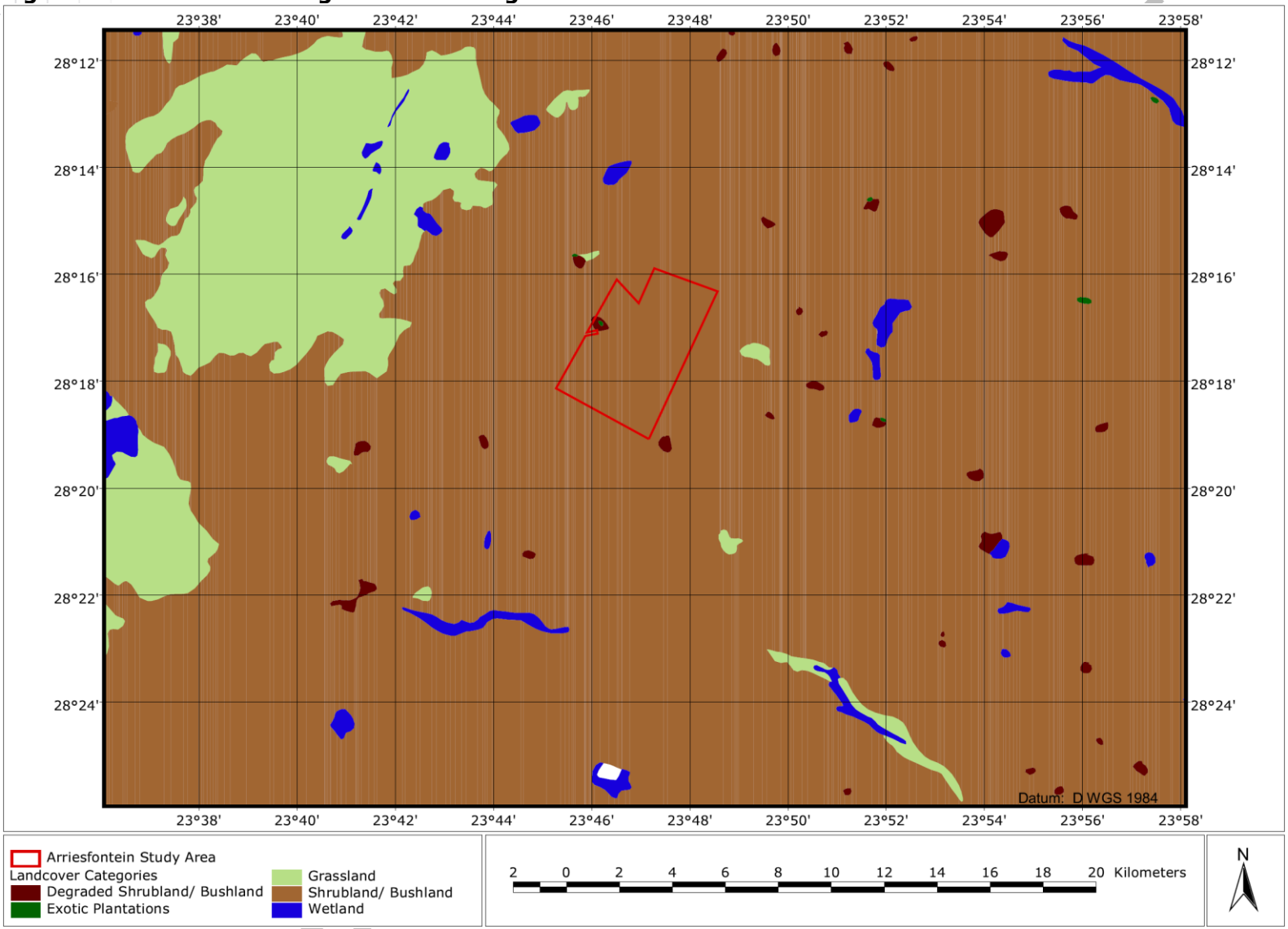


Figure 3: Land cover categories of the region



7.3 SURFACE WATER[4]

Water, salt and processes linked to concentration of both are the major controls of the creation, maintenance and development of peculiar habitats. Habitats formed in and around flowing and stagnant freshwater bodies, experiences waterlogging (seasonal or permanent) and regular, irregular or catastrophic flooding. Habitats with high levels of salt concentration form a highly stressed environment for most plants and often markedly affect the composition of plant communities. Invariably, both waterlogged and salt-laden habitats appear as 'special', deviating strongly from the typical surrounding zonal vegetation. They are considered to be of azonal character (Mucina & Rutherford, 2006). Water, geology, soil, topography and climate, is responsible for the creation of remarkably many types of habitats. Water chemistry, temperature and temporary changes in both, together with the amount of water (depth of water column), timing of occurrence (regular tides or irregular floods) and speed of its movement (discharge, flow and stagnation) are the major factors shaping the ecology of biotic communities occupying such habitats.

Ecotones (areas or zones of transition between different habitat types) are occupied by species occurring in both the bordering habitats, and are generally rich in species due to the confluence of habitats. In addition to daily visitors that utilise the water sources on a frequent basis, some flora and fauna species are specifically adapted to exploit the temporal or seasonal fluctuation in moisture levels in these areas, exhibiting extremely low tolerance levels towards habitat variation. Ecotonal interface areas form narrow bands around areas of surface water and they constitute extremely small portions when calculated on a purely mathematical basis. However, considering the high species richness, these areas are extremely important on a local and regional scale. Rivers also represent important linear migration routes for a number of fauna species as well as a distribution method for plant seeds.

The study area falls within the Vaal Primary Catchment area. Several endorheic pans are present within the study area and immediate surrounds (Figure 4). These features are typically circular to oval in shape, and where two or more pans have spread and combined, they form characteristically kidney-shaped or lobed wetlands. They are shallow, even when fully inundated, and usually less than about three meters deep. The southern Kalahari pans are characterised as 'dry or ephemeral lakes. These areas may have bare clay or more or less vegetated surfaces, contained in isolated enclosed depressions. Inundation is characteristically ephemeral. In the most arid regions, pans can stand dry for years between temporary flooding. Water loss is largely due to evaporation, and the high evaporation rates in the western part of the country contribute as much as low precipitation

[4] Please note that it is not the intention of this report to present a detailed account of the wetland and aquatic habitat types of the area or study site; this is normally addressed in a separate specialist report. However, certain aspects do related to the biodiversity of the study area and general comments pertaining to this attribute are therefore included in this report.

to the usual desiccated state (Allan, et al.). No major rivers are present within the study area, smaller rivers in the region include the Klein Riet River (Southwest) and Steenbok River (Northeast). These rivers are unlikely to be affected by the proposed development.

7.4 TOPOGRAPHY, RELIEF & SLOPES

The presence of habitat types of physical variability represents important biodiversity attributes. Hills and ridges have generally been shown to have a rich biodiversity consisting of an important habitat for sensitive species as well as high plant diversity. These habitat types are important in terms of habitat variability and ultimately biodiversity attributes that characterise a region. Hills and ridges have generally been shown to have a rich biodiversity consisting of an important habitat for sensitive species as well as high plant diversity. The topography of the study area is categorized as 'Plains and Pans' characterized by a gently undulating landscape. Various shallow drainage lines intersect the landscape. Altitude varies around 1,400 meters above sea level. No significant topographical features are present in the immediate vicinity of the study area.

7.5 GEOLOGY

The study area comprises mostly sand, with a small portion of Dolomite located in the western section of the study area (Figure 5).

From a geological viewpoint, 'sand' represents anything small enough to be carried by the wind, but big enough that it doesn't stay in the air, roughly 0.06 to 1.5 millimeters. It indicates a vigorous environment. Most sand is made of quartz or its microcrystalline cousin chalcedony, because that common mineral is resistant to weathering. The farther from its source rock sand is, the closer it is to pure quartz. But many "dirty" sands contain feldspar grains, tiny bits of rock (lithics), or dark minerals like ilmenite and magnetite. Another important aspect is what the sand makes, namely dunes, sandbars, beaches, etc. The presence of limestone is noted throughout the study area.

Figure 4: Surface water in the region of the study area

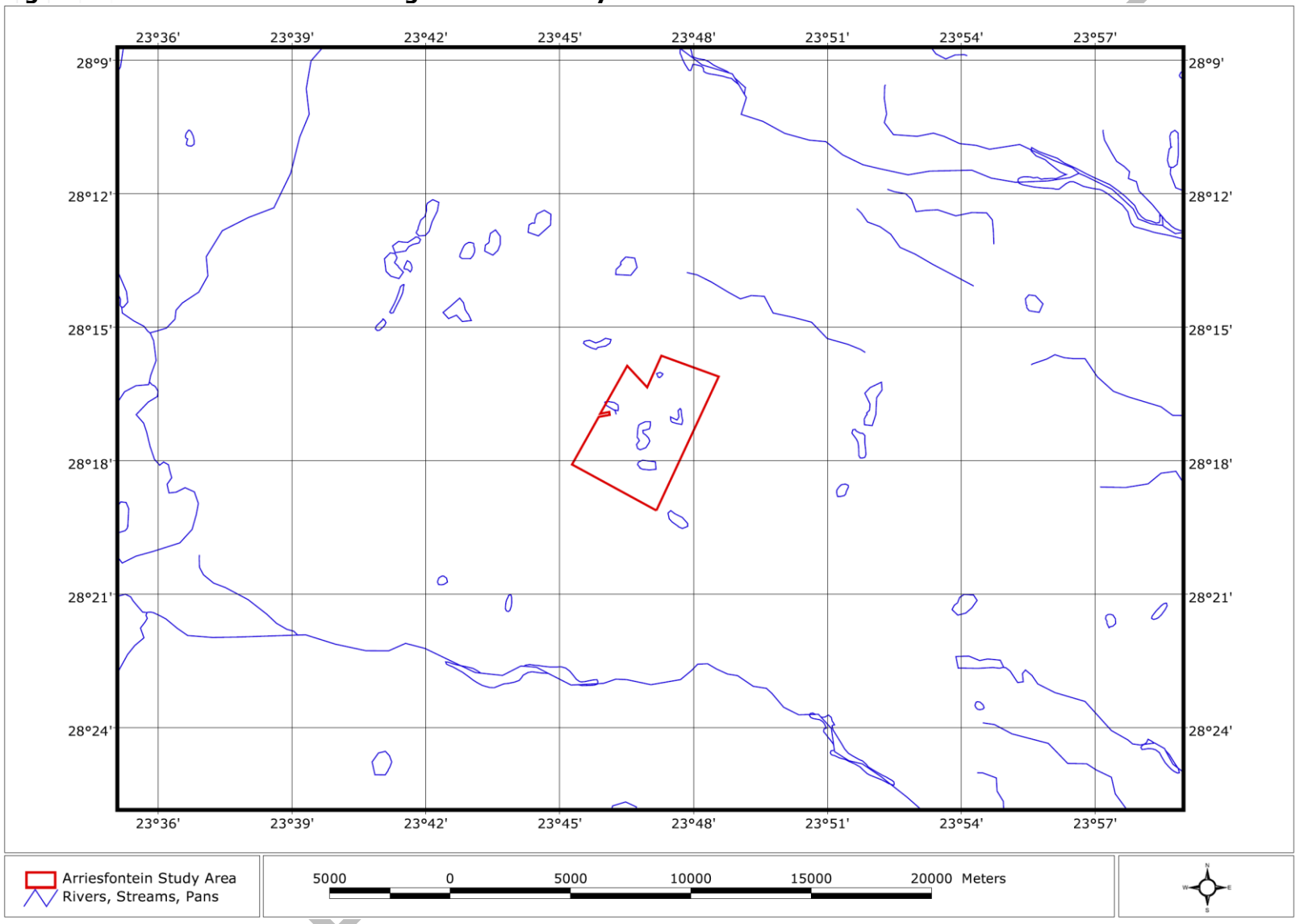
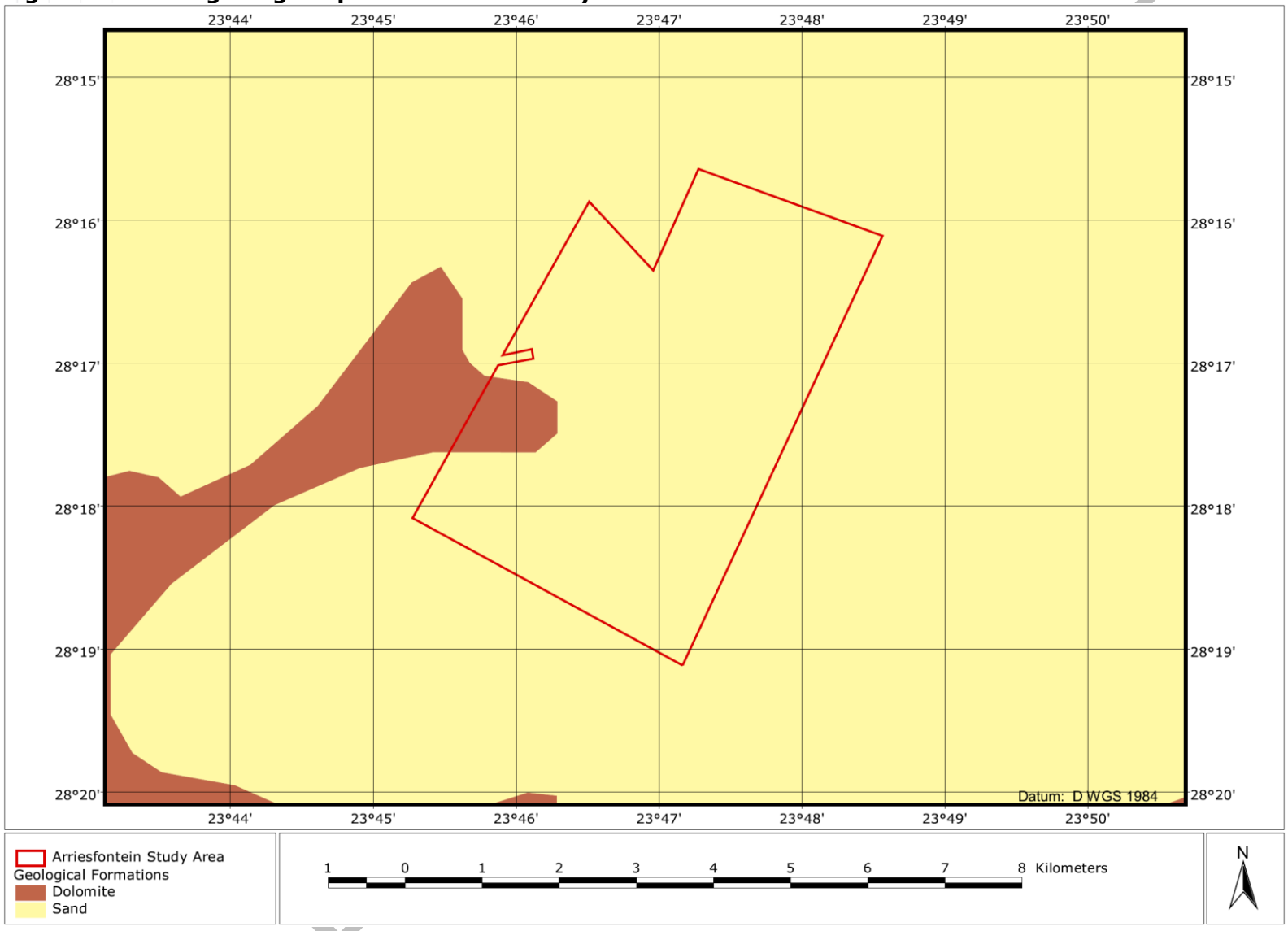


Figure 5: Broad geological patterns of the study area



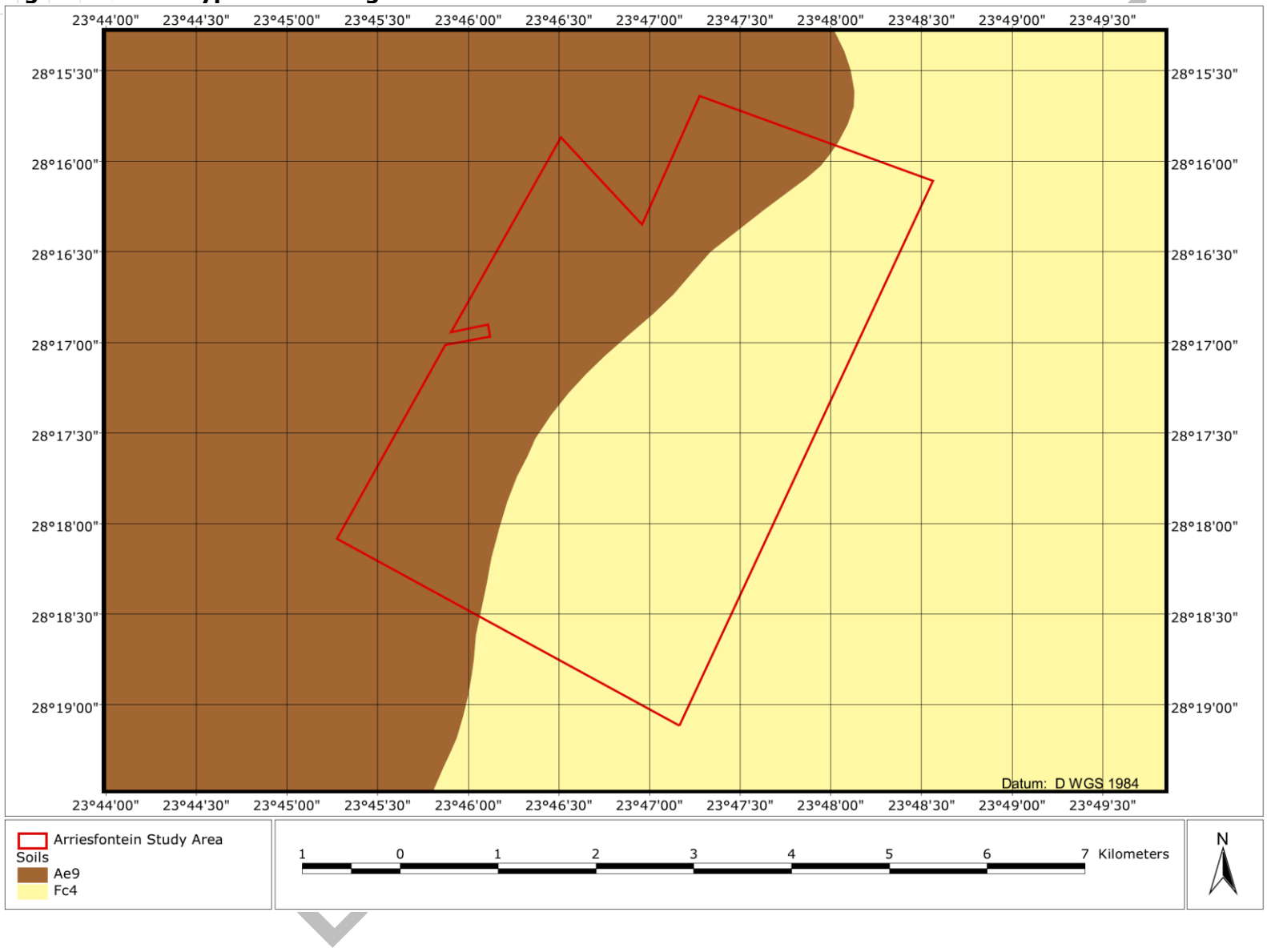
7.6 LAND TYPES

Although it is not in the scope of this report to present a detailed description of the soil types of the area, a basic description will suffice for this assessment as a strong association between ecological habitat types and land types are typically known to occur. Land types Ae9 and Fc4 are represented in the study area (Figure 6).

A- land types generally represent flat or slightly undulating landscapes, on granite, shale and Karoo sediments, which mostly give rise to deep, freely drained soils. Yellow & red soils without a water table predominate, belonging in one or more of the Inanda, Kranskop, Magwa, Hutton, Griffon or Clovelly soil forms. The land does not qualify as a plinthic catena and one of the above soil forms occupy at least 40% of the area (red, high base status, >300mm deep, no dunes). Map units Aa to Ai refer to yellow and red soils without water tables and belonging in one or more of the following soil form: Inanda, Kranskop, Magwa, Hutton, Griffin and Clovelly. The map units refer to land that does not qualify as a plinthic catena and in which one or more of the above soil forms occupy at least 40% of the area.

Fc- land types are intended to accommodate pedologically young landscapes that are not predominantly rock and not predominantly alluvial or Aeolian an in which the dominant soil formation processes have been rock weathering, the formation of orthic topsoil horizons and, commonly clay illuviation, giving rise typically to lithocutanic horizons. The soil forms, which epitomize these processes, are Glenrosa and Mispah. However, exposed rock and soils belonging in almost any of the other soil forms may be found in these land types, provided these other soils do not qualify the land for inclusion in another map unit. Shallow and deep soils of the Oakleaf form developed by rock weathering are accommodated here. Fc refers to land where lime occurs regularly in upland and valley bottom soils.

Figure 6: Land types of the region



7.7 AREAS OF CONSERVATION IMPORTANCE

The study area is situated within Griqualand West Centre of Endemism. This is an indication that the habitat that characterises the study area could potentially be significant in terms of species richness and diversity. The region was thus named because of the Griqua, a KhoeKhoe people, who lived there.

The mountainous western parts of the WC are covered by Kalahari Mountain Bushveld, and the eastern plateau area is covered by Kalahari Plateau Bushveld, both endemic to the centre (Low & Rebelo, 1996). *Tarchonanthus camphoratus* is a particularly common woody species in these two bushveld types. Typical mountain species include *Searsia tridactyla, Croton gratissimus* and *Buddleja saligna.* Pockets of Karoo-type vegetation increase towards the south and west, especially in overgrazed areas. Succulents of the Asclepiadaceae, Euphorbiaceae and Mesembryanthemaceae are well represented in the centre.

The proximity of the GWC is signified by the pockets and tongues of wind-blown, orange-red Kalahari sand that have accumulated in some of the intermontane valleys. The vegetation of the GWC is still fairly intact, although extremely poorly conserved. Apparently, the Kalahari Plateau Bushveld is the only Savanna Biome vegetation type that is not represented in any sizeable nature reserve (Van Rooyen & Bredenkamp, 1996b). Bush encroachment, which is due to inappropriate management practices (mainly overgrazing by domestic livestock), is a major problem in many parts of the region.

8 BOTANICAL ASSESSMENT

8.1 REGIONAL VEGETATION

The regional vegetation is described as Ghaap Plateau Vaalbosveld (Mucina & Rutherford, 2006), comprising the flat plateau from around Campbell in the south, east of Danielskuil through Reivilo to around Vryburg in the north and is characterised by a well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. The open tree layer has *Olea europaea* subsp. *africana, A. tortilis, Ziziphus mucronata* and *Searsia lancea. Olea europaea* is more important in the southern parts of the unit, while *Acacia tortilis, A. hebeclada* and *A. mellifera* are more important in the north and parts of the west of the unit. Much of the south-central part of this unit has remarkably low cover of *Acacia* species for an arid savannah, dominated by the non-thorny *Tarchonanthus camphoratus*, *Searsia lancea* and *Olea europaea* subsp. *africana.*

The conservation status of this vegetation type is regarded Least Threatened, although none is conserved in statutory conservation areas. Only about 1% is transformed.

Biogeographically important species that occur in this unit include *Calobota cuspidosa, Nuxia gracilis, Blepharis marginata, Putterlickia saxatilis, Tarchonanthus obovatus, Euphorbia wilmaniae, Prepodesma orpenii, Digitaria polyphylla, Panicum kalaharense, Corchorus pinnnatipartitus, Helichrysum arenicola* and *Orbea knobelii*. The endemic taxon *Rennera stellata* is also present within this unit.

- **Trees**

Acacia erioloba, *A. mellifera* subsp. *detinens, Searsia lancea, A. karroo, A. tortilis,* subsp. *heteracantha* and ***Boscia albitrunca***.

- **Shrubs**

Olea europaea* subsp. *africana, *Rhigozum trichotomum, Tarchonanthus camphoratus, Ziziphus mucronata, Diospyros austro-africana, D. pallens, Ehretia rigida, Euclea crispa* subsp. *ovata, Grewia flava, Gymnosporia buxifolia, Lessertia frutescens, Searsia tridactyla, Acacia hebeclada* subsp. *hebeclada, Aptosimum procumbens, Chrysocoma ciliata, Helichrysum zeyheri, Hermannia comosa, Lantana rugosa, Leucas capensis, Melolobium microphyllum, Peliostomum leucorrhizum, Pentzia globosa, P. Viridis, Thesium hystrix* and *Zygophyllum pubescens.*

- **Succulent shrubs**

Hertia pallens and *Lycium cinereum.*

- **Woody climber**

Asparagus africanus

- **Graminoids**

Anthephora pubescens, Cenchrus ciliata, Digitaria eriantha subsp. *eriantha, Enneapogon scoparius, Eragrostis lehmanniana, Schmidtia pappophoroides, Themeda triandra, Aristida adscensionis, A. congesta, A. diffusa, Cymbopogon pospischilii, Enneapogon cenchroides, E. desvauxii, Eragrostis echinochloidea, E. obtusa, E. rigidior, E. superba, Fingerhuthia africana, Heteropogon contortus, Sporobolus fimbriatus, Stipagrostis uniplumis* and *Tragus racemosus.*

- **Herbs**

Barleria macrostegia, Geigeria filifolia, G. ornativa, Gisekia africana, Helichrysum cerastioides, Heliotropium ciliatum, Hermbstaedtia odorata, Hibiscus marlothianus, H. pusillus, Jamesbrittenia aurantiaca, Limeum fenestratum, Lippia scaberrima, Selago densiflora, Vahlia capensis subsp. *vulgaris* and *Aloe grandidentata.*

8.2 Regional Diversity

Information obtained from the SANBI database indicate the known presence of only 8 plant species within the ¼ degree grid that is sympatric to the study area (2823BD), reflecting a poor floristic knowledge of the region.

8.3 Floristic Diversity of the Site

A total of 116 plant species were recorded during the field investigations (Appendix 1). The recorded diversity could not be compared to existing knowledge about the flora of the region due to poor sampling records. However, in spite of a relative low diversity recorded on this site, it appears to be representative of the regional vegetation type. The physiognomically dominant woody stratum is represented by 10 tree species (8.6%) and 16 shrub species (13.8%). A well-developed herbaceous stratum (Table 3) is represented by 56 forbs (48.3%) and 23 grass species (19.8%). The perennial spring is occupied by 7 sedge species (6.0%). The floristic diversity comprises 44 families (Table 4), dominated by Poaceae (23 species, 19.8%), Asteraceae (21 species, 18.1%) and Fabaceae (9 species, 7.8%).

The physiognomy of the study area is also representative of the regional vegetation type, exhibiting a dominant shrub/ tree layer and a diverse herbaceous layer. Small endorheic pans are scattered within the woodland habitat, comprehending azonal habitat types.

Table 3: Growth forms recorded in the study area

Growth Form	Number	Percentage
Forb	56	48.3%
Geophyte	3	2.6%
Grass	23	19.8%

Sedge	7	6.0%
Shrub	16	13.8%
Succulent	1	0.9%
Tree	10	8.6%
Total	**116**	

Table 4: Plants families recorded in the study area		
Growth Form	**Number**	**Percentage**
Agavaceae	1	0.9%
Aizoaceae	1	0.9%
Amaranthaceae	1	0.9%
Anacardiaceae	3	2.6%
Apiaceae	1	0.9%
Asclepiadaceae	1	0.9%
Asteraceae	21	18.1%
Boraginaceae	1	0.9%
Campanulaceae	1	0.9%
Caryophyllaceae	1	0.9%
Casuarinaceae	1	0.9%
Celastraceae	1	0.9%
Chenopodiaceae	1	0.9%
Cucurbitaceae	1	0.9%
Cupressaceae	1	0.9%
Cyperaceae	7	6.0%
Ebenaceae	2	1.7%
Ehretiaceae	1	0.9%
Fabaceae	9	7.8%
Hyacinthaceae	2	1.7%
Iridaceae	1	0.9%
Lamiaceae	1	0.9%
Liliaceae	1	0.9%
Lobeliaceae	2	1.7%
Malvaceae	4	3.4%
Meliaceae	1	0.9%
Moraceae	1	0.9%
Oleaceae	1	0.9%
Papaveraceae	1	0.9%
Poaceae	23	19.8%
Portulacaceae	1	0.9%
Ranunculaceae	1	0.9%
Rhamnaceae	1	0.9%
Rubiaceae	1	0.9%
Salicaceae	1	0.9%
Scrophulariaceae	4	3.4%
Selaginaceae	2	1.7%
Sentianaceae	2	1.7%
Solanaceae	1	0.9%
Sterculiaceae	3	2.6%
Tiliaceae	1	0.9%
Vahliaceae	1	0.9%
Verbenaceae	1	0.9%
Zygophyllaceae	2	1.7%

8.3.2 Flora species of Conservation Importance

South Africa's Red List system is based on the IUCN Red List Categories and Criteria Version 3.1 (finalized in 2001), amended to include additional categories to indicate species that are of local conservation concern. The IUCN Red List system is designed to detect risk of extinction. Species that are at risk of extinction, also known as threatened or endangered species are those that are classified in the categories Critically Endangered (CR), Endangered (EN) and Vulnerable (VU).

No Red Data species are known to occur in the ¼ degree grids in which the study areas are located, reflecting poor sampling records for the region. Since much of the study area comprises relative pristine woodland habitat, the possibility that Red Data species might be present within the study area cannot be excluded, albeit estimated to be a medium-low probability. No plant species that are included in any of the threatened categories (Critically Endangered - Possibly Extinct, Critically Endangered, Endangered, Vulnerable) were encountered during the survey period. Furthermore, habitat types encountered in the study area are typical of the region and no habitat type of unique quality is present that is particularly apposite for the potential presence of Red Data flora species.

8.3.3 Protected Tree Species

In terms of the National Forests Act of 1998 certain tree species can be identified and declared as protected. All trees occurring in natural forests are also protected in terms of the Act. Protective actions take place within the framework of the Act as well as national policy and guidelines. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization. In terms of the National Forests Act of 1998, protected tree species may not be "cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold, except under license granted by the Department of Water Affairs and Forestry (or a delegated authority)". The following species are present in the study area and are protected under this act:

- *Acacia erioloba;* and
- *Olea europaea* subsp*. africana*

It is therefore necessary to conduct a survey that will determine the number and relevant details pertaining to protected tree species on the property for the submission of application forms to NCDENC and DAFF prior to the disturbance of these individuals.

8.4 VEGETATION DEVELOPMENT DRIVERS

Natural vegetation of the study area is representative of the regional savanna vegetation. Little degradation is evident on a local and regional scale, mostly in the form of linear infrastructure and the effects of livestock farming and suboptimal management strategies (fire management) that tend to result in densification of the shrub/ tree later and localised species changes. Cultivation is generally not possible due to the absence of arable soils as well as inadequate rainfall. The regional vegetation is therefore mostly the result of complex interacting driving forces that include climatic-, geological-, topographical- and moisture gradients typical of the savanna regions of southern Africa.

Wetland related habitat, contrary to regional vegetation patterns, comprises a relative small extent of natural habitat in the stud area, exhibiting moderate degradation levels resulting from utilisation from livestock. Development of wetland communities and variations are driven by the interplay of local and regional substrate-, moisture- and topographical gradients. Regionally the development of these habitat types are placed on a topographical and complex geological gradient that is also likely to affect the moisture duration of the soils, resulting in the variation between ephemeral and permanent wetland types. Locally, the development of vegetation patterns are likely to be driven by topographical placement, slopes, local soil characteristics and moisture content and inundation of the soils, resulting in a gradient between wetland and terrestrial grasslands, characterised by the absence/ presence and abundance of specific species (flora and fauna).

8.5 MACRO HABITAT TYPES & VARIATIONS

Natural (untransformed) vegetation of the study area and the surrounds is representative of the regional vegetation types, exhibiting limited divergence from the species composition, diversity and vegetation structure described by Mucina (Vegmap, 2006). Zonality of natural habitat of the study area is represented by the interplay of terrestrial and wetland related woodland habitat types. Results of the photo analysis and site investigations revealed the presence of the following macro habitat types and habitat variations (Figure 7):

- Degraded Habitat, including;
  - Excavations/ Spoils heaps;
  - Road Infrastructure/ Railways/ Homestead;
- Natural Woodland Habitat, including
  - (*Searsia lancea*) Open Woodland;
  - (*Tarchonanthus camphoratus*) Closed Shrubveld;
- Wetland Habitat, including:
  - Natural Spring; and
  - Endorheic Pans & Wetlands.

8.5.1 Degraded Habitat

These areas are regarded low in floristic sensitivity. The likelihood of encountering plant species of conservation importance is regarded low.

- **Excavations/ Spoils heaps**

This category includes areas that were created by the development of the railway infrastructure and borrowpits excavated for the building of local dirt roads. Vegetation that characterise these areas comprises secondary and opportunistic species. The possibility of encountering Red Data flora species within these areas is regarded negligent.

- **Road Infrastructure/ Railways/ Homestead**

This category includes some of roads and railways traversing the study area. Vegetation comprises species that indicate a transformed and poor status. These areas are generally devoid from vegetation, secondary and opportunistic species occur to some extent. A low floristic sensitivity and status is ascribed to these areas.

The homestead is characterised by plant species normally associated with human habitation, frequently exotic invasive species such as *Agave sisalana, Juniperus species, Casuarina species, Morus species* and *Argemone ochroleuca.*

8.5.2 (Tarchonanthus camphoratus) Closed Shrubveld;

This category comprises the largest extent of the study area and is characterised by a mosaical interplay of varying biophysical environmental conditions that give rise to the vegetation that is characteristic of the regional vegetation type. The physiognomy is dominated by a well-developed, relative dense shrub layer, consisting of *Tarchonanthus camphoratus, Searsia tridactyla* and to a lesser extent, *Calobota cuspidosa, Grewia flava, Diospyros lycioides, Searsia pyroides* and *Olea europaea* subsp. *africana.* The herbaceous layer is diverse, comprising the grasses *Cymbopogon pospischilii, Eragrostis lehmanniana, E. obtusa, Aristida congesta* subsp. *barbicollis, Centropodia glauca, Elionurus muticus, Fingerhuthia africana, Heteropogon contortus, Stipagrostis ciliata* and *Themeda triandra.* Forbs that are encountered frequently in this unit include *Berkheya* species, *Chrysocoma* species, *Gazania krebsiana, Geigeria ornativa, Helichrysum argyrosphaerum, Hermannia althaeifolia, Hibiscus* species, *Jamesbrittanea aurantiaca, Melolobium candicans, Pentzia calcarea, Rosenia oppositifolia* and *Wahlenbergia undulata.*

These areas are typified by the presence of sandy soils with limited presence of calcareous surface rock.

This unit exhibit moderate levels of sensitivity; a medium-low probability of encountering threatened flora species is estimated. Flora species that are included in other conservation categories include the protected trees *Acacia erioloba* and *Olea europaea* subsp. *africana.* These species were encountered at relative low abundance levels.

8.5.3 (Searsia lancea) Open Woodland

The association of this habitat type, with the pans of the region indicates that an infrequent occurrence of inundated soils occurs. The woody stratum is characterised by relative large trees conforming to open woodland, with shrubs and low trees occurring at much lower densities compared to the *Tarchonanthus camphoratus* shrubveld. The species composition of the herbaceous layer is also markedly different, with a lower physiognomy, comprising a high abundance of low forbs, including *Bulbostylis hispidula, Dianthus micropetalus, Geigeria ornativa, Heliotropium ciliatum, Hibiscus pusillus, Homeria pallida* and *Pentzia calcarea.* The grass layer is typically less diverse, comprising *Digitaria eriantha, Eragrostis lehmanniana, Sporobolus species* and *Themeda triandra.*

The open woody layer is prominently dominated by *Searsia lancea* and *Olea europaea* subsp. *africana.* Shrubs occurring frequently include *Calobota cuspidosa, Diospyros austro-africana, D .lycioides, Grewia flava, Rosenia oppositifolia, Searsia tridactyla* and low occurrences of *Tarchonanthus camphoratus.*

These areas are characterised by the extensive presence of calcareous surface rock.

8.5.4 Wetland Habitat

The ephemeral nature of surface water in the region is strongly indicated by the vegetation of wetland related habitat. Typically dry for most of the year, the pans contain surface water, or inundated conditions, only for brief periods subsequent to severe rain that usually occur in the form of thundershowers. The nature of surface water determines the development of the features.

- **Natural Spring**

The natural spring, occurring in the central western part of the study area contains water on a permanent basis; vegetation is therefore characteristically adapted to permanently inundated conditions. The presence of several sedges is characteristic, including *Cyperus muricinux, Cyperus species, Fimbristylis* species, *Juncus rigidus, Pycreus* species and *Scirpus dioecus.* Other species normally associated with inundated conditions include the forbs *Ciclospermum leptophyllum, Lobelia erinus, Ranunculus multifidus, Sebaea leiostyla* and *Walafrida densiflora,* as well as the tree *Salix babylonica.*

This unit is regarded highly sensitive, and a moderate likelihood is estimated for the potential presence of Red Data flora species occurring in this area, in spite of the vegetation being slightly degraded due to surrounding land use activities and frequenting cattle.

- **Endorheic pans & Wetlands**

Endorheic pans vary significantly in nature and floristic composition. The basal cover is usually dominated by low, mat-forming forbs, including *Aptosimum albomarginatum, Arctotis arctotoides, Helichrysum argyrosphaerum, Indigofera daleoides* and cf. *Walafrida species*. The fringes of this unit is typically characterised by the presence of a geophytic species cf. *Ornithogalum* species (unidentified). The grass layer is similarly dissimilar to surrounding terrestrial habitat, comprising the species *Cynodon dactylon, Enneapogon desvauxii, Eragrostis echinochloidea, Eragrostis obtusa* and *Themeda triandra*. Woody species are generally absent, low occurrences of *Calobota cuspidosa, Gymnosporia buxifolia, Olea europaea* subsp*. africana, Ziziphus mucronata* and *Searsia lancea* is noted.

The fringes of this unit is characterised by the presence of termite mounds. Evidence of severe impacts from livestock presence within these areas is observed in trampling of soils and high grazing pressure. The flora of this unit, while moderately likely to contain flora species of conservation importance, exhibit attributes of moderate-high in floristic sensitivity, mostly due to the association with temporary inundation.

Because the area was surveyed during a dry period, and considering the extremely periodic nature of inundation of these areas, it is regarded highly likely that the floristic composition could vary significantly during and subsequent to an inundation period.

Figure 7: Floristic Habitat Types of the study area

8.6 FLORISTIC SENSITIVITY OF THE STUDY AREA

Floristic sensitivity values are presented in Table 5. These estimations are used to ascribe a sensitivity index value to units of the respective variations, illustrated in Figure 8. Habitat sensitivity is categorised as follows:

Low No natural habitat remaining; this category is usually represented by developed areas, nodal and linear infrastructure, areas of agriculture or cultivation, areas where exotic species dominate exclusively, mining land (particularly surface mining), etc. The possibility of these areas reverting to a natural state is regarded impossible, even with the application of detailed and expensive rehabilitation activities. Similarly, the likelihood of plant species of conservation importance occurring in these areas is regarded negligent.

Medium – low All areas where the natural habitat has been degraded, with the important distinction that the vegetation has not been decimated and a measure of the original vegetation remain, albeit dominated by secondary climax species. The likelihood of plant species of conservation importance occurring in these areas is regarded low. These areas also occur as highly fragmented and isolated patches, typical to cultivated fields, areas that have been subjected to clearing activities and areas subjected to severe grazing pressure. The species composition of these areas is typically low and is frequently dominated by a low number of species, or invasive plants.

Medium Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation;

Also include areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

Medium – high Indigenous natural vegetation that comprehend a combination of the following attributes:

- The presence of habitat that is suitable for the presence of these species;
- Areas that are characterised by a high/ moderate-high intrinsic floristic diversity;
- Areas characterised by moderate to low levels of habitat fragmentation and isolation;
- Regional vegetation types that are included in the lower conservation categories, particularly prime examples of these vegetation types;
- Low to moderate levels of habitat transformation;
- A moderate to high ability to respond to disturbance factors;

It may also include areas that are classified as protected habitat, but that are of a moderate status;

High

Indigenous natural vegetation that comprehend for a combination of the following attributes:

- The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable);
- Areas where 'threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species;
- Regional vegetation types that are included in the 'threatened' categories (Critically Endangered, Endangered, Vulnerable), particularly prime examples of these vegetation types;
- Habitat types are protected by national or provincial legislation (Lake Areas Act, National Forest Act, draft Ecosystem List of NEM:BA, Mountain Catchment Areas Act, Ridges Development Guideline, Integrated Coastal Zone Management Act, etc.);
- Areas that have an intrinsic high floristic diversity (species richness, unique ecosystems), with particular reference to Centres of Endemism;

These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic resources. A major reason for the high conservation status of these areas is the low ability to respond to disturbances (low plasticity and elasticity characteristics).

Table 5: Floristic sensitivity estimations for the respective habitat types								
Criteria	**RD species**	**Landscape sensitivity**	**Status**	**Species diversity**	**Functionality/ fragmentation**	**TOTAL**	**SENSITIVITY INDEX**	**SENSITIVITY CLASS**
Community	**Criteria Ranking**							
Degraded Habitat	1	1	1	3	2	45	14%	low
Searsia Open Woodland	4	5	7	7	7	178	56	medium
Tarchonanthus Closed Shrubveld	4	5	7	8	8	186	58%	medium
Natural Spring	7	10	7	8	10	262	82%	high
Endorheic Pans & Wetlands	6	10	5	7	9	232	73%	medium-high

Figure 8: Floristic sensitivity of the study area

8.7 BOTANICAL IMPACT ASSESSMENT

The impact assessment is aimed at presenting a description of the nature, extent significance and potential mitigation of identified impacts on the floristic environment. These tabular assessments are presented in Section 8.8 in the form of an Impact Rating Matrix for expected impacts within the development area.

8.7.1 Identification of Impacts

No impacts were identified that could lead to a beneficial impact on the floristic environment of the study area since the proposed development is largely destructive as it involves the alteration of natural habitat or further degradation of habitat that is currently in a climax status.

Impacts resulting from the proposed development on floristic attributes of the study area are largely restricted to the physical effects of habitat clearance prior to the commencement of construction activities. Direct impacts include any effect on populations of individual species of conservation importance and on overall species richness. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of concern. In addition, impacts on sensitive or protected habitat are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty.

In contrast, indirect impacts are not immediately evident and can consequently not be measured at a moment in time. In addition, the extent of the effect is frequently at a scale that is larger than the actual site of impact. A measure of estimation is therefore necessary in order to evaluate the importance of these impacts. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities.

The following impacts are relevant to any type of development in a natural environment:

- Direct impacts on flora species of conservation importance;
- Loss or degradation of natural vegetation, sensitive or protected habitat;
- Loss/ degradation of surrounding habitat;
- Impacts on SA's conservation obligations & targets;
- Increase in local and regional fragmentation/ isolation of habitat; and
- Increase in environmental degradation, pollution (soils, surface water).

8.7.2 Nature of Impacts

Impacts that are likely to result from the proposed activities are described briefly below. This list was compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the floristic environment. The most significant impact will result from loss of habitat, which may have direct or indirect impacts on individual organisms or communities.

- **Direct Impacts on Flora Species of Conservation Importance**

This is a direct impact since it results in the physical damage or destruction of Red Data species/ communities, areas where these species are known to occur or areas that are considered particularly suitable for these species. Plant species of conservation importance, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers, as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they represent an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance, particularly in moist habitat conditions.

Red Data species are particularly sensitive to changes in their environment, having adapted to a narrow range of specific habitat requirements. Changes in habitat conditions resulting from human activities is one of the greatest reasons for these species having a threatened status. Surface transformation/ degradation activities within habitat types that are occupied by flora species of conservation importance will ultimately result in significant impacts on these species and their population dynamics. Effects of this type of impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest limitations in terms of mitigating or preventing this particular impact, is the paucity of species specific information that describe their presence, distribution patterns, population dynamics and habitat requirements. To allow for an accurate assessment, it is usually necessary to assess the presence/ distribution, habitats requirements, etc. associated with these species in detail and over prolonged periods; something that is generally not possible during EIA investigation such as this. However, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, potential impacts will be limited largely.

The likelihood of Red Data flora species occurring within the study area is moderate to low. Protected tree species (National Forest Act) are present within the study area, albeit at low densities.

- **Loss or Degradation of Natural Vegetation/ Sensitive or Protected Habitat**

The loss or degradation of natural vegetation or habitat that are regarded sensitive as a result of restricted presence in the larger region (atypical habitat) represents a potential loss of habitat and biodiversity on a local and regional scale. Sensitive habitat types might include mountains, ridges, koppies, wetlands, rivers, streams, pans and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is generally ascribed to floristic communities and faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

The endorheic pans present in the study area are included in this category, but the floristic status was found to be sub-optimal because of constant grazing pressure.

- **Impacts on Surrounding Habitat/ Species & Ecosystem Functioning**

Surrounding areas and species present in the direct vicinity of the study area could potentially be affected by indirect impacts resulting from construction and operational activities. This indirect impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to factors such as these may lead to a reduction in the resilience of ecological communities and ecosystems or loss or changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the drainage line, is regarded important. It is well known that the status of a catchment is largely determined by the status of the upper reaches of the rivers. Small drainage lines, such as the one on this property, might be insignificant on a regional scale, but the combined status of numerous such small drainage lines will determine the quality of larger rivers further downstream.

- **Impacts on SA's Conservation Obligations & Targets**

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas or threatened areas. The importance of vegetation types is based on the conservation status ascribed to

regional vegetation types (VEGMAP, 2006) and because impacts that result in irreversible transformation of natural habitat is regarded significant. However, only a moderate disruption of ecosystem functioning is assumed in the 'Least Threatened' vegetation types that occupy the study area.

The location of the study area within the Griqualand West Centre of Endemism was taken into consideration in the assessment of this impact.

- **Increase in Local & Regional Fragmentation/ Isolation of Habitat**

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances, might imply that the viable population of plants in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size.

The danger in this type of cumulative impact is that effects are not known or is not visible with immediate effect and normally when these effects become visible, they are usually beyond repair. Impacts on linear areas of natural habitat affect the migratory success of animals in particular.

The general region is characterised by low levels of transformation and habitat fragmentation. However, it is known that other similar developments are planned in the region. The level of fragmentation and habitat isolation is therefore likely to increase to some extent within the next few years.

- **Increase in Environmental Degradation, Pollution (soils, surface water)**

Cumulative impacts associated with this type of development could lead to initial, incremental or augmentation of existing types of environmental degradation, including impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases, these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor. Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

The nature of the development is such that pollution and degradation of the surrounding areas are expected to some extent.

8.7.3 Causative Activities

The following activities, related to the construction, operation and decommissioning phases of the proposed development, are expected to result in adverse impacts on the floristic environment:

- Clearing of land for construction purposes;
- Construction of required solar infrastructure;
- Construction of access roads;
- Presence of construction personnel within a natural environment (ablution, fires, damage to vegetation, etc.);
- Placement of power lines, cables and water pipelines, etc;
- Chemical contamination by construction vehicles and machinery;
- Operation of construction camps;
- Storage of materials required for construction, maintenance;
- Generation & Handling of Waste;
- Removal and dismantling of infrastructure during decommissioning;
- Rehabilitation activities (introduction of species);

Not all of the impacts are relevant to each of these activities, only the effects of relevant ones will be assessed in subsequent tables.

8.8 BOTANICAL IMPACT RATING TABLES

8.8.1 *Construction Phase*

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Construction Phase: Clearance of Land												
Direct impacts on flora species of conservation importance	6	5	3	4	56	M	6	5	2	4	52	M
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	3	4	56	M	4	5	2	4	44	M
Loss/ degradation of surrounding habitat	6	4	3	3	39	M	6	4	2	2	24	L
Impacts on SA's conservation obligations & targets	4	5	3	3	36	M	4	5	3	3	36	M
Increase in local and regional fragmentation/ isolation of habitat	4	5	2	5	55	M	4	5	2	5	55	M
Increase in environmental degradation, pollution (soils, surface water)	6	4	2	3	36	M	6	4	2	2	24	L
Construction Phase: Construction of Required Solar Infrastructure												
Direct impacts on flora species of conservation importance	6	5	3	2	28	L	8	5	2	2	30	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	2	2	26	L	6	5	2	2	26	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	4	4	2	2	20	L
Increase in environmental degradation, pollution (soils, surface water)	6	4	2	3	36	M	4	4	2	2	20	L
Construction Phase: Construction of Access Roads												
Direct impacts on flora species of conservation importance	6	5	3	2	28	L	4	5	2	2	22	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	2	2	26	L	6	5	2	2	26	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	4	4	2	2	20	L
Impacts on SA's conservation obligations & targets	4	5	3	2	24	L	4	5	3	2	24	L
Increase in local and regional fragmentation/ isolation of habitat	4	4	3	2	22	L	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	3	2	22	L	4	4	2	2	20	L
Construction Phase: Presence of Personnel within a Natural Environment												
Direct impacts on flora species of conservation importance	6	5	3	3	42	M	8	5	2	2	30	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	2	3	39	M	8	5	2	2	30	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	3	30	L	4	4	2	2	20	L

Construction Phase: Placement of Power Lines, Cables, Water Pipelines, etc.												
Direct impacts on flora species of conservation importance	6	5	3	2	28	L	6	5	2	2	26	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	2	3	39	M	6	5	2	2	26	L
Loss/ degradation of surrounding habitat	6	5	2	3	39	M	6	5	2	2	26	L
Impacts on SA's conservation obligations & targets	4	5	3	2	24	L	4	5	2	2	22	L
Increase in local and regional fragmentation/ isolation of habitat	4	5	2	2	22	L	4	5	2	2	22	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	3	30	L	4	4	2	2	20	L
Construction Phase: Chemical Contamination												
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	3	36	M	6	4	2	2	24	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	6	4	2	3	36	M	6	4	2	2	24	L
Construction Phase: Storage of Materials												
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	3	36	M	6	4	2	2	24	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	3	30	L	4	4	2	2	20	L
Construction Phase: Generation & Handling of Waste												
Direct impacts on flora species of conservation importance	6	4	2	2	24	L	6	4	2	2	24	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	2	24	L	6	4	2	2	24	L
Loss/ degradation of surrounding habitat	4	4	2	2	20	L	4	4	2	2	20	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	2	20	L	4	4	2	2	20	L

8.8.2 Operational Phase

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Operational Phase: Presence of Personnel within a Natural Environment												
Direct impacts on flora species of conservation importance	6	5	3	2	28	L	8	5	2	2	30	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	5	2	2	26	L	8	5	2	2	30	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	3	30	L	4	4	2	2	20	L
Operational Phase: Chemical Contamination												
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	3	36	M	6	4	2	2	24	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	6	4	2	3	36	M	6	4	2	2	24	L
Operational Phase: Storage of Materials for Maintenance												
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	3	36	M	6	4	2	2	24	L
Loss/ degradation of surrounding habitat	6	4	2	3	36	M	6	4	2	2	24	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	3	30	L	4	4	2	2	20	L
Operational Phase: Generation & Handling of Waste												
Direct impacts on flora species of conservation importance	6	4	2	2	24	L	6	4	1	2	22	L
Loss or degradation of natural vegetation, sensitive or protected habitat	6	4	2	2	24	L	6	4	1	2	22	L
Loss/ degradation of surrounding habitat	4	4	2	2	20	L	4	4	2	2	20	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	2	20	L	4	4	2	2	20	L

8.8.3 *Closure & Decommissioning*

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Closure & Decommissioning: Removal of Infrastructure												
Direct impacts on flora species of conservation importance	4	5	1	2	20	L	2	5	1	2	16	L
Loss or degradation of natural vegetation, sensitive or protected habitat	4	4	1	2	18	L	2	4	1	2	14	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	1	2	18	L	2	4	1	2	14	L
Closure & Decommissioning: Rehabilitation Activities												
Direct impacts on flora species of conservation importance	4	5	1	2	20	L	2	5	1	2	16	L
Loss/ degradation of surrounding habitat	4	5	2	3	33	M	2	4	2	2	16	L
Increase in environmental degradation, pollution (soils, surface water)	4	5	2	3	33	M	2	4	2	2	16	L
Closure & Decommissioning: Presence of Personnel within a Natural Environment												
Direct impacts on flora species of conservation importance	4	5	2	2	22	L	2	5	2	2	18	L
Loss or degradation of natural vegetation, sensitive or protected habitat	4	4	2	2	20	L	2	4	2	2	16	L
Loss/ degradation of surrounding habitat	4	4	2	2	20	L	2	4	2	2	16	L
Increase in environmental degradation, pollution (soils, surface water)	4	4	2	2	20	L	2	4	2	2	16	L

8.9 DISCUSSION

The study area comprises extensive areas of shrubveld/ woodland that is representative of the regional vegetation type. The general woodland vegetation exhibit little signs of degradation, but also little sensitive floristic attributes. A medium floristic sensitivity is ascribed to the natural terrestrial habitat types that were identified in the study area. This medium floristic sensitivity took cognisance of the location of the study area within the Griqualand West Centre of Endemism as well as the 'Least Threatened' status ascribed to Ghaap Plateau Vaalbosveld. Except for a number of protected trees that occur scattered in the area, the chance of encountering flora species of a high conservation status is regarded relative low. This woodland habitat is well represented in the surrounding region.

Contained within the major terrestrial woodland community are small endorheic pans that represent an azonal habitat form. These areas are characterised by temporary and intermittent inundation subsequent to severe rain showers. The floristic characteristics of these areas are dominated by species that are adapted to temporary inundation. The status of these areas is however slightly degraded due to intensive grazing by cattle livestock. A medium-high floristic sensitivity is ultimately ascribed to these pans, which is mostly based on the wetland association of these features. Aerial imagery indicates that numerous other small pans are present in the surrounding areas.

A perennial spring is situated in the central-western part of the study area, representing the only feature of high floristic sensitivity. It is unlikely that this feature will be affected by the proposed development, but every precaution should be taken to prevent peripheral impacts from affecting the status of this feature. Degraded and transformed habitat of the study area does not contain any floristic features of sensitivity, in fact, alien and invasive species predominate in these areas. The control of these species is strongly recommended.

Results of the impact assessment reflect moderately significant impacts will likely to occur during the construction phase. These impacts are mostly associated with habitat clearance prior to the commencement of construction. Impacts associated with the operational and decommissioning phases are regarded localised and of relative low significance. The loss of this natural, terrestrial woodland is not expected to result in significant impacts on the floristic environment beyond the boundaries of the site. The implementation of generic mitigation measures is expected to ameliorate likely impacts to an acceptable level. It should however be noted that the removal of Protected tree species (*Acacia erioloba* and *Olea europaea* subsp. *africana*) is subject to the submission of relevant applications to NCDENC and DAFF as per the National Forests Act (Act no 84 of 1998). Towards this purpose it will be necessary to conduct a survey to determine the density of protected tree species on the property. Wetland habitat types, because of a higher floristic sensitivity ascribed to them, as well as a lower representation in the surrounding region, should be excluded from the propose development as far as technically feasible. Other mitigation

measures recommended to protect these features mostly include the prevention of contamination from surrounding developments.

8.10 RECOMMENDED MITIGATION MEASURES

8.10.1 Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude as much as technically feasible of sensitive habitat from the proposed development;

Mitigation Measure 2 - Implement a suitable buffer zone (at least 30m) between the edge of these areas habitat and any type of development or surface disturbance;

Mitigation Measure 3 - Prevent all and any influx of water into wetland habitat;

Mitigation Measure 4 - Prevent contamination of natural habitat, wetland and endorheic pans from any source of pollution;

Mitigation Measure 5 - Locate, remove and relocate all plant species of conservation importance that are present within development areas. A site assessment is recommended whereby the study area is scrutinised for the presence of any of these protected trees. All individuals will be georeferenced and applications for the removal/ relocation will be submitted to relevant authorities.

8.10.2 General Aspects

Mitigation Measure 6 - Appoint an Environmental Control Officer (ECO) prior to commencement of construction. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 7 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of natural habitat and effects of the development on the natural environment;

8.11 ENVIRONMENTAL CONTROL OFFICER

Mitigation Measure 8 - Have overall responsibility for the implementation of the EMP;

Mitigation Measure 9 - Ensure that the developer and all contractors are aware of specifications, legal constraints and general standards and procedures pertaining to the project specifically with regards to the environment;

Mitigation Measure 10 - Ensure that all stipulations within the EMP are communicated and adhered to by the developer and contractors;

Mitigation Measure 11 - Monitor the implementation of the EMP throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes;

Mitigation Measure 12 - Be fully conversant with the Environmental Impact Assessment for the project, the conditions of the RoD, all relevant environmental legislation and with the EMP;

Mitigation Measure 13 - Ensure that periodic environmental performance audits are undertaken on the project implementation;

Mitigation Measure 14 - Convey the contents of the EMP to the site staff and discuss the contents in detail with the Project Manager and Contractors;

Mitigation Measure 15 - Take appropriate action if the specifications contained in the EMP are not followed;

Mitigation Measure 16 - Monitor and verify that environmental impacts are kept to a minimum, as far as possible;

Mitigation Measure 17 - Compile progress reports on a regular basis, with input from the Site Manager, for submission to the Project Manager, including a final post-construction audit carried out by an independent auditor/consultant.

8.11.1 Fences & Demarcation

Mitigation Measure 18 - Demarcate construction areas by semi-permanent means/ material, in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit spread of impacts;

Mitigation Measure 19 - No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

8.11.2 Fire

Mitigation Measure 20 - The Project team will compile a Fire Management Plan (FMP) and Contractors directed by the ECO will submit a FMP. The Project FMP shall be approved by local Fire Protection Association, and shall include *inter alia* aspects such as relevant training, equipment on site, prevention, response, rehabilitation and compliance to the National Veld and Forest Fire Act, Act No. 101 1998;

Mitigation Measure 21 - Prevent all open fires;

Mitigation Measure 22 - Provide demarcated fire-safe zones, facilities and suitable fire control measures;

Mitigation Measure 23 - Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited;

Mitigation Measure 24 - The irresponsible use of welding equipment, oxy-acetylene torches and other naked flames, which could result in veld fires, or constitute a hazard and should be guided by safe practice guidelines; and

Mitigation Measure 25 - The use of fire as a management tool should be guided and instructed by a qualified ecologist.

8.11.3 Roads & Access

Mitigation Measure 26 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

Mitigation Measure 27 - A road management plan should be compiled prior to the commencement of construction activities;

Mitigation Measure 28 - Dust control on all roads should be prioritised;

Mitigation Measure 29 - No roads should be allowed within ecologically sensitive areas.

8.11.4 Workers & Personnel

Mitigation Measure 30 - Provide temporary on-site ablution, sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 31 - Abluting anywhere other than in provided toilets shall not be permitted. Under no circumstances shall use of the veld be permitted;

8.11.5 Vegetation Clearance & Operations

Mitigation Measure 32 - All individuals/ stands of Protected Trees must be identified and clearly marked prior to the start of construction or maintenance procedures;

Mitigation Measure 33 - The landowner must immediately take steps to remove alien vegetation as per Conservation of Agricultural Resource Act, namely:

- Uprooting, felling or cutting;
- Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;
- The application of control measures regarding the utilisation and protection of veld in terms of regulation 9 of the Act;
- The application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11of the Act;
- Any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.
- According to the Conservation of Agricultural Resource Act (No. 43 of 1983) as amended, the person applying herbicide must be adequately qualified and certified as well as registered with the appropriate authority to apply herbicides.

Mitigation Measure 34 - The size of areas subjected to land clearance will be kept to a minimum;

Mitigation Measure 35 - Only areas as instructed by the Site Manager must be cleared and grubbed;

Mitigation Measure 36 - Cleared vegetation and debris that has not been utilised will be collected and disposed of to a suitable waste disposal site. It will not be burned on site;

Mitigation Measure 37 - All vegetation not required to be removed will be protected against damage;

Mitigation Measure 38 - Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;

Mitigation Measure 39 - Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and vice versa and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983) and must be addressed on a continual basis, through an alien vegetation control and monitoring programme;

Mitigation Measure 40 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;

Mitigation Measure 41 - Stored topsoil will be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds, which would adversely affect its suitability for planting;

Mitigation Measure 42 - No spoil material will be dumped outside the defined site;

Mitigation Measure 43 - Disturbance of vegetation must be limited to areas of construction;

Mitigation Measure 44 - The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO;

Mitigation Measure 45 - Ensure proper surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 46 - Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation;

Mitigation Measure 47 - The grass mix should consist of indigenous grasses adapted to the local environmental conditions;

Mitigation Measure 48 - The revegetated areas should be temporarily fenced to prevent damage by grazing animals;

Mitigation Measure 49 - Re-vegetated areas showing inadequate surface coverage (less than 30% within eight months after re-vegetation) should be prepared and re-vegetated from scratch;

Mitigation Measure 50 - Damage to re-vegetated areas should be repaired promptly;

Mitigation Measure 51 - Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the grasses to properly establish;

8.12 WASTE

Mitigation Measure 52 - As far as possible, waste should be avoided, reduced, re-used and/or recycled. Where this is not feasible, all waste (general and hazardous) generated during the construction of the power station may only be disposed of at appropriately licensed waste disposal sites (in terms of Section 20 of the

Environment Conservation Act, No 73 of 1989 and in accordance with the new waste act: National Environmental Waste Management Act 2008);

Mitigation Measure 53 - Prevent and advocate against the indiscriminate disposal of rubbish, litter or rubble;

Mitigation Measure 54 - The burning of general waste material under any circumstances is not to be allowed;

Mitigation Measure 55 - The use of small on-site incinerators for waste burning should be investigated, and if found feasible, be implemented;

Mitigation Measure 56 - Waste will be sorted at source (i.e. the separation of tins, glass, paper etc); recycled waste of this sort will be collected by an accredited waste removal contractor;

Mitigation Measure 57 - A stormwater management plan will be compiled that will address, inter alia, capturing and storage of stormwater;

Mitigation Measure 58 - All runoff water from fuel deposits, workshops, vehicles washing areas and other equipment must be collected and directed through oil traps to settlement ponds. These ponds must be suitably lined and should be cleaned as soon as practicable, and the sludge disposed off at a suitable waste site;

Mitigation Measure 59 - No wastewater or water containing any chemical or pollutant should be released from, or escape as effluent, from the site.

9 FAUNAL ASSESSMENT

Please take note that the faunal assessment in this document excludes avifauna as it presented as a separate report. General aspects are however mentioned as it does relate to the faunal diversity of the site.

9.1 REGIONAL FAUNAL DIVERSITY

The study area is located within the Ghaap Plateau Vaalbosveld regional vegetation type (Eastern Kalahari Bushveld Bioregion: Savanna Biome – VegMap 2006). This vegetation type is listed as 'Least Threatened'. The Savanna Biome (or ecoregion) of South Africa occurs in the northeastern parts of the country, stretching southwards to the lowland areas of KZN and extending into the Eastern Cape. It is the largest ecoregion in South Africa, comprising 46% of the country. The annual rainfall varies from 235 mm in the Kalahari Savanna in the west (region of the study area) to more than 1,000mm in the east. This great variation in environmental and climatic attributes results in significant vegetation disparity and animal diversity. Fire and animals are important drivers in maintaining savanna ecosystem processes. Threats to this ecoregion includes rapidly expanding development of settlements for impoverished human populations and the associated need for firewood and building materials, diminishing water supply, agriculture (especially sugar cane and subtropical products) and overgrazing.

It is important to view the study area on an ecologically relevant scale; consequently, all sensitive animal species (specific faunal groups) known from the Northern Cape Province are included in this assessment. Detailed regional and scientific data on all faunal groups are lacking (notably for most of the invertebrate groups) and as a result only data sets on specific faunal groups allow for habitat sensitivity analyses based on the presence/ absence of sensitive faunal species (Red Data species) and their specific habitat requirements. The following faunal groups were included in these analyses:

- Invertebrates: Butterflies (South African Butterfly Conservation Assessment – http://sabca.adu.org.za)
- Amphibians: Frogs (Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland)
- Reptiles: Snakes and other Reptiles (South African Reptile Conservation Assessment – http://sarca.aduorg.za)
- Birds: All bird groups (Roberts VII Multimedia: Birds of Southern Africa, PC Edition)
- Mammals: Terrestrial Mammals (Red Data Book of the Mammals of South Africa: A Conservation Assessment)

As more data become available, additional faunal groups are likely to be added to these assessments. Dragonflies and Damselflies (Invertebrata: Insecta: Odonata) are some examples of future inclusions.

Animals known to be present in the Q-grid 2823BD were considered potential inhabitants of the study area (all species known from the Northern Cape Province were therefore included in the assessment to limit the known effects of sampling bias; except for birds where sampling has been comprehensive in the last decade.

9.2 FAUNAL DIVERSITY OF THE SITE

A total of 80 animal species was recorded during the site investigation (Table 6), by means of visual sightings, tracks, scats, burrows and species-specific calls. This diversity includes one scorpion, one dragonfly, one termite, one beetle, three butterflies, one bee, one frog, 8 reptiles, 45 birds and 18 mammals. The 80 species found to occur in the study area did not include any Red Data species. Additionally, invertebrates of 22 families were also confirmed to occur in the study area (for various reasons, these animals could only be identified to family level – Table 7). The animals (species and families) observed in the study area are, for the most part, typical arid savanna species and representative of savanna animal communities that are widespread in the regional areas of the Ghaap Plateau Vaalbosveld and in the larger extent of the Eastern Kalahari Bushveld Bioregion.

Table 6: Animal species recorded in the study area during the site investigation

Class	Order	Family	Biological Name	English Name
Arachnida	Scorpiones	Scorpionidae	*Opistophthalmus carinatus*	Burrowing Scorpion
Insecta	Odonata	Aeshnidae	*Anax imperator*	Blue Emperor
	Isoptera	Termitidae	*Trinervitermes sp*	Snouted Harvester Termite
	Coleoptera	Scarabaeidae	*Pachnoda sinuata*	Garden Fruit Chafer
		Nymphalidae	*Danaus chryssipus*	African Monarch
		Pieridae	*Belenois aurota*	Brown-veined White
		Papilionidae	*Papilio demodocus*	Citrus Swallowtail
	Hymenoptera	Apidae	*Apis mellifera*	Honey Bee
Amphibia	Anura	Bufonidae	*Amietophrynus poweri*	Western Olive Toad
Reptilia	Testudines	Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise
	Squamata	Atractaspididae	*Atractaspis bibronii*	Bibron's Burrowing Asp
		Colubridae	*Dasypeltis scabra*	Common Egg Eater
		Elapidae	*Naja nivea*	Cape Cobra
		Viperidae	*Bitis arietans*	Puff Adder
		Lacertidae	*Pedioplanis lineoocellata*	Spotted Sand Lizard
		Agamidae	*Agama aculeata*	Ground Agama
		Gekkonidae	*Pachydactylus capensis*	Cape Thick-toed Gecko
Aves	Galliformes	Numididae	*Numida meleagris*	Helmeted Guineafowl
		Phasianidae	*Scleroptila levaillantoides*	Orange River Francolin
	Anseriformes	Anatidae	*Anas erythrorhyncha*	Red-billed Teal
			Anas undulata	Yellow-billed Duck
	Ciconiiformes	Threskiornithidae	*Bostrychia hagedash*	Hadeda Ibis
		Ardeidae	*Ardea melanocephala*	Black-headed Heron
	Falconiformes	Accipitridae	*Melierax canorus*	Pale Chanting Goshawk
	Gruiformes	Rallidae	*Fulica cristata*	Red-knobbed Coot
	Charadriiformes	Burhinidae	*Burhinus capensis*	Spotted Thick-knee
		Charadriidae	*Vanellus armatus*	Blacksmith Lapwing
			Vanellus coronatus	Crowned Lapwing

	Columbiformes	Columbidae	*Streptopelia capicola*	Ring-necked Dove
			Spilopelia senegalensis	Laughing Dove
	Cuculiformes	Cuculidae	*Chrysococcyx caprius*	Diderick Cuckoo
	Strigiformes	Tytonidae	*Tyto alba*	Western Barn Owl
		Caprimulgidae	*Caprimulgus rufigena*	Rufous-cheeked Nightjar
	Apodiformes	Apodidae	*Apus caffer*	White-rumped Swift
	Passeriformes	Laniidae	*Nilaus afer*	Brubru
			Lanius collurio	Red-backed Shrike
			Lanius collaris	Common Fiscal
		Corvidae	*Corvus albus*	Pied Crow
		Alaudidae	*Mirafra fasciolata*	Eastern Clapper Lark
			Calendulauda africanoides	Fawn-coloured Lark
		Pycnonotidae	*Pycnonotus nigricans*	African Red-eyed Bulbul
		Hirundinidae	*Hirundo rustica*	Barn Swallow
			Ptyonoprogne fuligula	Rock Martin
			Cecropis cucullata	Greater Striped Swallow
			Cecropis semirufa	Red-breasted Swallow
		Cisticolidae	*Cisticola juncidis*	Zitting Cisticola
			Prinia flavicans	Black-chested Prinia
		Sylviidae	*Sylvia subcaerulea*	Chestnut-vented Tit-Babbler
		Zosteropidae	*Zosterops pallidus*	Orange River White-eye
		Sturnidae	*Creatophora cinerea*	Wattled Starling
		Muscicapidae	*Cossypha caffra*	Cape Robin-Chat
			Erythropygia paena	Kalahari Scrub Robin
			Sigelus silens	Fiscal Flycatcher
		Passeridae	*Passer motitensis*	Great Sparrow
		Ploceidae	*Sporopipes squamifrons*	Scaly-feathered Weaver
			Ploceus velatus	Southern Masked Weaver
		Estrildidae	*Uraginthus granatinus*	Violet-eared Waxbill
		Viduidae	*Vidua regia*	Shaft-tailed Whydah
		Motacillidae	*Motacilla capensis*	Cape Wagtail
		Fringillidae	*Crithagra atrogularis*	Black-throated Canary
			Crithagra flaviventris	Yellow Canary
			Emberiza flaviventris	Golden-breasted Bunting
Mammalia	Lagomorpha	Leporidae	*Lepus capensis*	Cape Hare
	Rodentia	Sciuridae	*Xerus inauris*	Cape Ground Squirrel
		Bathyergidae	*Cryptomys hottentotus*	Common Mole-rat
		Hystricidae	*Hystrix africaeaustralis*	Porcupine
	Carnivora	Felidae	*Caracal caracal*	Caracal
		Hyaenidae	*Proteles cristata*	Aardwolf
		Herpestidae	*Cynictis penicillata*	Yellow Mongoose
			Galerella sanguinea	Common Slender Mongoose
			Suricata suricatta	Meerkat
		Canidae	*Canis mesomelas*	Black-backed Jackal
			Otocyon megalotis	Bat-eared Fox
			Vulpes chama	Cape Fox
	Tubulidentata	Orycteropodidae	*Orycteropus afer*	Aardvark
	Hyracoidea	Procaviidae	*Procavia capensis*	Rock Hyrax
	Artiodactyla	Suidae	*Phacochoerus africanus*	Common Warthog
		Bovidae	*Strepsiceros strepsiceros*	Cape Kudu
			Raphicerus campestris	Steenbok
			Sylvicapra grimmia	Bush Duiker

Table 7: Invertebrate families occurring in the study area			
Class	**Order**	**Family**	**English Name**
Insecta	Thysanura	Lepismatidae	Silverfish
	Mantodea	Mantidae	Praying Mantids
	Orthoptera	Gryllidae	Crickets
		Pyrgomorphidae	Foam Grasshoppers
		Acrididae	Short-horned Grasshoppers
	Hemiptera	Notonectidae	Backswimmers
		Cicadellidae	Leafhoppers
		Cicadidae	Cicadas
		Pentatomidae	Stink Bugs
		Gerridae	Water Striders
	Thysanoptera	Thripidae	Common Thrips
	Coleoptera	Carabidae	Ground Beetles
		Meloidae	Blister Beetles
		Scarabaeidae	Scarab Beetles
		Tenebrionidae	Darkling Beetles
	Diptera	Culicidae	Mosquitoes
		Tabanidae	Horse Flies
		Muscidae	House Flies
	Hymenoptera	Formicidae	Ants

9.3 RED DATA FAUNA ASSESSMENT

Criteria are used in partnership with the known distribution of Red Data species as well as their known habitat requirements to estimate their likelihood of occurring in the study area. Red Data species that were not observed in the study area during the field assessment were assessed by implementing the following criteria:

- the size of the study area;
- the location and connectivity of the study area with regards to other natural faunal habitats; and,
- the presence/absence, status and diversity of natural faunal habitats within the study area.

A total of 96 Red Data animals are known to occur in the Northern Cape Province (butterflies, frogs, reptiles and mammals) and birds in the Q-grid 2823BD – Table 8. This includes 18 listed as Data Deficient (DD), 31 as Near Threatened (NT), 36 as Vulnerable (VU), 5 as Endangered (EN) and 6 as Critically Endangered (CR). It is estimated that 73 of the 96 animals listed have a low probability of occurring in the study area, 12 have a moderate-low probability, 6 a moderate probability, 3 a moderate-high and 2 species a high probability of occurring in the study area.

Table 8: Red Data Fauna assessment for the study area			
Species Details			**Probability Assessment**
Biological Name	**English Name**	**RD**	
Butterflies			

Aloeides kaplani	Kaplan's Copper	Vulnerable	low
Aloeides nollothi	Nolloth's Copper	Vulnerable	low
Aloeides pallida jonathani	Giant Copper	Data Deficient	low
Chrysoritis azurius	Azure Opal	Vulnerable	low
Chrysoritis beaufortius stepheni	Stephen's Opal	Vulnerable	low
Chrysoritis dicksoni	Dickson's Strandveld Copper	Critically Rare	low
Chrysoritis pan lysander	Lysander Opal	Data Deficient	low
Chrysoritis trimeni	Trimen's Opal	Vulnerable	low
Chrysoritis turneri wykehami	Wykeham's Opal	Vulnerable	low
Lepidochrysops badhami	Badham's Blue	Vulnerable	low
Lepidochrysops penningtoni	Pennington's Blue	Vulnerable	low
Lepidochrysops titei	Tite's Blue	Vulnerable	low
Lepidochrysops wykehami	Wykeham's Blue	Vulnerable	low
Phasis pringlei	Pringle's Arrowhead	Vulnerable	low
Thestor dryburghi	Dryburgh's Skolly	Vulnerable	low
Thestor pringlei	Pringle's Skolly	Vulnerable	low
Tuxentius hesperis	Western Pie	Data Deficient	low
Tuxentius melaena griqua	Black Pie	Data Deficient	low
Frogs			
Cacosternum karooicum	Karoo Caco	Data Deficient	low
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	low
Strongylopus springbokensis	Namaqua Stream Frog	Vulnerable	low
Reptiles			
Bitis inornata	Plain Mountain Adder	Vulnerable	low
Bitis schneideri	Namaqua Dwarf Adder	Vulnerable	low
Cordylus macropholis	Large-scaled Girdled Lizard	Near Threatened	low
Cordylus mclachlani	McLachlan's Girdled Lizard	Vulnerable	low
Dermochelys coriacea	Leatherback Turtle	Critically Rare	low
Gerrhosaurus typicus	Karoo Plated Lizard	Near Threatened	low
Goggia gemmula	Richtersveld Pygmy Gecko	Data Deficient	low
Goggia microlepidota	Small-scaled Gecko	Near Threatened	low
Homopus signatus	Speckled Padloper	Near Threatened	low
Lamprophis fiskii	Fisk's House Snake	Vulnerable	low
Typhlosaurus lomiae	Lomi's Blind Legless Skink	Vulnerable	low
Birds			
Phoenicopterus roseus	Greater Flamingo	Near Threatened	low
Phoenicopterus minor	Lesser Flamingo	Near Threatened	low
Mycteria ibis	Yellow-billed Stork	Near Threatened	low
Ciconia nigra	Black Stork	Near Threatened	low
Leptoptilos crumeniferus	Marabou Stork	Near Threatened	low
Sagittarius serpentarius	Secretarybird	Near Threatened	high
Gyps africanus	White-backed Vulture	Vulnerable	moderate-low
Gyps coprotheres	Cape Vulture	Vulnerable	moderate-low
Torgos tracheliotus	Lappet-faced Vulture	Vulnerable	moderate-low
Circus ranivorus	African Marsh Harrier	Vulnerable	moderate-low
Circus maurus	Black Harrier	Vulnerable	moderate-low
Aquila rapax	Tawny Eagle	Vulnerable	moderate
Polemaetus bellicosus	Martial Eagle	Vulnerable	moderate
Falco naumanni	Lesser Kestrel	Vulnerable	moderate-low
Falco biarmicus	Lanner Falcon	Near Threatened	moderate-high
Falco peregrinus	Peregrine Falcon	Near Threatened	moderate-low
Ardeotis kori	Kori Bustard	Vulnerable	high
Neotis ludwigii	Ludwig's Bustard	Vulnerable	moderate

Anthropoides paradisea	Blue Crane	Vulnerable	moderate-low
Charadrius pallidus	Chestnut-banded Plover	Near Threatened	low
Rostratula benghalensis	Greater Painted-snipe	Near Threatened	low
Glareola nordmanni	Black-winged Pratincole	Near Threatened	moderate-low
Mammals			
Acinonyx jubatus	Cheetah	Vulnerable	low
Atelerix frontalis	South African Hedgehog	Near Threatened	low
Bathyergus janetta	Namaqua Dune Mole-rat	Near Threatened	low
Bunolagus monticularis	Riverine Rabbit	Critically Rare	low
Chrysochloris asiatica	Cape Golden Mole	Data Deficient	low
Chrysochloris visagiei	Visagie's Golden Mole	Critically Rare	low
Cistugo lesueuri	Leseur's Wing-gland Bat	Near Threatened	low
Cistugo seabrai	Angolan Wing-gland Bat	Vulnerable	low
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	moderate
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	low
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	low
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	low
Crocuta crocuta	Spotted Hyaena	Near Threatened	low
Cryptochloris wintoni	De Winton's Golden Mole	Critically Rare	low
Damaliscus lunatus lunatus	Tsessebe	Endangered	low
Diceros bicornis bicornis	Black Rhinoceros - arid ecotype	Critically Rare	low
Elephantulus intufi	Bushveld Elephant-shrew	Data Deficient	low
Equus zebra hartmannae	Hartmann's Mountain Zebra	Endangered	low
Erimitalpa granti	Grant's Golden Mole	Vulnerable	low
Graphiurus platyops	Rock Dormouse	Data Deficient	low
Hippotragus equinus	Roan Antelope	Vulnerable	low
Hyaena brunnea	Brown Hyaena	Near Threatened	moderate
Lycaon pictus	African Wild Dog	Endangered	low
Manis temminckii	Pangolin	Vulnerable	low
Mellivora capensis	Honey Badger	Near Threatened	moderate-high
Miniopterus schreibersii	Schreiber's Long-fingered Bat	Near Threatened	moderate
Mirounga leonina	Southern Elephant Seal	Endangered	low
Myosorex varius	Forest Shrew	Data Deficient	low
Mystromys albicaudatus	White-tailed Rat	Endangered	low
Otomys slogetti	Sloggett's Rat	Data Deficient	low
Panthera leo	Lion	Vulnerable	low
Paratomys littledalei	Littledale's Whistling Rat	Near Threatened	low
Petromys typicus	Dassie Rat	Near Threatened	low
Poecilogale albinucha	African Weasel	Data Deficient	moderate-low
Rhinolophus capensis	Cape Horseshoe Bat	Near Threatened	low
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Near Threatened	moderate-low
Rhinolophus darlingi	Darling's Horseshoe Bat	Near Threatened	moderate-low
Rhinolophus denti	Dent's Horseshoe Bat	Near Threatened	low
Rhinolophus fumigatus	Ruppel's Horseshoe Bat	Near Threatened	low
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	low
Tatera leucogaster	Bushveld Gerbil	Data Deficient	moderate-high
Xerus princeps	Mountain Ground Squirrel	Near Threatened	low

9.4 FAUNAL HABITAT TYPES

The close relationship between vegetation units and specific faunal composition has been noted in several scientific studies. For the purpose of this investigation, floristic units are therefore considered representative of the faunal habitat types (Refer Figure 7). The following habitat types are indicated:

- Degraded Habitat/ Transformed Areas;
- Natural Woodland Habitat, including
  - (*Searsia lancea*) Open Woodland;
  - (*Tarchonanthus camphoratus*) Closed Shrubveld;
- Wetland Habitat, including:
  - Natural Spring; and
  - Endorheic Pans & Wetlands.

9.4.1 Degraded Habitat/ Transformed Areas

The homesteads and road/ railway infrastructure of the study area includes all areas characterized by man-made structures, including farm buildings, workers' quarters, roads, railways, gardens etc. The man-made structures and related infrastructure of the study area are transformed areas (none of the ecological elements of the original savanna habitat remains in these areas). Because of the transformed nature of the homesteads and infrastructure of the study area, it is deemed to have a **low faunal sensitivity**.

9.4.2 Endorheic Pan and Perennial Spring

Wetlands in arid regions such as the endorheic (calcareous) pans that are present in the study area have unique ecological characteristics and complex and variable ecosystem processes. They usually only have surface water for a very short period; the presence of surface water is unpredictable and variable; usually following a significant singular rainfall event. Surface water can be absent from these systems for years at a time; or be found a couple of times within a 12 month period. Arid wetland systems and the processes that drive them are poorly understood because of these variables and the unique responses of the biodiversity of the region to periodic environmental variation. The lack of ecological understanding and potential unique faunal communities that could be found within these systems during times of surface water being present, results in a predicted **medium-high faunal sensitivity** for the calcareous pans and drainage line of the study area.

During the survey period, no water was available within these features and the faunal diversity was particularly low. However, it is reasonable to assume that the faunal diversity of these areas will be significantly higher during periods of inundation. The availability of water within these features is typically associated with the presence of a high diversity of

aquatic invertebrates, avifauna that are strongly associated with aquatic conditions and amphibian species.

9.4.3 Natural spring

The natural spring situated in the central western part of the study area represents an unique ecological feature of the arid landscape found in the study area; it is the only area that is characterised by permanent surface water (the calcareous pans and drainage line found in the study area only features surface water periodically). Species found in the study area that were limited to the natural spring during the field investigation included the Yellow-billed Duck, Red-billed Teal, Red-knobbed Coot, Western Olive Toad, Backswimmers (Notonectidae) and Water Striders (Gerridae).

Given the relatively small size of the natural spring and associated surface water and unique nature of the ecological processes and faunal communities that characterise this faunal habitat, it is considered a "biodiversity hotspot" on the scale of the study area as well as a regional unique landscape feature. Based on this evaluation the natural spring found in the study area is deemed to have a **high faunal sensitivity**.

The preservation of this feature should be prioritised during the process. With the assumption that the entire study area will become the property of the proponent, it is strongly recommended that this feature be included in a proper management programme that has conservation principles as objectives. In particular, the extraction of water should not be allowed and access to cattle and other livestock should be prohibited.

9.4.4 Natural woodland

The natural woodland found in the study area dominates the regional landscape in which the study area is located. Most of the plants and animals that characterise the Ghaap Plateau Vaalbosveld (Eastern Kalahari Bushveld Bioregion) are likely to be found within the study area. Results of the field investigation confirmed the natural status of the woodland of the study area. Fauna species that are specifically adapted to this particular habitat type, include the Burrowing Scorpion, Leopard Tortoise, Ground Agama, Pale Chanting Goshawk, Rufous-cheeked Nightjar, Red-backed Shrike, Eastern Clapper Lark, Fawn-coloured Lark, Chestnut-vented Tit-Babbler, Kalahari Scrub Robin, Great Sparrow, Bat-eared Fox and Rock Hyrax.

The Ghaap Plateau Vaalbosveld is currently not regarded to be under threat (listed as Least Threatened; approximately 98% remains untransformed) and only small fragments of transformed habitat is present within the natural woodland present in the study area and surrounding regions. It is therefore estimated that the natural woodland of the study area has a **medium faunal sensitivity**.

During the field assessment, the study area was investigated and assessed in terms of the following biodiversity attributes:

- Habitat status: level of habitat transformation and degradation vs. pristine faunal habitat;
- Habitat diversity: the number of different faunal habitat types (both on micro- and macro-scale) found within the proposed site and bordering areas;
- Habitat linkage: the degree to which the faunal habitat of the proposed site is linked to other natural areas enabling movement of animals to and from the habitat found on site;
- Red Data species: the degree to which suitable habitat for the red data species likely to be found in the study area (larger study area) is located on each site; and
- Sensitive faunal habitat: the relative presence of faunal sensitive habitat type elements such as surface rock associated with outcrops and hills as well as wetland elements.

Faunal habitat sensitivities are grouped into sensitivity classes (Table 9) based on the calculated averages:

- Low - 0-20%
- Medium-low - 20-40%
- Medium - 40-60%
- Medium-high - 60-80%
- High - 80-100%

Table 9: Faunal Habitat Sensitivities for the study area

Habitat Type	Status	Diversity	Linkage	Red Data	Sens	Ave	Sens Class
Degraded Habitat	1	1	2	2	1	14%	Low
Endorheic Pans & Wetlands	7	7	8	5	8	70%	Medium-high
Natural Spring	8	9	8	7	9	84%	High
Natural Woodland	4	5	8	7	5	58%	Medium

Calculated faunal habitat sensitivities are similar to the floristic habitat sensitivities, for an illustration thereof, the reader is referred to Figure 8.

9.6 DISCUSSION

Very little of the study has been transformed and the habitat contained within the study area is largely representative of the regional habitat. Over-grazing has resulted in some degradation of the natural woodland and endorheic pans, but most of the original ecological characteristics and ecosystem processes of the Ghaap Plateau Vaalbosveld is still found in the study area. The natural woodland and wetland habitats found in the study area is also well connected to other untransformed woodland areas; the region in which the study area

is located is characterised by large areas of untransformed faunal habitat of varying levels of degradation (mostly as a result of overgrazing).
The animals observed in the study area during the field investigation did not include any unique species as far as the region of the study area is concerned. Most of the species recorded in the study area are in fact also present in extensive parts of South Africa. A high proportion is also present in the arid regions of the country. Except for the livestock present in the study area, no introduced or alien animal species were observed during the field investigation.

During the field investigation, none of the calcareous pans had significant surface water; it is reasonable to assume that the species richness of these areas will increase significantly when the presence of surface water attracts a variety of water birds and invertebrates.

9.7 FAUNAL IMPACT ASSESSMENT

The following impacts resulting from the proposed development are expected to affect the faunal attributes of the study area:

- Direct impacts on Red Data fauna species;
- Loss or Degradation of natural faunal habitat & in surrounding areas;
- The disruption of ecological connectivity and migration routes of larger, flightless animals as well as territorial infringement; and
- Direct impacts on common fauna species & interactions with structures & personnel.

9.7.1 Direct impacts on Red Data Fauna Species

Threatened animals contribute significantly to the ecological diversity of a region since their presence usually provides an indication of a relatively pristine environment. Although regarded as a direct and significant impact, developments such as this are unlikely to affect these animals directly since they are generally mobile and will ultimately be able to migrate away from impacts that result from the proposed development. Significantly, however, the loss of suitable habitat that is available to them represents a significant impact on the status of these animals. Aspects of these animals that will also be affected include migration patterns and suitable habitat for breeding and foraging purposes. Since these requirements are frequently stricter than most generalist species, impacts on their habitat are likely to be more significant than for most other, common fauna species.

No Red Data species were observed during the survey period and the Red Data assessment of this report indicates that it is unlikely that Red Data fauna species will occupy extensive parts of the study area.

9.7.2 Loss or Degradation of Natural Faunal Habitat & in Surrounding Areas

Natural habitat of the study area as well as surrounding areas will be affected adversely by direct impacts resulting from construction and operational activities. Particular reference is made to the loss of habitat resulting from surface clearing activities, the construction of infrastructure as well as less obvious impacts such as leaching of chemicals into the groundwater and surface water, generation of huge amounts of dust and spillages. Also of importance is the loss of habitat that are not necessarily considered suitable for Red Data species, but where a high diversity of animals are likely to occupy the area. Extensive areas that exhibit low fragmentation and isolation factors are included in this category. This impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to the natural habitat may lead to a reduction in the resilience of ecological communities and ecosystems and changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the wetland habitat types, is particularly important. A high conservation value is generally ascribed to floristic faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

Potential Mitigation: Ensure that the loss of faunal habitat is restricted to the development site itself. Infrastructure and related activities must be confined to the development site and not allowed to spread to nearby sensitive areas. Fences must be erected prior to construction and all personnel and contractors should be instructed as to the physical boundaries pertaining to their respective disciplines and measures set in place to ensure that they keep to these boundaries. In addition, erosion control measures must be put in place from the commencement of construction to ensure that artificial erosion associated with the activities of the project (construction, operation and decommissioning) does not degrade the natural ecological state of the faunal habitats bordering the study area and the various areas of activity.

9.7.3 Disruption of Ecological Connectivity & Migration Routes

The region is characterised by low transformation and fragmentation levels. It is therefore reasonable to assume that animals that utilises the existing areas of natural habitat will migrate extensively across the region. Foraging, available water, food sources, breeding

patterns and seasonal/ climate changes include some of the more obvious explanations for migration patterns of animals.

While most of the larger mammal species (ungulates) are restricted in their movement by fences, small and medium sized animals, that include predators, burrowing species, small mammals, invertebrate species, reptiles, amphibians, etc. utilises all available natural habitat as either corridors, 'stepping stones' or habitat. Loss of current migration routes or connectivity areas (stepping stones) within the study area will likely affect the migration pattern of some species. While larger animals are not likely to be affected significantly, smaller animals might not be able to cross or avoid certain types of development/ infrastructures. Particular reference is made to the disruption of migration patterns of flightless animals.

Potential Mitigation: All impacts must be limited to the site only; no land use changes or otherwise disturbances of animals outside of the study area should be allowed; vehicles should yield to larger animals on access roads. Wherever linear structures (roads and pipelines) bisect natural areas of untransformed faunal habitat measures should be put in place to ensure continued movement of all faunal groups needing to cross these manmade barriers.

9.7.4 Impacts on Common Fauna & Interactions with Structures & Personnel

Activities that are known to transpire from human–animal conflicts are likely to affect animals that utilise surrounding areas. Unwanted activities might include poaching, snaring, killing by accidental contact, capturing, effects of domestic cats and dogs, roadkills, etc. While the tolerance levels of common animal species is generally of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from the area of impact, some species would not able to relocate, such as ground living and small species.

It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. An aspect that is of concern is the presence of vehicles on access and infrastructure roads, leading to accidental death of animals, particularly amongst nocturnal animals.

The presence of personnel within the development area during construction and operational phases will inevitably result in some contact with animals. Therefore, encounters with dangerous animals (such as snakes) remain likely. In addition, the presence of domestic dogs and cats is generally associated with humans. These animals are frequently accountable for killing of natural fauna. It is also regarded moderately likely that the natural faunal component might be attracted to the artificial habitat that is created by the development. The establishment of human abodes generally result in the presence of foraging rodents, which is likely to attract smaller predators, raptors, owls, and snakes. The

lack of understanding from personnel frequently results in the unnecessary killing of these animals.

Potential Mitigation: Frequent policing of fences and areas bordering the mining area must be implemented with severe penalties to offenders that kill animals. Sensitizing personnel to the presence and handling of animals must form part of the induction. The construction of fences around all areas related to the project where personnel have daily access (construction, operation and decommission) is of the utmost importance. Regular inspection of these fences to ensure the fences' integrity and patrol of the borders and surrounding areas next to the site for the presence of snares etc. will limit the impact of poaching and snaring. Communication with farmers whose properties border the operational areas to create awareness of potential poaching problems in the area is important.

9.8 FAUNAL IMPACT RATING TABLES

9.8.1 Construction Phase

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Construction Phase: Footprint Clearance												
Impacts on RD fauna species	8	5	2	3	45	M	8	5	2	2	30	L
Degradation of natural faunal habitat	4	5	2	5	55	M	4	5	2	4	44	M
Disruption of ecological connectivity	4	4	2	5	50	M	4	4	2	5	40	M
Direct impacts & interactions with structures & personnel	4	4	2	5	50	M	4	4	2	3	30	L
Construction Phase: Establishment of Infrastructure												
Impacts on RD fauna species	8	4	2	4	56	M	8	4	2	4	56	M
Loss/ Degradation of faunal habitat & in surrounding areas	4	5	2	3	33	M	4	5	2	3	33	M
Disruption of ecological connectivity & migration routes	4	4	2	3	30	L	4	4	2	3	30	L
Direct impacts & interactions with structures & personnel	4	4	2	5	50	M	4	4	2	5	50	M
Construction Phase: Establishment of Linear Infrastructure (Roads, Pipelines, Powerlines, etc.)												
Impacts on RD fauna species	8	4	2	3	42	M	8	4	2	3	42	M
Loss/ Degradation of faunal habitat & in surrounding areas	4	5	2	2	22	L	4	5	2	2	22	L
Disruption of ecological connectivity & migration routes	4	4	3	3	33	M	4	4	3	3	33	M
Direct impacts & interactions with structures & personnel	4	4	3	5	55	M	4	4	3	5	55	M
Construction Phase: Generation and Handling of Waste												
Loss/ Degradation of faunal habitat & in surrounding areas	4	4	2	4	40	M	4	4	2	4	40	M

9.8.2 Operational Phase

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Operational Phase: Maintenance and Generation Activities												
Impacts on RD fauna species	8	5	4	2	34	M	8	5	2	2	30	L
Loss/ Degradation of faunal habitat & in surrounding areas	4	4	2	3	30	L	4	4	2	2	20	L
Disruption of ecological connectivity & migration routes	4	4	2	4	40	M	4	4	2	2	20	L
Direct impacts & interactions with structures & personnel	4	4	2	4	40	M	4	4	2	2	20	L
Operational Phase: Transportation												
Loss/ Degradation of faunal habitat & in surrounding areas	4	4	2	3	30	L	4	4	2	3	30	L
Disruption of ecological connectivity & migration routes	4	4	2	3	30	L	4	4	2	3	30	L
Direct impacts & interactions with structures & personnel	4	4	4	4	48	M	4	4	2	4	40	M
Operational Phase: Generation and handling of waste												
Loss/ Degradation of faunal habitat & in surrounding areas	2	4	2	3	24	L	2	4	2	2	16	L
Disruption of ecological connectivity & migration routes	2	4	2	2	16	L	2	4	2	2	16	L

9.8.3 Closure & Decommissioning

POTENTIAL ENVIRONMENTAL IMPACT	Environmental Significance Before Mitigation						Environmental Significance After Mitigation					
	M	D	S	P	TOTAL	SP	M	D	S	P	TOTAL	SP
Closure & Decommissioning: Removal of Infrastructure												
Loss/ Degradation of faunal habitat & in surrounding areas	4	4	2	3	30	L	2	4	2	2	16	L
Disruption of ecological connectivity & migration routes	4	4	3	3	33	M	2	4	2	2	16	L
Direct impacts & interactions with structures & personnel	4	4	2	3	30	L	2	4	2	2	16	L
Closure & Decommissioning: Rehabilitation												
Loss/ Degradation of faunal habitat & in surrounding areas	2	4	2	2	16	L	2	4	2	2	16	L
Disruption of ecological connectivity & migration routes	2	4	2	2	16	L	2	4	2	2	16	L
Direct impacts & interactions with structures & personnel	4	4	2	3	30	L	2	4	2	2	16	L
Closure & Decommissioning: Residual Impacts Post Closure												
Loss/ Degradation of faunal habitat & in surrounding areas	4	5	2	2	22	L	2	5	2	2	18	L

Direct impacts & interactions with structures & personnel	4	5	2	3	33	M	2	5	2	2	18	L

9.9 RECOMMENDED MITIGATION MEASURES

9.9.1 Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude as much of the highly sensitive habitat from the development as possible. Cognisance of the wetland ecologist/ specialist is regarded imperative in this regard. This should be done during the planning phase;

Mitigation Measure 2 - Implement a suitable buffer zone (at least 30m) between the edge of sensitive habitat and any type of development or surface disturbance;

Mitigation Measure 3 - Implement a suitable buffer zone around wetland habitat, taking cognisance of recommendations from the wetland report;

Mitigation Measure 4 - Prevent contamination of surrounding areas of natural habitat, from stockpiling, conveyor lines, water treatment facilities or any other source of pollution;

9.9.2 Roads & Access

Mitigation Measure 5 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

Mitigation Measure 6 - A road management plan should be compiled prior to the commencement of construction activities;

Mitigation Measure 7 - No roads should be allowed within ecologically sensitive areas. The use of roads around ecologically sensitive areas for the purpose of buffers should be done with circumspect particularly in view of accidental killing of animals;

9.9.3 Animals

Mitigation Measure 8 - No animal may be hunted, trapped, snared or captured for any purpose whatsoever. Fences and boundaries should be patrolled weekly in order to locate and remove snares/ traps;

Mitigation Measure 9 - Vehicular traffic should not be allowed after dark in order to limit accidental killing of nocturnal animals;

Mitigation Measure 10 - Speed of vehicles should be limited to allow for sufficient safety margins;

Mitigation Measure 11 - Dangerous animals should be handled by a competent person;

Mitigation Measure 12 - Compile a graphic list of potentially dangerous animals and present this to all workers as part of site induction;

Mitigation Measure 13 - Sensitize all personnel to the presence, characteristics and behaviour of animals on the site;

Mitigation Measure 14 - Include suitable procedures in the event of encountering potentially dangerous animals on the site;

Mitigation Measure 15 - Ensure that a snake handler and/ or anti venom serum is available at all times, together with a competent person to administer this serum;

Mitigation Measure 16 - No domestic pets should be allowed on the site.

10 ALTERNATIVES ASSESSMENT

10.1 'NO-GO' OPTION

This option is not required since it has been established that the proposed development is not likely to result in unacceptable and severe impacts on critically important floristic attributes that are limited to only the study area, or impacts of an unacceptable nature that extends beyond the boundaries of the site. Expected impacts can be ameliorated to an acceptable level with the application of feasible and cost-effective mitigation measures.

10.2 SITE LAYOUT ALTERNATIVES

This section will be completed subsequent to a specialist integration meeting where different layouts are discussed.

11 APPENDIX 1: FLORISTIC DIVERSITY OF THE SITE

Species Name	Growth Form	Family	Status/ Uses
Acacia erioloba	Tree	Fabaceae	Protected Tree (National Forest Act, 1998), edible parts, medicinal
Acacia karroo	Tree	Fabaceae	Edible parts, dyes and tans, medicinal uses, firewood
Agave sisalana	Succulent	Agavaceae	Declared Invader - Category 2
Alternanthera pungens	Forb	Amaranthaceae	Weed, pioneer species
Aptosimum albomarginatum	Forb	Scrophulariaceae	None
Aptosimum species	Forb	Scrophulariaceae	None
Arctotis arctotoides	Forb	Asteraceae	None
Argemone ochroleuca	Forb	Papaveraceae	Declared Invader - Category 1
Aristida congesta subsp. *barbicollis*	Grass	Poaceae	None
Aristida meridionalis	Grass	Poaceae	None
Aristida species	Grass	Poaceae	None
Asparagus species	Shrub	Liliaceae	None
Berkheya species	Forb	Asteraceae	Weed
Bidens pilosa	Forb	Asteraceae	Weed, edible parts
Bromus catharticus	Grass	Poaceae	Weed, average grazing potential
Bulbostylis hispidula	Sedge	Cyperaceae	None
Calobota cuspidosa	Shrub	Fabaceae	None
Casuarina species	Tree	Casuarinaceae	None
Centropodia glauca	Grass	Poaceae	Palatable grazing species, Decreaser
Chrysocoma species	Shrub	Asteraceae	None
Ciclospermum leptophyllum	Forb	Apiaceae	Exotic weed (S America)
Cirsium vulgare	Forb	Asteraceae	Declared Invader - Category 1, weed
Cotula coronopifolia	Forb	Asteraceae	
Cucumis africanus	Forb	Cucurbitaceae	Edible parts
Cymbopogon plurinodis	Grass	Poaceae	Unpalatable grazing
Cymbopogon pospischilii	Grass	Poaceae	None
Cynodon dactylon	Grass	Poaceae	Indicator of disturbed areas, grazing potential
Cyperus muricinux	Sedge	Cyperaceae	
Cyperus species	Sedge	Cyperaceae	None
Dianthus micropetalus	Forb	Caryophyllaceae	
Dicoma capensis	Forb	Asteraceae	Medicinal uses

Species Name	Growth Form	Family	Status/ Uses
Digitaria eriantha	Grass	Poaceae	Weaving, palatable
Diospyros austro-africana	Shrub	Ebenaceae	None
Diospyros lycioides	Shrub	Ebenaceae	Medicinal uses, edible parts, dyes
Ehretia rigida	Shrub	Ehretiaceae	None
Elionurus muticus	Grass	Poaceae	None, unpalatable
Enneapogon desvauxii	Grass	Poaceae	None
Eragrostis curvula	Grass	Poaceae	Edible parts, indicator of degraded areas
Eragrostis echinochloidea	Grass	Poaceae	None
Eragrostis lehmanniana	Grass	Poaceae	Weaving
Eragrostis obtusa	Grass	Poaceae	Indicator of poor habitat conditions
Eragrostis species	Grass	Poaceae	None
Felicia species	Forb	Asteraceae	None
Fimbristylis species	Sedge	Cyperaceae	None
Fingerhuthia africana	Grass	Poaceae	Moderate grazing potential
Gazania krebsiana	Forb	Asteraceae	None
Geigeria ornativa	Forb	Asteraceae	Potentially poisonous, indicator of poor habitat conditions
Gomphocarpus fruticosus	Shrub	Asclepiadaceae	Medicinal uses
Grewia flava	Shrub	Tiliaceae	Edible parts, weaving
Gymnosporia buxifolia	Shrub	Celastraceae	None
Helichrysum argyrosphaerum	Forb	Asteraceae	None
Helichrysum species	Forb	Asteraceae	None
Heliotropium ciliatum	Forb	Boraginaceae	None
Hermannia althaeifolia	Forb	Sterculiaceae	None
Hermannia cernua subsp. *jacobeifolia*	Forb	Sterculiaceae	
Hermannia species	Forb	Sterculiaceae	None
Heteropogon contortus	Grass	Poaceae	Moderate grazing potential, irritant
Hibiscus pusillus	Forb	Malvaceae	
Hibiscus species	Forb	Malvaceae	None
Hibiscus trionum	Forb	Malvaceae	None
Homeria pallida	Geophyte	Iridaceae	Potentially poisonous to livestock
Indigofera daleoides	Forb	Fabaceae	
Indigofera species	Forb	Fabaceae	None
Jamesbrittanea aurantiaca	Forb	Scrophulariaceae	None

Species Name	Growth Form	Family	Status/ Uses
Juncus rigidus	Sedge	Cyperaceae	
Juniperus virginiana	Tree	Cupressaceae	
Kohautia species	Forb	Rubiaceae	
Lactuca capensis	Forb	Asteraceae	None
Lobelia erinus	Forb	Lobeliaceae	None
Lobelia species	Forb	Lobeliaceae	None
Lotononis laxa	Forb	Fabaceae	
Lotononis species	Forb	Fabaceae	None
Malva species	Forb	Malvaceae	None
Melia azedarach	Tree	Meliaceae	Declared Invader - Category 3
Melinis nerviglumis	Grass	Poaceae	Increaser I
Melolobium candicans	Forb	Fabaceae	None
Morus species	Tree	Moraceae	Edible parts, Declared invader - Category 3
Nidorella anomala	Forb	Asteraceae	None
Olea europaea subsp. *africana*	Tree	Oleaceae	Protected Tree (National Forest Act, 1998)
cf. *Ornithogalum seineri*	Geophyte	Hyacinthaceae	
Ornithogalum species	Geophyte	Hyacinthaceae	
Osteospermum species	Forb	Asteraceae	
Pentzia calcarea	Shrub	Asteraceae	None
Portulaca quadrifida	Forb	Portulacaceae	
Pseudognaphalium luteo-album	Forb	Asteraceae	Weed (Europe)
Pycreus species	Sedge	Cyperaceae	
Ranunculus multifidus	Forb	Ranunculaceae	None
Rosenia oppositifolia	Shrub	Asteraceae	
Ruschia species	Shrub	Aizoaceae	None
Salix babylonica	Tree	Salicaceae	Declared Invader - Category 2
Salsola species	Shrub	Chenopodiaceae	None
Salvia disermas	Forb	Lamiaceae	None
Scirpus dioecus	Sedge	Cyperaceae	None
Searsia lancea	Tree	Anacardiaceae	Edible parts, tanning
Searsia pyroides	Shrub	Anacardiaceae	None
Searsia tridactyla	Shrub	Anacardiaceae	None
Sebaea leiostyla	Forb	Sentianaceae	None

Species Name	Growth Form	Family	Status/ Uses
Sebaea species	Forb	Sentianaceae	None
Selago species	Forb	Scrophulariaceae	
Senecio inaequidens	Forb	Asteraceae	None
Setaria verticillata	Grass	Poaceae	Edible parts
Solanum incanum	Forb	Solanaceae	
Sporobolus species	Grass	Poaceae	
Stipagrostis ciliata	Grass	Poaceae	None
Taraxacum officinale	Forb	Asteraceae	Weed
Tarchonanthus camphoratus	Shrub	Asteraceae	Medicinal uses
Themeda triandra	Grass	Poaceae	Palatable grazing
Tribulus terrestris	Forb	Zygophyllaceae	None
Tribulus zeyheri	Forb	Zygophyllaceae	None
Trifolium species	Forb	Fabaceae	
Vahlia capensis	Forb	Vahliaceae	None
Verbena bonariensis	Forb	Verbenaceae	Weed (S. America)
Wahlenbergia undulata	Forb	Campanulaceae	None
Walafrida densiflora	Forb	Selaginaceae	None
Walafrida species	Forb	Selaginaceae	
Ziziphus mucronata	Tree	Rhamnaceae	Edible parts, medicinal uses

12 PHOTOGRAPHIC RECORDS

Photo 1: Burrowing Scorpion (*Opistophthalmus carinatus*)

Photo 2: Bibron's Burrowing Asp (*Atractaspis bibronii*)

Photo 3: Example of the *Searsia lancea* Open Woodland

Photo 4: Example of the *Tarchonanthus camphoratus* Closed Shrubland

Photo 5: Example of an endorheic pan, not absence of shrubs/ trees

Photo 6: Note termite mounds on edge of endorheic pans

Photo 7: Leopard Tortoise (*Stigmochelys pardalis*)

Photo 8: Example of perennial spring

Photo 9: Example of endorheic pan, note calcareous plains

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Appendix G–Geotechnical Environmental Impact Assessment

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PRELIMINARY GEOTECHNICAL REPORT

TO	: WorleyParsons	**FROM**	:	Nino Welland
ATT	: Francois Humphries	**DATE**	:	20 February 2012
E Mail	:	**REFERENCE**	:	11-863.02
		NO. OF PAGES	:	1 of 3
COPY	:			
ATT	:			
E Mail	:			

PROPOSED CSP & PV SOLAR POWER PROJECT AT ARRIESFONTEIN, NORTHERN CAPE PROVINCE: GEOTECHNICAL INVESTIGATION: PRELIMINARY GEOTECHNICAL REPORT AND RECOMMENDATIONS

1. INTRODUCTION

Moore Spence Jones (Pty) Ltd (MSJ) was instructed by Mr Francois Humphries of Worley Parsons to complete the above-mentioned investigation in a letter of appointment dated 10 January 2012. The scope of works and costs are based on the MSJ revised quotation dated 7 November 2011 and referenced 11-863.01. The scope of works complies with the request set out in an e-mail from Mr Humphries, dated 03 November 2011.

The fieldwork was completed on 25th January 2012 and comprised the excavation of 38 test pits with soil profiling and limited sampling. The intention of this report is to provide preliminary foundation and earthworks recommendations based on the visual and tactile assessment of site conditions, since the laboratory test results are still outstanding.

2. INVESTIGATION METHOD AND RESULTS

2.1 Desk Study and Reconnaissance Survey

The published geological map of the area (2822 Postmasburg, scale 1:250 000, dated 1977) shows the site to be underlain by dolomitic limestone with subordinate coarsely crystalline dolomite with chert and lenses of limestone that form part of the Campbell Group of the Griqualand-West Sequence. Theses rocks are generally calciferous and have developed a pedogenic nodular or hardpan cover.

The soil cover is represented by quaternary Aeolian sand and rubble.

The available study area is approximately 1850 ha in a rectangular-shaped area located approximately 30 km north east of Lime Acres, in the Northern Cape Province. The northern, western and southern boundaries are represented by farms and the eastern boundary is represented by the Constantia Safari Game Reserve.

Numerous fences traverse the site and an active electric railway line runs through the centre of the site trending southwest-northeast. A powerline also passes through the site parallel to the railway.

Topographically the site is generally flat and gradients are not expected to be more than 2 %.

The Weinerts N- value for the site is approximately 20 and thus the site area occurs in an arid warm, dry region (TRH 4, 2.1). Residual soils are expected to be thin and gravelly and mechanical disintegration is the only mode of weathering. Pedogenic soils are expected to be calcareous (calcrete).

The mean annual surface temperature is between 17.5 and 20.0 degrees C and the potential for evaporation is between 2200 and 2400 mm (modified after DWAF, 1986). Mean annual precipitation is 300 to 400 mm. The type of weathering of the underlying bedrock is expected to be very slight (Fookes et al, 1971).

The erodibility of the subsoils in the area is expected to be low with a corresponding Erodibility Index of between 16 and 20 (Verster and WRC, 1992).

Seismologically, the site is characterised by seismic intensity of V (MMS) with a 10% probability of being exceeded at least once in a 50 year period (Geological Survey, 1992). This translates to a predicted maximum horizontal ground acceleration of less than 50 cm/s2 or 0.025g (CGS, 2003). Under these conditions, the probability of liquefaction is considered unlikely (Welland, 2002).

The total lightning risk (estimated for 2006-2007), based on flashes per km^2 and positive polarity lightning measurements, has been determined as severe (Gill, 2008).

2.2 Inspection Pits and Exposures

The main portion of the investigation comprised the excavation of 38 inspection pits using a Terex 860SX TLB machine. The in situ soil profile was recorded and limited representative samples were collected for laboratory testing to determine the engineering properties.

The depth of the 38 inspection pits ranged from between 0.10 m and 3.0 m below existing ground level. The average refusal depth of the inspection pits is 0.8 m on hardpan calcrete or weathered dolomite bedrock. Shallow refusal of the TLB (<1.5 m bgl) was encountered in 33 of the inspection pits (87%) at between 0.1 m and 1.3 m (average 0.6 m), of which 8 (21%) refused within 0.2 m, below existing ground level.

No ground water was encountered in any of the inspection pits and throughout the site. However, during periods of prolonged rainfall, particularly during the summer season, increased groundwater seepage flow can be anticipated, particularly at the soil / rock interface. Perched groundwater flows at the soil / rock interface. The following general soil profile was recorded as follows across the site:

Table 1: Summary of Soil Profiles where bedrock/refusal is <1.5m bgl (Zone A)

Depth (m-m)	Origin	EABC* (kPa)	Description
0-0.9	Transported	<50	Dry to slightly moist, orange brown, **loose**, intact, slightly fine gravelly silty SAND.
0-0.5	Aeolian with Pedogenic fragments	<50	Dry white, **indurated** fragments of **hard** rock CALCRETE in a matrix of dry to slightly moist, orange brown to greyish medium brown and medium brown, **loose**, intact, silty SAND to gravelly silty SAND of aeolian origin.
0-1.0	Transported	<50	Slightly moist, orange brown**, loose**, intact gravelly silty SAND to **medium dense**, friable, silty sandy GRAVEL.
0.2-1.3	Non-Indurated Calcrete	50-100	Dry, white, **medium dense**, moderately cemented, non-indurated CALCRETE
0.1-0.5	Hardpan Calcrete	500+	White to off white, indurated, well cemented, fractured, tabular, **medium hard to hard** rock HARDPAN CALCRETE with occasional remnants of

Depth (m-m)	Origin	EABC* (kPa)	Description
			DOLOMITIC host rock.
0.9-1.1	Residual Dolomite	100-200	Slightly moist, yellowish brown to off white, **medium dense**, calciferous, silty sandy GRAVEL.
0.1-0.4	Calciferous Dolomite	500+	Light grey, slightly weathered, thinly to medium bedded, close to medium jointed, **hard rock** calciferous DOLOMITE.

*EABC = estimated allowable bearing capacity

Table 2: Summary of Soil Profiles where bedrock/refusal is >1.5m bgl (Zone B)

Depth (m-m)	Origin	EABC* (kPa)	Description
0-0.5	Aeolian	<50	Slightly moist, orange brown, **loose**, intact, silty SAND.
0-1.1	Transported	<50	Slightly moist, orange brown, **medium dense**, intact, silty sandy GRAVEL with cobble to boulder sized rock fragments.
0.8-3.0	Non-Indurated Calcrete	50-100	Dry, white, **medium dense**, moderately cemented, non-indurated CALCRETE
0.5-3.0	Residual Dolomite	100-200	Slightly moist pinkish brown, **dense**, reworked, calciferous gravelly silty SAND and dry to slightly moist, yellowish brown to light grey, **dense to very dense**, intact and friable, calciferous, silty sandy GRAVEL with fine to cobble sized tightly packed rock fragments.

Table 3: Summary of Geotechnical Zoning

Zone	Location	Comments
A	Majority of the site	• Generally flat • Generally good founding conditions • Generally shallow hardpan calcrete with limited dolomite bedrock cropping out at surface on eastern boundary • Generally hard excavation from surface • Pile driven foundations restricted due to hard pedogenic material at surface
B	South-western corner and north central	• Generally flat • Soft to intermediate excavation to 3.0m • Anticipate hard rock+ below 3.0m • Encountered over +- 6 % of the site.

The following Table 4 shows the summary of the geotechnical constraints on the site:

Table 4: Summary of Geotechnical Parameters and Constraints

Geotechnical Condition	Parameter	Constraint and recommendations
Potential expansiveness/activity	Generally sandy and gravelly profiles. Non-plastic materials	Expansive soils not expected
Collapsibility	Expect collapse in the upper aeolian layers, generally very loose silty sands.	Low to medium collapse at low to medium loads in the upper transported sands.
Erodibility	SM	Significant in transported layers
Compressibility	GM:SM with LL < 50%	Nil to low possibility of compressibility in all other layers.
Bearing capacity & subgrade	Competent weathered bedrock or hardpan calcrete at 0.80 m depth average.	Weathered bedrock and hardpan calcrete to provide 250 kPa or more.
Seepage	No seepage encountered in any of the inspection pits over the site during the investigation.	De-watering during construction will probably not be required. Subsoil drainage measures should only be required in deep cuts.
Construction materials	GP:GM, SP:SM (generally A.1.b to A.3)	Most materials arising will most likely be suitable for construction purposes.
Excavatability	Anticipate soft excavation up to TLB refusal depths. Anticipate Intermediate to hard below these depths	Soft (SANS 1200) to 0.80 m average in transported, pedogenic and residual material. 87% of IP refused at <1.5m below surface. Expect intermediate to hard excavation below this level.

3. CONCLUSIONS

- The site comprises approximately 1850 ha of open veld with concentrated areas of dense vegetation and small existing structures. A number of fence lines and gravel roads traverse the site and an existing railway and power line runs through the site.
- Topographically the site is generally flat. Restricted and minor bulk excavations to create construction platforms will not be extensive.
- The majority of bulk and restricted excavations should be provisionally classed as 'soft' excavation according to SABS 1200D to an average depth of 0.80 m (but can be shallower than 0.5 m below surface in localised areas). Thereafter, heavy ripping due to estimated intermediate to hard excavation classification.
- Suitable foundation horizons occur at an average nominal depth of 0.8 m but can be shallower than 0.5 m below surface and generally the transported layers are **not** suitable for founding, even for lightly-loaded structures.
- Groundwater seepage should not be a problem during bulk earthworks and restricted foundation excavations.
- The use of materials for construction purposes is generally favourable.

4. PRELIMINARY RECOMMENDATIONS

- Suitable allowable bearing capacity in excess of 250 kPa for conventional pad foundations for the structures exists at an average depth of 0.80 m below existing ground levels on calcrete and weathered dolomite bedrock.
- Hard excavation and possible blasting should be expected below an average depth of 0.80 m below existing ground level. However, conditions < 0.80m should be expected over the majority of the site.
- In view of the above shallow bedrock conditions, the popular European foundation method of rammed piles are not recommended at this site.
- Finally it is important to note that the information given in this preliminary report relates specifically to the positions of the inspection pits put down on site and also in conjunction with the proposed FFL and structural loads. It is possible that variations in the subsoil conditions may be encountered elsewhere on site during construction. These variations must be taken into consideration during on site supervision and construction. For this reason it is important that Moore Spence Jones be appointed to evaluate these variations and the effect on the development so that unnecessary expense and delays can be avoided.

Nino Welland, Pr Eng., Pr Sci Nat
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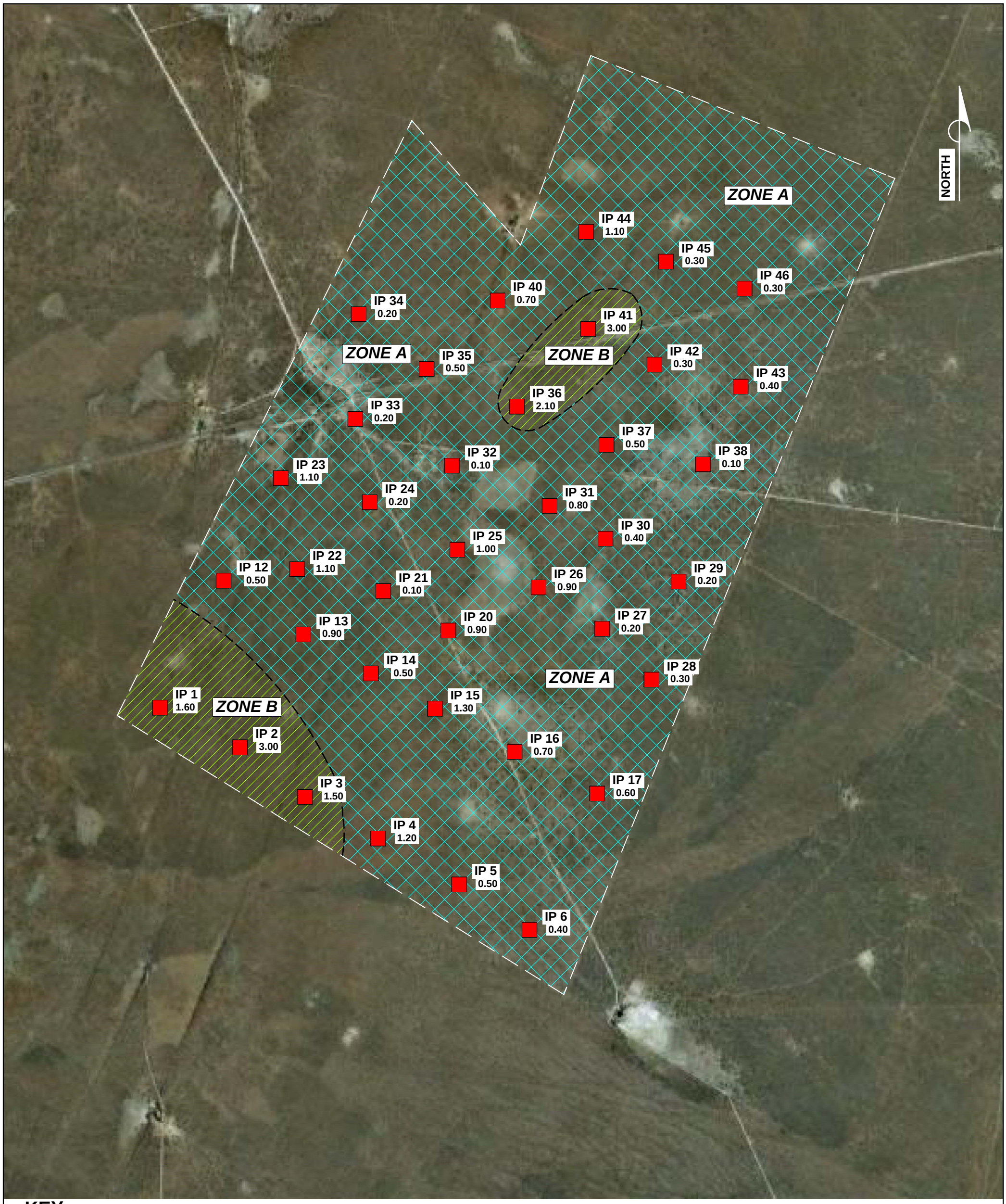
MOORE SPENCE JONES (PTY) LTD

APPENDIX A
Inspection Pit Profiles



KEY:

IP 1 1.60 — Approximate position of Inspection Pit showing final depth in metres below existing ground level.

ZONE A - Bedrock/Refusal is < 1,5 mbgl

ZONE B - Bedrock/Refusal is > 1,5 mbgl

0m 50m 100m

Graphic Scale
1 : 25000

Site Plan showing approximate positions of Inspection Pits.

Scale 1 : 25000 (On A3 Original)

WORLEY PARSONS

Geotechnical Investigation for Proposed CSP & PV Solar Power Project, Arriesfontein, Northern Cape

MOORE SPENCE JONES
CONSULTING GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS & SCIENTISTS

DATE	17/02/2012
DRAWN	W.H.
CHECK	A.M.W.
REFERENCE No.	11 - 863
FIGURE No.	1
REV.	

11-863 \ DRAWINGS \ 11-863 FIG1.DRG